A STUDY OF THE SUBSURFACE CONDITIONS PREVAILING IN THE NEWHALL-POTRERO OIL FIELD

Thesis by

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Frontispiece

Panorama of Potrero Canyon. View looking from the southeast (taken at point "A" on Plate II), showing the Newhall-Potrero oil field in the middle distance. The rough cliff face on the extreme right is composed of the basal Saugus.

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ACKNOWLEDGEMENTS

The writer wishes to expresse his appreciation to Mr. A. T. Lee of the Barndall Oil Company, without whose help in interpreting the well logs this report would not have been possible; to the Barnsdall Oil Company for making the logs available; and to Dr. J. Wyatt Durham and Dr. Hampton Smith of the California Institute of Technology for their helpful suggestions and criticisms.

ABSTRACT

The Newhall-Potrero Oil Field is a long, narrow, asymmetrical anticline whose longitudinal axis trends northwest-southeast. From a critical examination of many of the electric logs of the field, it is apparent that lensing of sands, thickening and thinning of both sands and shales, and rapid facies changes are prevalent throughout the field. Several of the oil sands in the Miocene either lens out or die out due to facies changes toward the southeast. Two faults of major displacement are well shown in the logs of four wells, with other faulting probably occuring. A stratigraphic correlation chart is presented to illustrate the rapid lithologic changes which prevail in the field.

The Newhall-Potrero anticline is exposed on the surface in the hills north of the Potrero, but seems to die out to the southeast. The rocks encountered at depth in the wells of the Newhall-Potrero field outcrop to the south, but no accurate correlations between the surface exposures and the well logs were possible.

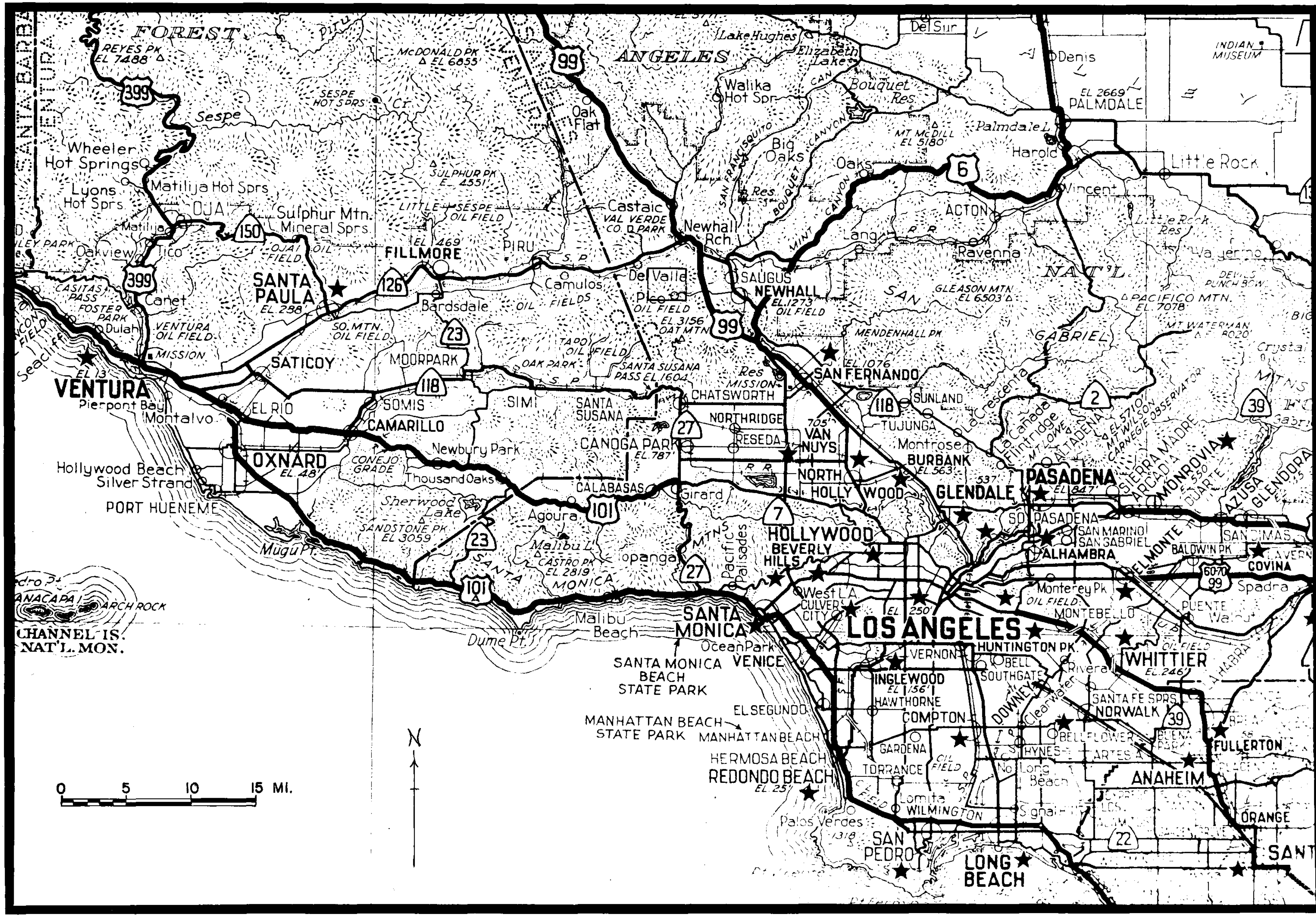

FOREST
ANGELES
SANTA BARBARA
VENTURA
REYES PK EL 7488
McDONALD PK EL 6855
SESPE HOT SPRS.
Sespe
Wheeler Hot Springs
Lyons Hot Sprs.
Matilija Hot Sprs
OJAI
Matilija
Sulphur Mtn. Mineral Sprs.
Oakview
Tico
Casitas Pass
Foster Park
Dulah
Canet
Ventura Oil Field
Mission
Seacliff
VENTURA
EL 13
Pierpont Bay
Montalvo
EL RIO
Hollywood Beach
Silver Strand
PORT HUENEME
OXNARD
EL 48
SANTA PAULA
EL 258
FILLMORE
PIRU
SATICOY
Bardsdale
MOORPARK
SOMIS
CAMARILLO
Newbury Park
Conejo Grade
Thousand Oaks
Sherwood Lake
Sandstone Pk EL 3059
Mugu Pt.
Agoura
Malibu L.
Castro Pk EL 2819
SANTA MONICA
Topanga
Dume Pt.
Malibu Beach
SIMI
SANTA SUSANA
CANOGA PARK
EL 787
CALABASAS
Girard
Camulos
Del Valle
Oak Flat
Castaic
Val Verde Co. Park
Newhall Rch.
SAUGUS
NEWHALL
EL 1273
Santa Susana Pass EL 1604
CHATSWORTH
NORTHRIDGE
RESEDA
VAN NUYS
NORTH HOLLYWOOD
SAN FERNANDO
EL 1076
SUNLAND
TUJUNGA
Montrose
BURBANK
EL 563
GLENDALE
PASADENA
EL 847
LaCrescenta
La Canada Flintridge
Altadena
Mt. Wilson Carnegie Observatory
Sierra Madre
Arcadia
Monrovia
Duarte
Azusa
Glendora
HOLLYWOOD
BEVERLY HILLS
Pacific Palisades
SANTA MONICA
Ocean Park
VENICE
West L.A.
Culver City
LOS ANGELES
EL 250
SO. PASADENA
San Marino
San Gabriel
ALHAMBRA
El Monte
Baldwin Pk
San Dimas
COVINA
Spadra
Monterey Pk
Montebello
Puente
WHITTIER
EL 246
VERNON
HUNTINGTON PK.
Bell
Southgate
Rivera
Downey
Clearwater
Santa Fe Sprs.
NORWALK
INGLEWOOD
EL 156
HAWTHORNE
COMPTON
GARDENA
TORRANCE
Bellflower
Hynes
Artesia
Buena Park
ANAHEIM
FULLERTON
ORANGE
SANTA
Lomita
WILMINGTON
Signal Hill
North Long Beach
LONG BEACH
SAN PEDRO
Palos Verdes
REDONDO BEACH
EL 25
HERMOSA BEACH
MANHATTAN BEACH
EL SEGUNDO
MANHATTAN BEACH STATE PARK
SANTA MONICA BEACH STATE PARK
ANACAPA I.
ARCH ROCK
CHANNEL IS. NAT'L. MON.
Lake Hughes
Elizabeth Lake
Del Sur
Denis
INDIAN MUSEUM
EL 2669
PALMDALE
Palmdale L.
Harold
Little Rock
Vincent
ACTON
Ravenna
Lang
Walika Hot Spr.
Bouquet Res.
Big Oaks
Mt. McDill EL 5180
SAN GABRIEL
NAT'L.
Gleason Mtn. EL 6503
Pacifico Mtn. EL 7078
Mendenhall Pk
Mt. Waterman
N
0 5 10 15 MI.
99
399
150
126
23
118
101
27
7
6
2
39
60-70 99
22

PLATE I

PLATE I

Map of a portion of Southern California showing location of the Newhall-Potrero and Pico Canyon oil fields. Outlined area indicates approximate extent of aerial photograph reproduced in Plate II.

INTRODUCTION

Location of the area

The Newhall-Potrero Oil Field lies in a small valley or potrero in the northern foothills of the Santa Susana Mountains, between the old productive Pico Canyon field on the south and the Santa Clara River on the north, and about six and a half miles west of the town of Newhall, Los Angeles County, California. The southeast portion of the field lies in the extreme northern portion of the Pico Quadrangle of the United States Geological Survey, and is shown on Plate I.

The field may be reached by an oiled road connecting with U. S. Highway 99 about two miles west of Newhall. Barnsdall Oil Company, discoverer of the field, holds all the proved and adjoining acreage, except two small areas on the extreme northwestern and southeastern tips of the field.

Size of the area

The Newhall-Potrero Oil Field proper is about one-half mile wide and three miles long, trending in a northwesterly direction from the southeastern end of Potrero Canyon, but an area extending about two miles further south, as far as the Pico anticline, was mapped for the purpose of correlating surface exposures with the well logs.

Purpose of the investigation

The area considered in this report, and the well logs studied, were investigated as a partial fulfillment of the requirements for the degree of Master of Science at the California Institute of

Technology. This particular area was selected at the suggestion of Dr. John H. Maxson, then at the Institute, with the idea of correlating surface exposures in the Pico Canyon area with subsurface data in the Newhall-Potrero field.

Method of investigation

The recording of field data was done on aerial photographs with a scale of 1000 feet to the inch, and on a U. S. G. S. topographic sheet, the Pico Quadrangle, edition of 1940, enlarged to the same scale from 1:24000. Field data was obtained by walking the contacts and individual beds, and measuring attitudes with a Brunton compass. A pace and compass traverse was made of a portion of the section exposed in Pico Canyon

Structural features, where they affected the section between Pico Canyon and Potrero Canyon were mapped. No particular paleontological problem was studied, although numerous fossils were collected to aid in surface correlations.

Thirty-three electric logs from wells in the Newhall-Potrero field were studied in detail. These logs were selected from representative wells along the structure from the northwest end to the southeast end. For convenience in studying them, the logs were reduced photographically to a suitable size, arranged systematically from northwest to southeast, and lines of correlation drawn between them. After correlations had been completed over most of the section represented, they were traced on frosted acetate and black-and-white prints made. Structure contour maps were also prepared on frosted acetate.

PHYSICAL CONDITIONS

Relief and elevation

The lowest elevation in the area is in the bottom of the Potrero Canyon at about 1000 feet. Except for the rimrocks to the north which attain an elevation of about 1500 feet, the relief in Potrero Canyon area can be expressed in little more than 100 feet, with low rolling hills predominating. To the south the hills rise gradually to 2000 feet north of Pico Canyon, where the relief is of the order of 700-800 feet, with the hills adjacent to the Pico anticline reaching 2800 feet.

Topography

The Potrero Canyon consists for the most part of low, gently rolling hills confined to the Upper Pico shales, and is bordered on the north and northeast by a rimrock with steep escarpments which marks the base of the Saugus formation. Investigations were not carried beyond this rimrock ridge. In addition to this escarpment formed by the resistant conglomerates of the Saugus, topographic features are quite often associated with the geology of the area. Resistant beds, particularly in the Modelo formation, usually conglomerates or massive sandstones, frequently form strike ridges, often with steep southern slopes or escarpments. The surface expression of the Newhall-Potrero anticline is evidenced to some extent in the topography, forming a general topographic high.

Drainage

Streams in the area are all intermittent, with essentially a dendritic pattern, although influenced locally to some extent by the geology. Drainage in Potrero Canyon flows westward and empties

directly into the Santa Clara River near Del Valle; while drainage from the Pico Canyon area flows eastward and thence northward to join the Santa Clara River near Saugus.

Vegetation and culture

The view overlooking Potrero Canyon from the southeast is spectacular, particularly in the early Spring, in that the canyon consists entirely of low rolling hills covered with green grass and is completely surrounded by the typical brush-covered slopes of the mountainous areas of the Transverse Ranges. Scrub Oak and chaparall comprise most of the brush, with poison oak flourishing in the valleys during the spring and summer months. Potrero Canyon is located within the Rancho San Francisco, and most of the land has been, and is being, used for grazing purposes. Evidence of oil wells is removed as completely as possible as soon as the drilling is finished, with only christmas trees, pipe lines, and the offices and pumping plants remaining to change the appearance of the valley.

Pico Canyon has been considered the oldest productive oil area in California, dating back to the use of seepage oil in 1850, although the first attempt at drilling was in 1869, and the first serious drilling in 1875. For the most part the field has been abandoned, although many of the old wooden rigs are still standing. In the last year or so, several pumps have been put on the old wells, and are now operating.

Exposures

Good exposures in Potrero Canyon, with the exception of the Saugus rimrock, are rare, although the rock type can usually be determined through soil content. Strikes and dips, on the other hand, are generally unobtainable. The Pico-Saugus contact is

almost everywhere well exposed, but difficulty is encountered in tracing individual beds within the Pico formation, particularly if they are of small thickness.

In Pico Canyon, the Modelo formation is well exposed, especially on the steep southern slopes of the ridges to the north of the Pico anticline, as well as in the road cuts.

HISTORICAL REVIEW

Although the region of Pico Canyon was one of the first oil producing localities in the state, the first account of the geology of the area was that by Eldridge which was published in 1907. Eldridge mapped two formation in the area, the Vaqueros, as a member of the Modelo, and the Fernando gravels, seemingly conformable on the Vaqueros. The contact between the two approximates that between the Modelo and the Pico as mapped by the writer.

In 1914, English published a short account of the Fernando Group; in which he came to the conclusion that at least part of the "Vaqueros" in reality belonged to the Fernando Group.

The Pico formation was first defined in 1924 by Kew who used lithology as the main basis for separating it from the Modelo and the Saugus. At that time microfossils had not been used, either to separate the Pliocene into the Pico (upper Pliocene) and Repetto (lower Pliocene), or to accurately place the division between the Miocene and Pliocene; nor were megafossils present at critical points in the type section of Pico Canyon to make the divisions.

These three reports are the only published accounts dealing with the geology of the area. Other reports deal in general with the development of the fields of the Newhall District, Walling giving a concise summary of the history of development of these fields up to 1934. Several State Mineralogist's Reports also deal with this phase.

Early exploitation of the Newhall District took place on the steeply dipping sedimentary beds along the axis of the Pico anticline. All of the early wells were located near seepages, with little or no regard to the geology or structure. Development was completed by 1915, with no further activities until the discovery of the Newhall-Potrero field in 1937.

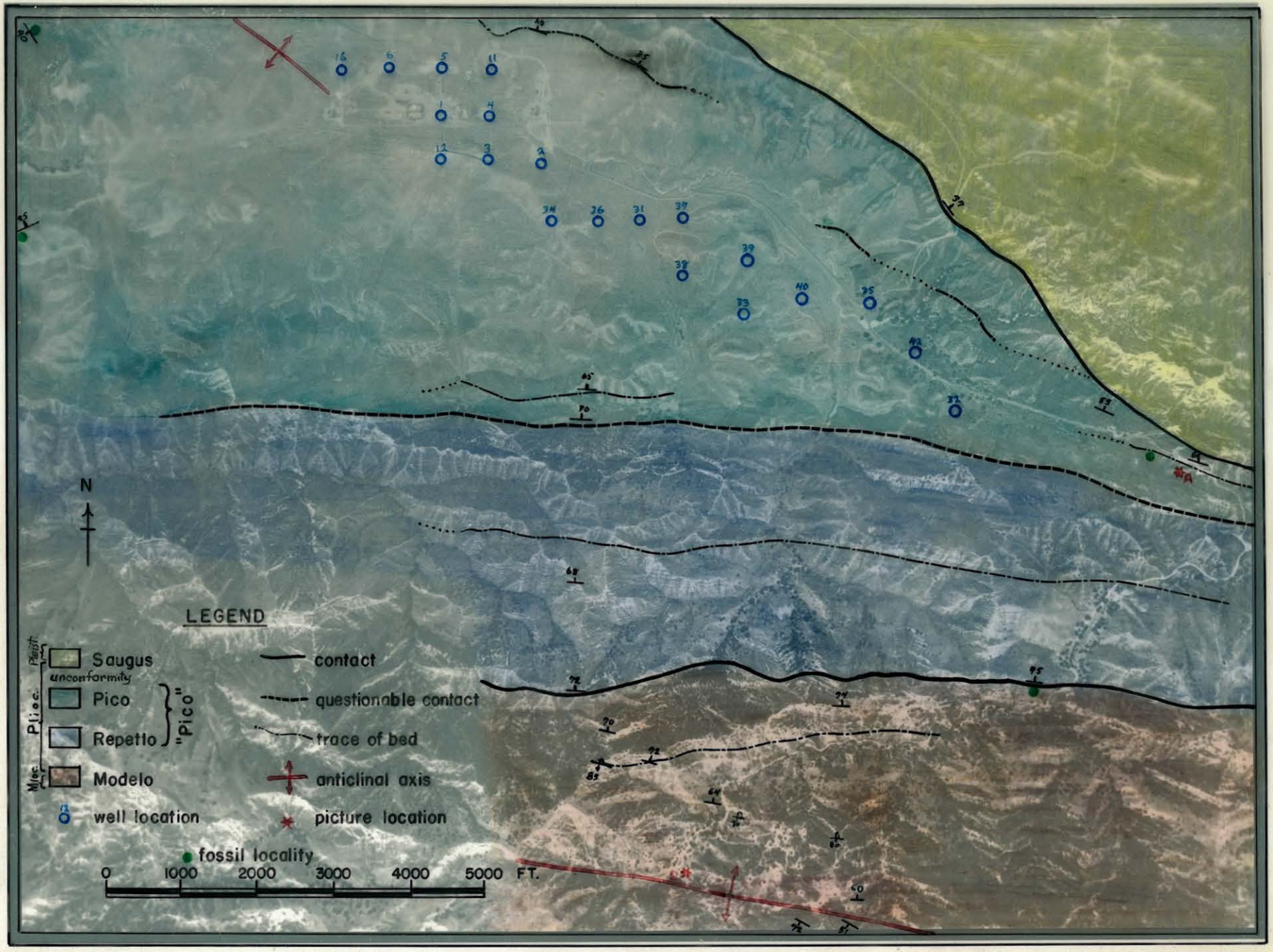

N
LEGEND
Saugus
unconformity
Pico
Repetto
Modelo
Plioc.
Mioc.
Pleist.
"Pico"
well location
fossil locality
contact
questionable contact
trace of bed
anticlinal axis
picture location
0
1000
2000
3000
4000
5000 FT.

PLATE II

Aerial photograph of the Newhall-Potrero - Pico Canyon area. Overlay shows location of a few of the wells in Newhall-Potrero oil field, and general geology of the area.

GEOLOGY

Stratigraphy

Aside from alluvium, the only rocks encountered in the wells are sedimentary beds belonging to the Pico formation (undifferentiated) of Pliocene age, and the upper Modelo formation of upper Miocene age. These formations are all of marine origin, although a few leaf impressions were found at one horizon in the Modelo (?) near the base of the Pico formation as originally described; these were, however, associated with fossils which were probably of marine origin, the indication being that they were deposited in brackish or semi-brackish water near shore.

The Pico formation is exposed at the surface over practically the entire field, but is overlain unconformably by the younger Saugus formation, the base of which outcrops as the rimrock bordering the potrero on the northeast. The contact between the upper Pico and the lower Pico (Repetto ?) is difficult to determine in the field, but it is the writer's opinion that it can be traced in a general way by a vegetation change near the south edge of the potrero. North of this line the rocks are mainly brown silty shales, while to the south they are definitely more sandy, with frequent sandstone and conglomerate beds.

The average vertical thickness of undifferentiated Pico penetrated by most of the wells in the field is from 6000 to 6500 feet, in general predominantly shale, but, as may be seen in the well logs, containing, particularly in the lower part, lenses of a sandy facies. Attempts to correlate between wells in the Pico generally meet with little success due to the rapid lithologic changes and thickening and thinning, and only short lateral correlations can be made in a few cases.

The contact between the lower Pico and the Modelo has been variously

PLATE III

Pico anticline, showing incompetency of the Modelo shales at the sharp anticlinal fold. View looking east from the head of Pico Canyon at the point marked "B" on Plate II.

placed by different authors. The writer of this report followed the convention established by Kew in his original definition of the Pico formation, and mapped the base of the Pico at the base of the gray and brown silts containing beds of gray sandstone and conglomerate. Below this are mainly brown shales with well-bedded sandstones and some conglomerate, the difference being mainly between the grayish silts and the brown shales. No evidence of the contact being anything but conformable was observed by the writer in the area studied. Foraminiferal investigation, however, have shown that the contact between the Miocene and Pliocene is several hundred feet lower stratigraphically than the mapped base of the Pico.

All production in the Newhall-Potrero field is obtained from the upper Miocene beds which underlie the Pico. The first oil sand encountered below the Pliocene-Miocene contact is considered the top of the First Zone. The sand bodies are very irregular and gradually change into a shale facies near the center of the field. In the central area the First Zone attains a thickness of about 290 feet, including some shaley members. Separated by about 50 feet of shale from the First Zone is a sand body which attains a maximum thickness of 100-150 feet, and has been designated the Second Zone. The Second Zone pinches out to the northwest about the center of the field.

The best marker in electric log correlations is the Third Zone, which is a large sand body with only minor shale breaks, and attains a maximum thickness of about 260 feet, but thins out until it disappears entirely near the southeastern corner of the field.

Between the Second and Third Zones, an intermediate thin sand member, designated the "T" Zone occurs, but lenses out both to the northwest and the southeast.

PLATE IX

MAP OF
NEWHALL-POTRERO OIL FIELD
SHOWING
CONTOURS ON TOP OF THE 3rd ZONE
AND
THICKNESS OF THE 3rd ZONE

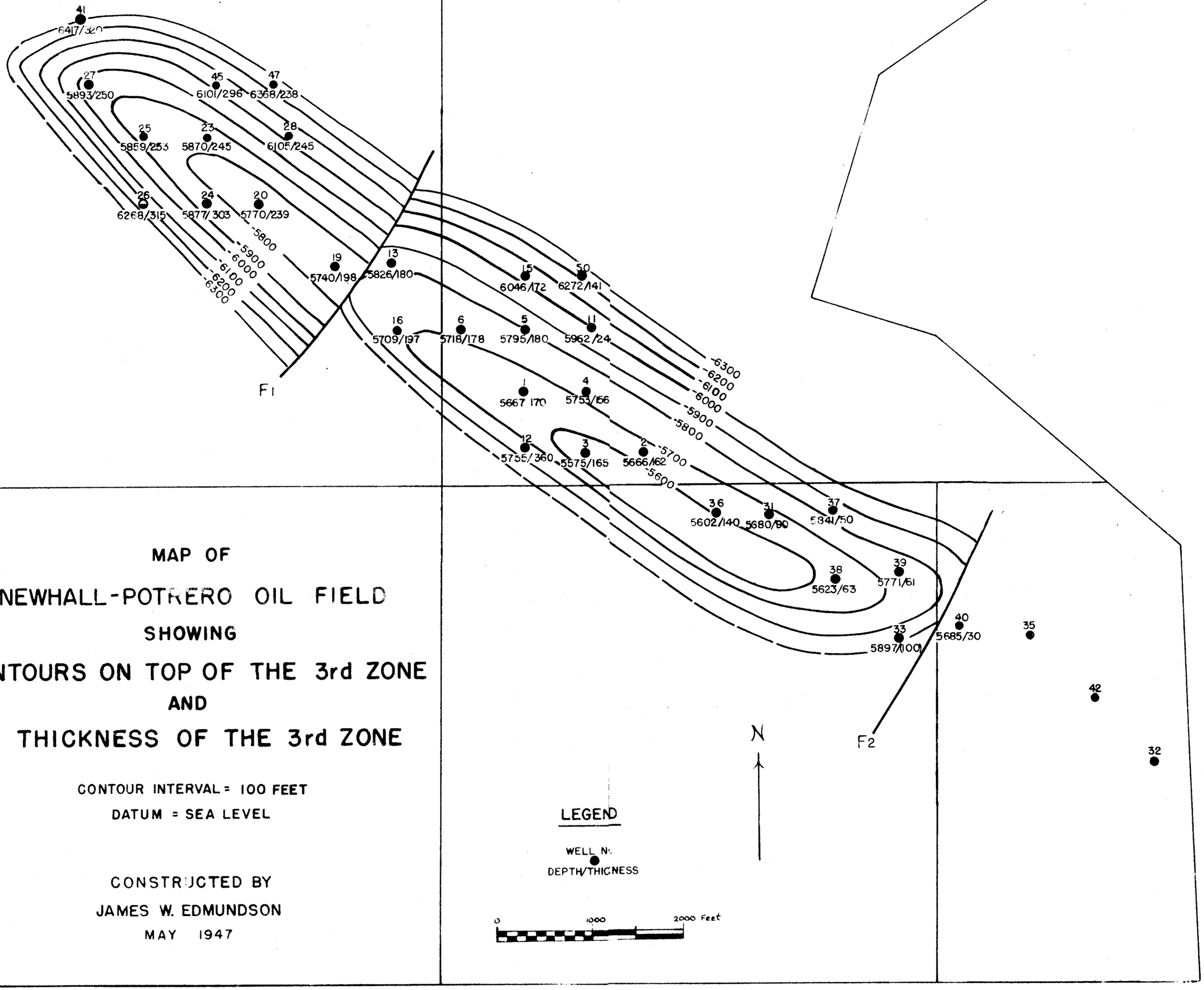
CONTOUR INTERVAL = 100 FEET

DATUM = SEA LEVEL

CONSTRUCTED BY

JAMES W. EDMUNDSON

MAY 1947



Although it is believed that these reservoir rocks outcrop to the south in Pico Canyon, with the Third Zone probably being exposed near the crest of the Pico anticline, due to the rapid lithologic changes it was found impossible to correlate the well logs with the measured section in Pico Canyon with any degree of confidence.

Structure

The structure of the Newhall-Potrero oil field is shown on Plate IV, and is that of a long, narrow, faulted assymetrical anticline, whose longitudinal axis trends northwesterly, and whose limbs dip more steeply to the southwest than to the northeast. Surface expression of the fold may be observed in the hills north of the potrero bottom, but the fold seems to die out to the southeast, and all dips are northerly from there to Pico Canyon.

The Pico anticline is a sharply folded assymetrical anticline (see Plate III) which has been overturned to the north in some parts. The overturning of some of the beds on the North limb of the anticline is well shown in outcrops and road cuts in the hillside on the south side of Pico Canyon, and in the southerly escarpment across the valley.

Faulting in the Newhall-Potrero field is of minor importance as far as the accumulation of oil is concenned. From the data available to the writer, two unmistakable faults of major displacement were located. Although others are probably present, data was insufficient to establish their presence beyond a reasonable doubt, so they were ommitted from the section.

INTERPRETATION OF THE ELECTRIC LOGS

The best marker in electric log correlation, and for that matter, the only bed which carries through consistently throughout nearly the eintire field, is the Third Zone. From an examination of the well logs of some of the flanking wells, particularly on the southwest limb of the anticline, the Third Zone seems to undergo extreme thickening in a short distance. However this apparent thickening is due entirely to the steep dips encountered in these wells. In well no. SSF 12, for instance, the vertical thickness of the Third Zone is 360 feet, while adjacent wells to the East penetrate only 165-170 feet of sand. Assuming 165 feet as being the true thickness at that locality, a dip of about 60° would give a vertical thickness of 360 feet. Dips computed from the logs of three wells are less than this, indicating that the dip changes rapidly between the wells. Similar computations carried out on other wells agree closely with the dips recorded in the cores.

Although not found in the field investigations, a probable local undonformity was located at the 4000 foot level by electric log correlations alone. It is believed by the writer that the majority of the faulting in the field took place prior to the deposition of sediments overlying this unconformity, which probably corresponds to the base of the "Pico". The principle reason for the presence of the unconformity is shown on the correlation chart (Plate V) just below the unconformity near the fault labeled F_1. The sandstone lens which is shown clearly to the right of the fault is displaced upward on the left by the fault, but the overlying shale section is almost entirely missing, while a sandstone member above the unconformity continues across, apparently undisplaced.

Correlations between even adjacent wells were sometimes very

difficult, and there is considerable disagreement in the interpretations of different individuals. The writer's interpretations are well shown on Plate V. Lensing, particularly of the sandy members, thickening and thinning, and facies changes are very prevalent throughout the field.

As the faults shown on the chart were encountered at most in two wells, the true dip and strike cannot be determined, and the trends on the structure contour map is assumed. The apparent dip shown on the chart would in every case be equal to or less than the true dip.

Since the correlation chart is strictly a stratigraphic correlation, the apparent irregularities in structure should not be taken as significant. Wells located on the flanks of the structure would cause the correlation lines to descend. Some of the apparent thickening of individual beds could be due to varying dips in the strata which would not show on the section if they were in a direction away from the line of section.

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