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SUPPLEMENT TO THE GENERALIZED SUB-SURFACE GEOLOGICAL AND GEOPHYSICAL STUDY CAPISTRANO AREA ORANGE COUNTY, CALIFORNIA

NOVEMBER 1975

JANUARY 1979

CONTENTS

INTRODUCTION

In partial response to NRC question 361.35 regarding the Capistrano Embayment, this report was prepared to supplement and revise my November 1975 report "Generalized Sub-Surface Geological and Geophysical Study, Capistrano Area, Orange County, California" (6). The present report centers on interpretations of the relationship between onshore and offshore geologic structure in the vicinity of the San Onofre Site. The illustrations included in this report are based upon newly acquired onshore seismic data, recent geologic surface mapping, formerly acquired offshore seismic data (2), and re-examination of all former surface geology and all available onshore and offshore well data. A general discussion of the illustrations follow in order to demonstrate the bases of interpretation, but in particular, this report addresses response to parts (c), (d), and (e) of the above NRC question.

DISCUSSION OF ILLUSTRATIONS

EXHIBIT A-1 - Generalized Contours Near Top of Monterey Formation

General Comments

To present a comprehendable picture that reflects relatively late tectonics involving an area partly covered by water, a regional sub-surface contour map, based upon the most shallow and youngest information, is necessary.

After reviewing horizons within the Capistrano Embayment, the top of the Monterey Formation was selected as the best and most shallow horizon that could be mapped onshore and offshore. The contact of the top of the Monterey onshore outcrop, as mapped by surface workers (1) is shown on this exhibit. Microfaunal data indicate beds near this contact range in age from the lower part of the Upper Mohnian to Lower Mohnian. Sub-surface control on this horizon is provided by wells (microfaunal and electric log data) and seismic profiles. Where applicable, contouring of this horizon has been guided by folds observed in outcrop.

Western Geophysical's seismic "B" horizon (2), which is a "time map" was used to compile the offshore part of this map. Time "picks" on Western's map have been converted to depth using Western's velocities.

An area of "no data" exists between the most landward offshore seismic shot points and the shoreline. However, information from Mobil "San Clemente" No. 1 core hole, depth values from the seismic profiles, and extrapolition of onshore surface and well data to the offshore area--indicate that Western's seismic "B" horizon is approximately equivalent

to the top of the Monterey as contoured onshore. In my opinion, the accuracy of the onshore and offshore contours being equivalent is within 200 feet in elevation of each other.

A faulted anticline is interpreted to lie within the "no data" area mentioned above because of the southwest dip of seismic reflectors and the northeast dip of beds exposed along the shoreline. The dip of onshore beds decreases southeasterly along the shore and becomes nearly horizontal at the San Onofre Site. Quaternary deposits cover most of the older sediments, and surface dip data is quite sparse in the San Mateo Point--San Onofre area.

My structural interpretation of the offshore area is approximately the same as Western's with the exception of the fault near the Mobil "San Clemente" No. 1 core hole. Western, on their "time" map of the "B" horizon, has interpreted a fault southwest of the core hole. I agree that minor faulting may be present southwest of this hole. However, considering the age of the formation (Lower Mohnian) near the sea floor at this location together with the seismic data on Line No. 123, I interpret the main and significant fault to be northeast of the core hole as shown on this exhibit. Evidence of this fault lies between shot points 87 and 99 where:

1. An offset of reflections appear along the axis of a syncline, and
2. The bottom of the syncline has no reflections that flatten as they normally do.

In addition, spurious events (possibly reflected refractions), that could have been generated by this fault, occur between shot points 123 and 99 (see Structure Section K-L).

GENERAL STRUCTURE

From the El Toro area to San Juan Capistrano the overall structural setting of the Capistrano Embayment is a north-south synclinal basin interrupted by some west to northwest trending arches and some minor northwest trending faults. From San Juan Capistrano southward into the offshore area the synclinal basin becomes a series of northwest trending folds and faults nearly parallel to the shore line. Farther to the southeast and southwest the dominant structure is a more homoclinal, dipping southwestward. The South Coast Offshore fault zone comprises the major fault structure offshore.

FAULTING - Response to part (e) NRC question 361.35

Faults that more or less bound the Capistrano Embayment, or are exposed in outcrop outside the Embayment, are the Cristianitos fault on the east and the many faults of the San Joaquin Hills on the west. Faults cutting the Monterey Formation interior to the embayment are relatively rare, but several are shown in Exhibit A-1 generally south of San Juan Capistrano. The more important of these are discussed below. For discussion purposes three new fault names are introduced; these are, from east to west, the "Carr", "Vaciadero", and "Offshore Dana Point" faults.

Evidence for the "Carr" fault includes surface mapping (3), (4), and (5), and sub-surface contour spacing based on closest well control. The fault strikes north-northwest and dips steeply southwest. Its vertical displacement is down to the southwest (see Structure Section C-B). Its trace is obscured on the surface over one mile onshore from the shoreline. However, the shoreward extremities of seismic

lines No. 108 and No. 125 have evidence of faulting with "down-to-the-southwest" displacement. This displacement may possibly be the offshore extension of the "Carr" fault.

At one local area near the onshore surface trace of this fault a thin veneer of Niguel Formation has been mapped showing possible disturbance by this fault (4). The age of the Niguel Formation is probably Late Pliocene (5). Although we find that, in general, the Niguel Formation in the Capistrano Embayment is relatively undisturbed, this possible evidence suggests that the latest movement on the "Carr" fault may have been during the Late Pliocene.

Evidence for the "Vaciadero" fault consists of subsurface contouring based on local well control (dipmeter, paleontological, and electric log data). The fault plane is not exposed at the surface and is, therefore, believed to be older than the "Carr" fault. Its apparent direction of displacement, although larger, is the same as the "Carr" (see Structure Section C-B). Evidence of its strike is lacking. Its strike has been assumed to be similar to the "Carr" fault.

Evidence for the "Offshore Dana Point" fault consists of the low structural position of the seismic "B" horizon (approximate equivalent to the top of the Monterey) near the intersection of seismic lines No. 110 and No. 129 compared to the older surface rocks (San Onofre Breccia) cropping out at Dana Point. This suggests considerable vertical movement, down to the south (see Structure Section C-B). Evidence of "offset" of seismic reflections near the intersection of

line No. 110 and line No. 127 (SP 40), where a down-to-the-southwest displacement is indicated, is interpreted as the southeast extension of the "Offshore Dana Point" fault. If this fault is part of the Laguna Canyon fault zone onshore, as suggested by its alignment, and the two faults are contemporaneous, then the last movement of the "Offshore Dana Point" fault is probably no later than Upper Miocene.

The Dana Point fault has been mapped at the ground surface (1). Its dominant displacement appears to be vertical and down to the northeast, resulting in a horst block in the Dana Point area. Latest movement on this fault was also probably during the Upper Miocene.

The South Coast Offshore fault has been interpreted as a zone of faulting including displacements that are down to the southwest and down to the northeast. In occassional areas possible lateral displacement has been interpreted. Horst blocks within the fault zone have resulted from this variable direction of displacement. The fault zone also varies considerably in width (see Western's Horizon C map (2)). In addition, different age of movement has been involved since only older beds are disturbed in certain areas along the fault zone (see Structure Sections C-B, H-G, and I-J).

Only that part of the South Coast Offshore fault zone nearest the shore is seen at the seismic "B" horizon (near top Monterey). Evidence for this part of the fault zone is seen on seismic line No. 127, where labeled the "South Coast Offshore Fault", and on alignment toward the southeast, on seismic lines Nos. W-10, 145, WS 70-18, and 123.

However, the fault does not continuously displace this horizon although older beds may be disturbed. For example, the fault does not displace seismic horizon "B" on seismic lines Nos. 129 or 125. Some lateral movement (possibly 2500 feet) is suggested by offset contours near the intersection of seismic lines Nos. 145 and WS 70-18.

The Cristianitos fault appears to die out southerly at Monterey depth. However, along the projection of the Cristianitos fault, evidence of faulting of older beds can be observed on seismic line No. 106 (see Structure Section K-L).

Considerable minor faulting based on surface mapping (1) is shown in the central part of T8S, R7W, where Monterey crops out. Due to the lack of significant displacement of the top of the Monterey contact in outcrop, these faults are considered minor. At Monterey depth at more basinward positions the contours accordingly show minor to no displacement on these faults. Since the Niguel Formation, located farther north and west within the Capistrano Embayment has had relatively little fault disturbance, it is believed that movement on these faults in this area probably ceased during the Late Pliocene.

EXHIBIT B - Contours on Top of Cretaceous (Revised)

This exhibit, when formerly submitted under reference (6), was intended basically to demonstrate the Cristianitos fault at Cretaceous depth and its relationship to the January 1975 earthquakes.

The revised map, insofar as available data permits,

represents a better and more accurate regional interpretation of the area at Cretaceous depth because of newly acquired data and further study of faults in conjunction with the construction of the Monterey map, Exhibit A-1.

Most of the revisions of this map are confined to the southwestern portion from the Dana Point--San Clemente area northward into the northern part of T7S, R8W.

Newly acquired seismic data, specifically line No. 147 (discussed further below), contains information that supports the presence of a syncline, an anticline, and possibly, the Shady Canyon fault. The location of this line is plotted on this map and the interpretation of the structure at Cretaceous depth has been revised as shown by the contours.

The position of the Shady Canyon fault has been revised to conform with its interpreted location on line No. 147; that is, it is now shown about 1,000 feet northeast from its former location in the vicinity of line No. 147, but otherwise remains as shown on the original map.

The possible extension of the Shady Canyon fault southeast from the location of line No. 147 is based on Cretaceous well points to the east and estimates of Cretaceous depths west of the fault. More specifically, the Cretaceous depth, -5,360 feet at Roy Gill Krum No. 1, Section 7, T8S, R7W, is regionally fairly shallow. There are no deep holes southeast of the Shady Canyon fault except Roy Gill Forster No. 1, Section 13, T8S, R8W. This hole did not reach the Cretaceous, but it is estimated at -7,000 feet. I interpret this large difference of Cretaceous elevations between the above holes to be due to faulting--partly by the "Carr" fault (discussed above) and partly by the Shady Canyon fault (see Structure Section C-B).

The direction and length of the "Carr" and "Vaciadero" faults at Cretaceous depth have been changed to conform with the Monterey map where their displacement, direction, and length have been discussed above. These faults were not named in the original 1975 report but they can be identified on the original map by referring to Structure Section C-B.

An interpretation at Cretaceous depth of the Laguna Canyon and Temple Hill faults, plus some additional minor faulting have been added in the San Joaquin Hills area because they have been shown by former workers (1) and (4). They probably disturb the Cretaceous, and they show the direction of faulting in this area.

An interpretation is also shown at Cretaceous depth of the offshore anticline (near the shore line) cut by the "Dana Point", "Vaciadero", and "Carr" faults, (discussed above at Monterey depth).

Further Cretaceous mapping offshore was not attempted since the horizon would fall below the "Acoustic Basement" mapped by Western Geophysical (2). Seismic data is undiagnostic below this horizon offshore.

STRUCTURE SECTIONS

Sections A-B, D-E, C-B, and H-G accompanied the 1975 report (6) but they have been corrected to reflect revisions made on Exhibit B and to conform with the Monterey contours and faults shown on Exhibit A-1. Sections C-B and H-G have been extended seaward along seismic lines (2) and two additional sections, I-J and K-L have been prepared along

seismic lines to further demonstrate the geologic interpretation and relationship between the onshore and offshore in the vicinity of the San Onofre Site. Seismic horizons "B" and "C", mapped by Western Geophysical (2), have been converted to depth on these sections. The location of the South Coast Offshore fault zone, discussed above, is noted on the offshore portion of each section.

Section C-B shows the offshore anticline originating with a horst block (projected from Dana Point) and with considerable relief. Also, note that Section C-B shows the "B" horizon undisturbed by the South Coast Offshore fault zone. However, this horizon is shown offset by the landward edge of this fault zone on Section H-G.

Structure Section I-J was selected to fall directly under the San Onofre Site where a shallow hole bottomed at 989' in San Mateo Sands that appear in age to be equivalent to the lower part of the Capistrano. The offshore portion of this section is tied to seismic line No. WS 70-18, which illustrates the South Coast Offshore fault zone that forms a large horst block. The interpretation is partially supported by two shallow core holes, No. 92 and No. 93. These holes were drilled in 1968 by an oil group that was gathering data in preparation for offshore sales. These holes support the presence of a thin veneer of Quaternary and Uppermost Tertiary sediment in the offshore area. Based on these data, a thin, shallow interval of similar age sediments is presumed to be present also in the offshore portion of Section H-G and Section K-L.

Structure Section K-L is supported by the Mobil "San Clemente" No. 1 offshore core hole, total depth 6,130 feet,

seismic offshore data, and onshore surface geology. For reasons given under general comments, Exhibit A-1, the location of the fault immediately shoreward of the above core hole differs from Western Geophysical's interpretation (2). This fault is the landward edge of the South Coast Offshore fault zone.

Annotated Onshore Seismic Reflection Profiles

The following profiles (lines) have been annotated with geology and are discussed below in response to part (c), NRC question 361.35. The line locations are shown on Exhibits A-1 and B.

In general, these profiles have some value in relation to the dip of shallow beds and they have been used to support contours on Exhibit A-1. However, seismic reflections at Cretaceous depth are very poor and have less value. Line 147, the eastern part of line 152, and the Mobil vibroseis lines have partially aided the construction of the Cretaceous map, Exhibit B.

Seismic Line No. 152

The original records (1964), even with modern processing (1975), have resulted in very poor data to interpret. The eastward one-half of this line shows reflections with westward dip. The westward one-half has unreliable data at Cretaceous depth, however, some indication of minor folding at shallow depths occurs between shot points 21 and 28. Evidence of faulting is very weak and, without the benefit of surface geology and well data, the fault interpretation on the Cristianitos fault zone and branch faults

as shown on the annotated section could not be made. Only with the knowledge of the fault locations at the ground surface can the fault planes be extended in depth in the manner shown based upon the appearance of reflections. The dips shown on the fault planes are partly influenced by regional geologic evidence of westward dipping "down-to-the-west" movement on the Cristianitos and associated branch faults. Therefore, the seismic line alone, with no geologic supplementary data, has very little value in determining the age and capability of faults. It does, in general, help to confirm the west dip of the sediments east of the Cristianitos fault.

Vibroseis Line No. 8

This seismic section (1971) has slightly more useful data than N-152. Some evidence of faulting exists which can be interpreted without the aid of surface and sub-surface supplementary geologic information. The best fault evidence consists of the termination and apparent offset of reflections between shot points No. 190 and No. 200, which coincides with a surface fault that is a branch of the Mission Viejo fault. The Mission Viejo fault, however, which is a large fault, has little evidence of offset in the reflections. With the aid of surface geology and well data that falls on this line, a fairly good geologic interpretation is shown on this annotated seismic section. However, in respect to defining and evaluating the age and capability of faults, this seismic line alone--without surface and sub-surface geology has little value. Geologic structure section C-B, which falls partly on this seismic line, suggests that the Mission Viejo Fault and its branches

occurred sometime after the Lower Tertiary. With the surface geology, however, the reflections on vibroseis line No. 8 aid in determining the amount of fault displacement.

Seismic Line No. 147

This line was shot in 1954 and reprocessed in 1964 by Standard Oil. More useable data is present on this line than any other onshore seismic line examined in this area. Still the reflections are comparatively of low quality, but they do define an anticline and a syncline. Faulting is indicated where shown as the possible extension of the Shady Canyon Fault that is mapped on the surface in the San Joaquin Hills area to the northwest. A predominance of northward dipping reflectors (1.5 to 2.5 seconds) is shown on the section--mainly on the southern half. These data probably do not represent geology in the plane of the section. They are believed to be refractions from a source away from the plane of the section--possibly from faults located to the west on the eastern slope of the San Joaquin Hills. The section is supplemented by well data shown annotated along with an interpretation of the geology. Fault evidence is not strong, but the reflections indicate disturbance in the area where the Shady Canyon Fault is interpreted as possibly present. In this case the seismic data suggest that the latest movement on the Shady Canyon Fault was just prior to the deposition of the Monterey, probably during the Middle Miocene.

Seismic Line No. 160

This line was recently acquired from Standard Oil along with line No. 147. It was also shot in 1954 and reprocessed

in 1964 by Standard. Reflections on this line are very poor and there does not appear to be any substantial evidence to support faulting. Some minor folding is suggested in the more shallow beds as shown by the annotated geology. The poor data does partly support the general geology where the line is located on the contour maps--Exhibits A-1 and B.

Well Data

Well data comprise all available information pertaining to logs of "borings" requested under part (d) of NRC question 361.35. In August of 1977 all of the well data was compiled and annotated on electric logs of all holes that had run electric logs. The annotations showed in briefed form all significant data such as dipmeter, cores, sidewalls, tops of geologic horizons, fault interpretations, and paleontology. Where electric logs were not run the history and drillers log were compiled. All of these data were forwarded to the NRC in December 1977.

CONCLUSION

In addition to responses to specific portions of NRC question 361.35, this report includes an illustration (Exhibit A-1) of the most extensive, shallow, and mappable sub-surface horizon onshore and offshore in the San Onofre region. The interpretations shown on this and the additional illustrations suggest that the major tectonic activity within ten miles of the site took place prior to the termination of the Pliocene epoch, possibly two million years before present; and since that time the area has been tectonically quiet--with the exception of the South Coast Offshore fault zone along which some movement probably occurred in the Late Pleistocene. Data that I have examined reveal no additional faults of this or younger age within about five miles of the San Onofre site.

SELECTED REFERENCES

1. MORTON, P.K. MILLER, R.V. FIFE, D.L. 1973- Geo-Environmental Maps, Orange County, California: Calif. Div. of Mines & Geology, Preliminary Report 15

2. So. Calif. Edison Company San Onofre Nuclear Generating Station Units 2 and 3--Preliminary Safety Analysis Report, Amendment No. 11, Appendix 2E, April 1972

3. VEDDER, J.G. YERKES, R.F. SCHOELLHAMER, J.E. 1959- Geologic Map of The San Joaquin Hills, San Juan Capistrano Area, Orange County, California: U.S. Geological Survey Oil and Gas Investigations Map OM 193

4. EDGINGTON, W.J. 1974- Geology of The Dana Point Quadrangle, Orange County, California: Calif. Div. of Mines & Geology, Special Report 109

5. VEDDER, J.G. Revised geologic map, structure sections, and well table, San Joaquin Hills--San Juan Capistrano area, California; USGS Open File Report 75-552

6. So. Calif. Edison Company San Onofre Nuclear Generating Station Units 2 and 3--Recent Geotechnical Studies, Southern Orange County, California, Vol. II, Enclosure 3, February 1976

7. EHLIG, P.L. FARLEY, T. Geology Map Adjacent to San Onofre Nuclear Generating Station-- Unpublished 1978

T.5S,R.8W.
T.5S,R.7W.
T.5S,R.6W.
T.6S,R.8W.
T.6S,R.7W.
T.6S,R.6W.
T.7S,R.8W.
T.7S,R.7W.
T.7S, R.6 W.
T.8S,R.8W.
T.9S,R.7W.
T.9S,R.6W.
EL TORO
MARINE CORPS
AIR
STATION
CAMP PENDLETON
MARINE CORPS BASE
Arriba
Ficklin
#1
TD 3856
SHADY CANYON FAULT
LAGUNA CANYON FAULT
TEMPLE HILL FAULT
ZONE
MONTEREY OUTCROP
CRISTIANITOS
FAULT
MONTEREY OR OLDER
Surface Syncline
VACIADERO
FAULT
"CARR"
FAULT
DANA POINT
"OFFSHORE" DANA POINT FAULT
SOUTH COAST OFFSHORE FAULT
SAN JOAQUIN HILLS "HIGH"
MONTEREY BUTTRESSED AGAINST SAN
GREAT BASIN
C.H. NO. 53
T.D. 750'
MOBIL
S.C. NO. 1
T.D. 6130'
A
B
C
D
E
G
H
I
J
K
L
LEGEND
500 Contour Interval (sub-sea)
Abandoned exploratory hole or core hole
Abandoned oil well
Control Well (Monterey)
TD Total Depth
-1755 Subsea point on Top Monterey (Offshore point is Seismic "B" Horizon which is approx. equivalent to Top Monterey)
Seismic shot point (onshore)
Seismic shot point (offshore)
T Township
R Range
S South
W West
Fault, dip direction shown
Anticline
Surface Syncline (projected from surface)
Monterey or equivalent outcrop
Monterey covered
NOTE:
① Onshore surface faults and Monterey Outcrop after:
a.) Morton P.K., Miller R.V., Fife D.L., 1973; Geo-Environmental Maps Orange Co., CA: Calif. Div. of Mines & Geology, Preliminary Report 15.
b.) Ehlig P.L., & Farley T., 1978, unpublished mapping San Diego County.
② Offshore contours in part after:
Western Geophysical Seismic Lines (Time converted to depth)
So. Cal. Edison Co., San Onofre Gen. Stn. Units 2 & 3
PSAR Amendment No. 11, Appendix 2E, April, 1972.
③ Fault names "CARR", "VACIADERO" and "OFFSHORE" DANA PT. FAULTS used for this report only.
EXHIBIT A-1
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CAPISTRANO AREA
ORANGE COUNTY, CALIFORNIA
Generalized Contours near
Top Monterey
PREPARED FOR SOUTHERN CALIFORNIA EDISON COMPANY
SAN ONOFRE PROJECT, UNITS 2 & 3
0 2000 4000 FT.
DATE: DECEMBER, 1978

T5S,R8W.
T5S,R7W.
T5S,R6W.
BASEMENT
COMPLEX
OUTCROP
FAULT
T6S,R8W.
T6S,R7W.
T6S,R6W.
CRISTIANITOS FAULT ZONE AT CRETACEOUS DEPTH
ALISO
FAULT
CRETACEOUS
OUTCROP
E
A
TO SHELL "IRVINE ONE"
D
SHADY
CANYON
FAULT
T.7S,R8W.
T.7S,R.7W.
T7S,R6W.
B
TEMPLE
HILL
FAULT
LAGUNA CANYON FAULT ZONE
Jan. '75 Epicenters
No.1
No.2
MOBIL VIBROSEIS LINE
MISSION
VIEJO
FAULT
FORSTER
BRANCH
G
F
"CARR"
"VACIADERO"
FAULT
R8W.
T8S,R7W.
T8S,R6W.
DANA PT FAULT
"OFFSHORE" DANA PT FAULT
CAMP PENDLETON MARINE CORPS BASE
C
H
T.9S,R7W.
T9S,R6W.
LEGEND
1000' Contour Interval (locally -500')
Abandoned Exploratory Hole or Core Hole
Abandoned Oil Well
TD Total Depth
-5640 Subsea Point on Top Cretaceous
T Township
R Range
S South
W West
DIPMETER
INTERSECTION OF FAULT ZONE WITH TOP OF CRETACEOUS ON "DOWN" SIDE OF FAULT
CRISTIANITOS FAULT ZONE
INTERSECTION OF FAULT ZONE WITH TOP CRETACEOUS ON "UP" SIDE OF FAULT.
Fault
Control Wells (Cretaceous)
Anticline
Syncline
Cretaceous Outcrop
Basement Complex Outcrop
NOTE: Surface Geology for Cretaceous & Basement Complex Generalized after Morton P.K., Miller R.V., Fife D.L., 1973, GEO-ENVIRONMENTAL MAPS ORANGE CO., CA.: Calif. Div. of Mines & Geology, Preliminary Report 15.
N
EXHIBIT B
JACK C. WEST
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CAPISTRANO AREA
ORANGE COUNTY, CALIFORNIA
GENERALIZED CONTOURS ON BASE TERTIARY - TOP CRETACEOUS
PREPARED FOR SOUTHERN CALIFORNIA EDISON COMPANY
SAN ONOFRE PROJECT-UNIT 2&3
0 2000 4000 FT.
DATE JULY 1975
REV. NOV. 1978


D
E
SHELL
C.F. 26
Sec. 16 T 7 S, R 8 W
Elev 303'
1951
S.P. 701
Elev 220'
SHELL OIL CO.
S.P. 712
Sec. 9 T 7 S, R 8 W
Elev 194'
S.P. 723
Elev 285'
S.P. 734
Elev 360'
C.H. 14
Elev 195'
S.P. 745
Elev 200'
SHELL OIL CO.
Sec. 10 T 7 S, R 8 W
S.P. 756
Elev 239'
C.F. 45
Elev 223'
C.F. 40
Elev 230'
S.P. 778
Elev 260'
SHELL OIL CO.
S.P. 789
Sec. 11, T 7 S, R 8 W
Elev 310'
S.P. 800
Elev 337'
SHELL C.F. # 35
Sec. 12 T 7 S, R 8 W
Elev 311'
1952
SHELL C.F. # 36
Sec. 12 T 7 S, R 8 W
Elev 448'
1952
SHELL C.F. # 37
Sec. 7 T 7 S, R 7 W
Elev 684'
1952
SHELL
C.F. 38
Sec. 8 T 7 S, R 7 W
Elev 462'
C.F. # 41
Elev 583'
1952
SHELL
C.F. 39
Sec. 9 T 7 S, R 7 W
Elev 676'
1952
SEA LEVEL
MONTEREY FM.
SAN ONOFRE BRECCIA
TOPANGA
VAQUEROS
SESPE
SANTIAGO
SILVERADO
WILLIAMS
SHADY CANYON FAULT
QUATERNARY Quaternary
QUATERNARY Alluvium
CAPISTRANO
SILTSTONE
TD 860'
TD 502'
TD 500'
TD 501'
TD 512'
TD 563'
TD 1021'
TD 2723'
NON MARINE VAQUEROS (IN PART)
NIGUEL
PLIOCENE
UPPER MIOCENE
MIDDLE MIOCENE
LOWER MIOCENE
OLIGOCENE
EOCENE
PALEOCENE
CAPISTRANO
MONTEREY
SAN ONOFRE BRECCIA
TOPANGA - VAQUEROS
(UNDIFF.)
SESPE
SANTIAGO
SILVERADO
WILLIAMS
TD 895'
TD 662'
TD 699'
TD 766'
TD 1016'
TD 704'
SAN ONOFRE BRECCIA
SESPE
CRISTIANITOS FAULT ZONE
QUATERNARY
Terrace & Alluvium (Undiff)
SESPE FM.
TERTIARY
SANTIAGO FM.
SILVERADO FM.
WILLIAMS FM.
LADD FM.
CRETACEOUS
TRABUCO FM.
BASEMENT COMPLEX
JURASSIC
1000 Meters
5000 FT
2000 M
3000 M
10,000 FT
4000 M
1000 M
5000 FT
2000 M
3000 M
10,000 FT
PLAN VIEW
0 4000 8000 FT
T 7 S, R 8 W
T 7 S, R 7 W
LEGEND
Abandoned Oil Well
Abandoned Exploratory Hole or Core Hole
1969 Year of Abandonment
Electric Log Curve
Dipmeter corrected to line of section
10° - Dipmeter reading
Core Dip (direction interpretative)
Unconformable formation contact
Conformable formation or member contact
Interbedded or gradational marine and non-marine formation or member contact
TD = Total Depth
SEC = Section
T = Township
R = Range
S = South
W = West
SS = Sandstone
SH = Shale
CG = Conglomerate
LS = Limestone
FM = Formation
MBR = Member
(Undiff) = Undifferentiated
SURFACE GEOLOGY REFERENCES
1 Morton, P.K., 1970, Geology of the NE 1/4 and NW 1/4 Canada Gobernadora Quadrangle, Orange Co., Ca Calif Div of Mines & Geology, Preliminary Report 10
2 Morton, R.K., Edgington, W.J., & Fife, D.L., 1974, Geology and Engineering Geologic Aspects of the San Juan Capistrano Quadrangle, Orange Co. Ca Calif Div of Mines & Geology, Special Report 112
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CONSULTING PETROLEUM GEOLOGIST
CAPISTRANO AREA
ORANGE COUNTY, CALIFORNIA
GEOLOGIC STRUCTURE SECTION
D-E
PREPARED FOR SOUTHERN CALIFORNIA EDISON COMPANY
SAN ONOFRE PROJECT UNIT-2&3
0 500 1000 FEET
DATE JULY, 1975
Rev. Dec. 1978

H
G
LANDWARD PORTION
WESTERN GEOPHYSICAL SEISMIC LINE — 127
(migrated depth section)
SP88
SP76
SP64
SP52
SP40
SP28
SEA LEVEL
OCEAN BOTTOM
CAPISTRANO
SEISMIC HORIZON "B"
UPPER MIOCENE
MONTEREY
SEISMIC HORIZON "C"
MIDDLE MIOCENE
SOUTH COAST OFFSHORE FAULT ZONE
(APPROX. EQUIV. TOP MONTEREY) "B"
"C" (APPROX. EQUIV. TO TOP SAN ONOFRE)
SAN ONOFRE BRECCIA
OFFSHORE DANA POINT FAULT
"VACADERO" FAULT
CRETACEOUS ?
"CARR" FAULT
SHADY CANYON FAULT ?
GUTHRIE (HANCOCK) KRUM #65-21
1956
TEXAS CO. O'NEILL EST. NCT#2-1
1954
TEXAS CO. O'NEILL EST. NCT#1-1
1954
TEXACO O'NEILL CH #1
1964
MONTEREY
TOPANGA VAQUEROS (UNDIFF)
SESPE
SANTIAGO
SILVERADO
WILLIAMS
TERTIARY
CRETACEOUS
PLEASANTS
SCHULZ
HOLZ
LADD
TRABUCO
BASEMENT COMPLEX
CRISTIANITOS FAULT ZONE
SANTIAGO FM.
SILVERADO FM.
WILLIAMS FM.
PLEASANTS
SCHULZ
HOLZ
LADD FM.
TRABUCO FM.
CRETACEOUS
JURASSIC
EOCENE
PALEOCENE
PLEASANTS SS. MBR.
SHULZ SS. MBR.
HOLZ SHALE MBR.
BAKER CANYON CG. MBR.
TRABUCO FM.
MISSION VIEJO FAULT
BASEMENT COMPLEX
1000M
5000FT.
2000M
3000M
10,000FT.
PLAN VIEW H-G (Extended offshore)
LINE-127
SHORE LINE
INTERSTATE 5
4000 FT.
Offshore Sub-Surface Geology after Western Geophysical Company, in part: So. Calif. Edison Co., San Onofre Gen. Sta. Units 2 & 3, PSAR, Amendment No. II, Appendix 2E, April 1972
PLAN VIEW
LEGEND
Abandoned Oil Well
Abandoned Exploratory Hole or Core Hole
1969 Year of Abandonment
Electric Log Curve
Dipmeter corrected to line of section
Dipmeter reading
Core Dip (direction interpretative)
Unconformable formation contact
Conformable formation or member contact
Interbedded or gradational marine and non-marine formation or member contact
TD = Total Depth
SEC = Section
T = Township
R = Range
S = South
W = West
SS = Sandstone
SH = Shale
CG = Conglomerate
LS = Limestone
FM = Formation
MBR = Member
(Undiff) = Undifferentiated
SURFACE GEOLOGY REFERENCES
1. Morton, P.K., 1972, Reconnaissance Geology of the Northeast portion of the San Clemente Quadrangle, Orange Co., Ca. Calif. Div. of Mines, Unpublished Map
2. Blanc, R.P., & Cleveland, G.B., 1968, Natural Slope Stability as Related to Geology, San Clemente Area, Orange & San Diego Cos., Ca. Calif. Div. of Mines & Geology, Special Report 98
JACK C. WEST
CONSULTING PETROLEUM GEOLOGIST
CAPISTRANO AREA
ORANGE COUNTY, CALIFORNIA
GEOLOGIC STRUCTURE SECTION
H-G
PREPARED FOR SOUTHERN CALIFORNIA EDISON COMPANY
SAN ONOFRE PROJECT UNIT 2&3
0 500 1000FEET
DATE JULY 1975
REV. DEC. 1978

I

J

LANDWARD PORTION

WESTERN GEOPHYSICAL SEISMIC LINE WS 70-18

(Migrated Depth Section)

SP 234 SP 222 SP 210 SP 198 SP 186 SP 174 SP 162 SP 150 SP 138 SP 126

CORE HOLE No. 93 (Projected)

CORE HOLE No. 92 (Projected)

SEA LEVEL

OCEAN BOTTOM

PLEISTOCENE

PLIOCENE (Top Fanita)

Quaternary sand

Repetto

TD 750'

TD 790'

UPPER MOHNIAN

LOWER MOHNIAN

CAPISTRANO FM.

"B" Horizon (Approx Equivalent to Top Monterey)

Seismic "B" Horizon

UPPER MIOCENE

MONTEREY FM.

?

LUISIAN

"C" Horizon (Approx Equivalent to Top San Onofre)

SAN ONOFRE BRECCIA

MIDDLE MIOCENE

Seismic "C" Horizon

SOUTH COAST OFFSHORE FAULT ZONE

1000 M

3000 FT

2000 M

10,000 FT

SAN ONOFRE GEN. STN.

S.O. UNIT No.3 BORING 1

Elev. 89' KB

N 46°E W 71°E N 80°E

Shore Line Quaternary Interstate 5 Monterey 28° (Projected) 35° (Proj.) 15° (Proj.)

20/21° True

SEA LEVEL

SAN MATEO - L. CAPISTRANO (Undifferentiated)

TD 989'

MONTEREY

SAN ONOFRE BRECCIA

SANTIAGO

EOCENE

SAN ONOFRE BRECCIA

SANTIAGO

CRISTIANITOS FAULT

1000 M

3000 FT

2000 M

SP = Seismic Shot Point

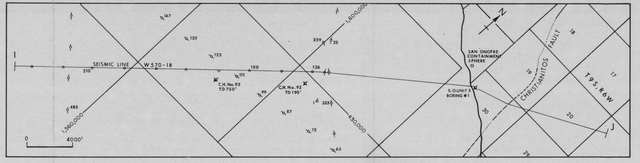
—— Conformable Fm. Contact

~~~ Unconformable Fm. Contact

NOTE: Onshore Surface Geology after Ehlig & Farley unpublished mapping 1976.

Offshore Sub-Surface Geology after Western Geophysical Company, in part; So. Calif. Edison Co., San Onofre Gen. Stn., Units 2 & 3, PSAR, Amendment No.11, Appendix 2B, April 1972.

PLAN VIEW



JACK C. WEST

CONSULTING PETROLEUM GEOLOGIST

CAPISTRANO AREA

SAN DIEGO COUNTY, CALIFORNIA

Geologic Structure Section I-J

PREPARED FOR SOUTHERN CALIFORNIA EDISON CO.

SAN ONOFRE PROJECT UNIT 2 & 3

0 1000 2000 FEET

DEC. 1978
~~~

LANDWARD PORTION

WESTERN GEOPHYSICAL SEISMIC LINE #123

K

L

SP123 SP111 SP99 SP87 SP75 SP63 SP51 SP39 SP34 N38E

MOBIL SAN CLEMENTE #1 Elev. 35' KB

SEA LEVEL

OCEAN BOTTOM

CAPISTRANO "B" HORIZON

Lower Pebble 600' (1st temple)

TOP SAND 1

2

MONTEREY SAND

3 BASE SAND 3700'

4

TOP SAN ONOFRE 4320' (Lutitas) 4700'

5

SAN ONOFRE BRECCIA

6

T.D. 6130'

NOTE: DIAGRAMMATIC ELECT. LOG CURVES

1000M

5000 FT

2000M

3000M

10,000 FT

SOUTH COAST OFFSHORE FAULT ZONE

? L. PLIOCENE ? RECENT - U. PLIOCENE (undifferentiated) ?

SEISMIC "B" HORIZON (APPROX. TOP MONTEREY) (LOWER MOHNIAN)

UPPER MIOCENE

MONTEREY ? SAND

(APPROX. EQUIV. TOP SAN ONOFRE)

SEISMIC "C" HORIZON

MIDDLE MIOCENE

CRISTIANITOS FAULT ?

CAPISTRANO FM.

MONTEREY FM.

SAN ONOFRE BRECCIA

Shoreline N40E

QUAT. Landslide

QUATERNARY Terrace

SEA LEVEL

MIDDLE MIOCENE

SANTIAGO

EOCENE

1000M

5000FT

2000M

SP = Seismic Shot Point

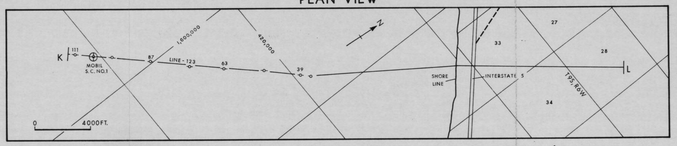
Conformable Fm. Contact

Unconformable Fm. Contact

NOTE: Onshore Surface Geology after Ehlig & Farley unpublished mapping 1978.

Offshore Sub-Surface Geology after Western Geophysical Company, in part; So. Calif. Edison Co., San Onofre Gen. Sta., Units 2 & 3, PSAR, Amendment No. 11, Appendix 2E, April 1972.

PLAN VIEW



JACK C. WEST

CONSULTING PETROLEUM GEOLOGIST

CAPISTRANO AREA

SAN DIEGO COUNTY, CALIFORNIA

Geologic Structure Section K-L

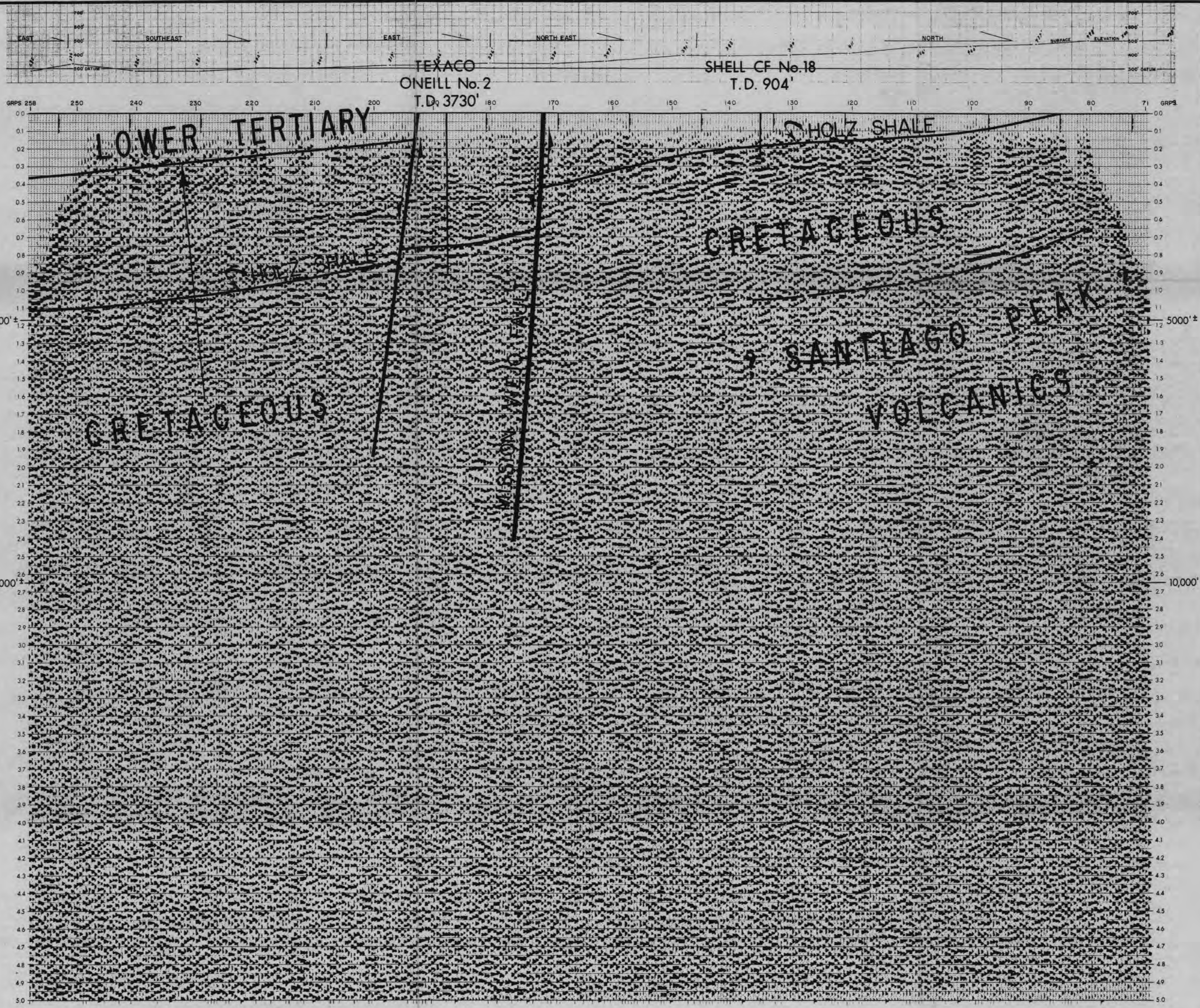
PREPARED FOR SOUTHERN CALIFORNIA EDISON CO.

SAN ONOFRE PROJECT UNIT 2 & 3

0 1000 2000 FEET

DEC. 1978


LINE: N 152
S.P. : 1-31
SOUTHWEST
SOUTHERN CALIFORNIA EDISON COMPANY
PARTY 32
SAMPLE RATE 4 MS.
PROCESS: DIGITAL 100% RECORDS
LINE: N 152
DATUM PLANE: SEA LEVEL
WESTERN GEOPHYSICAL
RECORDING
AMPLIFIER :
A. V. C. : FAST
DATE : SEPTEMBER, 1954
SYSTEM : DYNAMITE
FILTER : 25-47 50%
SPREAD : 600'-0'-600'
S. P. INT. : 600 (VARIABLE)
GRP. INT. : 55' (VARIABLE)
PHONES / GRP. : 3
PROCESSING
1. TRANSCRIPTION
2. REFORMAT
3. DECONVOLUTION
4. FILTER
5. DYNAMIC AND STATIC CORRECTIONS
6. DISPLAY
DECONVOLUTION INFORMATION
TIME VARIANT MINIMUM PHASE INVERSE FILTER
AUTO. CORR. INT. : 3 ZONES OF 1573 MS.
SEARCH ZONE : 32 MS.
OPERATOR LENGTH: 172 MS.
TIME ZONE : 0.0-5.0 SEC.
TIME VARIANT FILTER
TIME ZONE | L.C. (CPS) H.C.
.02 - .8 SEC. 20/24 56/36
.8 - 2.5 SEC. 14/24 44/36
2.5 - 3.5 SEC. 10/24 32/36
3.5 - 5.0 SEC. 8/24 20/36
PLAYBACK
DATE : JULY 17, 1975
REEL : 524140
CRISTIANITOS FAULT ZONE
SOUTHERN CALIFORNIA EDISON COMPANY
Seismic Line No. N 152
PURCHASED FROM CHEVRON
GEOLOGIC ANNOTATIONS
By
Jack C. West
Consulting Petroleum Geologist
Note: Original records shot in 1954
For shot point locations refer to map - contours near top Monterey - shale 1" = 4000' by J.C.W.
December 1978
ELEVATION
DEPTH (APPROXIMATE)
CAPISTRANO FM
MONTEREY FM
SAN ONOFRE BRECCIA
SAN ONOFRE
SAN ONOFRE
SAN ONOFRE
SANTIAGO FM.
LOWER TERTIARY
SILVERADO FM.
CRETACEOUS
CRETACEOUS
BASEMENT



LINE 8
V.P's 84 - 244
AREA ORTEGA
LOCATION ORTEGA HWY 74
DATUM 300'

MOBIL OIL CORP.

FIELD RECORDING DATA

RECORDED BY G.S.I. PARTY 139 DATE JAN. 1971
ENERGY SOURCE VIBROSEIS SWEEP FREQ 14 - 56 SWEEP LENGTH 8 SEC
ENERGY PATTERN 4 VIBRATORS INLINE INSTRUMENTS 10,000
GROUP INTERVAL 200' GROUP PATTERN 36 INLINE
STANDARD SHOT POINT INTERVAL 400'
STANDARD SPREAD 5500'-900'-0-900'-5500'
MULTIPLICITY 12 FOLD RECORDING FILTER 12/24-52
AMPLITUDE CONTROL STRAIGHT SAMPLE RATE 4 MS

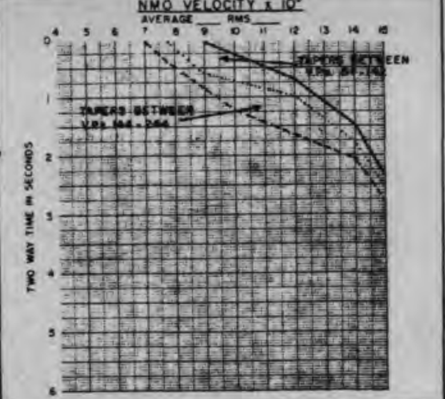
DIGITAL PROCESSING SEQUENCE

PROCESSING SAMPLE RATE 8 MS

1 DIVERSITY STACK
2 CORRELATION
_ TRACE EDIT
_ GAIN REMOVAL AND TRUE AMPLITUDE RECOVERY
3 VELOCITY ANALYSIS
4 DATUM STATIC CORRECTION (CORRECTION VELOCITY 5000 fps.)
4 NORMAL MOVEOUT CORRECTION
_ RESIDUAL MOVEOUT CORRECTION
_ RESIDUAL STATIC CORRECTIONS
_ TIME VARYING TRACE EQUALIZATION
5 12 FOLD COMMON DEPTH-POINT STACK
5 FIRST BREAK SUPPRESSION
6 TIME VARIANT DECONVOLUTION 16 PTS 8 MS
NUMBER OF OPERATORS 4 GATE 4.400 SEC.
_ TIME VARIANT DIGITAL FILTER ___ PTS ___ MS
8 DIGITAL FILTER 35 PTS 8 MS
7 TIME VARIANT SCALING

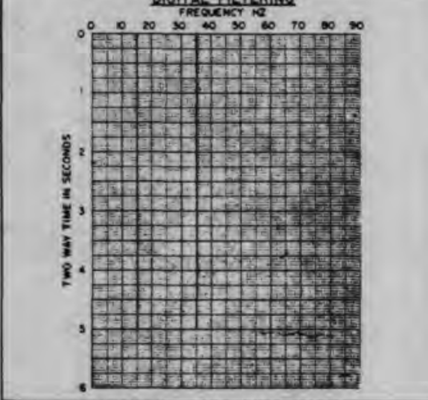
NMO VELOCITY x 10³

AVERAGE ___ RMS ___



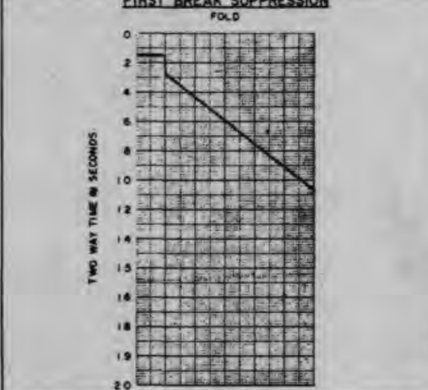
DIGITAL FILTERING

FREQUENCY HZ



FIRST BREAK SUPPRESSION

FOLD



DISPLAY DATA

ANALOG FILTER High OUT Low OUT
ANALOG GAIN 12 + 6 - 4 ANALOG MIX NONE
NORMAL X INTERCHANGE ___
SCALE Horizontal 12 tr/in Vertical 5 in/sec
REQ NO 1682 HT NO 0-139-630 REC NO 354-373
QUALITY CONTROL CHECK ___
APPROVED BY ___

GEOPHYSICAL SERVICE INC.

SOUTHERN CALIFORNIA EDISON COMPANY

Mobil Vibroseis Line No. 8

PURCHASED FROM MOBIL

GEOLOGIC ANNOTATIONS

By

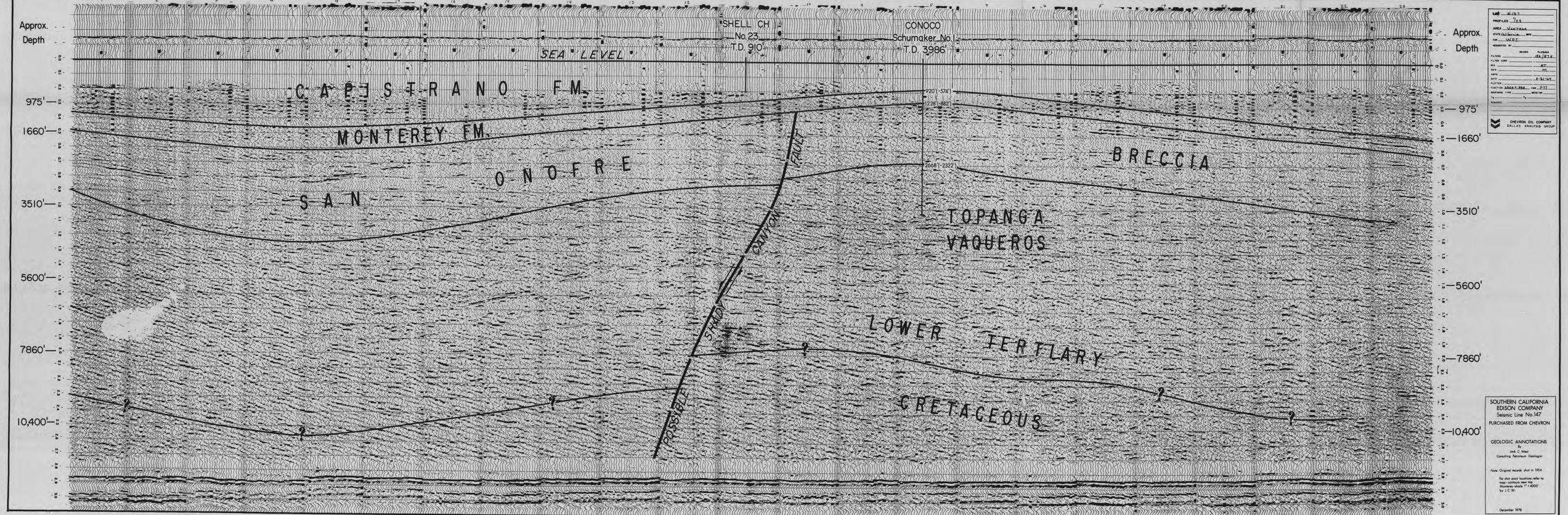
Jack C. West

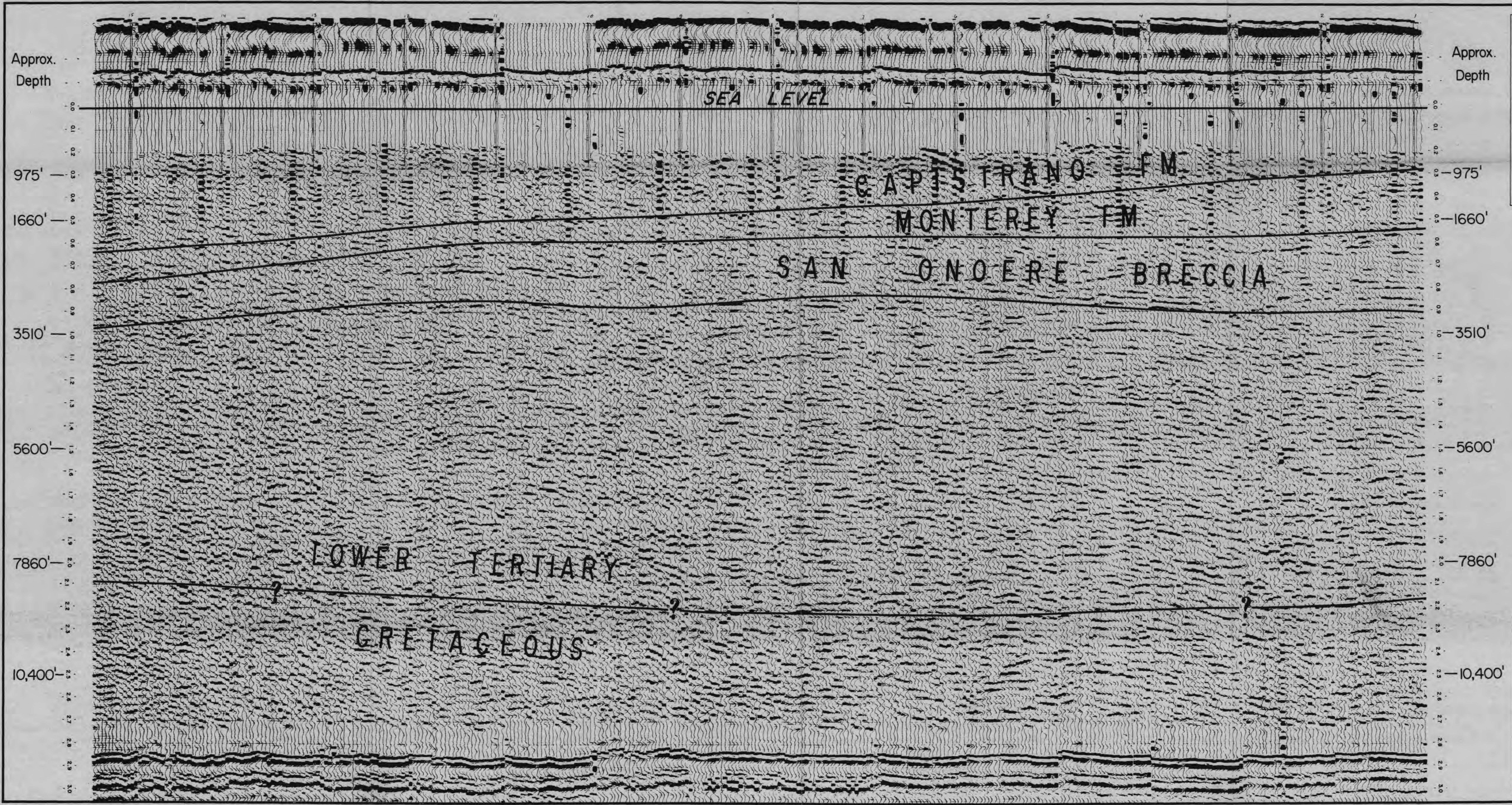
Consulting Petroleum Geologist

Note: Shot in 1971

For shot point locations refer to map-contours near top Monterey-shale 1" = 4000' by J.C.W.

December 1978


Approx. Depth
"SHELL CH" No.23 T.D. 910'
CONOCO Schumaker No.1 T.D. 3986'
SEA LEVEL
CAPISTRANO FM.
MONTEREY FM.
SAN ONOFRE
BRECCIA
TOPANGA
VAQUEROS
LOWER TERTIARY
CRETACEOUS
PASSIVE
SHADY
CANYON
FAULT
920' (-574')
1228' (-882')
2068' (-2322')
975'
1660'
3510'
5600'
7860'
10,400'
Approx. Depth
975'
1660'
3510'
5600'
7860'
10,400'
CHEVRON OIL COMPANY
DALLAS ANALYSIS GROUP
SOUTHERN CALIFORNIA EDISON COMPANY
Seismic Line No.147
PURCHASED FROM CHEVRON
GEOLOGIC ANNOTATIONS
By
Jack C. Weir
Consulting Petroleum Geologist
Note: Original records shot in 1954
For shot point locations refer to map - contours read top Monterey - shale 1"= 4000'
by J.C.W.
December 1978



LINE N160
PROFILES 16/1
AREA VENTAGE
STATE California
FOR WOI
REQUESTED BY
RECORD
FILTERS 18K/57K
FILTER TYPE
MIX ST
GAIN M
AMPS
DATE 8-24-64
PLOTTER
FUNCTION 6305I:4DZ 5-77
GEOPHONE TYPE
REMARKS
CHEVRON

SOUTHERN CALIFORNIA EDISON COMPANY
Seismic Line No.160
PURCHASED FROM CHEVRON

GEOLOGIC ANNOTATIONS
By
Jack C. West
Consulting Petroleum Geologist

Note: Original records shot in 1954

For shot point locations refer to map - contours near top Monterey-shale 1"=4000' by J.C.W.

December 1978