Supplement Data to Accompany
Electric Logs

Contents

Huntington Beach Oil Field

8002210415

SUPPLEMENTAL DATA TO ACCOMPANY ELECTRIC LOG DATA PACKET
IN RESPONSE TO QUESTION 361.61

METHODOLOGY

The methodology used to confirm the geologic slip rate for the NIZD was based on work by Hill (1954 and 1971) who estimated lateral displacement along segments of the NIZD by matching subsurface sedimentary rock facies and thicknesses based on electric log (E-log) interpretations and correlations. Hill's tecnique is based on the fact that an E-log records the sequence of strata, such as sands and interbedded sand and shale facies, that are encountered in a well. By comparing E-logs from adjacent wells, facies changes, both vertically and laterally, that exist between the wells for any given specific horizon or interval can be determined. Thus, the amount of horizontal displacement for the NIZD was estimated by correlating or matching several facies and facies changes for two or three stratigraphic intervals recorded on E-logs from wells on one side of the zone with E-logs from wells on the opposite side. The estimates of horizontal displacement along the NIZD, based on E-log correlations of wells, are from three oil fields, Seal Beach, Long Beach, and Huntington Beach. The results are listed on Tables 361.61-1, 361.61-2, and 361.61-3 and are shown graphically on Figures 361.61-2 and 361.61-3.

Electric logs used in the study were obtained from the California Division of Oil and Gas. Stratigraphic data, horizons, lithologic units, formations, and relative geologic ages were based on stratigraphic data established by the California Division of Oil and Gas, American Association of Petroleum Geologists and petroleum companies operating in the three oil fields, Long Beach, Seal Beach

and Huntington Beach, for additional information on this subject, see response to question 361.61. The ages of the stratigraphic units were based on the Upper Cenozoic Stratigraphic Column of the Western Los Angeles Basin (Nardin and Henyey, 1978), also see response to question 361.45 g.

DATA PACKETS

The data included in the attached packets for each oil field consist of:

1) well location map showing the wells used in the study;

2) cross sections and stratigraphic data showing the major marker horizons, formations, and relative geologic ages; and

3) a set of annotated E-logs.

Also provided are the Cenozoic Correlation Section across the Los Angeles Basin published by the American Association of Petroleum Geologists (Knapp and others, 1962) and Upper Cenozoic Stratigraphic Column for the western margin of the Los Angeles Basin (Nardin and Henyey, 1978).

SEAL BEACH

Eight horizontal displacements were calculated in Seal Beach field using the technique of matching correlation intervals on E-logs, from one side of the fault with E-logs from wells on the opposite side of the fault. The intervals used consist of the A_4-A_5, B_2-C and E-G horizons.

Interval A_4-A_5 (Pico Formation) is upper Pliocene in age (Knapp and others, 1962) and consists of three relatively blocky sands in the upper portion of the interval that thicken laterally from the northwest towards the southeast. A sequence of interbedded sand and shales, underlying the blocky sands, are underlain by another relatively thick blocky sand. Examination of the A_4-A_5 interval on the Hellman Estate 49 E-log (correlation well) with respect to E-logs on the southwest side of the fault (reference wells) indicated that the best correlation is between Bixby A-64 and Bixby A-62. Further examination of the lateral facies changes of the upper blocky sands, that thicken from the northwest to the southeast indicated that the interval in Hellman Estate 49 correlates closest with the same interval in Bixby A-64. The same correlation procedure was applied to Bryant LW-2 and Hellman Estate 45 to establish their most probable correlations relative to the reference wells. Based on these analyses, the A_4-A_5 interval of Bryant LW-2 correlates closest with the A_4-A_5 interval of San Gabriel 52, and Hellman Estate 45 with Bixby A-64.

The correlation interval B_2-C (Repetto Formation) is lower Pliocene age (Knapp and others, 1962). This interval is predominantly composed of sands that are blocky in the upper and middle portions of the interval becoming shaly in the lower portion. The major facies changes in this interval occur to the upper most blockly sand below the B_2 horizon and the sandy facies above the B_4 horizon. The upper most blocky sand thickens from the southeast to the northwest whereas in the lower portion, one sand thickens from the southeast to the northwest while another sand (the sand just above the B_4 horizon) thickens from the northwest to the southeast. Using the same procedures as applied to the A_4-A_5 interval, the B_2-C interval in Hellman Estate 49 is

interpreted to correlate between Bixby A-62 and San Gabriel 52; but it was closest with Bixby A-62 with respect to the lateral facies changes of the upper and lower most sands. In a similar analysis, the B_2-C interval in Bryant LW-2 correlates closest to San Gabriel 51 and Hellman Estate 45 correlates closest with Bixby A-64.

Interval E-G (Repetto Formation) is lower Pliocene in age (Knapp and others, 1962) and consists of a relatively thick blocky sand in the upper portion with a moderate increase in the amount of shale in the lower portion. Based on the overall characteristics of the interval, Hellman Estate 49 correlates between San Gabriel 51 and San Gabriel 40. The lateral facies change of the lower most sand, that thickens from the southeast to the northwest, suggests that Hellman Estate 49 correlates closest with San Gabriel 51. Using the same interval, E-G, Hellman Estate 45 correlates closest with San Gabriel 52.

LONG BEACH

Eleven horizontal displacements were measured along the NIZD in the Long Beach field on the basis of matching selected stratigraphic intervals on E-logs from wells on one side of the NIZD to E-logs from wells on the opposite side. The intervals used include: A to top of C Sands; top of the lower Wilbur zone (TW) to top of the Alamitos zone (TA); TW to J; TA to J; J to M; W to Z; and AH to AL.

Interval A to top of C Sands (Pico Formation) is upper Pliocene in age (Ingram, 1968) and consists primarily of a thick section of shale at the top and bottom of the interval separated by distinctive sands with interbedded shales. The sand facies thicken laterally from southeast towards the northwest across the field. Based on the overall trend of

facies changes of the interval within the field, Wallace 1 is estimated to correlate closest to Amebco 1. However, on the basis of individual sand thickness, Wallace 1 may correlate slightly to the west of Amebco 1 where additional well control does not exist.

Intervals TW to TA, TW to J, TA to J, J to M, and W to Z (Repetto Formation) are lower Pliocene in age (Ingram, 1968). These intervals are characterized by thick blocky sands and interbedded sand and shale sequences generally separated by thick shale sections. The selection of overlapping correlation intervals such as TW to TA, TW to J and TA to J, was necessary due to the spacing and depth of available E-logs, especially along the southwest side of the NIZD.

The TW to TA interval consist of a blocky sand facies in the upper part and a distinctive shale in the lower part. Laterally, the blocky sands present at the northwest end of the field change to thinner sands with interbedded shales towards the southeast end of the field. Examination of the E-logs indicated that Farrell 2-1 correlates between Cresson Comm. 8, Cresson Comm. 16, and Texaco C-8, but was judged closest to Cresson Comm. 16 based on the development of the upper sands that thicken to the northwest. This interval in Allied 34 correlates between Dennai 9 and Pala 3 but closest with Pala 3. The same interval in Dodge 3 correlates between Texaco B-18 and B-33 but closest to B-18.

Interval TW to J consists of two sand facies separated by a thick shale facies above the TA horizon. This interval in Carlin 1 correlates best between Amebco 2 and Encinas 1. But closest to Encinas 1 based on the similarity in the development of the two sand facies and lateral facies change of the upper sand that thickens from the southeast to northwest.

Interval TA to J in Allied 34 consists of an interbedded sand-shale facies at the top and bottom of the interval separated by a thick blocky sand facies. This interval in Allied 34 correlates best between TC 1 (Shell 97-1) and Fry 5; but it is closest to Fry 5 on the basis of the similarity in the development of the sand-shale facies below the uppermost sand and at the bottom of the thick sandy facies above the J horizon.

Interval J to M is composed of a distinct shale in the upper part that grades into a thick blocky sand facies in the middle portion and an interbedded sand-shale facies at the bottom of the interval. This interval as represented in Sudduth 7 correlates between Amebco 1 and Amebco 2 based on the similarity in the facies sequence and thickness. But, the correlation appears to be closest to Amebco 2 on the basis of the development and thickness of the interbedded sand-shale facies at the bottom of the interval.

The interval J to the top of the Brown zone in Farrell 2-1 correlates between Dormax 1 and Texaco D-3. The correlation is closest to Dormax 1 based on the similarity in the development of the blocky sand facies above and below the M horizon and the lateral facies change, from an interbedded sand-shale to more sandy facies, of the lower most blocky sand.

Interval W to Z consists of a thick blocky sand facies in the upper part and a blocky sand to interbedded sand-shale facies in the lower part. This interval in Dodge 3 correlates best between Dormax 1 and Texaco D-3, but closest to D-3. These interpretations are based upon lateral facies changes, increased thickness and development on the sand facies above and just below the X horizon and the increase in shalyness from the northwest towards the southeast in the

lower part of the interval. This interval in Farrell 2-1 correlates between Dormax 1 and Pala 3, based on the development and thickness of the upper sand facies, that thickens to the southeast. But the correlation is closest to Dormax 1 on the basis of the lower interbedded sand-shale facies that becomes shaly to the southeast.

Interval AH-AL (Puente Formation) is upper Miocene in age (Ingram, 1968) and consists primarily of a blocky sand facies that becomes less blocky to the northwest with increasing interbedded shales. This interval in Alamitos 48A correlates between Texaco Field 28 (A-11), Malcom Davis 8, and Allied 34. Alamitos 48A correlates closest to Field 28 based on the development of the sandy facies in the AH-AL and AL-AJ segments of the interval, that increase in thickness and become blocky from the northwest to the southeast.

HUNTINGTON BEACH

In the Huntington Beach field, only one displacement was measured using the technique of correlating E-log characteristics across the NIZD. The lack of additional displacement measurements is due to the unavailability of E-logs having suitable depths adjacent to the NIZD and the complicated geologic structure (numerous faults) associated with the Huntington Beach oil field, as the fault splays out to the south.

The initial study, based on several large scale E-logs and greatly reduced logs, shown on cross-sections of the field (Hazenbush and Allen, 1958), shows that Diehl 1 correlates closest with Bolsa S-41 based on the correlation of the upper part of division "A". Subsequent to the initial study, additional E-logs were obtained for the southwest

side of the NIZD adjacent to S 41. The location of the additional E-logs are shown on the enclosed well location map for the Huntington Beach field. The additional E-logs do not alter the initial correlation, but rather confirm the initial correlation.

The refined analysis consists of correlating an interval from a pair of wells on the northeast side of the zone to a group of wells on the southwest side. The correlation interval, top of Jones Sand to just below the AG-2 horizon (Puente Formation), is upper Miocene in age (Hazenbush and Allen, 1958) and consists of moderately to well developed sands at the top and bottom of the interval separated by an interbedded sand-shale facies. This interval in wells Diehl 1 and Jacober 1 correlates closest with a group of wells, Bolsa S-31, S-41, S-51, S-61A, S-72A and S-71A, that are centered around Bolsa S-41 and S-61. This correlation is based on the similarity in the development and thickness of the shaly facies in the interval, and on lateral facies changes that occur to the interval in general.

Examination of the available E-logs and E-logs presented on the cross sections by Hazenbush and Allen (1958) indicates that the interval becomes sandy to the northwest, southwest and southeast from wells S 41 and S 61A. The general shaly characteristic of this facies change in the area of S 41 and S 61A, suggests that this area was probably an existing or growing structural high during deposition of the interval. This same general facies change also occurs to the northwest and northeast from wells Diehl 1 and Jacober 1, suggesting that this area was also a high during the deposition of the interval. A review of the enclosed structural contour map (drawn on the top of the Jones sand) for the Huntington Beach field shows that both groups of wells are located approximately on existing structural highs.

Although only one displacement along the NIZD in the Huntington Beach oil field could be estimated based on the matching of facies across the zone. Support for the amount of displacement estimated is provided by the similarity in the facies change that occurs in both group of wells and the similarity in the location of the two groups of wells on structural highs on opposite sides of the NIZD.

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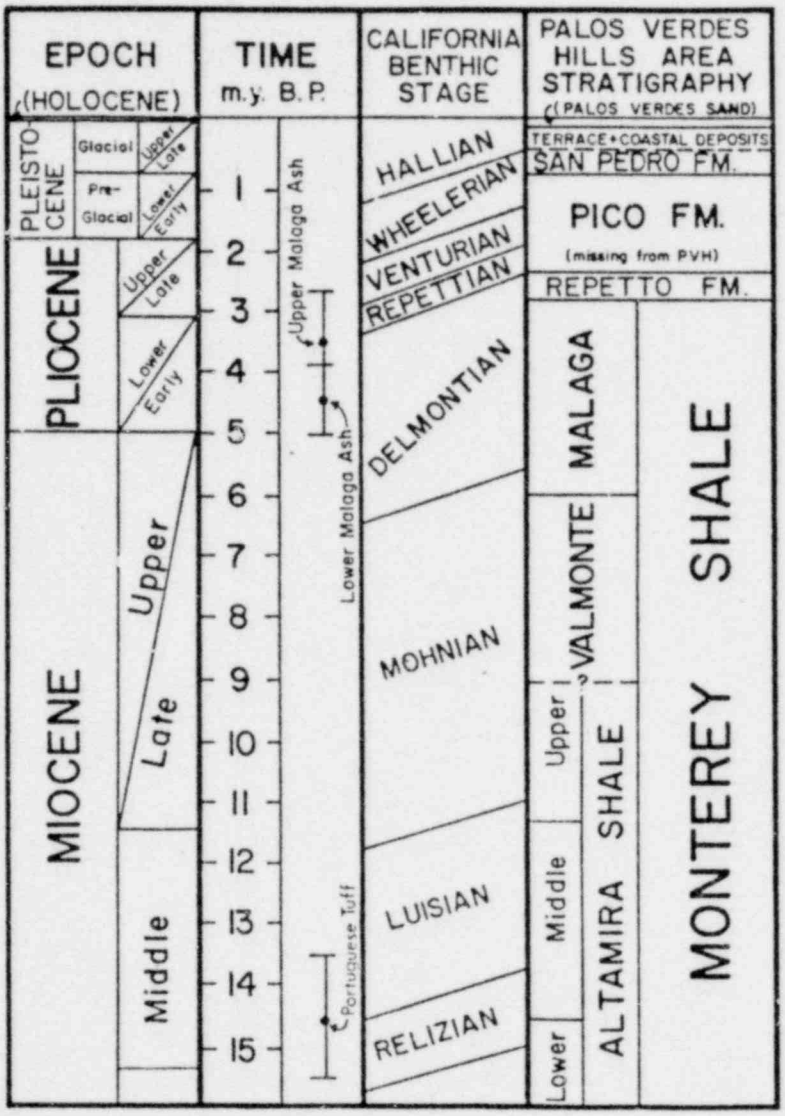
List of Annotated E-Logs

Crane 11

Diehl 1

Jacober 1



Upper Cenozoic Stratigraphic Column Applicable to Western Margin of Los Angeles Basin (Nardin and Henyey, 1978).

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Huntington Beach Oil Field
Annotated E-Logs
SW side of NIZD

List of Annotated E-logs

Bolsa S-71A

Bolsa S-72A

Bolsa S-61A

Bolsa S51

Bolsa S-41

Bolsa S-31

Huntington 89

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