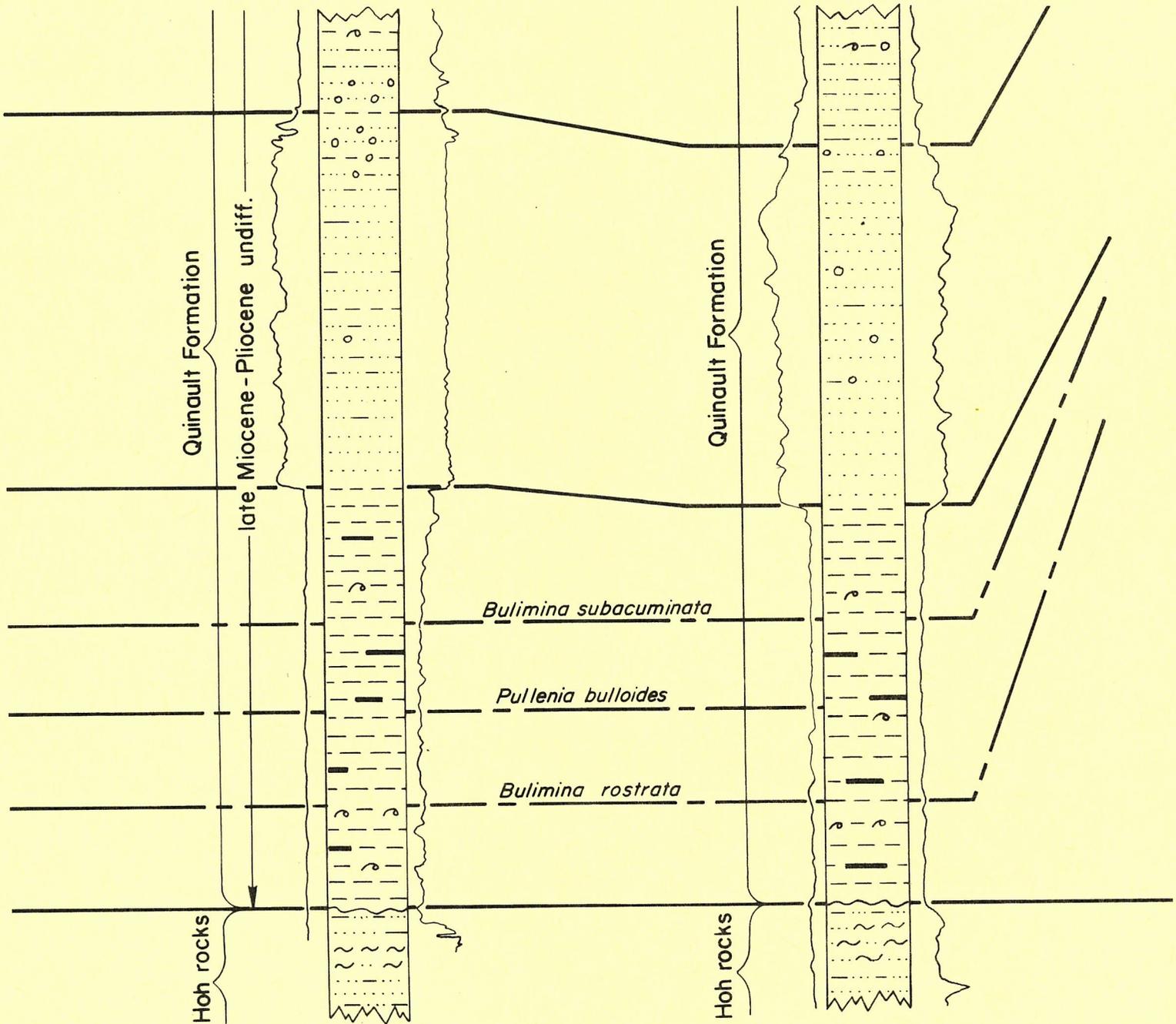


STATE OF WASHINGTON  
DEPARTMENT OF NATURAL RESOURCES

BRIAN BOYLE, Commissioner of Public Lands  
RUSSELL W. CAHILL, Supervisor

DIVISION OF GEOLOGY AND EARTH RESOURCES

REPORT OF INVESTIGATIONS 26



COASTAL WELLS OF WASHINGTON

By  
WELDON W. RAU AND CARL R. McFARLAND

1982

**INTRODUCTION**

The purpose of this report is to present available downhole data from Washington coastal wells and to graphically indicate available correlations between wells based on interpretation of these data. Most of the basic information comes from records on file in the Division of Geology and Earth Resources, Department of Natural Resources. In 1968, an informal, similar study was prepared as a Division Open-File Report (Rau, 1968). Since that time new data have become available from both additional wells and surface studies. This information is here used to update and formalize the previous report.

**GEOLOGIC FRAMEWORK**

Two major rock units separated by a regional unconformity of late middle Miocene age are known to underlie much of the Washington coastal area. The older rocks encountered below the unconformity are referred to as the Hoh rock assemblage (Rau, 1973, 1979, 1980). They are known to range in age from middle Eocene to early middle Miocene. The younger rocks above the unconformity are of late Miocene and Pliocene age and in places extend into the Pleistocene (Rau, 1970, 1979, 1980, and Bird, 1972). All wells are vertically arranged on the chart to show their relation to the late middle Miocene hiatus, represented by a horizontal line.

**HOB ROCK ASSEMBLAGE**

Hob rocks are largely deep water (bathyal or deeper) marine sedimentary rocks and are composed of silts, shales, and sandstones. The Hoh rock assemblage is a complex of many facies, having been accreted to the continent from the tectonic Juan de Fuca Plate (Rau, 1973, 1979, 1980). Many of these rocks are turbidite sequences and are largely graywacke clastic sedimentary rocks where fossils are rare. Although comparable in age, lithologically Hob rocks are generally distinct from the fossiliferous shallower water (neritic, bathyal and shelf) deposits of the inland areas of western Washington (Paine and Hozer, 1967; Snavely and others, 1968; Gover and Paine, 1968; Rau, 1967, 1969, 1973, 1979, 1980; and Wells, 1979, 1981). Hob rocks have undergone much tectonism as they are completely folded and faulted into large blocks of sedimentary rock sequences separated by numerous major zones of tectonic melange. In places melange materials are believed to have migrated diapirically within the Hoh rocks, as well as into overlying younger strata (Rau and Grocott, 1974).

**LATE MIOCENE-PLEISTOCENE SEQUENCE QUINAILT FORMATION**

These younger strata are unconformably on Hob rocks. They are moderately folded and consist of silts, shales, sandstones, and conglomerates and represent marine turbidite to littoral conditions of deposition. Their known outcrop area is confined to a 12-mile-long coastal area between Point Grenville and the Quetta River, extending inland no more than 2 miles (Rau, 1973). Here they constitute the type area of the Quinault

Formation (Rau, 1970). From data of the present report, equivalent strata are known to extend outward in the subsurface at least to the Ocean City area. Furthermore, they are known to be extensive on much of the adjacent continental shelf of Washington (Grim and Bennett, 1969; Snavely and Pearl, 1973; Snavely, Pearl, and Lander, 1977; Snavely, personal communication; and unpublished records on file with the Division of Geology and Earth Resources).

**Age and Correlations**

Although foraminiferal biostratigraphy and paleogeologic subsurface studies have been conducted on rocks of the type Quinault Formation (Rau, 1970) and equivalent subsurface strata (Bergen and Bird, 1972), there still remains much to be developed concerning the biostratigraphy, as well as biochronology, paleogeology, and correlations of these strata to those of other basins. The placement of the late Miocene-Pliocene boundary in California sequences, where numerous and detailed investigations have been conducted over a period of many years, is still very much under discussion (Haller, 1980). It therefore is not surprising that differing views are apparent among biostratigraphers as to where this boundary should be placed. The similar sequences of species, precise correlations to the California biostratigraphic units are not made usually without some reservation. Based on the presently available data it seems likely that the development of provincial zones for the entire Washington sequence, much like that already developed for the Ocean City area by Bergen and Bird (1972), will best provide the highest degree of accuracy for correlations, at least on the stage level, to California late Miocene-Pliocene sequences.

On the basis of data available to us, in the present report the occurrence (usually highest well to well) is anticipated that with additional data, future studies will enlarge upon and refine the ability to present detailed correlations within the late Miocene-Pliocene sequence of Washington City and to correlate, at least to the stage level, to the California late Neogene sequence.

**ACKNOWLEDGMENTS**

The downhole data and samples supplied by numerous petroleum companies to the State of Washington and placed on file in the Division of Geology and Earth Resources have been the major source of basic information for this report. Acknowledgments are therefore extended to those companies whose wells are here represented. Special thanks are given to the Union Oil Company of California, through the arrangements of Arthur Lewis, for the loan of additional materials for study. Discussions with, and constructive comments by Alvin A. Abrogen and Gregory H. Blain of the Union Oil Company of California, Fred W. Bergen of the Shell Oil Company, Paul D. Snavely and Ray E. Pearl of the U.S. Geological Survey, and Dana B. Bradwin and James D. Moore of Olympia, Washington, have aided much in formulating interpretations.

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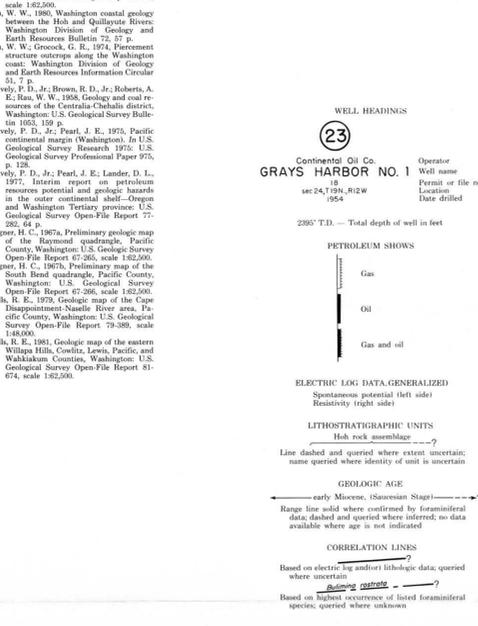
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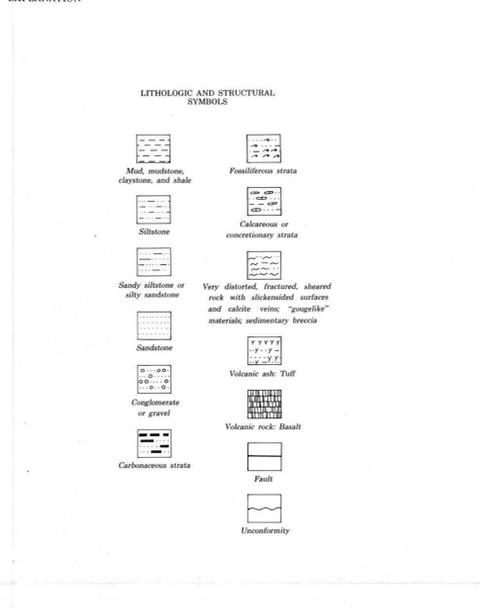
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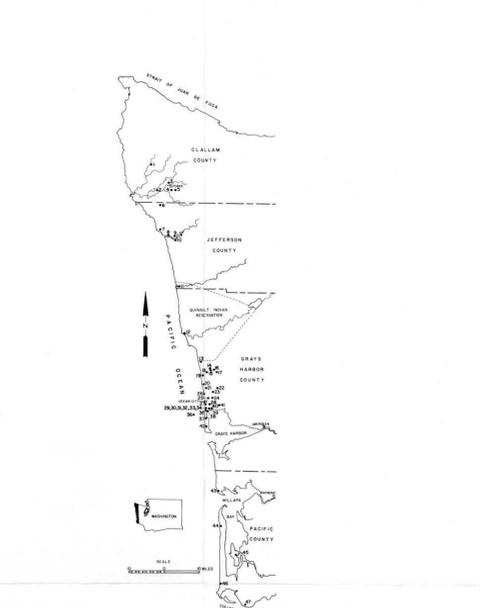
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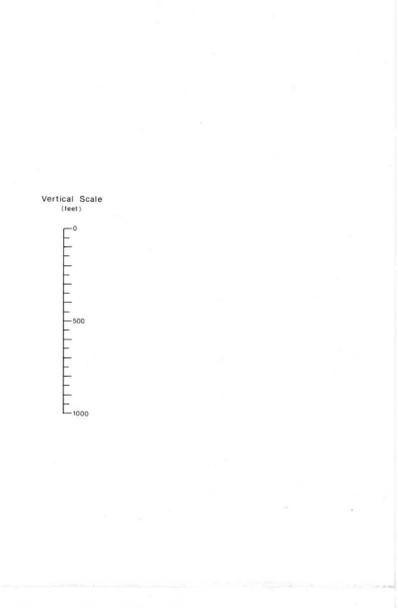
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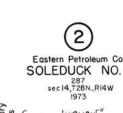
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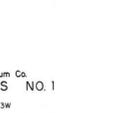
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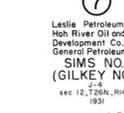
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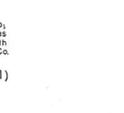
**9**



**10**



**11**



**12**



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This well was cored at frequent intervals. According to descriptions of these cores, a sequence of badly fractured and sheared sandstone and siltstone was penetrated. Although unconfined, foraminifera of the Oligocene Zuercheria Stage are reported from the lower part of and of the Miocene Succinea Stage from the upper part of the well.

Records show that 12 wells were drilled in the vicinity of the Jefferson oil seep. The first two were drilled between 1913 and 1919 a short distance south of the seep, and the remaining wells were drilled in the 1930's in the immediate vicinity of the seep. Most of the wells were less than 1,000 feet in depth. The greatest depth was penetrated by the Sims No. 1 (Gilley No. 1) well to a total depth of 2,135 feet. Records for this well are the most complete of the group and therefore it is presented as representative of them. Substantial petroleum shows are recorded for this and other wells of the area.

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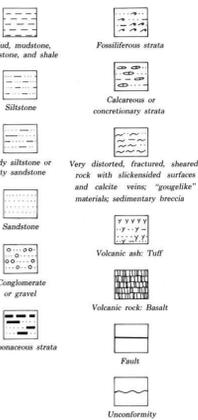
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EXPLANATION

LITHOLOGIC AND STRUCTURAL SYMBOLS

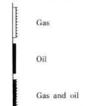


WELL HEADINGS

Continental Oil Co. Operator  
**GRAYS HARBOR NO. 1** Well name  
18 Permit or file no.  
sec 24, T9N, R12W Location  
1954 Date drilled

2895 T.D. — Total depth of well in feet

PETROLEUM SHOWS



ELECTRIC LOG DATA, GENERALIZED

Spontaneous potential (left side)  
Resistivity (right side)

LITHOSTRATIGRAPHIC UNITS

Hob rock assemblage

Line dashed and queried where extent uncertain; name queried where identity of unit is uncertain

GEOLOGIC AGE

early Miocene (Saussean Stage)

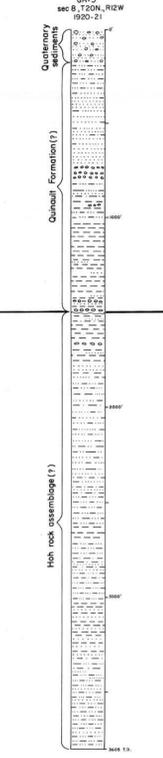
Range line solid where confirmed by foraminiferal data; dashed and queried where inferred; no data available where age is not indicated

CORRELATION LINES

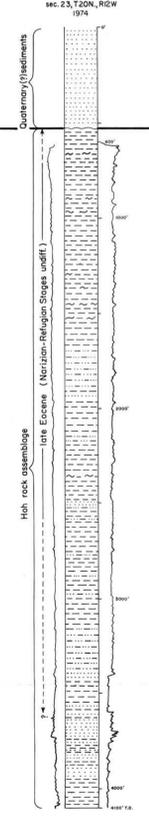
Based on electric log and/or lithologic data; queried where uncertain

Based on highest occurrence of listed foraminiferal species; queried where unknown

Standard Oil Co. of California  
**NORTHWESTERN NO. 2**  
(MOCLIPS NO. 2)  
sec 8, T9N, R12W  
1920-21



Development Associates, Inc.  
**CARLISLE NO. 1-23**  
292  
sec 24, T20N, R12W  
1924

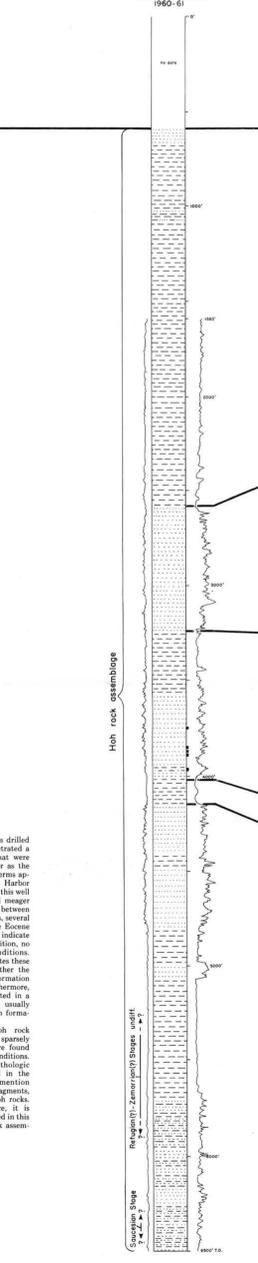


Two wells were drilled in the vicinity of Mo-clips—the first to only 629 feet and the second (discussed here) to 3,805 feet. Available records consist of brief lithologic descriptions from frequent intervals. Interpretations suggest that surficial materials were penetrated to about 170 feet. The rocks described from a depth of 170 to about 1,500 feet are thought to be a part of the Quaternary Formation. Between depths of 1,500 feet and the total depth of 3,805 feet Hob rocks are believed to have been penetrated. Traces of oil and gas are recorded throughout much of the sections assigned to the Hob rocks.

The Carlisle 1-23 is one of four wells drilled within a radius of a half mile. It penetrated a series of siltstones and sandstones that were tentatively referred to by the operator as the Montezuma and Astoria Formations—terms applied to Miocene units of the Grays Harbor basin. An examination of cuttings from this well by the writers has produced scattered meager foraminiferal assemblages from depths between 600 and 3,600 feet. Among these faunas, several reasonably well confirmed a general late Eocene age. Furthermore, all assemblages indicate substantial water depths during deposition, no less than upper bathyal conditions. Paleontologic evidence therefore indicates these rocks are substantially older than either the Quaternary or the Montezuma Formation of the Grays Harbor basin. Furthermore, indications are that they were deposited in a deeper water environment than is usually considered for the Grays Harbor basin formations.

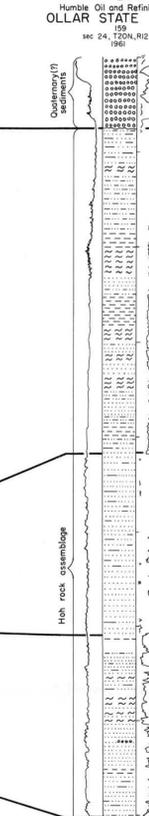
The Olympic strata of the Hob rock assemblage (Rau, 1973) are only sparsely fossiliferous, but these fossils that are found indicate deep water depositional conditions. Furthermore, records on the lithologic descriptions of the rocks penetrated in the Carlisle 1-23 well occasionally mention slickensided surfaces and calcite fragments, typical lithologic characteristics of Hob rocks. On the basis of the above evidence, it is suggested here that the strata penetrated in this well are best referred to the Hob rock assemblage.

Sunshine Mining Co. & Cascade Natural Gas  
**RAYONIER NO. 1-A**  
292  
sec 24, T20N, R12W  
1960-61



This well, with a total depth of 6,500 feet, is the deepest of a group of wells drilled in the immediate area. The upper 2,000 feet penetrated was reported largely as shale. Major thicknesses of sandstone were penetrated in the lower 4,000 feet of the well in which some oil shows were reported. Foraminiferal studies were conducted on numerous samples from frequent intervals in this well. Other than nondiagnostic arenaceous taxa, only four small assemblages, three from an interval between 3,300 and 5,800 feet and one at 6,400 feet, were indicators of age. Those from the upper interval suggest a general latest Eocene-Oligocene age (Rafanjan and Zemorrian Stage), whereas the assemblage from the lower interval appears to be of a younger age, early Miocene (Saussean Stage).

Humble Oil and Refining Co.  
**OLLAR STATE NO. 1**  
182  
sec 24, T20N, R12W



The Ollar State No. 1 well was located about 200 feet from the Rayonier No. 1 well. As was mentioned in the latter well, fine-grained strata were penetrated in the upper 2,000 feet, whereas sandstone was very largely reported in the lower 4,000 feet of the Ollar State No. 1 well. No fossil data are on record for this well. However, gross lithologic and <sup>75</sup>Fe log similarities suggest broad correlations to the nearby Rayonier No. 1 well. Thus, the strata penetrated in the Ollar State No. 1 well are also referred to as the Hob rock assemblage.

The available faunal evidence therefore suggests an anomalous stratigraphic situation which may well be the result of faulting, overturned beds, or general complexity of structures. All faunas suggest deposition in at least bathyal water depths. The anomalous stratigraphic distribution of deep water faunas is evidence to support the referral of these strata to the Hob rock assemblage. Furthermore, the frequent occurrence of thick sandstones interbedded with fine-grained strata typical turbidite sequences known to be common in Hob rocks. Reliable <sup>75</sup>Fe or lithologic correlations are not apparent between this well and the Carlisle 1-23, a quarter mile to the northwest.

Union Oil Co. of California  
**POLSON NO. 1**  
228  
sec 27, T20N, R12W  
1947



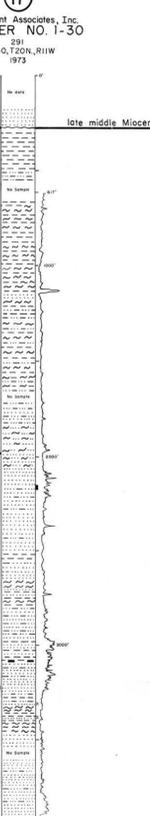
Quaternary sediments were probably penetrated to a depth of at least 200 feet. All or part of the interval between 200 and 928 feet is best referred to a shallow-water facies of the Quaternary Formation. Fossil materials are reported from this interval at several horizons below 600 feet. From a depth of 928 feet to the total depth of 2,108 feet, lithologic descriptions strongly characterize Hob rocks. Lithologic descriptions of nine cores evenly spaced throughout the interval commonly refer to badly fractured or broken and sheared siltstone with slickensided surfaces, brecciated or gouge-like materials with calcite stringers or veins, and greenstones. These terms vividly describe typical Hob melange rocks.

The Baker No. 1 well, located the farthest east of a group of five wells, appears to have been drilled in the same general sequence of rocks as was penetrated in the other four wells. Shale and siltstone are reported from the upper 2,000 feet of the well, whereas thick beds of sandstone with minor siltstone and shale interbeds are recorded from the lower part. Records give no mention of fossil material and only a few sparse foraminiferal assemblages have been extracted from the interval between 3,300 and 3,400 feet. They are questionably referred to a general late Eocene age. The frequent mention of slickensided surfaces and calcite-filled fractures, together with the lack of abundant fossil material, suggests that rocks penetrated in this well, as in the other four wells of the immediate area, are best referred to the Hob rock assemblage.

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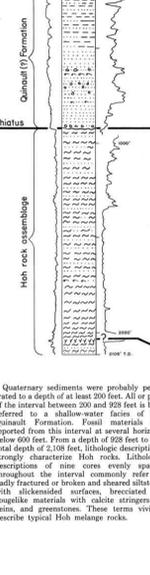
Development Associates, Inc.  
**M.A. BAKER NO. 1-30**  
291  
sec 30, T20N, R12W  
1973



The Baker No. 1 well, located the farthest east of a group of five wells, appears to have been drilled in the same general sequence of rocks as was penetrated in the other four wells. Shale and siltstone are reported from the upper 2,000 feet of the well, whereas thick beds of sandstone with minor siltstone and shale interbeds are recorded from the lower part. Records give no mention of fossil material and only a few sparse foraminiferal assemblages have been extracted from the interval between 3,300 and 3,400 feet. They are questionably referred to a general late Eocene age. The frequent mention of slickensided surfaces and calcite-filled fractures, together with the lack of abundant fossil material, suggests that rocks penetrated in this well, as in the other four wells of the immediate area, are best referred to the Hob rock assemblage.

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Shell Oil Co.  
**SHELL McLEAVE NO. 1-33**  
228  
sec 33, T20N, R12W  
1970



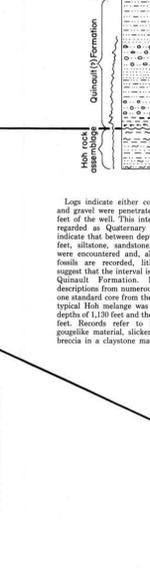
Logs indicate either conglomerate or sand and gravel were penetrated in the upper 400 feet of the well. This interval is questionably regarded as Quaternary sediments. Records indicate that between depths of 400 and 1,130 feet, siltstone, sandstone, and conglomerate were encountered and, although no data on fossils are recorded, lithologic descriptions suggest that the interval is best referred to the Quaternary Formation. Based largely on descriptions from numerous sidewall cores and one standard core from the bottom of the hole, typical Hob melange was penetrated between depths of 1,130 feet and the total depth of 1,344 feet. Records refer to fine microstructures, gouge-like material, slickensided surfaces, and breccia in a claystone matrix.

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Union Oil Co. of California  
**LAMB NO. 1**  
228  
sec 9, T20N, R12W  
1947



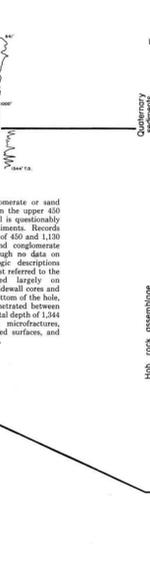
Cores from twenty-three intervals were spaced throughout the entire 2,379 feet of this well. Thus, descriptions of these cores provide good lithologic data throughout the well. Sand and gravel, clay, and silt are recorded to a depth of 140 feet. These sediments are best referred to the Quaternary. Core descriptions from a depth of 140 feet to the total depth of 2,379 feet vividly describe the lithology of classic Hob melange. Frequent reference is made throughout this interval to gouge, crumbed and fractured sandstone and siltstone, numerous calcite veins, and badly sheared rocks. A strong deflection on the resistivity curve between 2,000 and 2,100 feet may indicate the presence of a volcanic block. However, no confirming lithologic description is available through this interval because records show it to be a drilled rather than a cored interval. Large volcanic blocks are common in some surface outcrops of Hob melange. Altered volcanic are recorded at a depth of approximately 2,000 feet in the Polson well No. 1 (No. 18), located some 20 miles to the north. This too may be a volcanic block in melange. A possible correlation is shown only to suggest that perhaps a certain zone in melange rocks of the area may contain numerous volcanic blocks.

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Shell Oil Co.  
**SHELL GRAYS HARBOR NO. 1-15**  
228  
sec 15, T9N, R12W  
1970



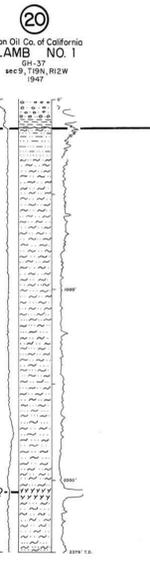
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Union Oil Co. of California  
**PARKER NO. 1**  
228  
sec 16, T9N, R11W  
1947



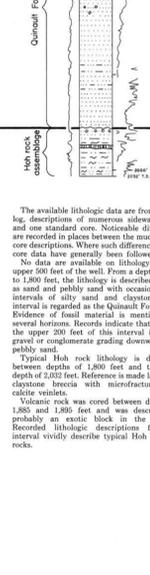
Data available on this well are confined largely to an <sup>75</sup>Fe log record, a well history, and descriptions of 18 cores spaced throughout the well between depths of 500 and 1,775 feet. The upper 500 feet of the well are only descriptively described from mud observations. On this basis, the first 300 feet penetrated are questionably referred to a Quaternary assemblage. Blocks penetrated between depths of 500 and 1,200 feet are referred to the Quaternary Formation. Core descriptions indicate much sandstone and conglomerate, with fossil material recorded near the top of the interval. Carbonized wood is mentioned at several horizons. Silty sandstones are occasionally referred to, particularly in the lower part of this interval.

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Continental Oil Co.  
**GRAYS HARBOR NO. 1**  
18  
sec 24, T9N, R12W  
1954



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El Paso Products Co.  
**GRAYS HARBOR CO. NO. 36-1**  
231  
sec 36, T9N, R12W  
1974



The available lithologic data are from a mud log and an examination of cuttings from this well. Foraminiferal samples have provided limited data from sparse faunas that indicate an undifferentiated late Miocene-Pliocene age to a depth of at least 1,200 feet. Several small assemblages from depths of 2,000 feet and more are essentially nondiagnostic of age other than to suggest a pre-late Miocene age. Based on the combined paleontologic, lithologic, and <sup>75</sup>Fe log data, the contact between the late Miocene-Pliocene Quaternary Formation and the older Hob rocks is placed at a depth of 1,740 feet. Below this depth, siltstone and sandstone cuttings are decidedly more indurated than above and appear typical of Hob rocks.

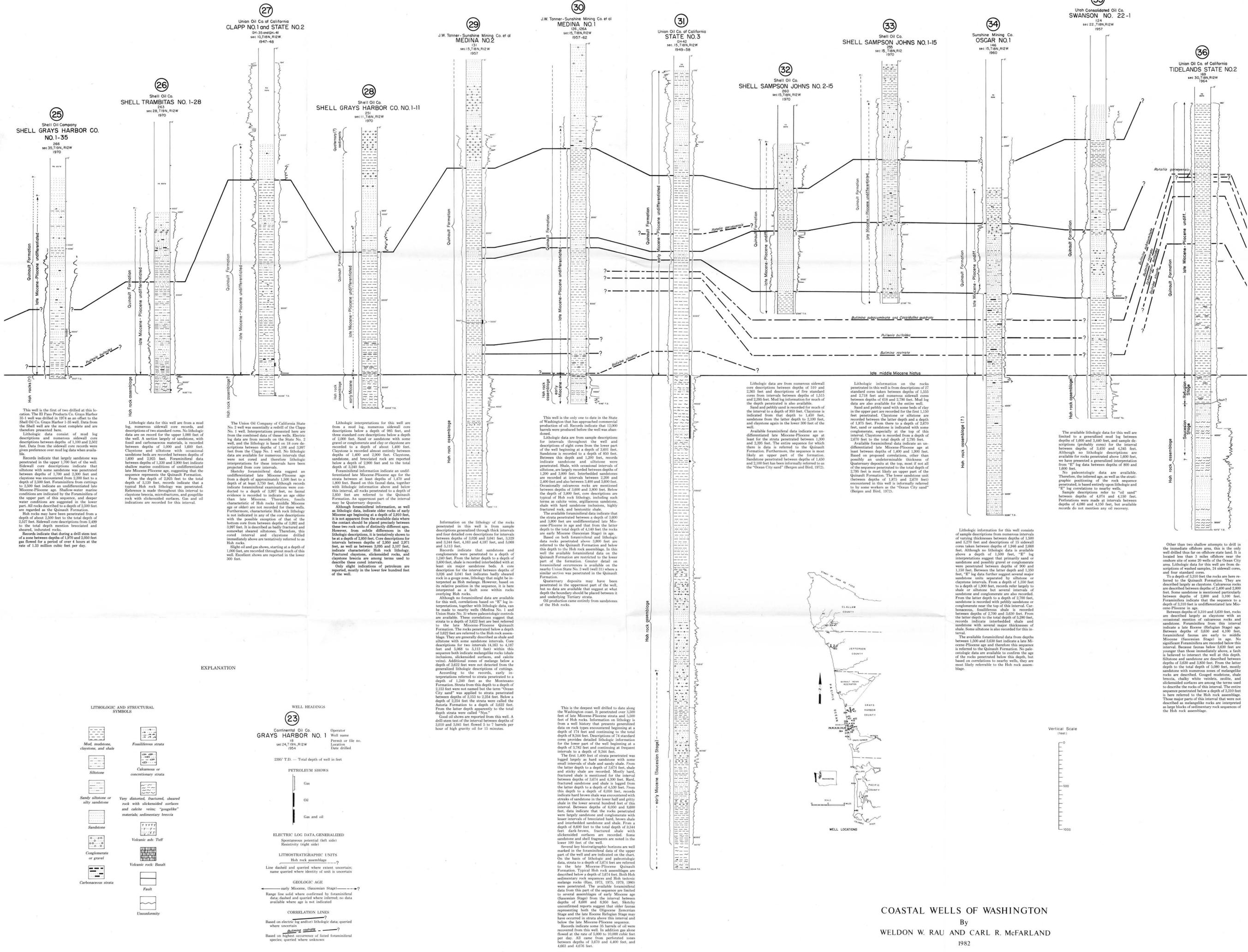
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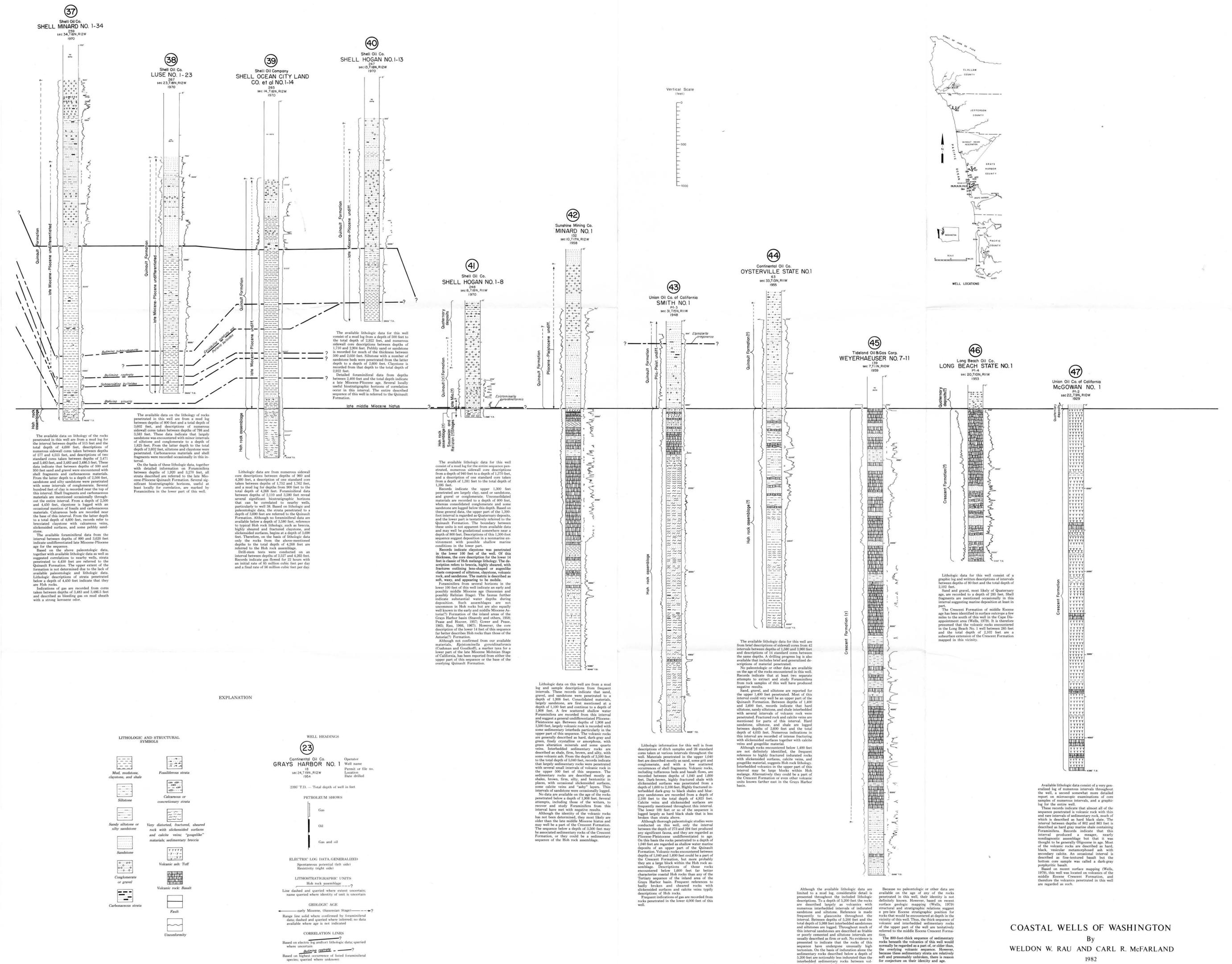
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COASTAL WELLS OF WASHINGTON  
By  
WELDON W. RAU AND CARL R. MCFARLAND  
1982



COASTAL WELLS OF WASHINGTON  
By  
WELDON W. RAU AND CARL R. McFARLAND  
1982



The available lithologic data for this well consist of a mud log from a depth of 500 feet to the total depth of 2,922 feet, and numerous standard core descriptions between depths of 1,710 and 2,904 feet. Pebbly sand or sandstone is recorded for much of the thickness between 900 and 2,050 feet. Siltstone with a number of sandstone beds were penetrated from the latter depth to a depth of 2,600 feet. Claystone is recorded from that depth to the total depth of 2,922 feet.

Detailed stratigraphic data from depths between 2,400 feet and the total depth indicate a late Miocene-Pliocene age. Several locally useful biostratigraphic horizons of correlation occur in this interval. The entire described sequence of this well is referred to the Quinault Formation.

The available data on the lithology of rocks penetrated in this well are from a mud log between depths of 900 feet and a total depth of 3,022 feet, and descriptions of numerous standard cores taken between depths of 700 and 3,083 feet. These data indicate that largely sandstone and conglomerate to a depth of 1,200 feet, and silty sandstone and siltstone and conglomerate to a depth of 3,022 feet, siltstone and claystone were penetrated. Carbonaceous materials and shell fragments were recorded occasionally in this interval.

On the basis of these lithologic data, together with detailed information on Foraminifera from depths of 1,200 and 3,070 feet, all strata described are referred to the late Miocene-Pliocene Quinault Formation. Several significant biostratigraphic horizons, useful at least locally for correlation, are marked by Foraminifera in the lower part of this well.

Lithologic data are from numerous standard core descriptions between depths of 900 and 4,200 feet, a description of one standard core taken between depths of 1,750 and 1,762 feet, and a mud log for depths from 900 feet to the total depth of 4,208 feet. Foraminiferal data between depths of 2,110 and 3,586 feet reveal several significant biostratigraphic horizons that can be correlated to nearby wells, particularly to well 38. Based on lithologic and paleontologic data, the strata penetrated to a depth of 3,000 feet are referred to the Quinault Formation. Although no foraminiferal data are available below a depth of 3,000 feet, reference to typical Hob rock lithology, such as breccia, highly sheared and fractured claystone, and silty sandstone, begins at a depth of 3,000 feet. Therefore, on the basis of lithologic data only the rocks from the above-mentioned depths to the total depth of 4,208 feet are referred to the Hob rock assemblage.

Drill-stem tests were conducted on an interval between depths of 3,527 and 4,208 feet. Records indicate gas flowed for 22 hours with an initial rate of 55 million cubic feet per day and a final rate of 36 million cubic feet per day.

Foraminifera from several horizons in the lower 100 feet of this well indicate an early and possibly middle Miocene age (Saucian and possibly Relian Stage). The fauna further indicate substantial water depths during deposition. Such assemblages are not uncommon in Hob rocks but are also equally well known in the early and middle Miocene Astoria(?) Formation of the inland area of the Grays Harbor basin (Stavely and others, 1958; Pease and Hoover, 1957; Cover and Pease, 1965; Rau, 1966, 1967). However, the core description of the lower 14 feet of this sequence far better describes Hob rocks than those of the Astoria(?) Formation.

Although not confirmed from our available materials, *Epistominella gracilidorsum* (Cushman and Goddard), a marker taxa for a lower part of the late Miocene Relian Stage of California, has been reported from either the upper part of this sequence or the base of the overlying Quinault Formation.

Lithologic data on this well are from a mud log and sample descriptions from frequent intervals. These records indicate that sand, gravel, and sandstone were penetrated to a depth of 1,908 feet. Consolidated materials, largely sandstone, are first mentioned at a depth of 1,100 feet and continue to a depth of 1,908 feet. A few scattered shallow water Foraminifera are recorded from this interval and suggest a general undifferentiated Pliocene-Pleistocene age. Between depths of 1,080 and 3,500 feet, largely volcanic rock is recorded with some sedimentary interbeds particularly in the upper part of this sequence. The volcanic rocks are generally described as hard, dark-gray and green, finely crystalline or amorphous, with green alteration minerals and some quartz veins. Interbedded sedimentary rocks are described as shale, firm, brown, and silty, with some volcanic ash. From the depth of 5,500 feet to the total depth of 5,000 feet, records indicate that largely sedimentary rocks were penetrated with several small intervals of volcanic rock in the upper 500 feet of this sequence. The sedimentary rocks are described mostly as shales, brown, firm, silty, and heterotonic in places, with occasional silty sandstone and sandstone. No data are available on the age of the rocks penetrated below a depth of 1,908 feet. Several attempts, including those of the writers, to recover and study Foraminifera from this interval have met with negative results.

Although the identity of the volcanic rocks has not been determined, they most likely are older than the late middle Miocene hiatus and may well be a part of the Crescent Formation. The sequence below a depth of 2,000 feet may be associated sedimentary rocks of the Crescent Formation, or they could be a sedimentary sequence of the Hob rock assemblage.

Lithologic information for this well is from descriptions of ditch samples and 28 standard cores taken at various intervals throughout the well. Materials penetrated in the upper 1,040 feet are described mostly as sand, some grit and conglomerate, and with a few scattered occurrences of shell fragments. Volcanic rocks, including tuffaceous beds and basalt flows, are recorded between depths of 1,040 and 1,600 feet. Dark brown, highly fractured and interbedded dark-gray to black shales and blue-gray sandstones are recorded from a depth of 1,600 feet to the total depth of 4,922 feet. Caliche veins and silty sandstone surfaces are frequently mentioned throughout this interval. The lower 100 feet or so of the sequence is logged largely as hard black shale that is less broken than strata above.

Although thorough paleontologic studies were conducted on this well, only the interval between the depth of 275 and 294 feet produced any significant fauna, and they are regarded as Peninsular. The interval between 275 and 294 feet is broken than strata above.

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The available lithologic data for this well are from brief descriptions of standard cores from 42 intervals between depths of 1,580 and 5,000 feet and descriptions of 14 standard cores between the same depths. A drilling progress log is also available that includes brief and generalized descriptions of material penetrated.

No paleontologic or other data are available on the age of the rocks encountered in this well. Records indicate that at least two separate attempts to extract and study Foraminifera from rock samples of this well have produced negative results.

Sand, gravel, and siltstone are reported for the upper 1,400 feet of this well. Most of this interval could very well be an upper part of the Quinault Formation. Between depths of 1,400 and 2,600 feet, records indicate that hard siltstone, sandy siltstone, and shale interbedded with several intervals of volcanic rock were penetrated. Fractured rock and caliche veins are mentioned for parts of this interval. Hard sandstone, siltstone, and shale are logged between depths of 2,200 feet and the total depth of 4,032 feet. Numerous indications in this interval are recorded of intense fracturing with slickensided surfaces together with caliche veins and pozzolanic material.

Although rocks encountered below 1,400 feet are not definitely identified, the frequent reference to highly fractured indurated rocks with slickensided surfaces, caliche veins, and pozzolanic material, suggests Hob rock lithology. Interbedded volcanics in the upper part of this interval may be large blocks within Hob melange. Alternatively they could be a part of the Crescent Formation or even other volcanic units known farther east in the Grays Harbor basin.

Although the available lithologic data are limited to a mud log, considerable detail is presented throughout the included lithologic descriptions. To a depth of 5,200 feet the rocks are described largely as volcanics with numerous interbedded intervals of indurated sandstone and siltstone. Reference is made frequently to glauconite throughout the interval. Between depths of 5,200 feet and the total depth of 5,288 feet interbedded sandstones and siltstones are logged. Throughout much of this interval sandstones are described as friable or poorly cemented and siltstone intervals are usually described as firm or soft. No evidence is presented to indicate that the rocks of this sequence have undergone unusually high tectonism. On the basis of indication alone the sedimentary rocks described below a depth of 5,200 feet are noticeably less indurated than the interbedded sedimentary rocks between volcanics in the interval above.

Because no paleontologic or other data are available on the age of any of the rocks penetrated in this well, their identity is not definitely known. However, based on recent surface geologic mapping (Wells, 1959) structural and stratigraphic relations suggest a pre-late Eocene stratigraphic position for rocks that would be encountered at depths in the vicinity of this well. This thick sequence of volcanic and interbedded sedimentary rocks of the upper part of the well are tentatively referred to the middle Eocene Crescent Formation.

The 800-foot-thick sequence of sedimentary rocks beneath the volcanics of this well would normally be regarded as a part of, or older than, the overlying volcanic sequence. However, because these sedimentary strata are relatively soft and presumably unbroken, there is reason for conjecture on their identity and age.

Lithologic data for this well consist of a graphic log and written descriptions of intervals between depths of 80 feet and the total depth of 2,102 feet.

Sand and gravel, most likely of Quaternary age, are recorded to a depth of 285 feet. Shell fragments are mentioned occasionally in this interval suggesting marine deposition at least in part.

The Crescent Formation of middle Eocene age has been identified in surface outcrops a few miles to the south of this well in the Cape Disappointment area (Wells, 1970). It is therefore presumed that the volcanic rocks encountered in the Long Beach No. 1 well between 285 feet and the total depth of 2,102 feet are a subsurface extension of the Crescent Formation mapped in this vicinity.

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