




UNITED STATES  
NUCLEAR REGULATORY COMMISSION  
WASHINGTON, D. C. 20555

MAY 10 1978

MEMORANDUM FOR: George Lear, Chief, Operating Reactors Branch #3, DOR  
FROM: Vernon L. Rooney, Project Manager, Operating Reactors  
Branch #3, DOR  
SUBJECT: SUMMARY OF MEETING HELD ON MARCH 3, 1978 TO DISCUSS  
FURTHER GEOLOGICAL INVESTIGATIONS FOR HUMBOLDT BAY  
UNIT NO. 3

On March 3, 1978, representatives of PG&E met with the regulatory staff to inform the staff of a proposed program for further geological investigations near the Humboldt Bay Unit No. 3 site. Following PG&E's presentation, the staff indicated that the proposed program appeared to be quite comprehensive and carefully focused on the remaining issues. The staff emphasized its belief that the most critical aspect of the program involved developing the ability to demonstrate that the plant could operate safely in close proximity to the Bay Entrance fault.

A list of attendees is enclosed as Attachment A. The information presented by PG&E is outlined in Attachment B. PG&E agreed to keep the regulatory staff informed as work progressed.

  
Vernon L. Rooney, Project Manager  
Operating Reactors Branch #3  
Division of Operating Reactors

Enclosures:  
As stated

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ATTACHMENT A  
LIST OF ATTENDEES

<u>Name</u>	<u>Organization</u>
C. Nelson	NRC
J. Kelleher	NRC
C. Stepp	NRC
B. Smith	NRC
D. Caldwell	NRC
V. Rooney	NRC
J. Greeves	NRC
L. Reiter	NRC
W. Gammill	NRC
R. Hofmann	NRC
P. Shemanski	NRC
G. Lear	NRC
F. Brady	PG&E
J. Carroll	PG&E
D. Bettinger	PG&E
R. Locke	PG&E
M. Perkins	Woodward-Clyde Consultants
D. Tocher	Woodward-Clyde Consultants
L. Cluff	Woodward-Clyde Consultants
A. Patwardhan	Woodward-Clyde Consultants
P. Hanshaw	USGS
R. Morris	USGS
D. Hamilton	ESA

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ATTACHMENT B

PACIFIC GAS & ELECTRIC COMPANY

HUMBOLDT BAY REVIEW

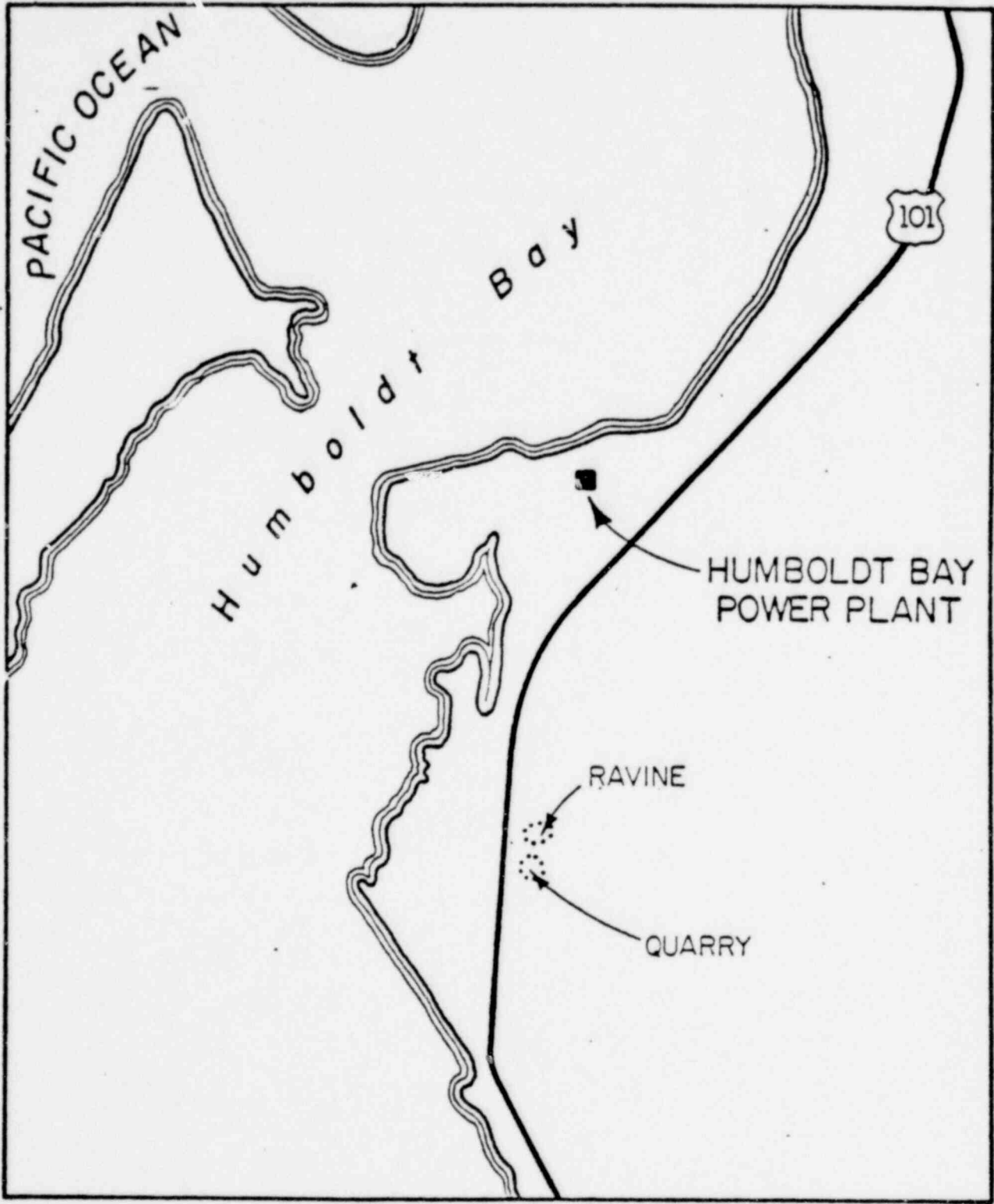
MEETING WITH NRC STAFF  
March 3, 1978

- |   |   |
|---|---|
| 1. Purpose of Meeting                                     | Frank Brady (PG&E)                        |
| 2. Purpose and Investigative Approach for Phase I Studies | Lloyd Cluff (WCC)                         |
| 3. On-Site Investigations                                 | Mike Perkins (WCC)<br>Doug Hamilton (ESA) |
| 4. Regional Investigations                                | Lloyd Cluff and<br>Don Tocher (WCC)       |
| - geological studies                                      |   |
| - seismological studies                                   |   |
| - earthquake engineering studies                          |   |
| 5. Summary  | Lloyd Cluff (WCC)<br>Frank Brady (PG&E)   |

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## SITE INVESTIGATIONS

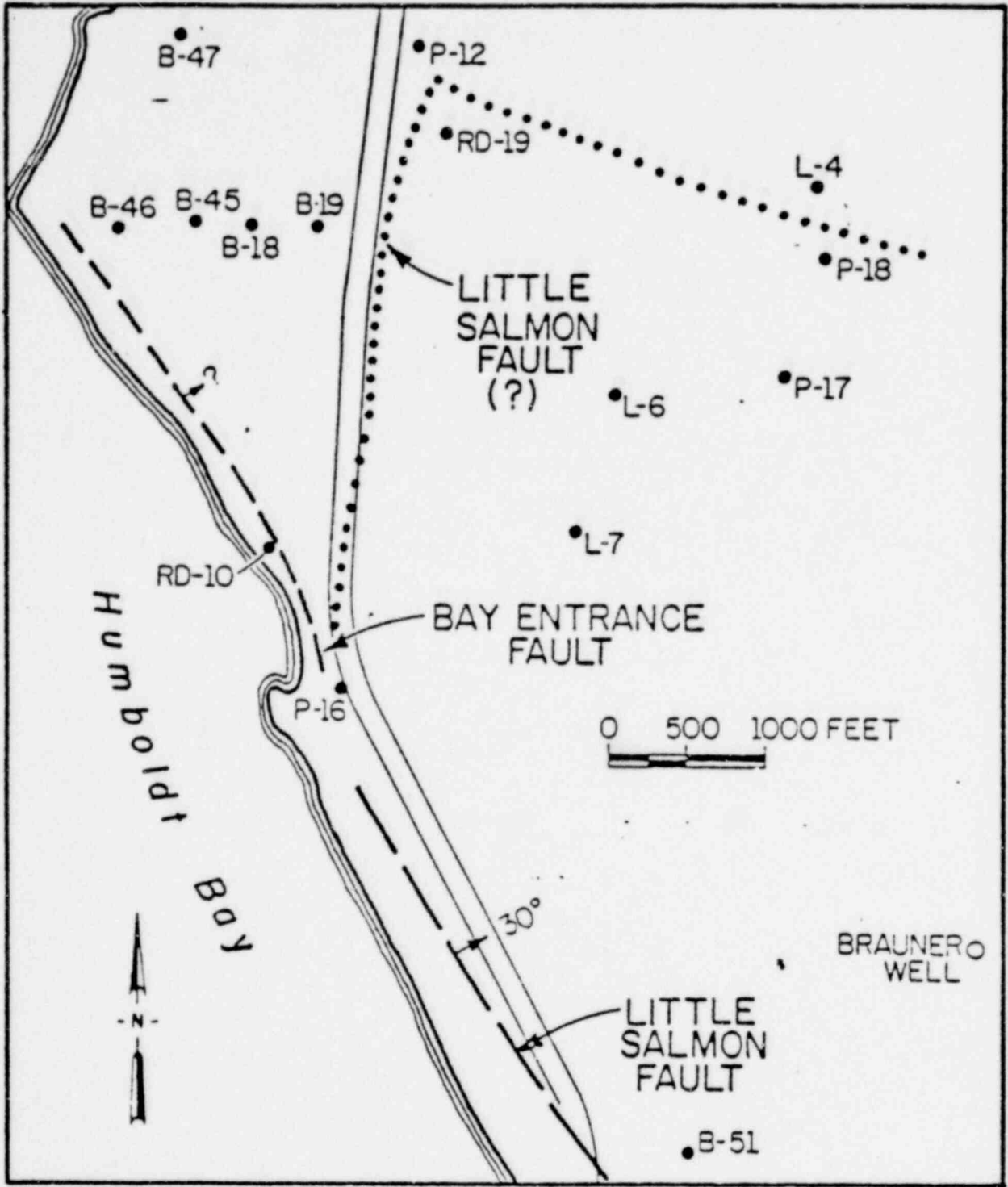
- TASK 1: AGE OF THE LITTLE SALMON FAULT NEAR HUMBOLDT HILL.
- TASK 2: ORIGIN OF OFFSETS IN FIELDS LANDING RAVINE AND SAND QUARRY.
- TASK 3: AGE OF THE CLAYSTONE MARKER AT THE SITE.
- TASK 4: CONTINUITY OF MARKER HORIZONS BENEATH THE SITE.
- TASK 5: BAY ENTRANCE FAULT INVESTIGATIONS.
- TASK 6: ORIGIN OF EAST-WEST TRENDING STEP AT THE BASE OF THE HOOKTON EAST OF FIELDS LANDING.



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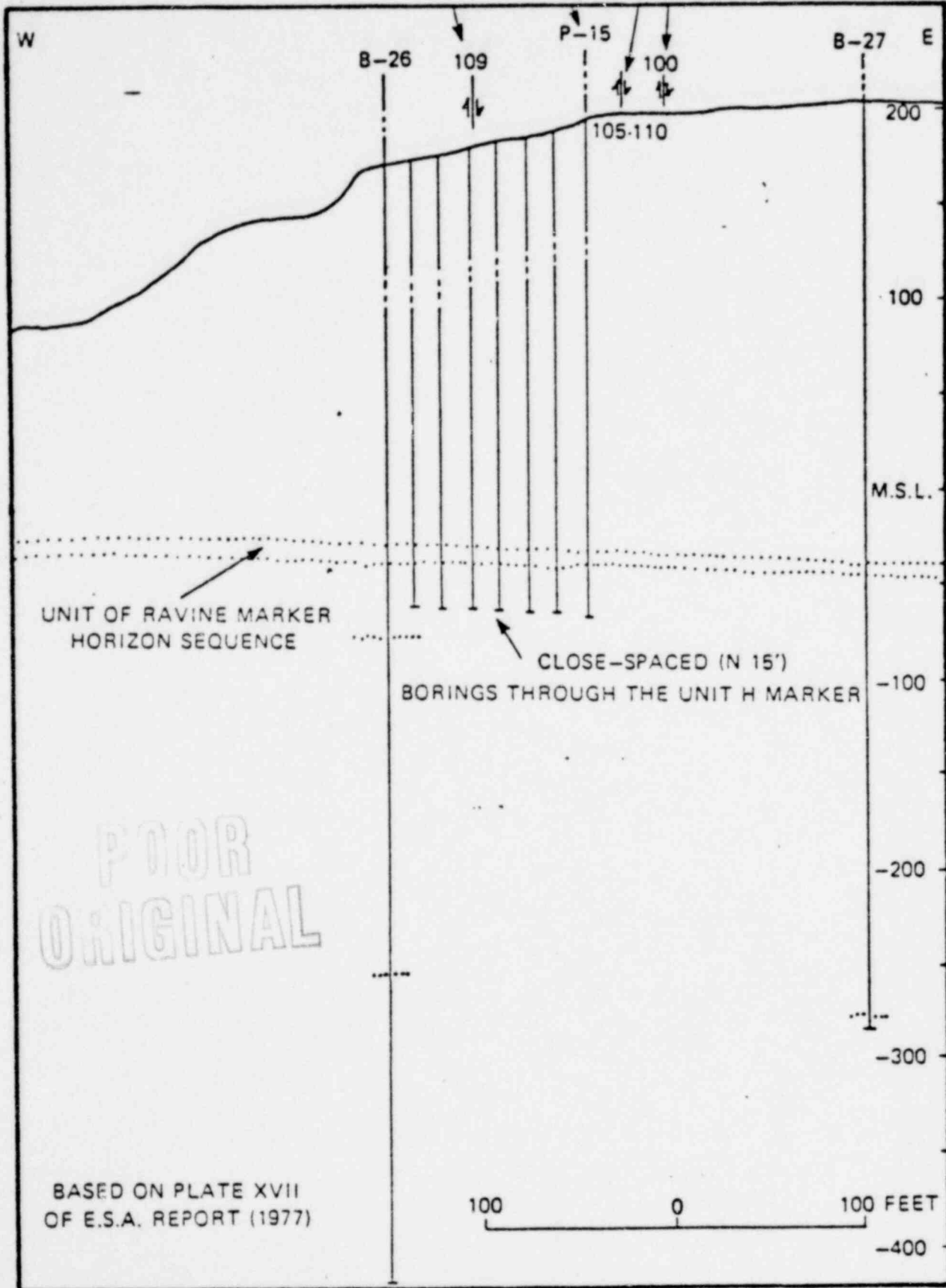
AREA OF ON-SITE INVESTIGATION



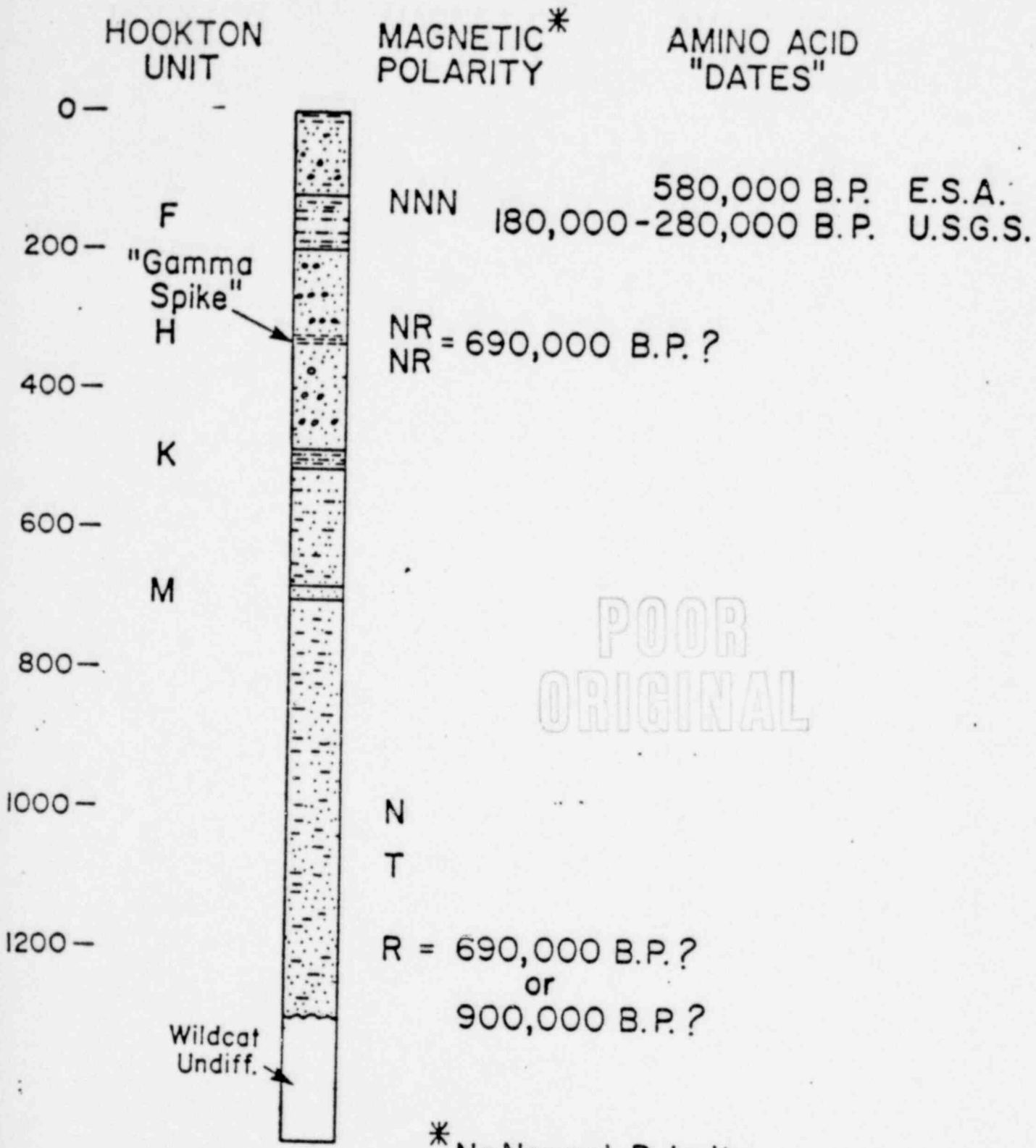
AREA OF TASK 1 INVESTIGATIONS

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PROJECTED TRENDS OF  
NUMBERED BREAKS IN RAVINE



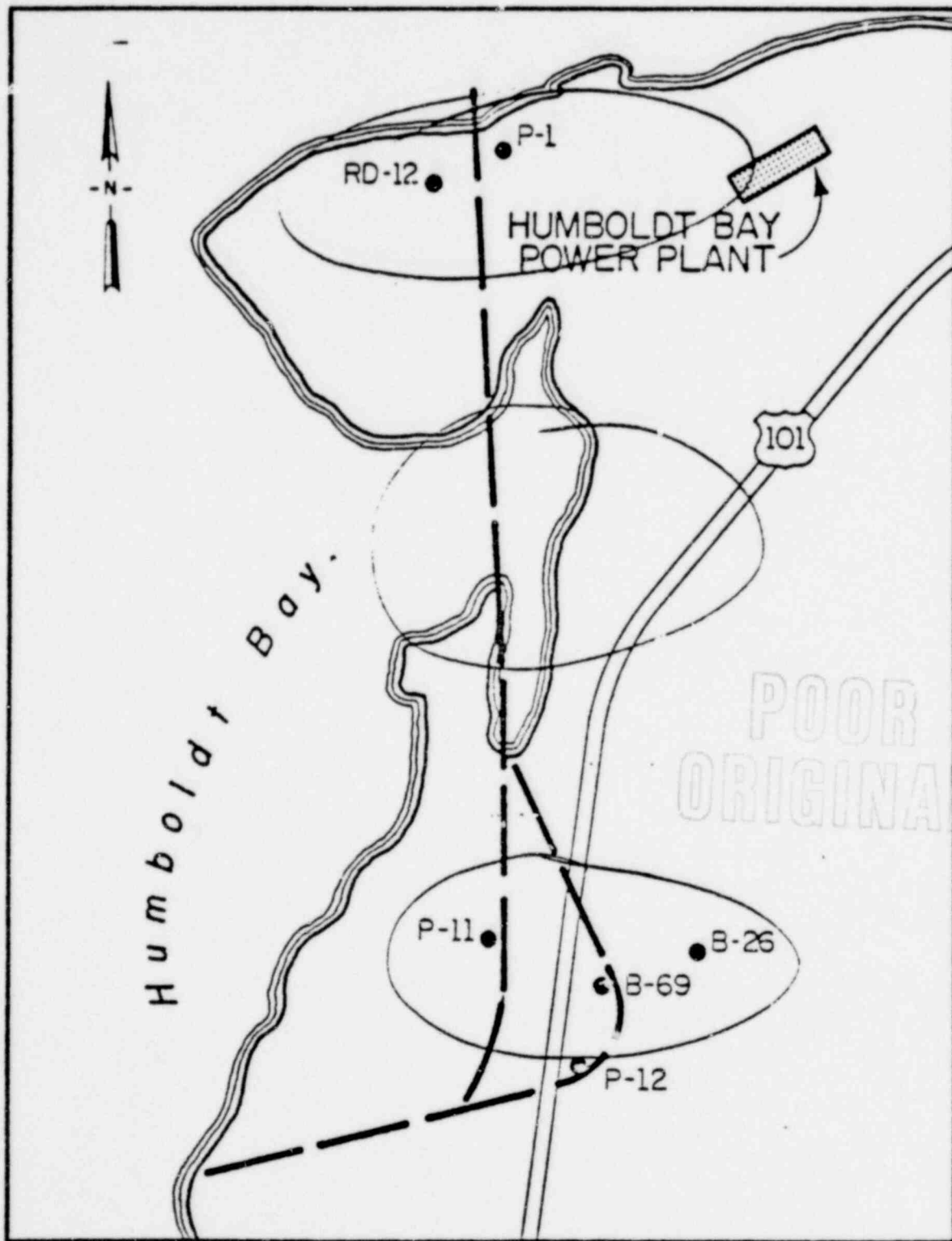
TASK 2 BORINGS-DIAGRAMMATIC



\* N=Normal Polarity  
 R=Reversed Polarity  
 T=Transitional Polarity

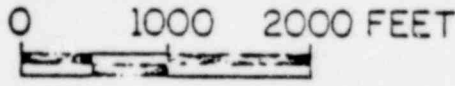
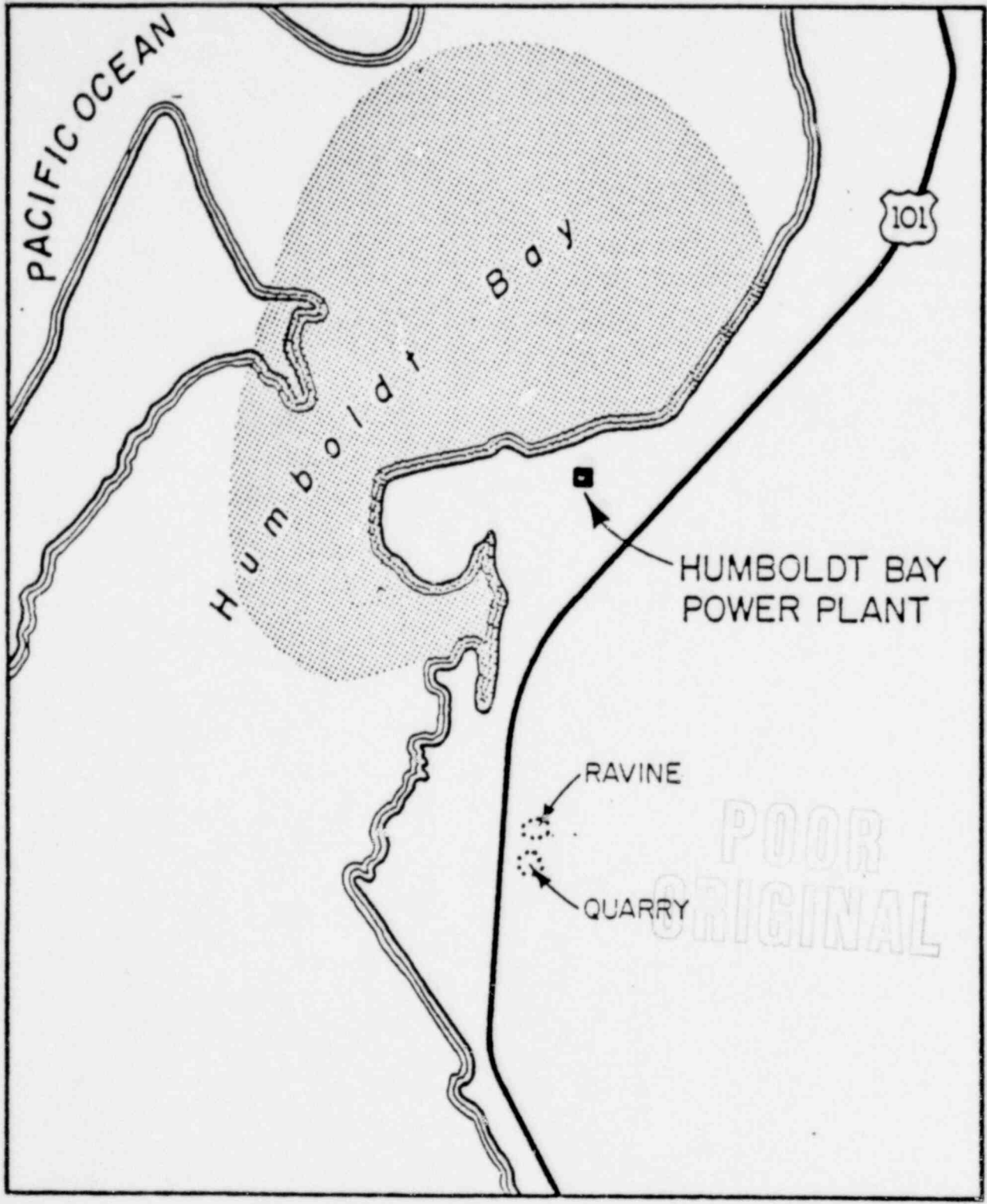
AVAILABLE DATA FOR AGE DATING  
 OF HOOKTON FORMATION





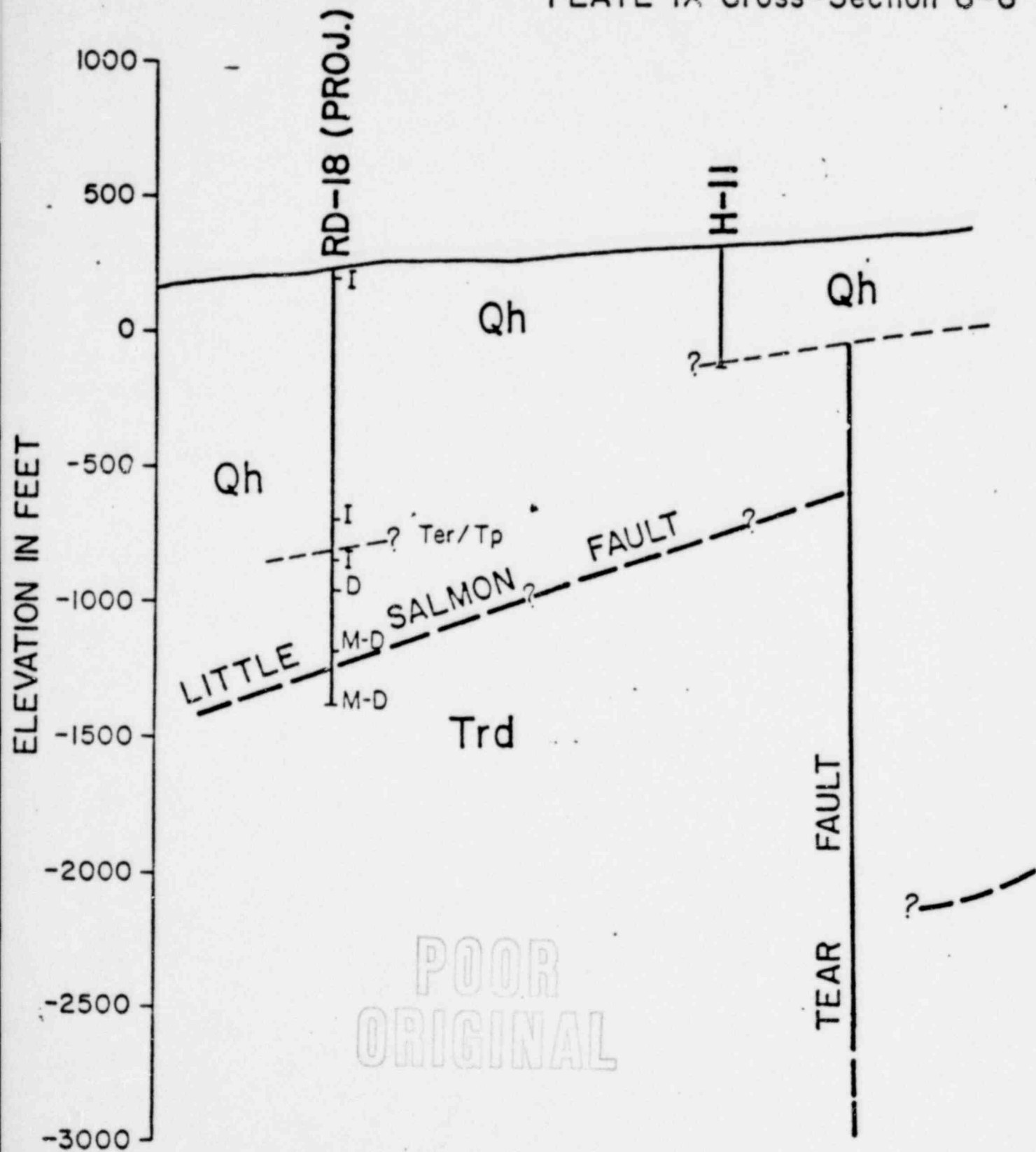
PROPOSED LOCATIONS/OF TASK 5 BORINGS

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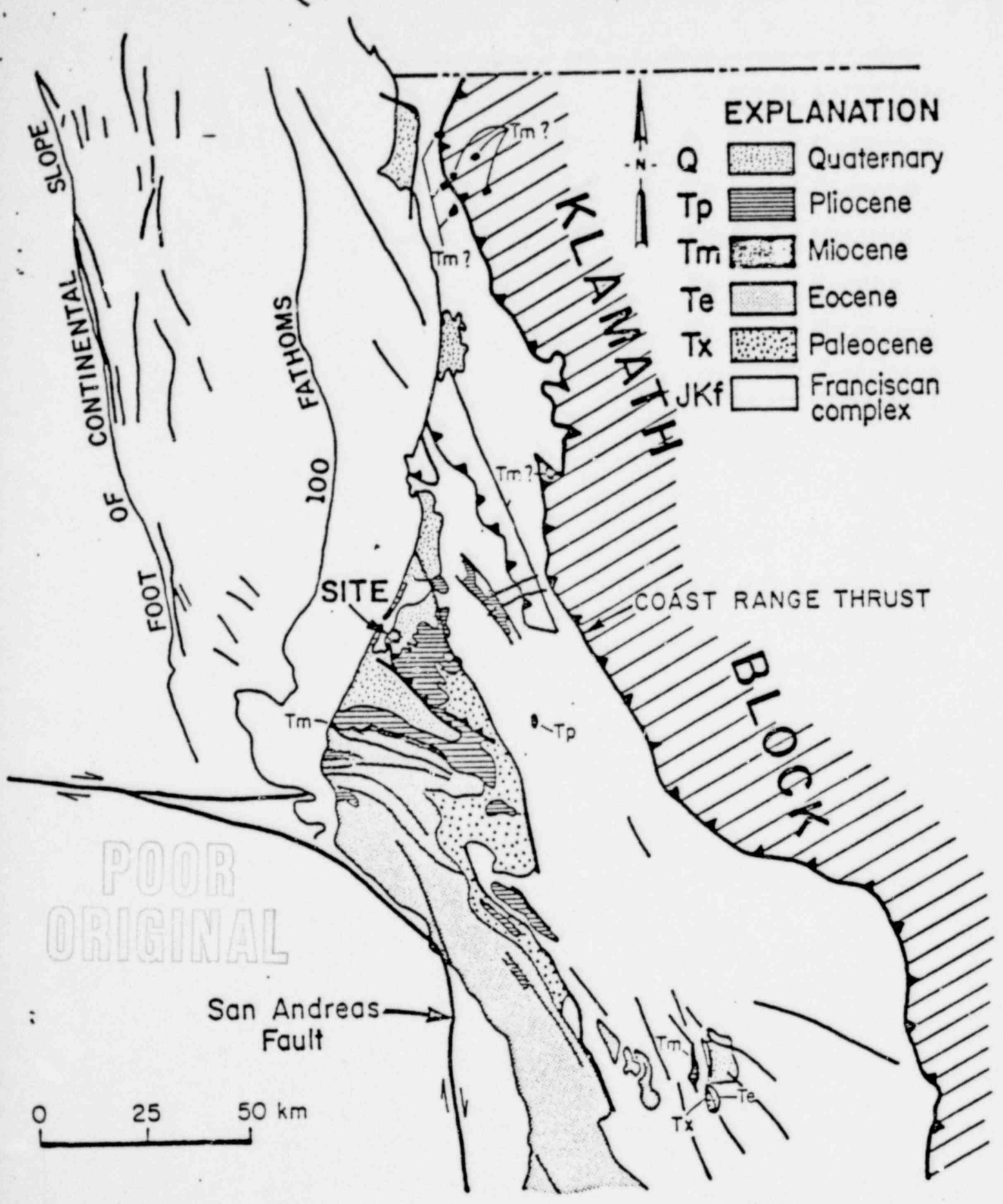
TASK 5:  
OFFSHORE SEISMIC REFLECTION LINES

BASED ON E.S.A. (1977)  
PLATE IX Cross-Section 6-6'

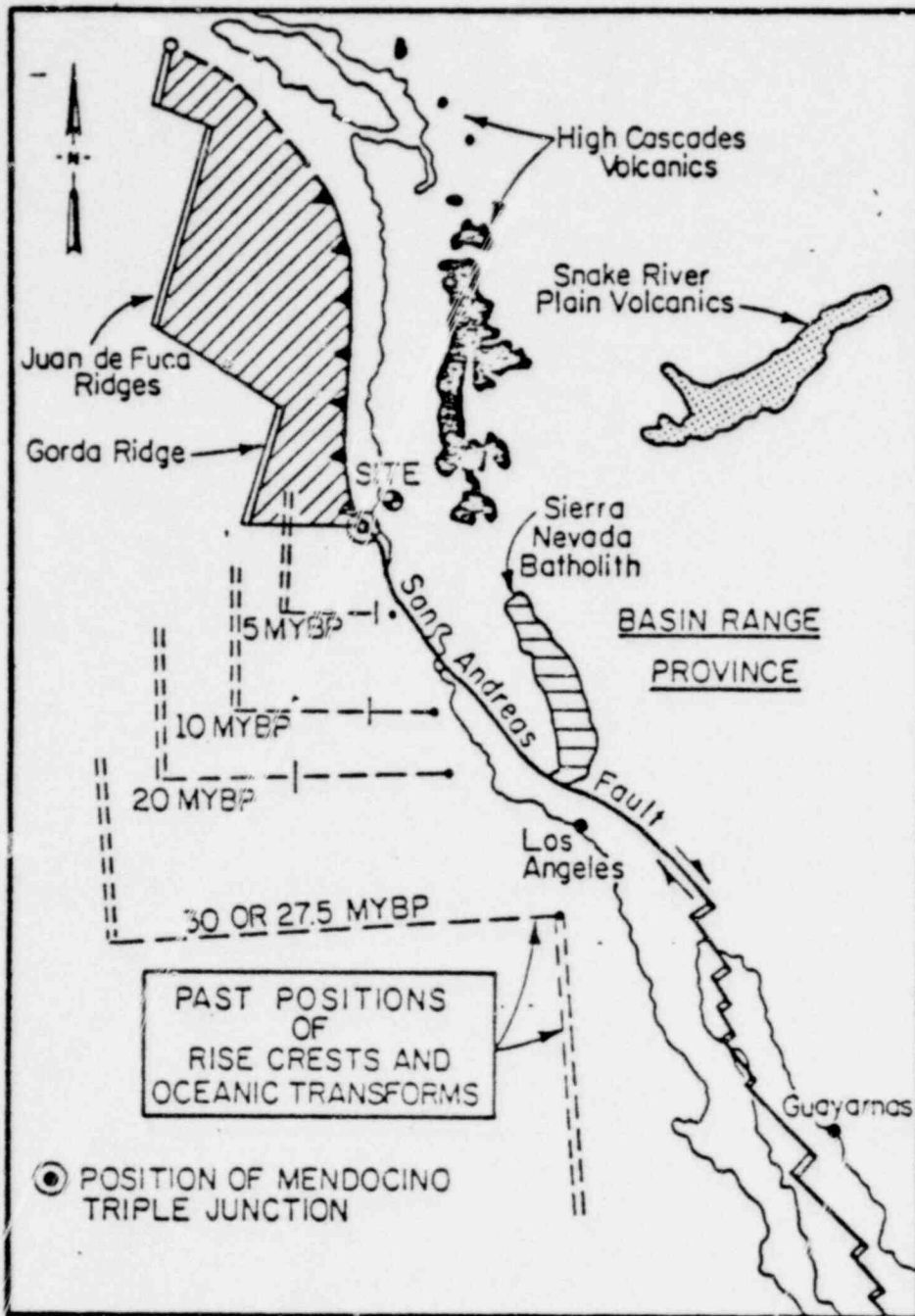


CROSS SECTION THROUGH E-W STEP IN BASE  
OF THE HOOKTON FORMATION

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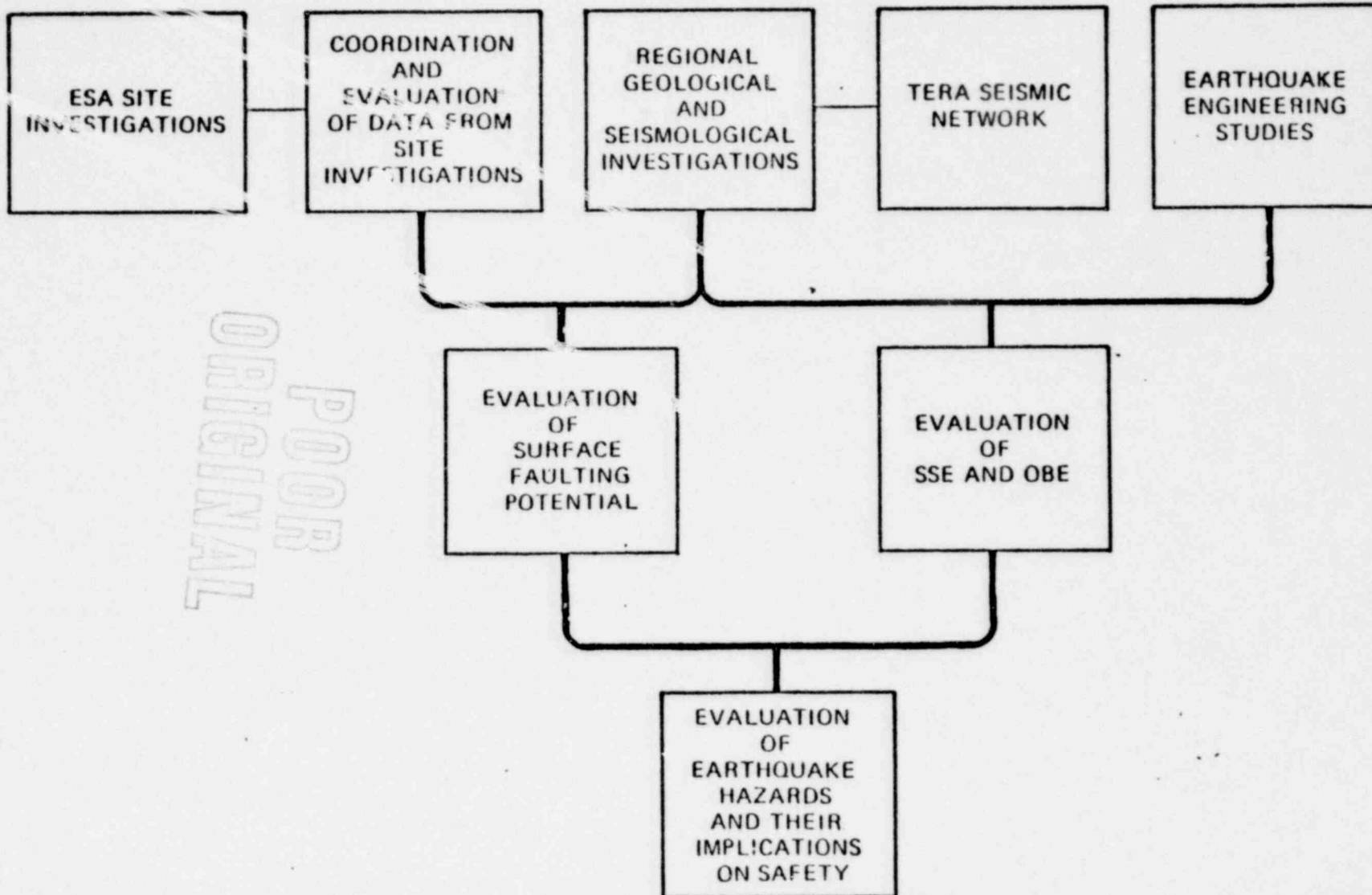


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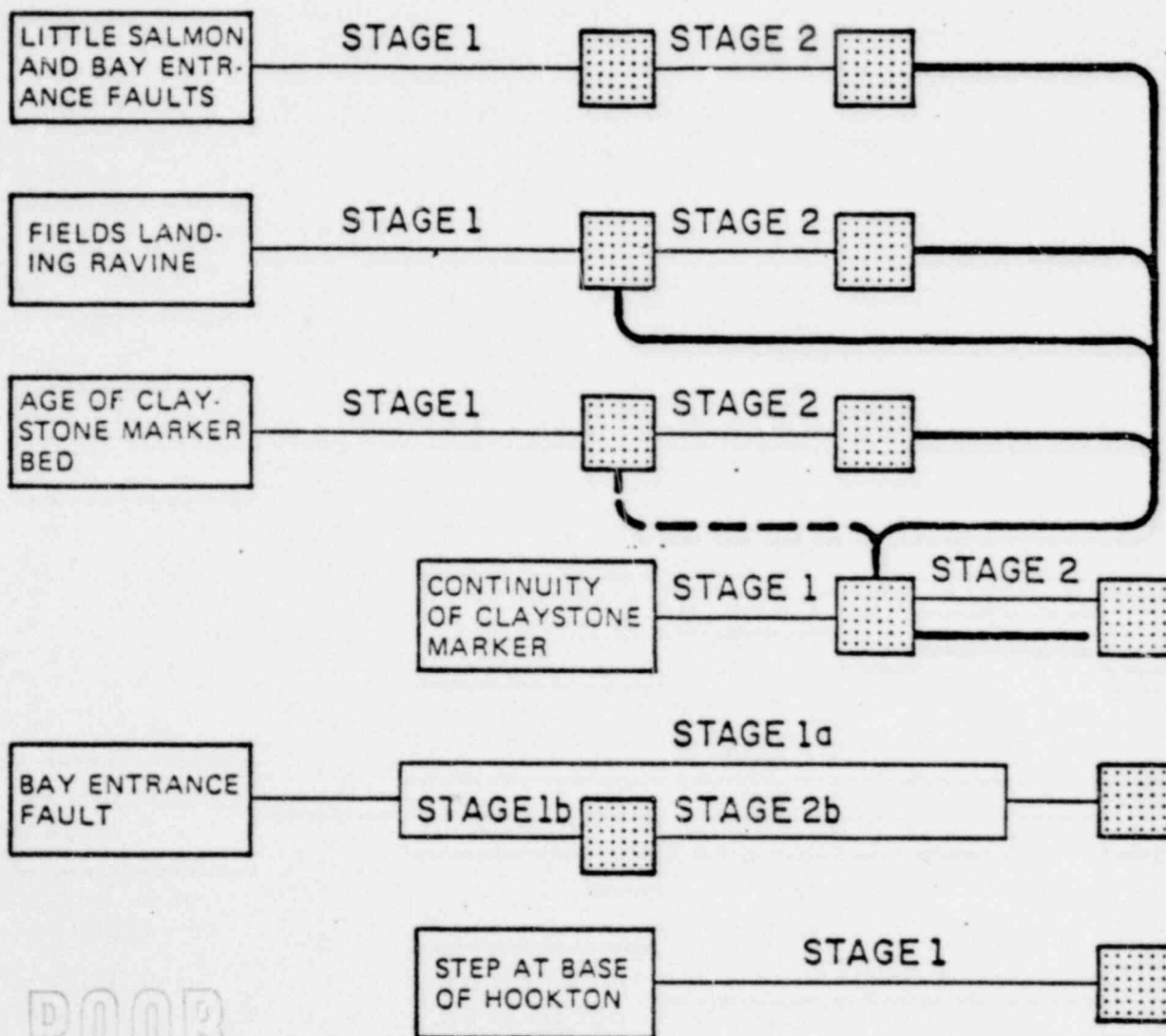
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# PHASE I SITE INVESTIGATIONS



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# PHASE I REGIONAL INVESTIGATIONS

## GEOLOGY

- ① FORMATION AND PROPAGATION OF FAULTS
- ② TECTONIC EVOLUTION OF THE MENDOCINO TRIPLE JUNCTION
- ③ GEOLOGIC AND TECTONIC EVOLUTION OF THE HUMBOLDT BAY REGION
- ④ QUATERNARY GEOLOGY AND AGE DATING

## SEISMOLOGY

- ① SEISMOGRAPHIC STUDIES OF REGIONAL TECTONICS
- ② RELATIONSHIP OF HISTORICAL EARTHQUAKES TO TECTONIC STRUCTURES
- ③ SITE SPECIFIC EARTHQUAKE CHARACTERISTIC

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FORMATION AND PROPAGATION  
OF FAULTS

- ① ANALYSIS OF REPORTED CASES OF NEW FAULTS.
- ② STUDY OF SECONDARY FAULT RUPTURE ASSOCIATED WITH HISTORIC EARTHQUAKES.
- ③ REVIEW OF TECTONIC MODELS CONTROLLING FAULTING.
- ④ REVIEW OF ROCK MECHANICS LITERATURE RELATING TO FRACTURE PROPAGATION.

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TECTONIC EVOLUTION OF  
MENDOCINO TRIPLE JUNCTION  
AND ITS RELATIONSHIP TO  
SEISMICITY AND FAULTING IN  
HUMBOLDT BAY REGION

- ① REVIEW PUBLISHED LITERATURE ON GEOLOGY, SEISMOLOGY, AND TECTONICS OF HUMBOLDT BAY REGION AND OTHER REGIONS OF "TRANSITIONAL TECTONICS".
- ② INCORPORATION OF DATA FROM EXPANDED SEISMOGRAPHIC ARRAY.
- ③ DEVELOPMENT OF SPECIFIC PLATE TECTONIC MODELS FOR HUMBOLDT BAY REGION.

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GEOLOGICAL AND STRUCTURAL  
EVOLUTION OF THE  
HUMBOLDT BAY REGION

- COMPILATION AND ANALYSIS OF AVAILABLE GEOLOGIC AND GEOPHYSICAL LITERATURE FOR HUMBOLDT BAY REGION .
  
- ANALYSIS OF PERTINENT AERIAL PHOTOGRAPHY AND OTHER AVAILABLE REMOTE SENSING IMAGERY .
  
- ANALYSIS OF AVAILABLE GEODETIC LEVELING DATA .
  
- REVIEW AND ANALYSIS OF AVAILABLE SEISMIC REFLECTION, GRAVITY, MAGNETIC, AND REFRACTION SURVEYS .
  
- FIELD RECONNAISSANCE .

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## QUATERNARY GEOLOGY AND AGE DATING

- ① REVIEW AVAILABLE LITERATURE REGARDING QUATERNARY GEOLOGY AND GEOMORPHOLOGY OF HUMBOLDT BAY AREA .
  
- ① FIELD RECONNAISSANCE TO ASSESS FEASIBILITY OF USING QUATERNARY DEPOSITS AND GEOMORPHIC SURFACES TO ASSESS RECENT TECTONIC HISTORY .
  
- ① SAMPLING OF CARLOTTA AND HOOKTON FORMATIONS FOR PALEOMAGNETIC AGE DATING .
  
- ① SAMPLING TUFF BEDS IN CARLOTTA FORMATION AND OTHER FORMATIONS FOR AGE DATING ANALYSIS (K/Ar; FISSION TRACK; TRACE ELEMENT CORRELATION) .

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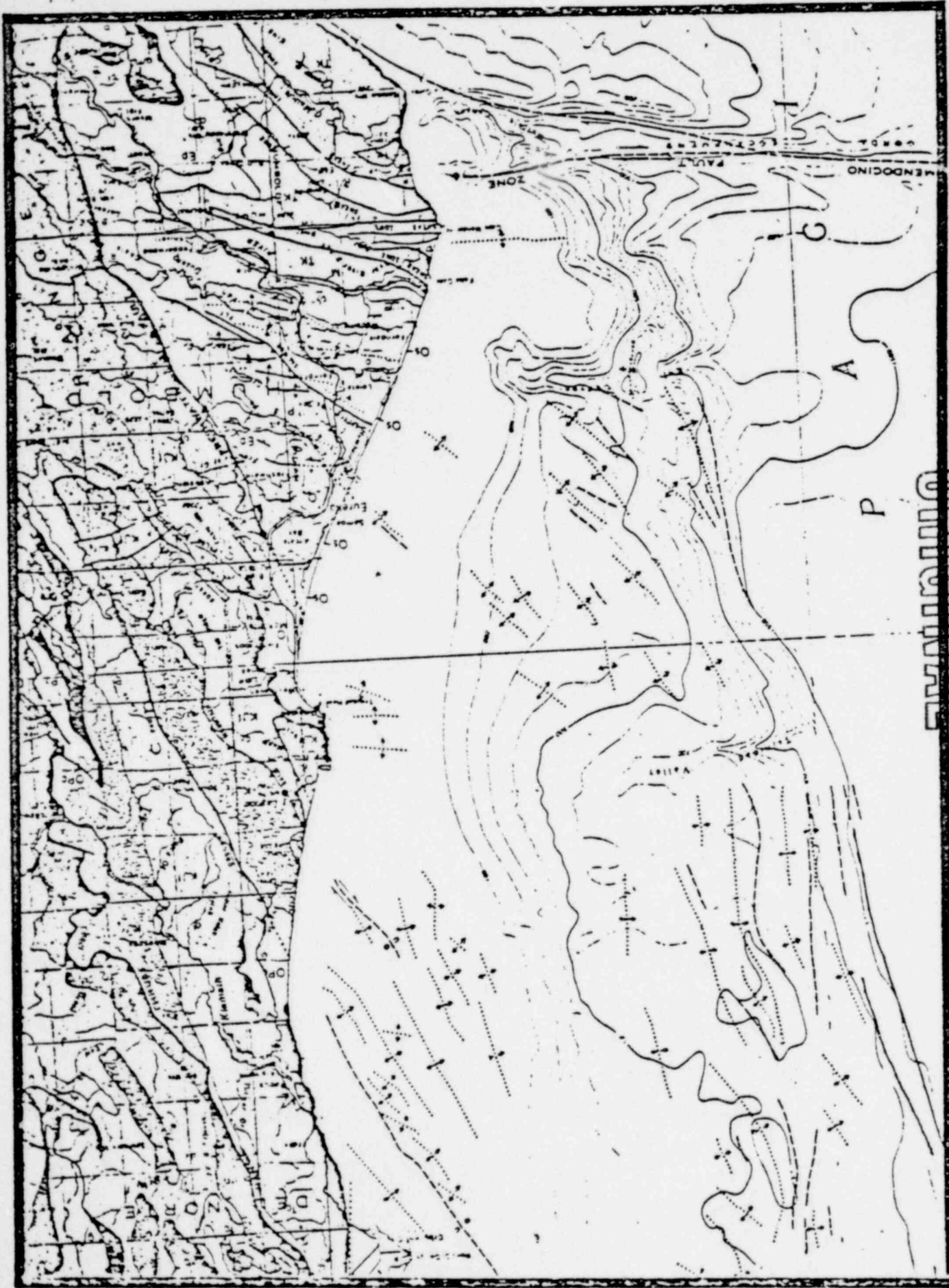
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PHASE I  
EARTHQUAKE ENGINEERING  
STUDIES

- REVIEW THE ASSESSMENT OF GROUND MOTION
- REVIEW THE ASSESSMENT OF LIQUEFACTION POTENTIAL

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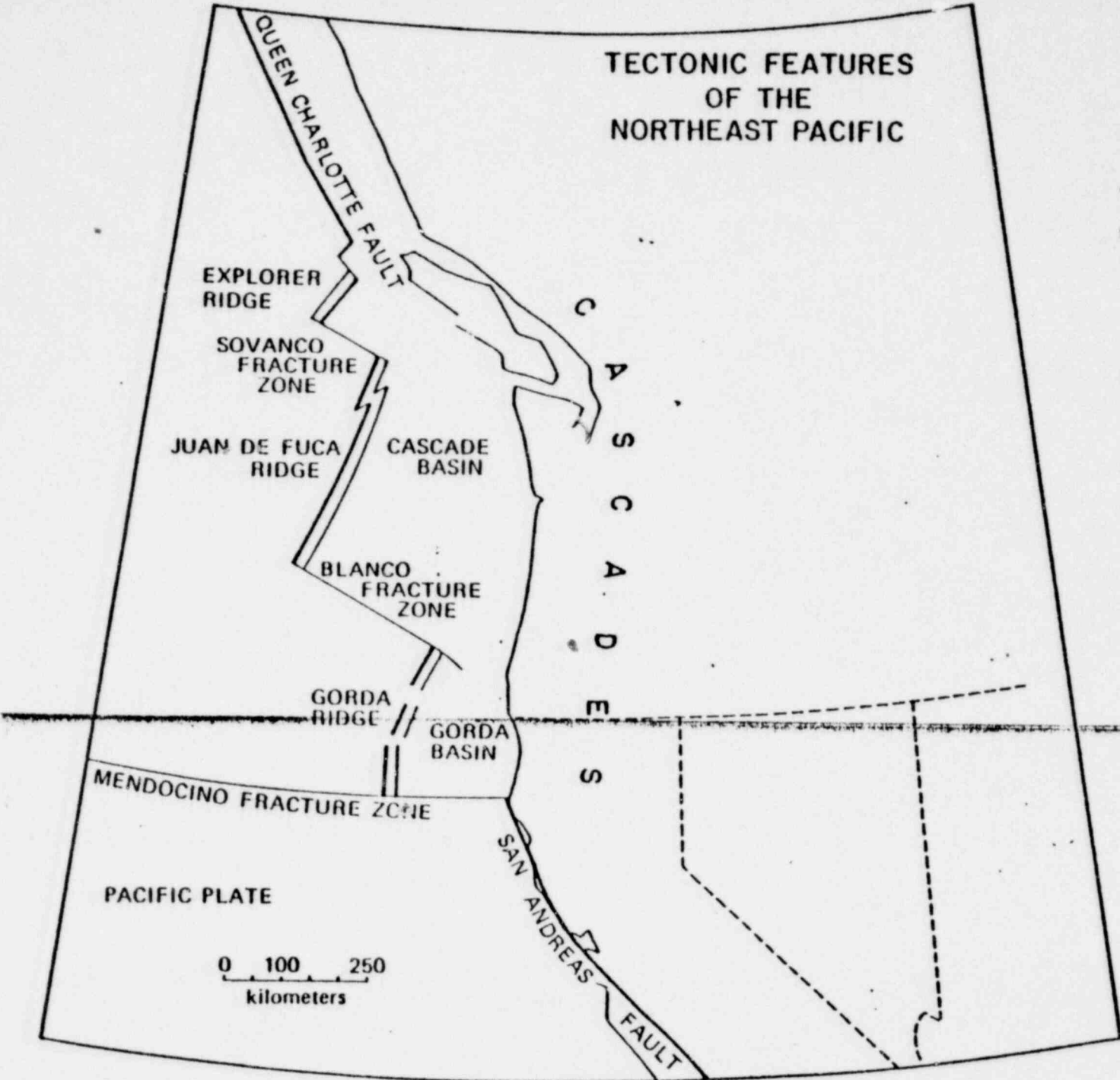
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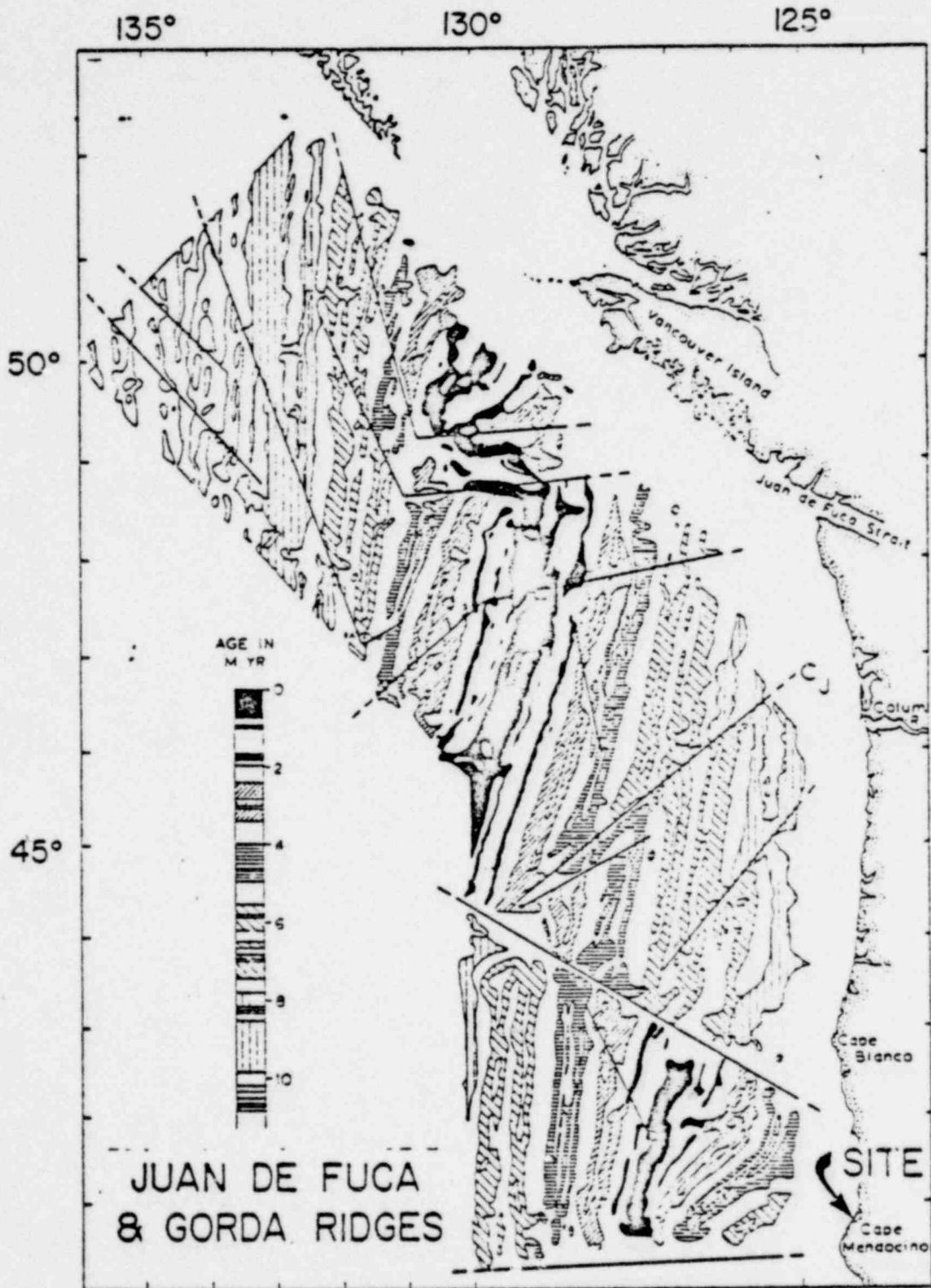
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# TECTONIC FEATURES OF THE NORTHEAST PACIFIC



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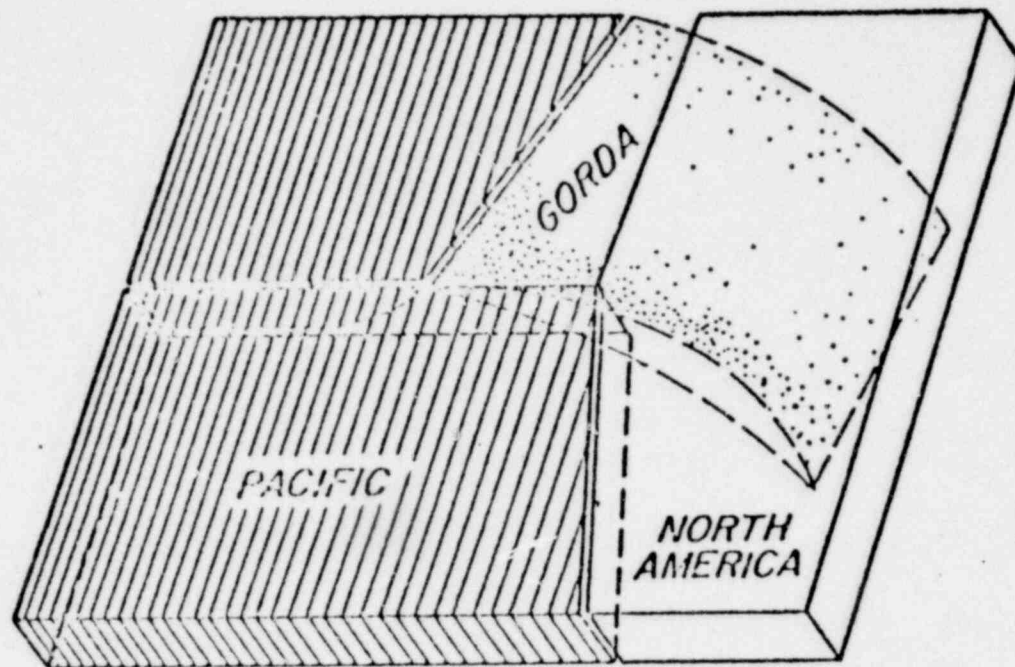


Raff-Mason magnetic anomaly pattern in the northeast Pacific, modified from Vine (1968).

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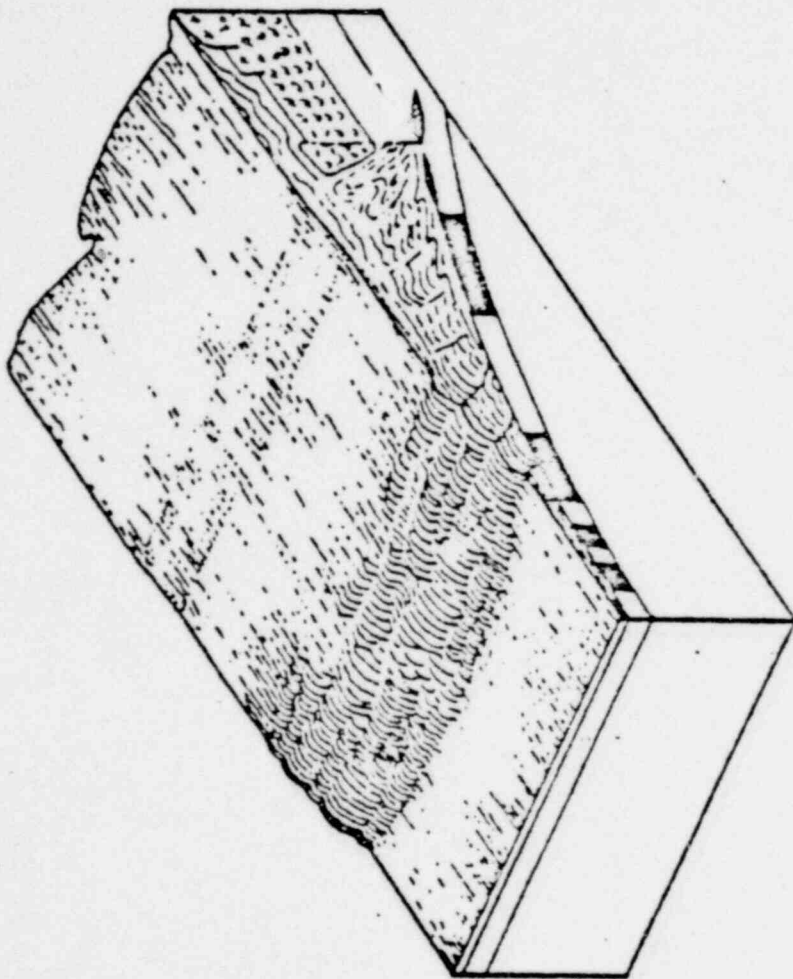


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SIMPLIFIED BLOCK DIAGRAM OF THE INFERRED RELATIONSHIP  
BETWEEN THE AMERICAN, PACIFIC AND GORDA LITHOSPHERIC PLATES  
WHICH MEET AT A TRIPLE JUNCTION AT CAPE MENDOCINO  
(MODIFIED FROM SILVER, 1971)

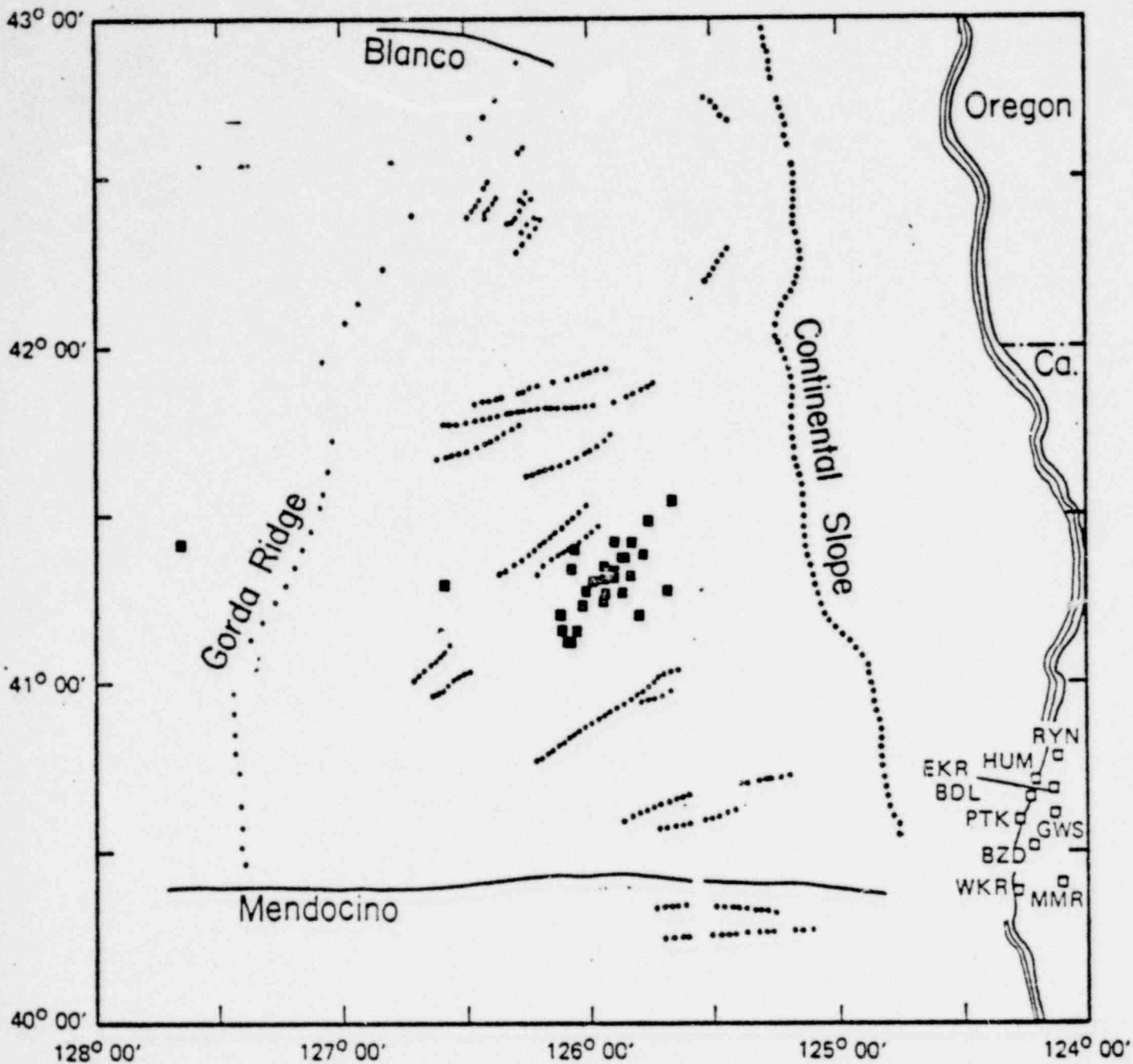
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BLOCK DIAGRAM OF THE SUGGESTED CRUSTAL STRUCTURE OF THE  
CONTINENTAL MARGIN OFF NORTHERNMOST CALIFORNIA

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AFTERSHOCKS OF THE NOVEMBER 26, 1976 EARTHQUAKE

$M_B=6.0$ ,  $M_S=6.8$ ,  $M_L=6.2$

FAULTS AFTER SILVER (1972)

AFTERSHOCK ZONE 50-60 KM

MMR



SEISMIC STATION



AFTERSHOCK LOCATION

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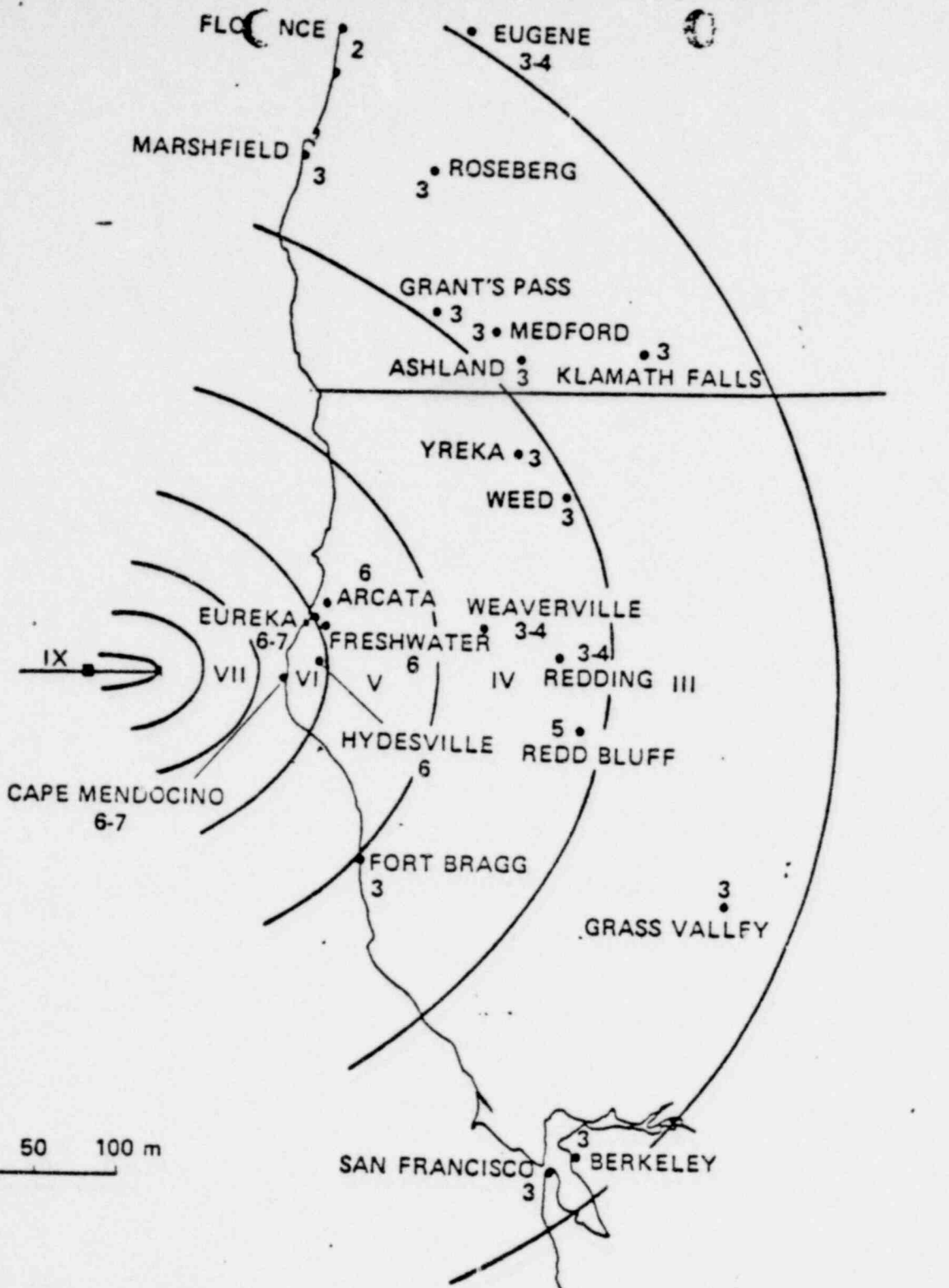


FIGURE 7  
 JANUARY 31, 1922  
 M = 7.3

- VII PREDICTED INTENSITY (R.F.)
- 7 ACTUAL INTENSITY (R.F.)
- ISOSEISMAL EPICENTER WITH INFERRED FAULT (AFTER EVERNDON, 1975)
- TOWN WITH REPORTED INTENSITY

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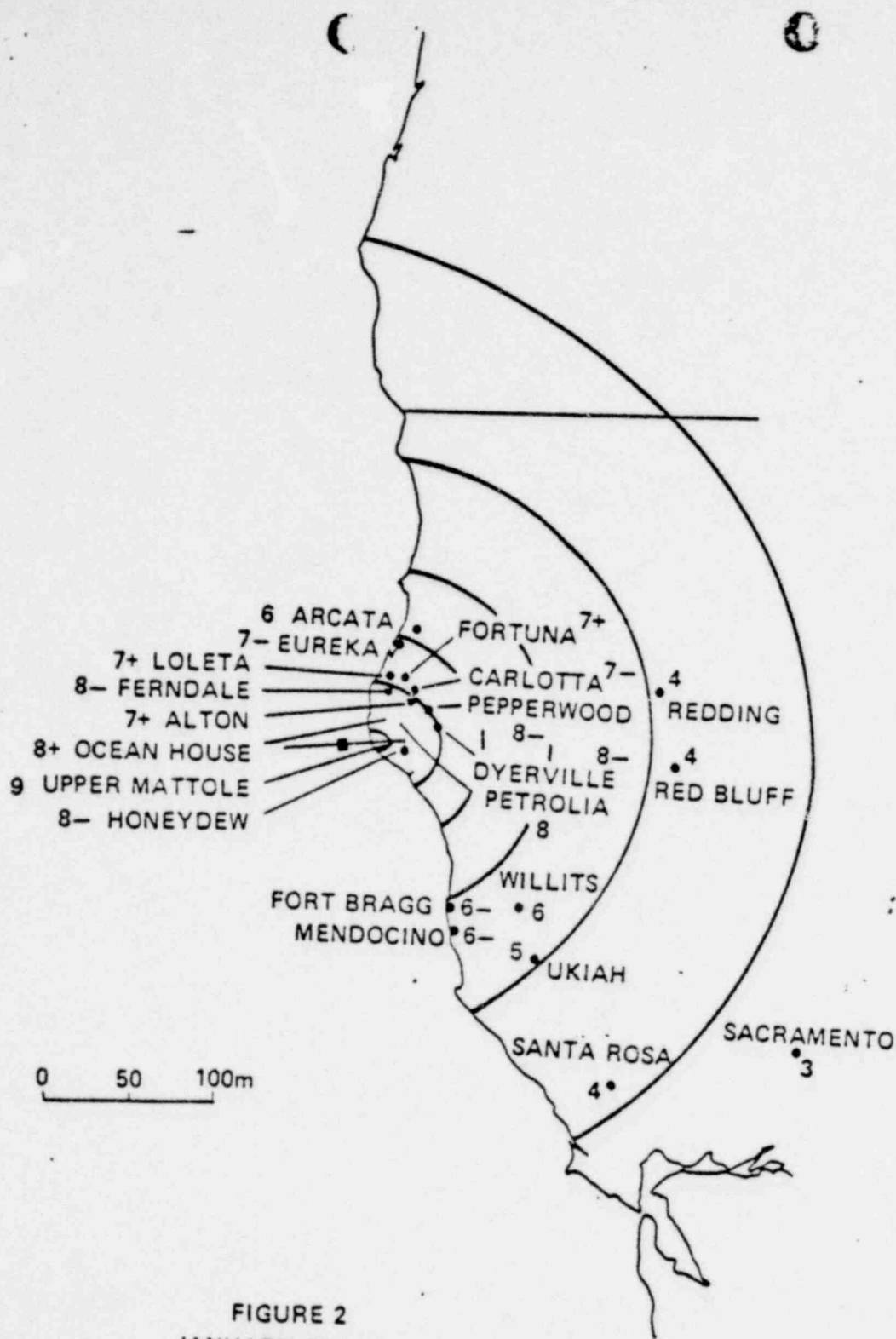


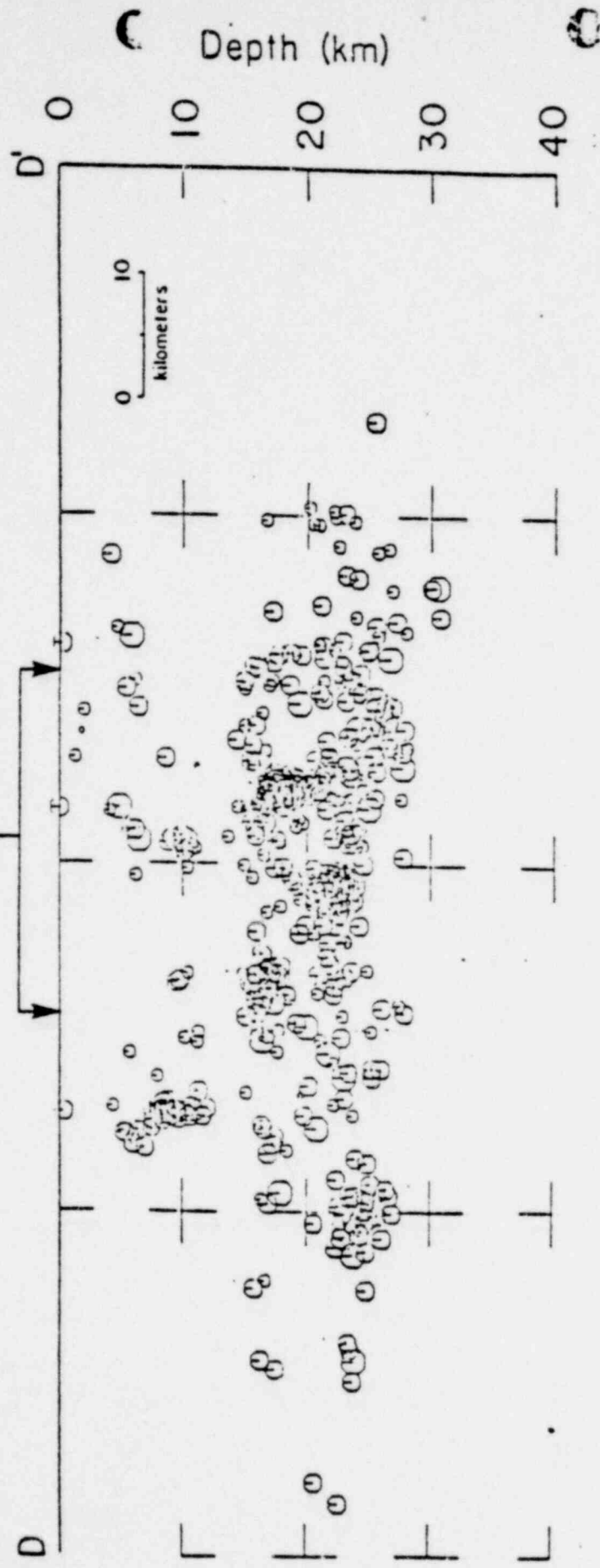
FIGURE 2  
 JANUARY 22, 1923  
 $M_L = 7.2$

- 7 ACTUAL INTENSITY (R.F.)
- ISOSEISMAL EPICENTER
- WITH INFERRED FAULT (AFTER EVERNDON, 1975)
- TOWN WITH REPORTED INTENSITY

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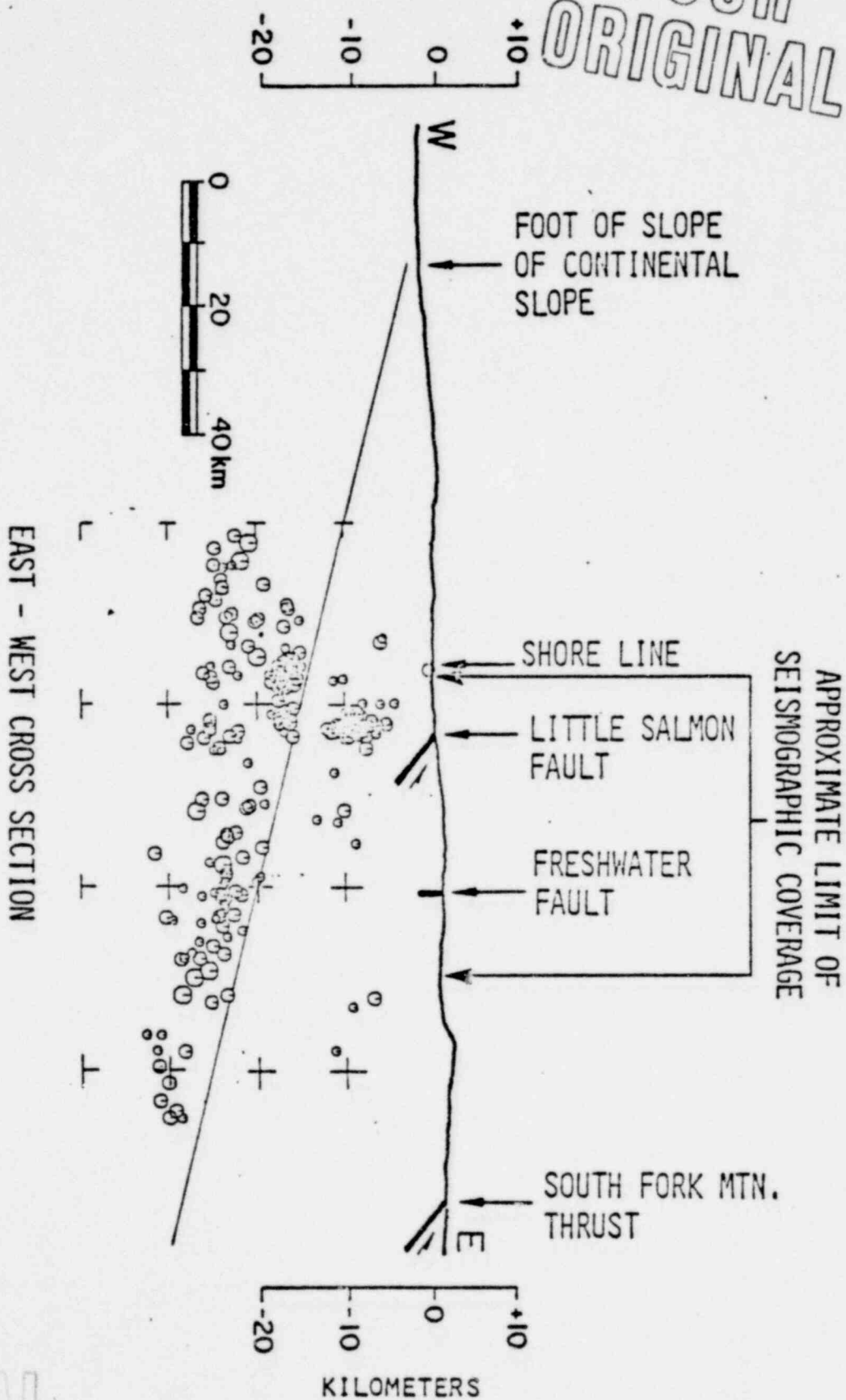
APPROXIMATE LIMIT OF  
SEISMOGRAPHIC COVERAGE



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FERNDALE EARTHQUAKE  
AND AFTERSHOCKS WITHIN 36 HOURS

EXPLANATIONS

- ▼----- FAULTS, DASHED WHERE APPROXIMATELY LOCATED, DOTTED WHERE CONCEALED BENEATH YOUNGER DEPOSITS. BARBS INDICATE UPTHROW SIDE OF THRUST FAULT.
- LINEAMENT OBSERVED ON AERIAL PHOTOS, HAVING CHARACTERISTICS SUGGESTIVE OF A FAULT OR FAULT-LINE ORIGIN
- SHEAR ZONE, (CAPE MENDOCINO REGION)
- <1.5 MAGNITUDE
- 1.5 TO 2.5 MAGNITUDE
- > 2.5 MAGNITUDE
- MAIN SHOCK

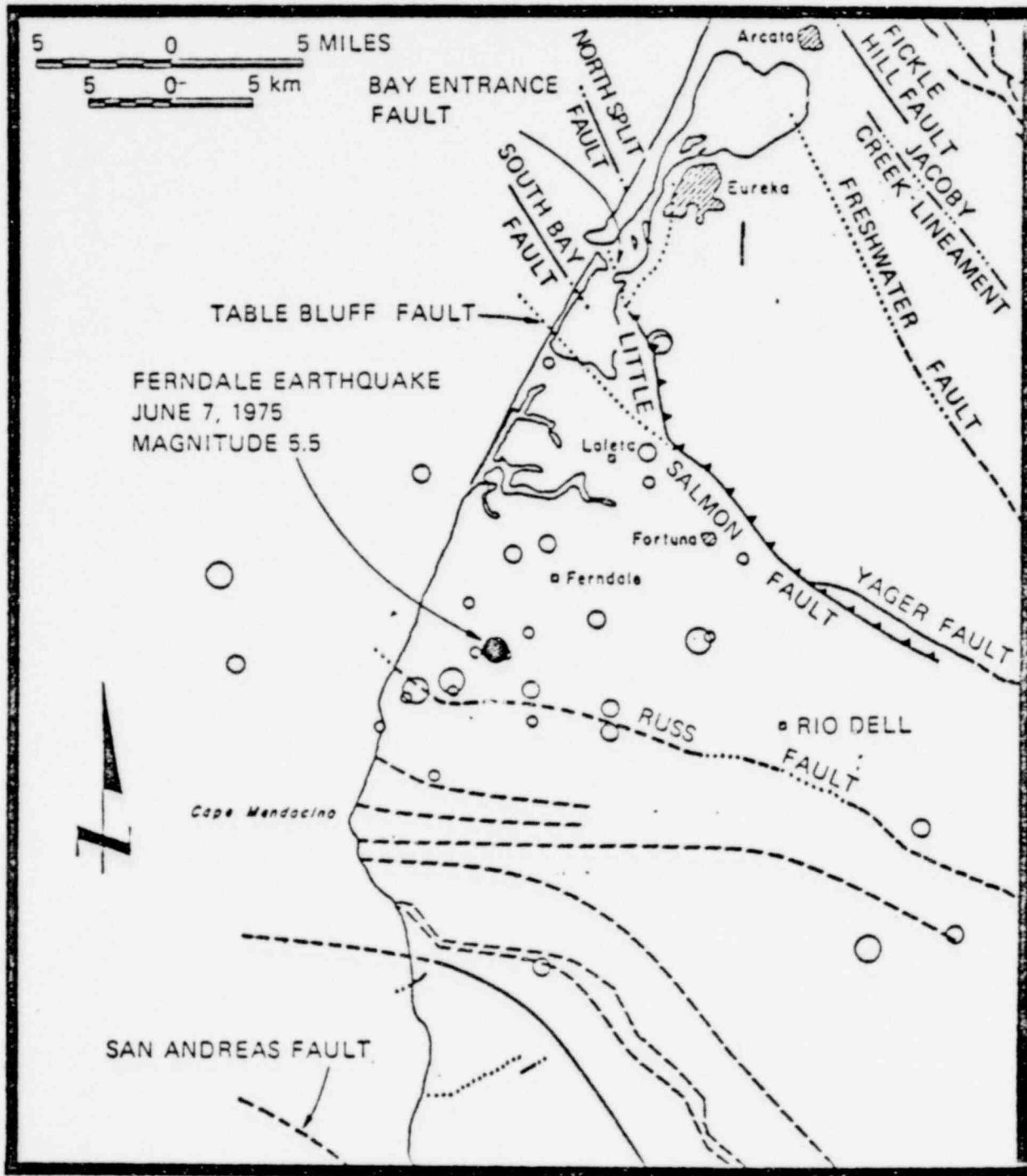
NOTES

1. TOPOGRAPHIC BASE FROM THE U.S.G.S. 1:250,000 EUREKA AND REDDING SHEETS.
2. FAULT DATA FROM THE CALIF. DIV. OF MINES AND GEOLOGY 1:250,000 REDDING SHEET (STRAND, 1962) AND THE CALIF. DIV. OF MINES AND GEOLOGY 1:750,000 GEOLOGIC MAP OF CALIFORNIA, NORTH HALF (PRELIMINARY) (JENNINGS, 1973). SUPPLEMENTED BY DATA FROM MARINE GEOPHYSICAL SURVEYING, GEOLOGIC MAPPING, AND PHOTOGEOLOGIC ANALYSIS BY EARTH SCIENCES ASSOCIATES, 1972-1975.

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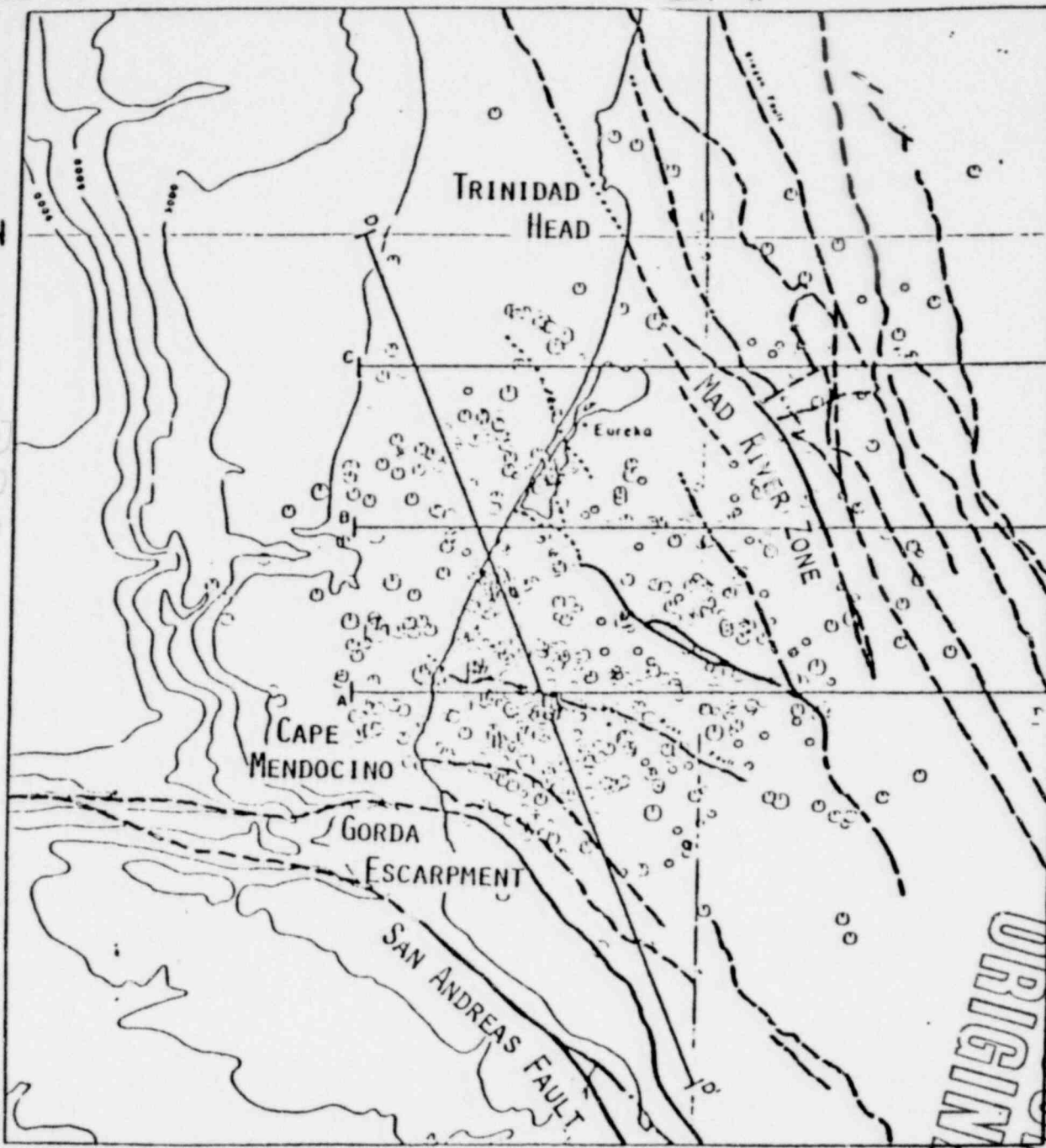
125° W

124° W

41° N

1024 558

40° N



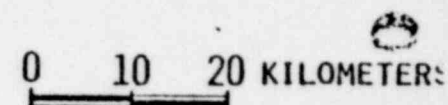
### EXPLANATION

#### EPICENTERS

MAGNITUDE	SYMBOL
0.4	•
0.5-1.4	◦
1.5-2.4	◌
2.5-3.4	○
3.5-4.4	⊙
4.5	⊕

#### FAULTS

DASHED WHERE APPROXIMATELY LOCATED, DOTTED WHERE CONCEALED

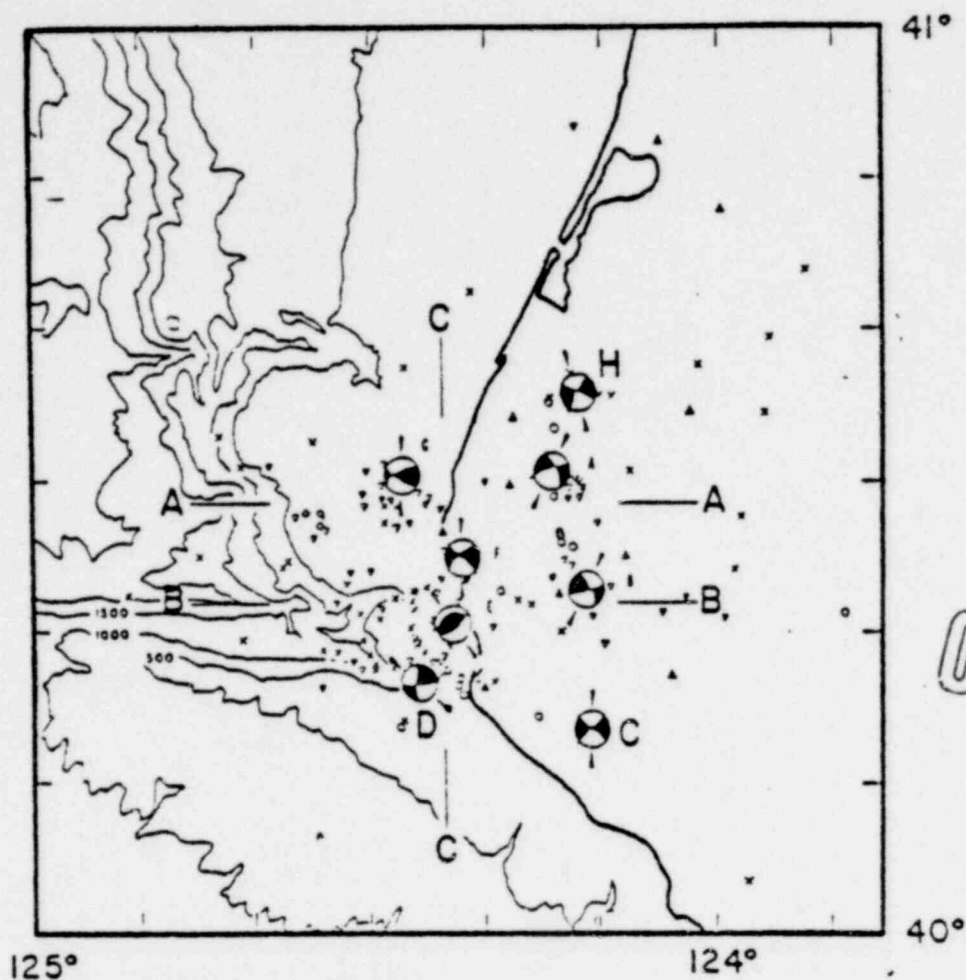


SUBMARINE CONTOUR INTERVAL 1500 FT.

EPICENTERS THROUGH FEBRUARY 1977

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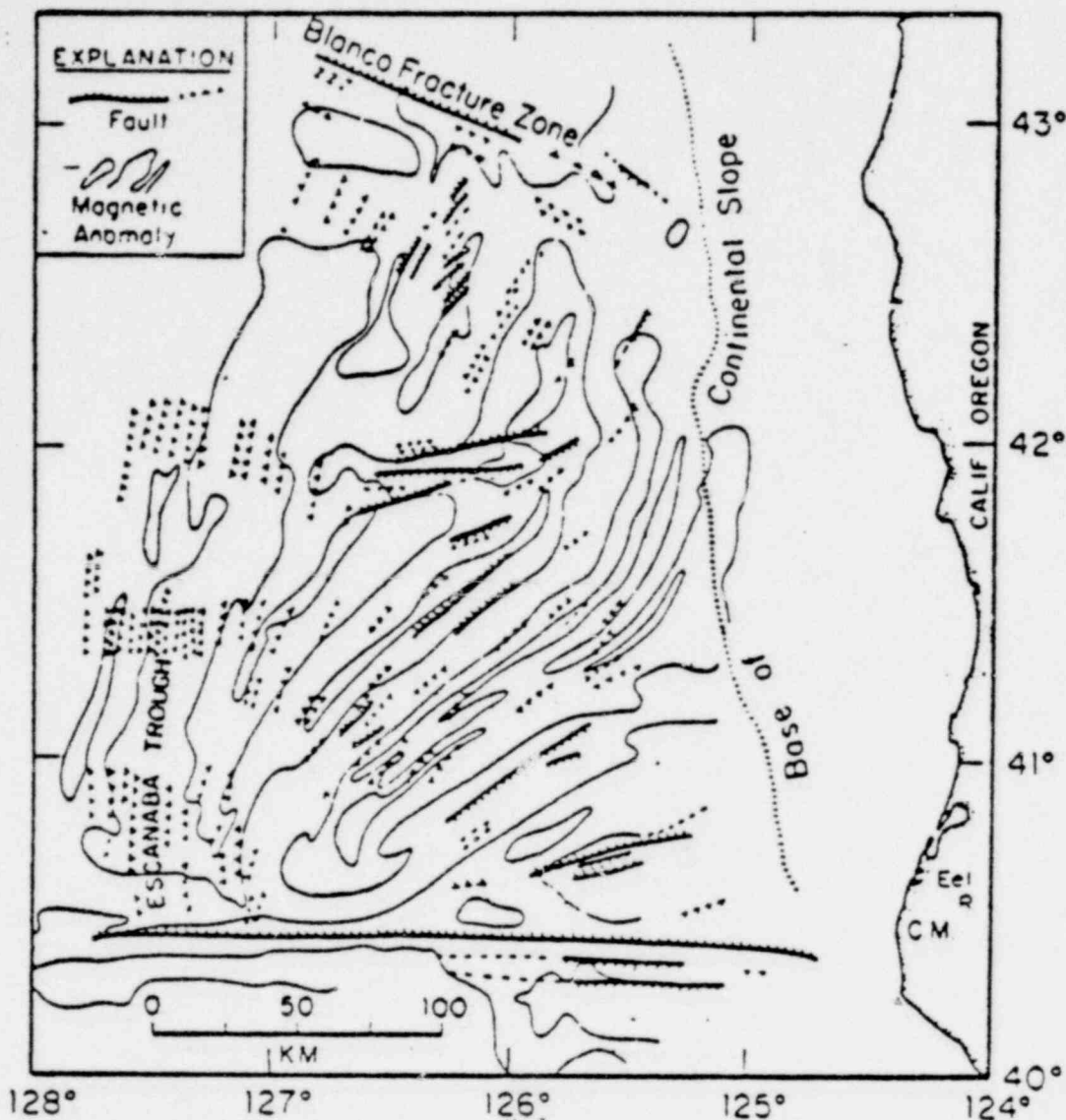


FOCAL MECHANISM FOR REGION OF CAPE MENDOCINO,  
 DARK REGIONS ARE COMPRESSION, ARROWS INDICATE  
 DIRECTION OF PRINCIPAL COMPRESSIVE STRESS,  
 (SIMILA, PEPPIN, McEVILLY, 1975)

- H REPRESENTS A COMPOSITE OF AN EAST-WEST ALIGNMENT  
 OF EPICENTERS, NOT ASSOCIATED WITH ANY MAPPED FAULTS  
 OR SHEAR ZONES (EVENTS ARE SHALLOW 0-20 KM).
- A, B REGIONS LOCATED NEAR THE ROUGHLY EAST-STRIKING  
 SURFACE SHEAR ZONES (EVENTS ARE DEEP).
- C A COMPOSITE BASED ON A FEW HYPOCENTERS LOCATED  
 IN THE COASTAL REGION EAST OF PUNTA GORDA.
- D INFERRED RIGHT-LATERAL SLIP COINCIDES WITH  
 THE LANDWARD EXTENSION OF THE GORDA ESCARPMENT  
 (EVENTS ARE 10-30 KM).

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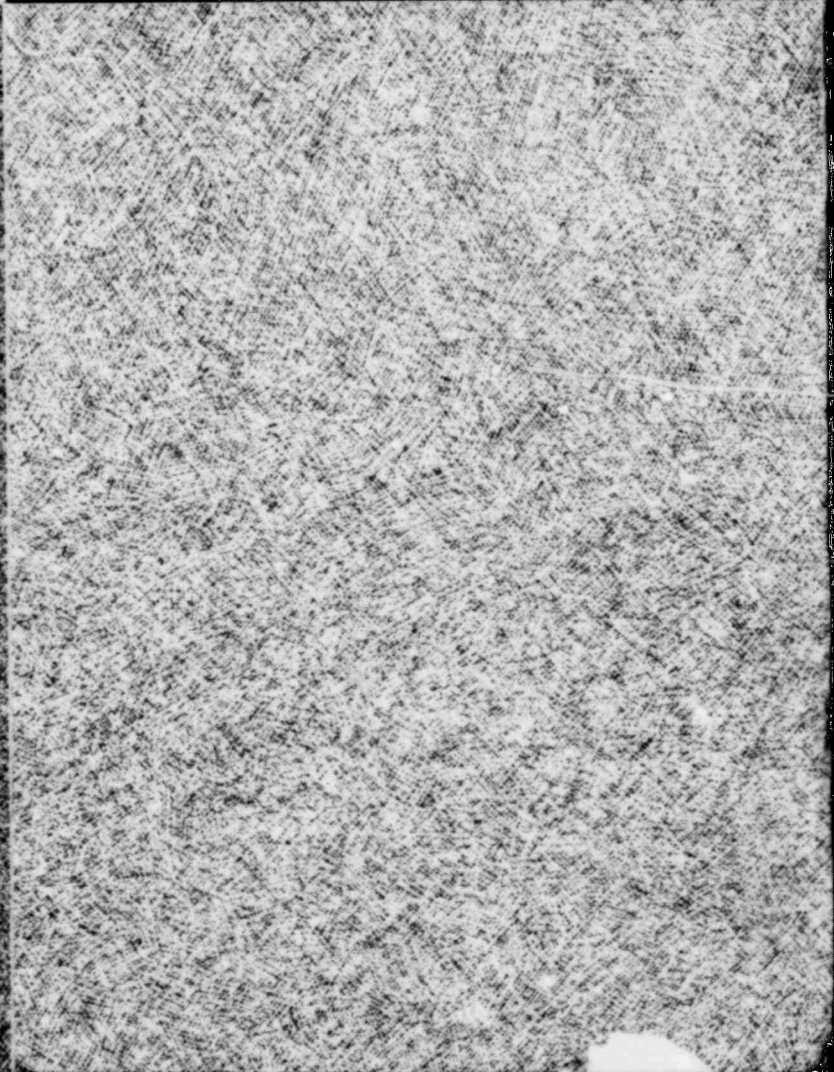
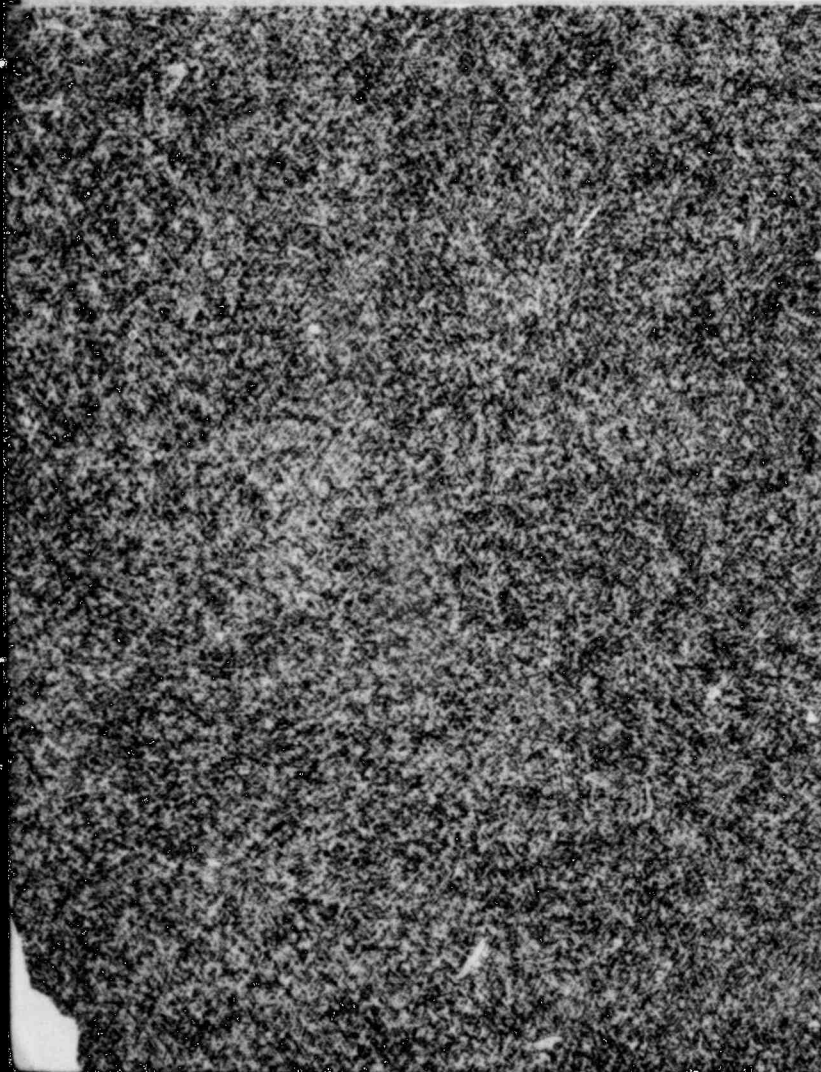
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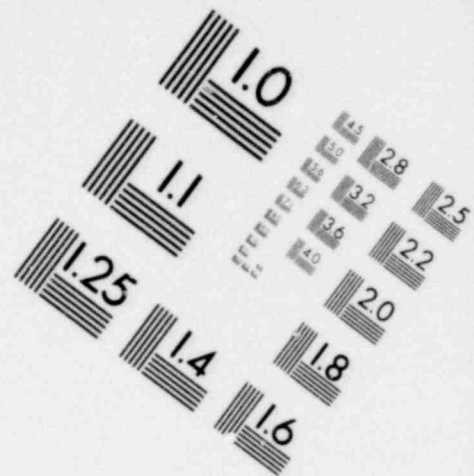
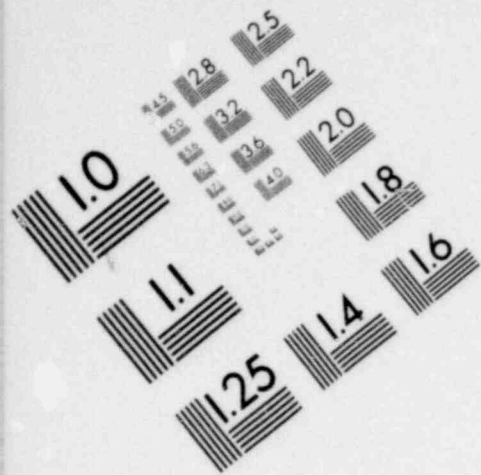


FAULT MAP OF THE GORDA BASIN AND VICINITY, SUPERIMPOSED ON THE RAFF AND MASON (1961) MAGNETIC ANOMALY PATTERN. SOLID LINES REPRESENT FAULTS WHOSE TRENDS ARE MAPPED BY SEVERAL AIR-GUN PROFILES. DASHED FAULTS HAVE BEEN CROSSED ONLY ONCE AND SHOULD NOT BE CONSIDERED AS INDEPENDENTLY MAPPED TRENDS. HACHURES SHOW DOWNTROWN SIDE. FAULTS FROM THE SOUTHERN END OF THE ESCANABA TROUGH WERE TAKEN FROM DATA ON SITE NO. 4 OF SCAN EXPEDITION, S10, BUT THEIR TRENDS REPRESENT MY OWN INTERPRETATION (SILVER, 1971).

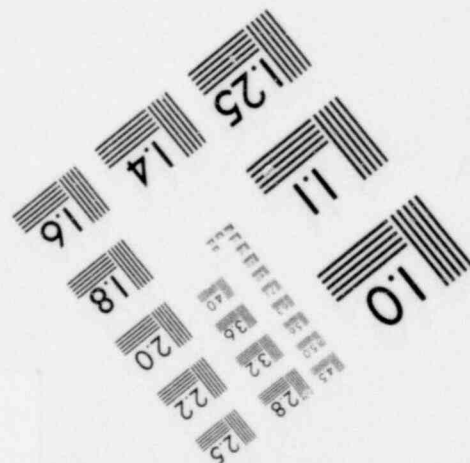
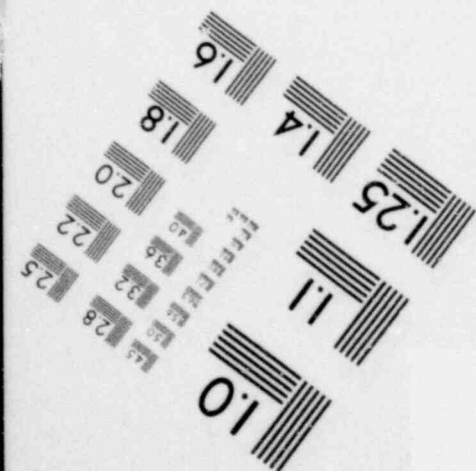
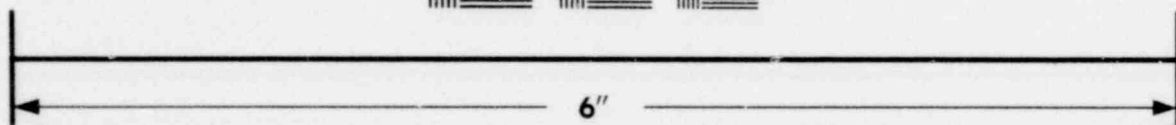
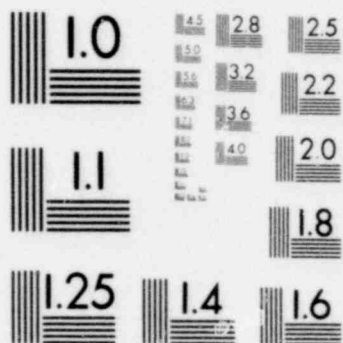
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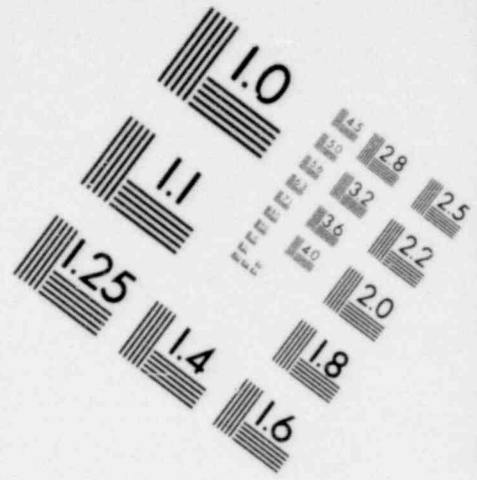
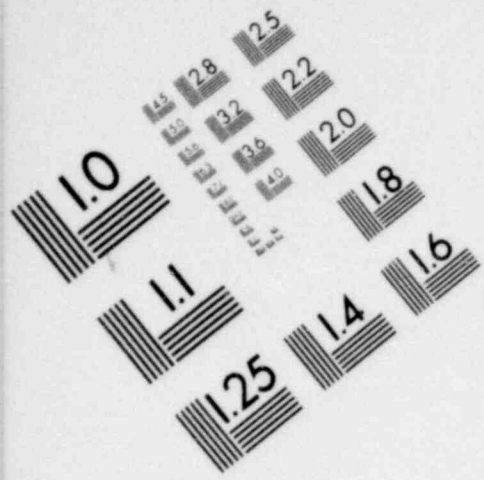
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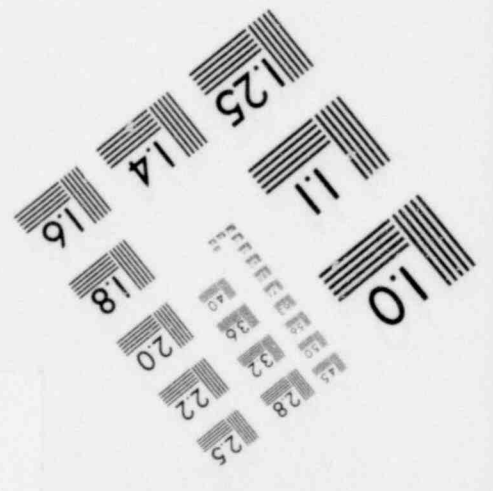
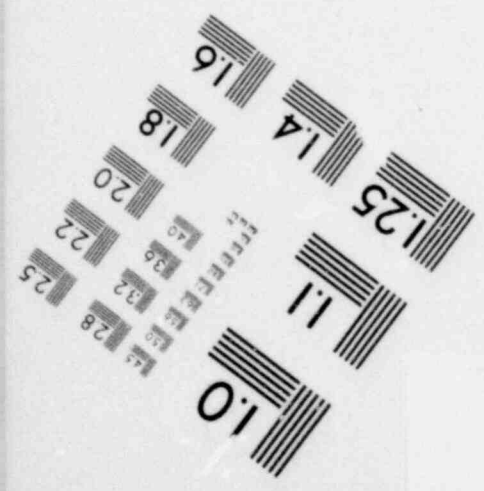
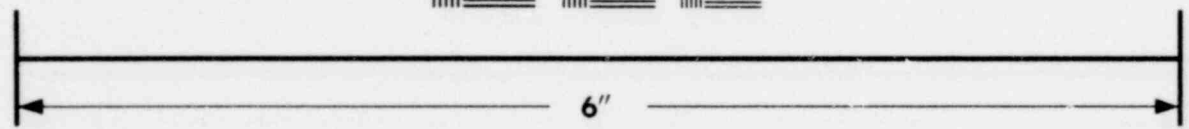
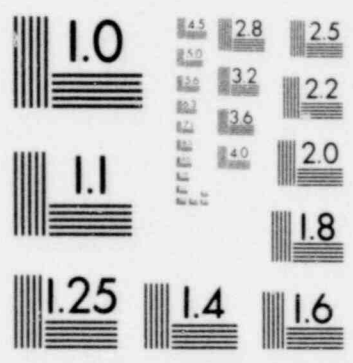


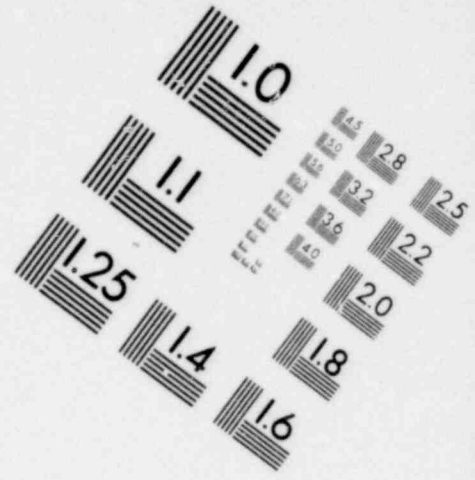
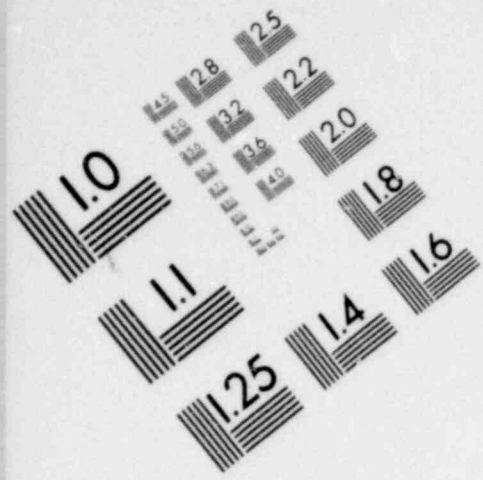
**IMAGE EVALUATION  
TEST TARGET (MT-3)**



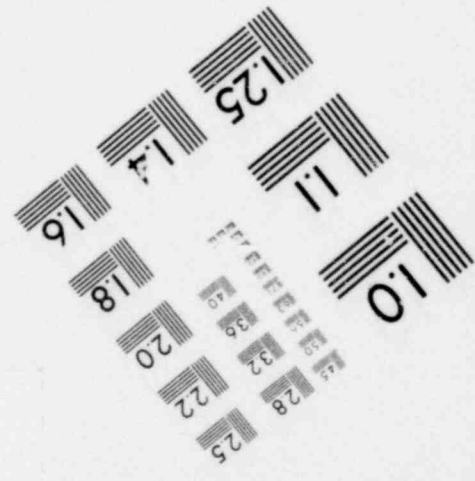
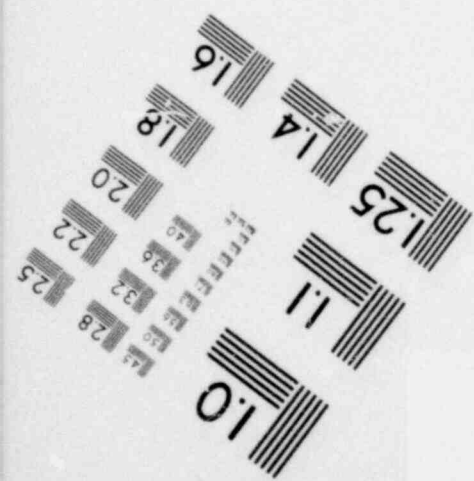
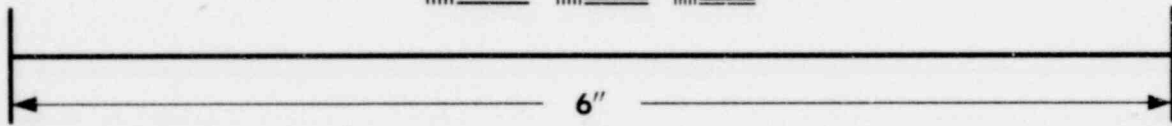
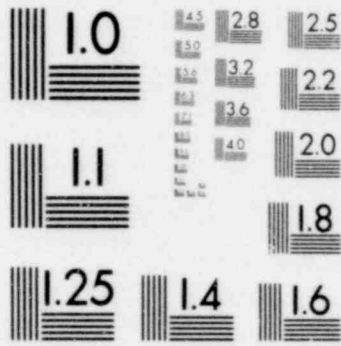


**IMAGE EVALUATION  
TEST TARGET (MT-3)**

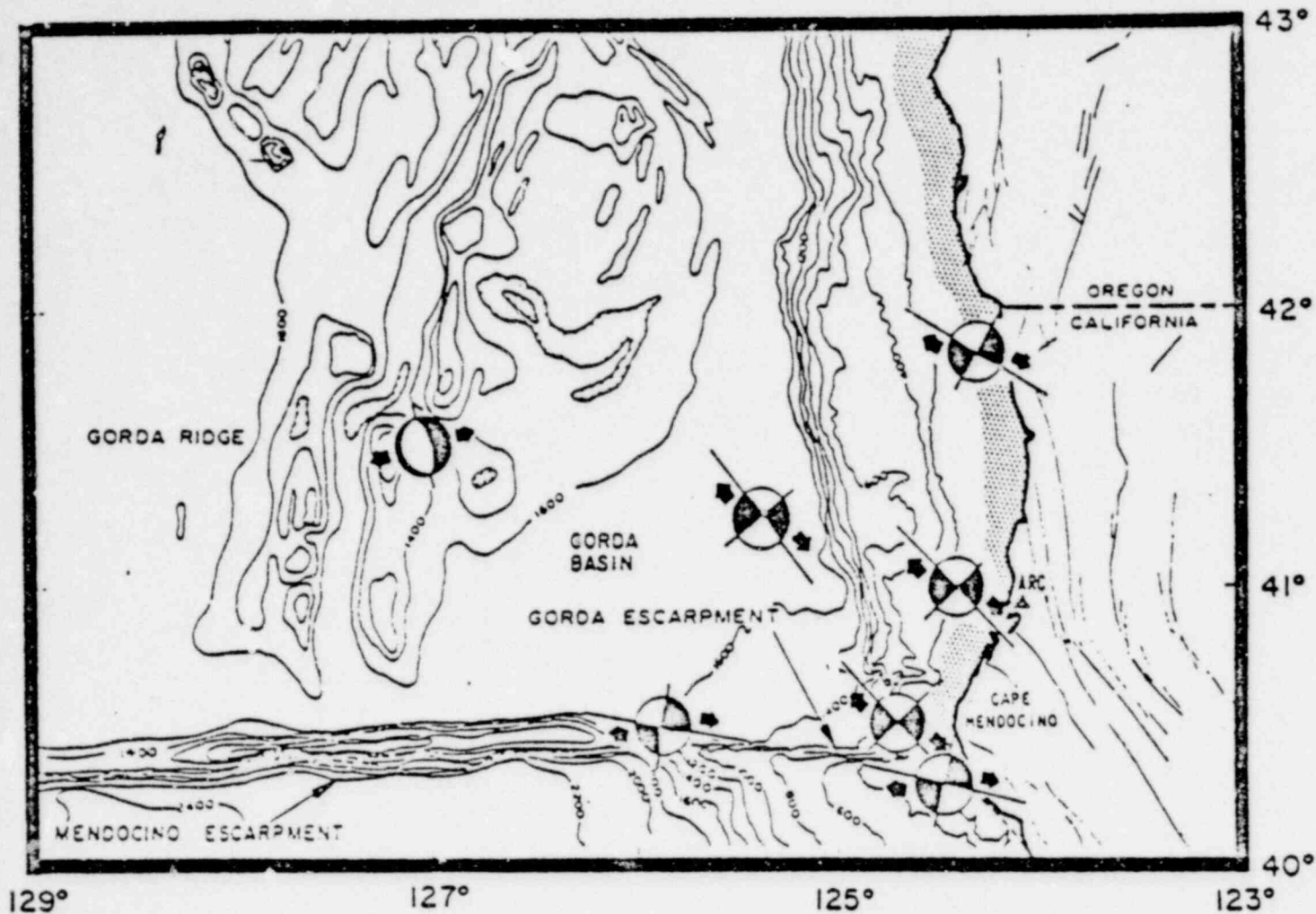




**IMAGE EVALUATION  
TEST TARGET (MT-3)**



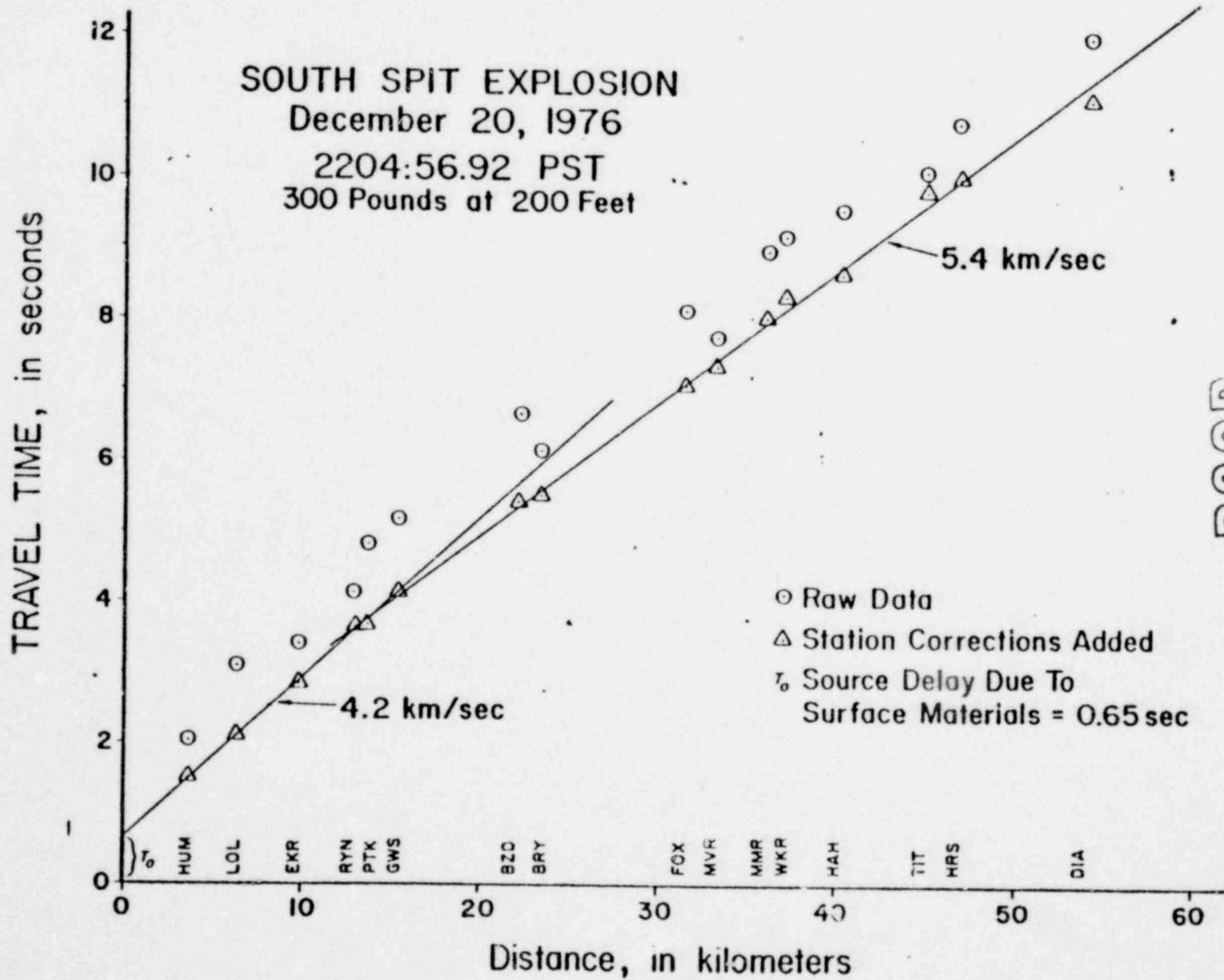




REGIONAL TECTONIC FEATURES OFF THE COAST OF NORTHERN CALIFORNIA, FAULT-PLANE SOLUTIONS FROM McEVILLY (1968). DARK QUADRANTS ARE COMPRESSION. SEA-FLOOR CONTOUR INTERVAL, 200 FM. ARC = ARCATA SEISMOGRAPHIC STATION (SIMILA, PEPIN, McEVILLY, 1975).

POOR  
ORIGINAL

1025 001



POOR ORIGINAL

1025 002

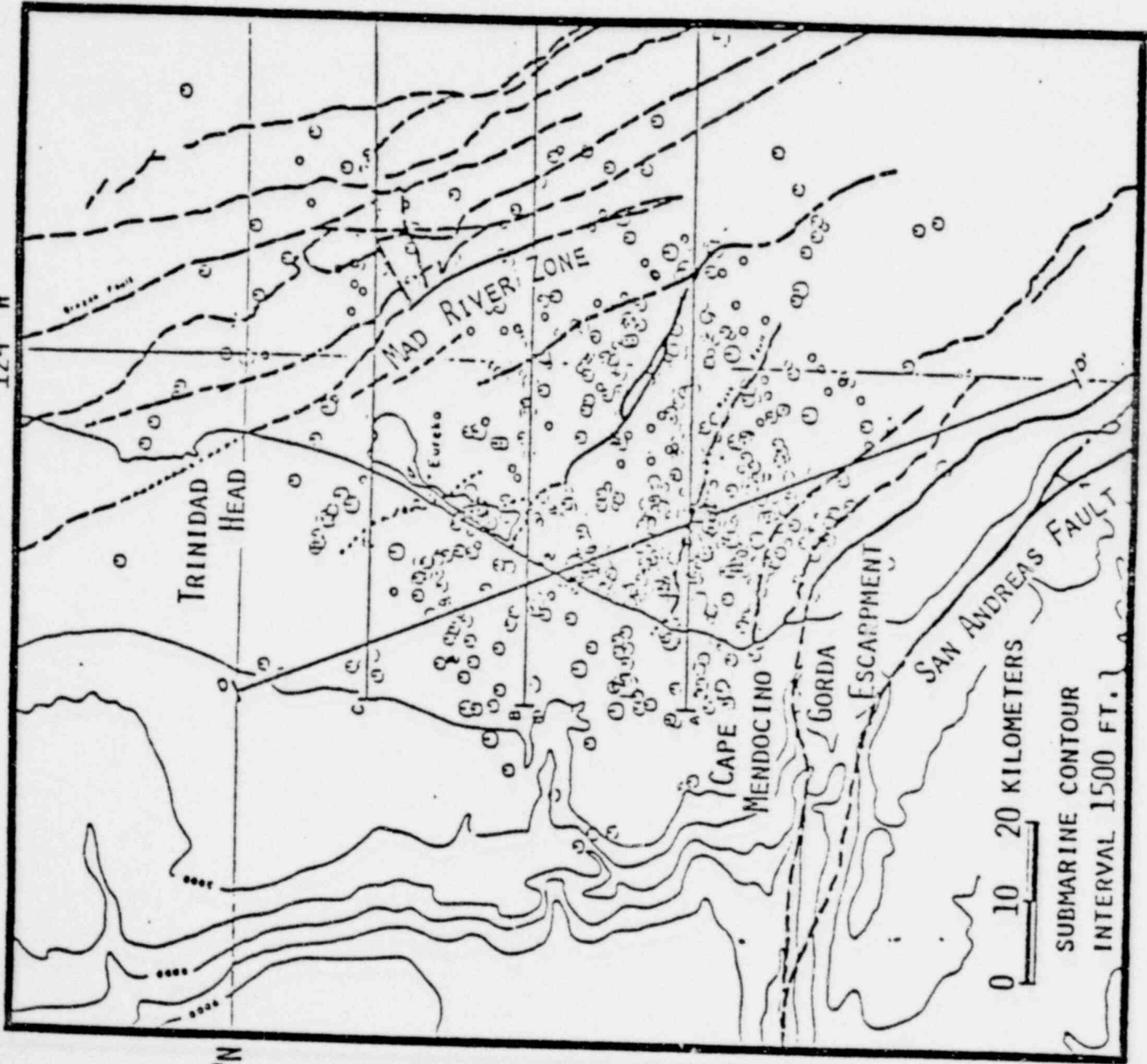
125° W

124° W

41° N

1025 003

40° N



### EXPLANATION

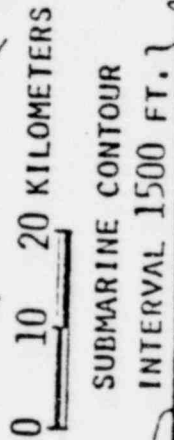
#### EPICENTERS

MAGNITUDE	SYMBOL
0.4	•
0.5-1.4	◦
1.5-2.4	◌
2.5-3.4	◉
3.5-4.4	⊙
4.5	⊕

#### FAULTS

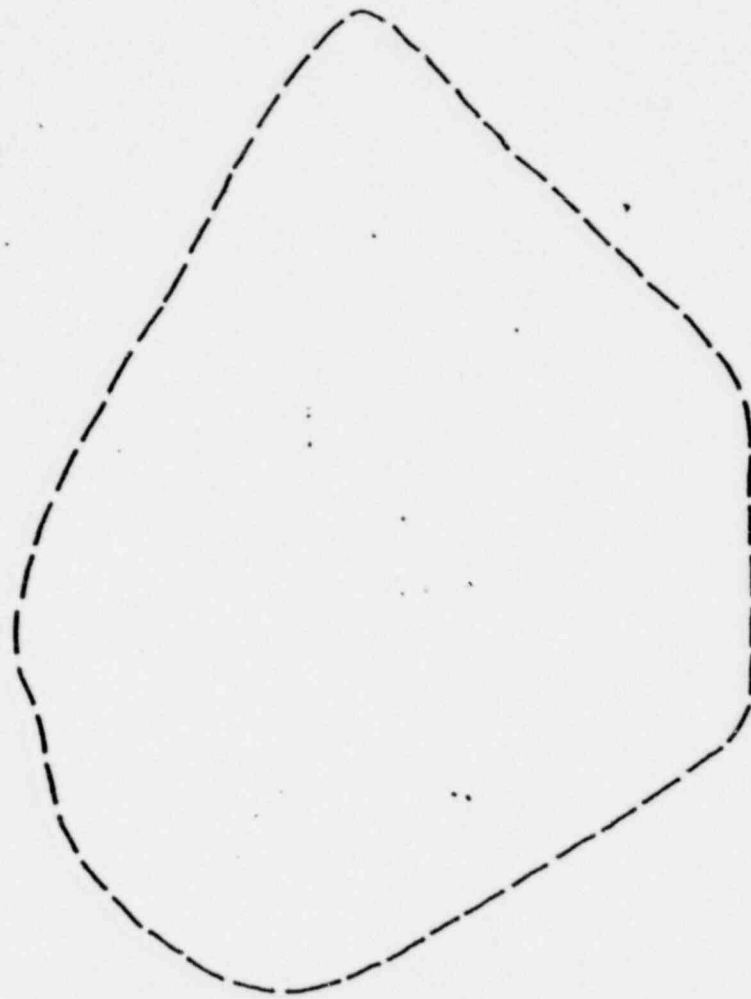
DASHED WHERE APPROXIMATE;  
 LOCATED, DOTTED WHERE  
 CONCEALED

POOR  
 ORIGINAL

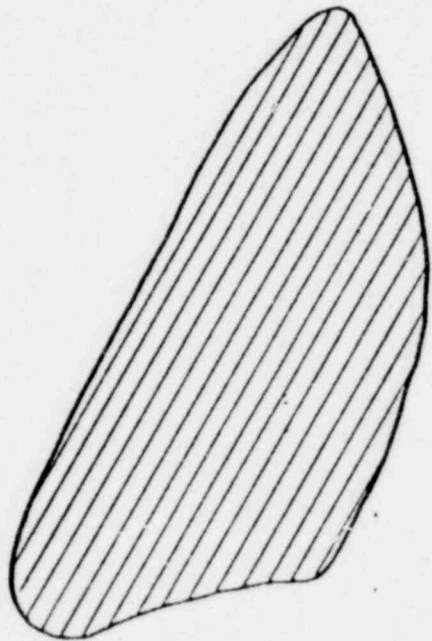


EPICENTERS THROUGH FEBRUARY 1977

1025 004

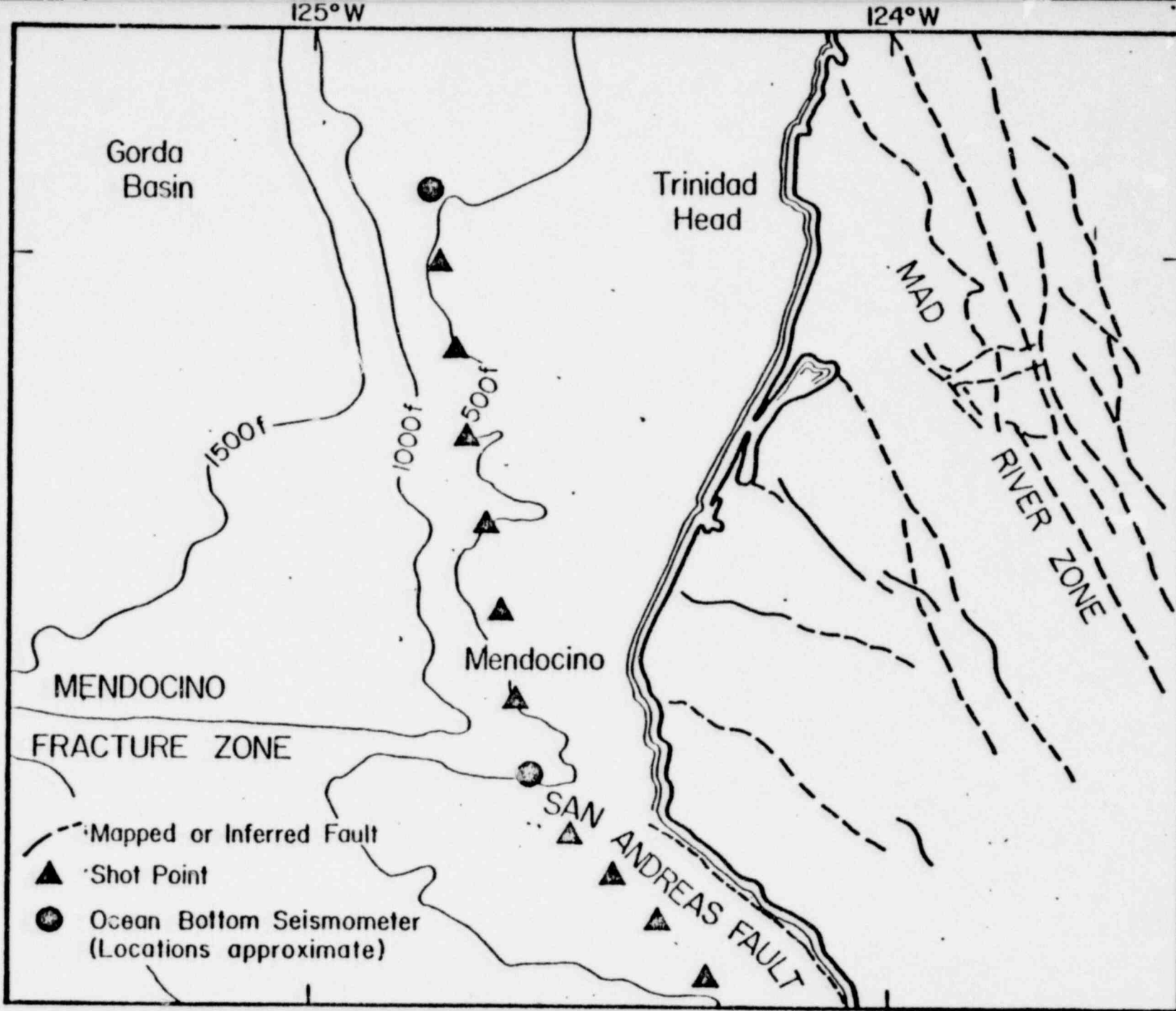


— — — PROPOSED EXTENSION OF  
NETWORK CONFIGURATION



SEISMOGRAPHIC INSTRUMENT  
COVERAGE THROUGH FEB.  
1977

1025 005



OFFSHORE REFRACTION LINE SCHEMATIC

1025 006