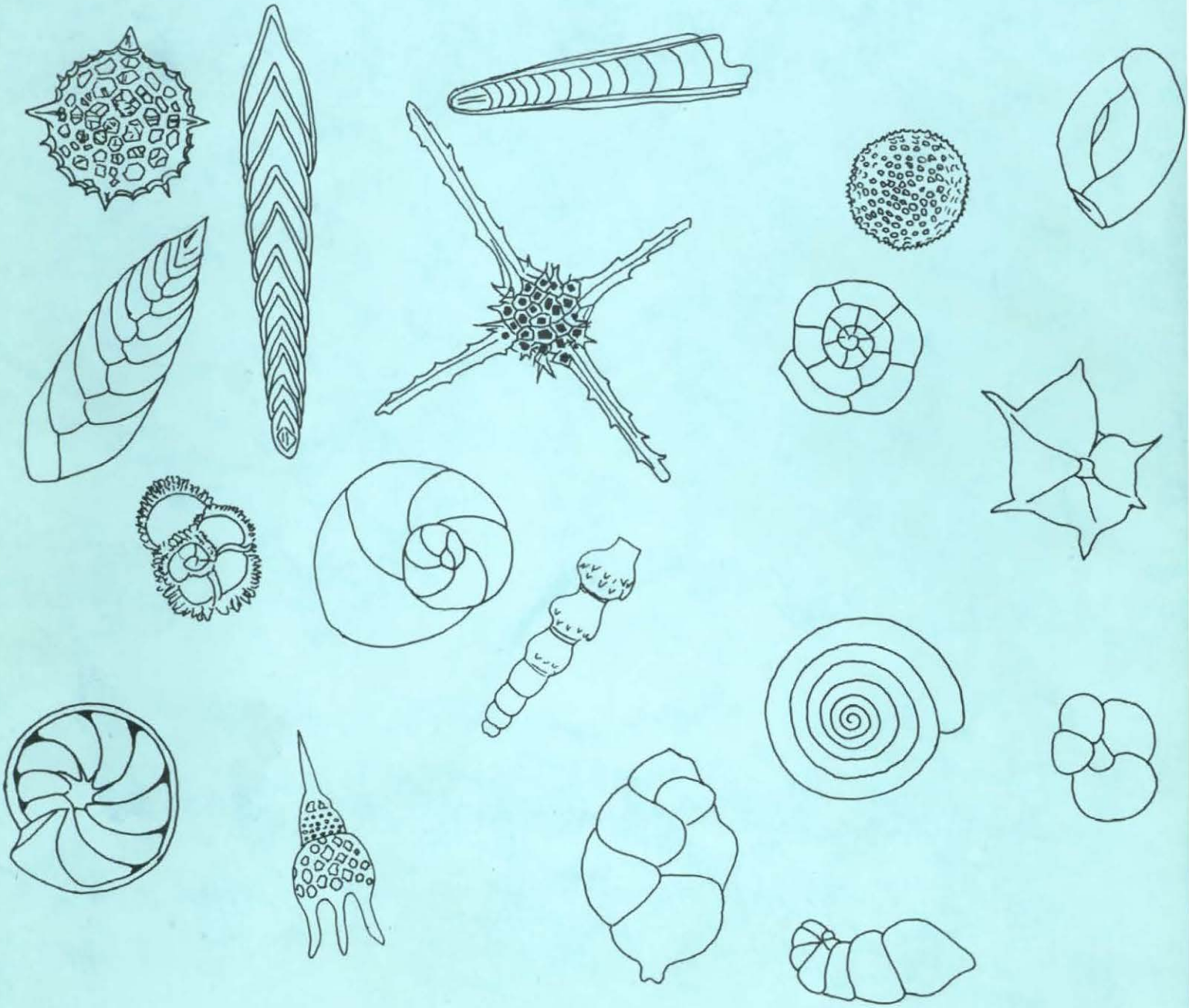
SUBSURFACE GEOLOGY OF THE LOWER COLUMBIA AND WILLAMETTE BASINS, OREGON



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SUBSURFACE GEOLOGY

OF THE

LOWER COLUMBIA AND WILLAMETTE BASINS, OREGON

Oil and Gas Investigations No. 2

by V. C. Newton, Jr.

1969

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FOREWORD

This is the second in a series of publications of the State of Oregon Department of Geology and Mineral Industries that discusses the petroleum potential in various parts of Oregon. The first report, published in 1963, covered part of the Snake River basin along the eastern border of the state near Vale and Ontario, where several test wells encountered large but discontinuous "shows" of gas. The present report is concerned with northwestern Oregon, particularly the lower Columbia and Willamette basins.

The northwestern part of Oregon has been an area of petroleum exploration for more than 40 years, but most of the important drilling activity has been confined to two brief periods -- the middle 1940's during and shortly after World War II and the late 1950's and early 1960's, resulting from the gas and oil showings in the Barr No. 1 well near Lebanon. Although no commercial production developed after this explorational effort, the work has shown that thick sections of marine rocks exist in this region and that in some areas porous and permeable sands are present. The study presents all available subsurface data that the author was able to obtain, largely through the kind cooperation of the various oil companies that have worked in the state. Most of the information was derived from 25 test wells, the preponderant number of which were drilled within the last 20 years. From this information the author is able to show that northwestern Oregon has the requisite geologic environment in regard to potential source beds, reservoir beds, and structures suitable for the entrapment of commercial quantities of oil and gas. It is hoped that reports of this type, giving geologic details of a basin region, will encourage future field and laboratory studies by private industry.

R. E. Corcoran
State Geologist

October, 1969

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ABSTRACT

The Pacific margin of North America, including western Oregon, was part of a mobile tectonic belt which is believed to have been covered by the sea many times in geologic history. However, the pre-Tertiary history is not well understood in the area of this report, because these older rocks are not exposed outside the Klamath Mountains in southwestern Oregon and none of the deep drillings made thus far have reached the older rocks. During early and middle Tertiary time the sea covered most of western Oregon to a depth of several thousand feet. Vast outpourings of basic lava and volcanic ash accompanied marine deposition in the Tertiary eugeosyncline of western Oregon; the volcanic piles at times rose above the level of the sea to form low islands. Two main areas of marine deposition developed in the eugeosyncline, namely the lower Columbia basin and the Willamette basin. The basins were deepened by diastrophisms in late Eocene and early Miocene time. The region was raised above sea level by the end of middle Miocene time and was never again inundated.

Pliocene-Pleistocene diastrophism folded the Coast Range sedimentary and volcanic rock into a north-trending anticlinorium while, to the east, volcanism formed the High Cascade Mountains. The Willamette lowland separated the two mountain ranges and on occasion was the site of large lakes during the Pleistocene.

Northwesterly and northeasterly trending structures in western Oregon are believed to have originated during middle Miocene diastrophism. A northerly structural terrane was superimposed upon the older folds during late Pliocene-early Pleistocene upheaval. Major faulting parallels the regional structural trend except for a large transverse fault which cuts the Coast Range along the southern border of the volcanic highlands in the northwest portion of the state.

Information from 25 deep exploratory drillings was used in making the subsurface study. Formations penetrated included porous sands which were found to be saturated with salt water in every test. Stratigraphic units are related to faunal zones in a paleontologic report contained in the appendix. Subsurface correlation showed Tertiary rocks to be at least 10,000 feet thick in northwestern Oregon and perhaps as much as 20,000 feet thick in some places. East-dipping early and middle Eocene marine beds are believed to extend for a distance beneath the Cascade Mountains, while younger sediments apparently change to a volcanic facies along the western margin of the Cascade Range. Unusually high-pressure salt-water zones were found in two deep drillings in the central Willamette Valley, but structural and hydrologic information is too limited to allow speculation as to whether or not production could be found at nearby locations. A 4900-foot hole on the east side of the Willamette Valley encountered hydrocarbon shows along what is thought to be the upper Eocene strand line. Several locations appear to have merit as drilling prospects in the Willamette and lower Columbia basins where structural and stratigraphic conditions are favorable. More deep drilling is needed to explore the basin areas.

SUBSURFACE GEOLOGY

OF THE

LOWER COLUMBIA AND WILLAMETTE BASINS, OREGON

Vernon C. Newton, Jr.

Introduction

Purpose and scope

This study is intended to correlate subsurface with surface stratigraphy of the lower Columbia-Willamette region in northwestern Oregon on the bases of lithology, paleontology, and electric logs of deep oil drillings (figure 1). The 25 test holes (table 1 in the appendix) that provided subsurface data for the report generally represent two periods of drilling activity: that in the post-war boom following World War II and that resulting from reported oil and gas shows in the Linn County Oil Development Co.'s wildcat drilled near the town of Lebanon in 1958. The latter period of activity, often referred to as the "Willamette Valley play," includes the drilling of five more deep holes between 1960 and 1963 (figure 2).

The general plan of this report is to present, first, a summary of prospects in the study area and, second, the historical and structural development of the region. These are to be followed by a discussion of subsurface sections, each of which is illustrated graphically (plates 1 through 6) in order to show general lithologic character and explain stratigraphic relationships. The text is concluded by a discussion of petroleum prospects. Formation test data (table 1), sample descriptions (table 2), gas analyses (table 3), and water analyses (table 4) are given in the appendix. Paleontological examination of well samples are also in the appendix.

The drillings mentioned in this report are too widely spaced to allow definition of structure; they have been used mainly to show stratigraphic relationships. Besides offering interpretations of the stratigraphy, this report serves as a collection of deep drilling records from northwestern Oregon.

Location and geography of study area

The subsurface study covers the lower Columbia River area and the Willamette Valley in the northwestern portion of the state (figure 1 and plate 7). The lower Columbia area encompasses the westernmost reaches of the Columbia River valley and the adjoining 25-mile-wide arcuate belt of Tertiary marine rocks lying south of the river in Oregon. The lower Columbia River valley is separated into two basin areas in this report: the Astoria and the Nehalem. The Astoria basin lies at the west end of the valley and the Nehalem at the east end. The Willapa Hills of southwestern Washington flank the lower Columbia River valley on the north, and the Tillamook Highlands define it on the south. The Columbia River has followed this structural downwarp through the Coast Range since Miocene time; uplift during late Pliocene and early Pleistocene time has not significantly altered its course (Lowry and Baldwin, 1952) (figure 3).

The lower Columbia River area is mountainous and thickly timbered. Except for a few cities along the river, the region consists of timberland with small farms in the intermountain valleys. Average rainfall

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* Petroleum Engineer, State of Oregon Department of Geology and Mineral Industries.

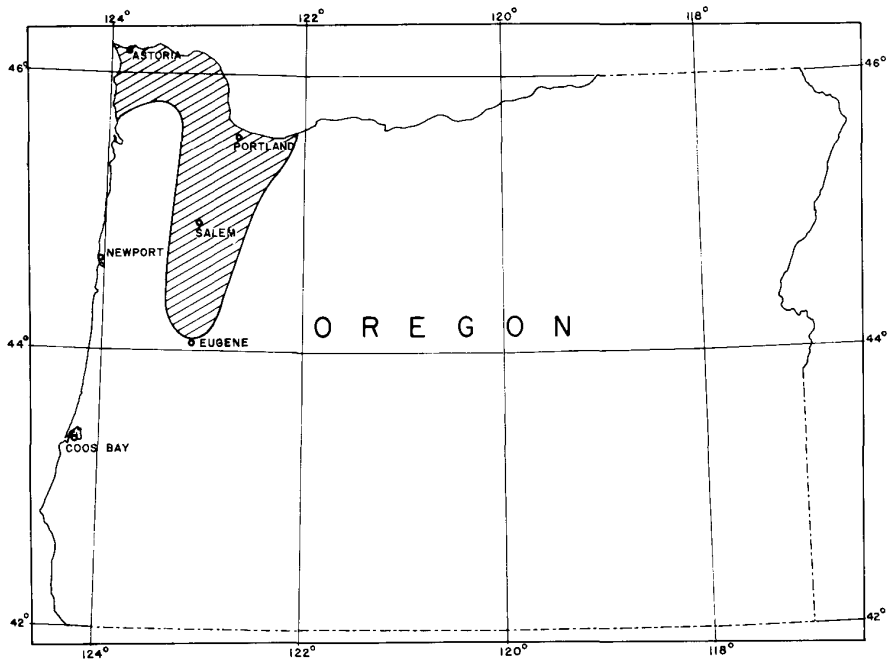


Figure 1. Index map of Oregon showing area of subsurface study.

in northwestern Oregon is between 40 and 75 inches (Oregon State Board of Higher Education, 1940).

The Willamette Valley, which joins the lower Columbia River valley near Portland, is a north-trending rectangular lowland approximately 180 miles long and 60 miles wide, bordered on the west by the Coast Range and on the east by the Cascade Mountains. It is part of the Willamette-Puget trough, a structural feature that formed in late Tertiary time contemporaneously with the Coast Range uplift. In this report it is separated into three areas: northern (including the Tualatin Valley); central; and southern. The topography of the valley is level to rolling. Forested areas are present, but farmland predominates outside the urban areas. The Willamette Valley is the most highly industrialized region in Oregon and contains more than two-thirds of the state's population.

Acknowledgments

The U.S. Geological Survey oil and gas investigations series of maps has been very useful in the making of the present study, as were the reports and maps prepared by Wells and Peck (1961) and Peck and others (1964). The author takes full responsibility for the contents of this report and has used various references to compile a viewpoint of geologic conditions in western Oregon. Sincere thanks are due to E. M. Baldwin, P.D. Snavely, Jr., R. J. Deacon, and our staff members for their constructive comments and advice in the preparation of this publication. Appreciation is also expressed to R. E. Thoms for his paleontological correlations of well samples; his information complemented data obtained from the oil companies and assisted in establishing subsurface stratigraphic control. Much credit is due the following firms for their excellent cooperation in furnishing drilling records: Gulf Oil Corp., Texaco, Inc., Reserve Oil & Gas, Atlantic-Richfield, Standard Oil of California, Humble Oil & Refining, Union Oil, Oregon Oil & Gas, and Linn County Oil Development Co.

Figure 2. Seismic crew outlining objectives for deep drilling in the southwestern Willamette Valley, 1963.

Prospective Areas Summarized

Deep drilling in northwestern Oregon has been unsuccessful thus far in finding commercial production or, for that matter, significant shows of oil or gas. However, the work has shown that thick sections of marine rocks exist in the region and that in some cases porous and permeable sands are present. All the tests made on these sands thus far yielded connate marine water. A review of deep-hole records and published geologic mapping suggests that there are several possible locations in the Willamette and lower Columbia River valleys which could lead to commercial discoveries of petroleum (see discussion of prospects on page 28).

A great thickness of Tertiary marine sediments, ranging from late Eocene to middle Miocene, exists in the northwest corner of the state. The sediments pinch out or interfinger with volcanic rocks of the Coast Range. Stratigraphic conditions in this type of environment provide the elements for entrapment of petroleum. In the Willamette and lower Columbia regions, geologic structures having closure and containing a thick section of Yamhill, Cowlitz equivalent, or Astoria age sediments are good possibilities. Major faulting along the west border of the Willamette Valley may have provided o barrier to migration of formation fluids. Secondary faulting, local warping, and facies changes provide other, though limited, prospects for entrapment of hydrocarbons along the west side of the Willamette Valley. Prospects for reservoirs should improve northward along the valley margin as the thickness of Tertiary marine rocks increases in that direction; field studies indicate that the deeper portion of the eugeosyncline was in the north during the latter part of Tertiary time.

The eastern margin of the Eocene sea is hidden beneath volcanic rocks of the Western Cascades, so that structural conditions are not known in that region. Deep drillings along the front of the Cascade Mountains have confirmed that Tertiary marine sedimentary rocks interfinger with continental volcanic rocks along the shore of the ancient seas. Oligocene and Eocene sediments along this shoreline could be targets for oil explorations, especially for stratigraphic-type accumulations. In all of the localities mentioned more detailed geological and/or geophysical studies are needed before drilling sites can be chosen.

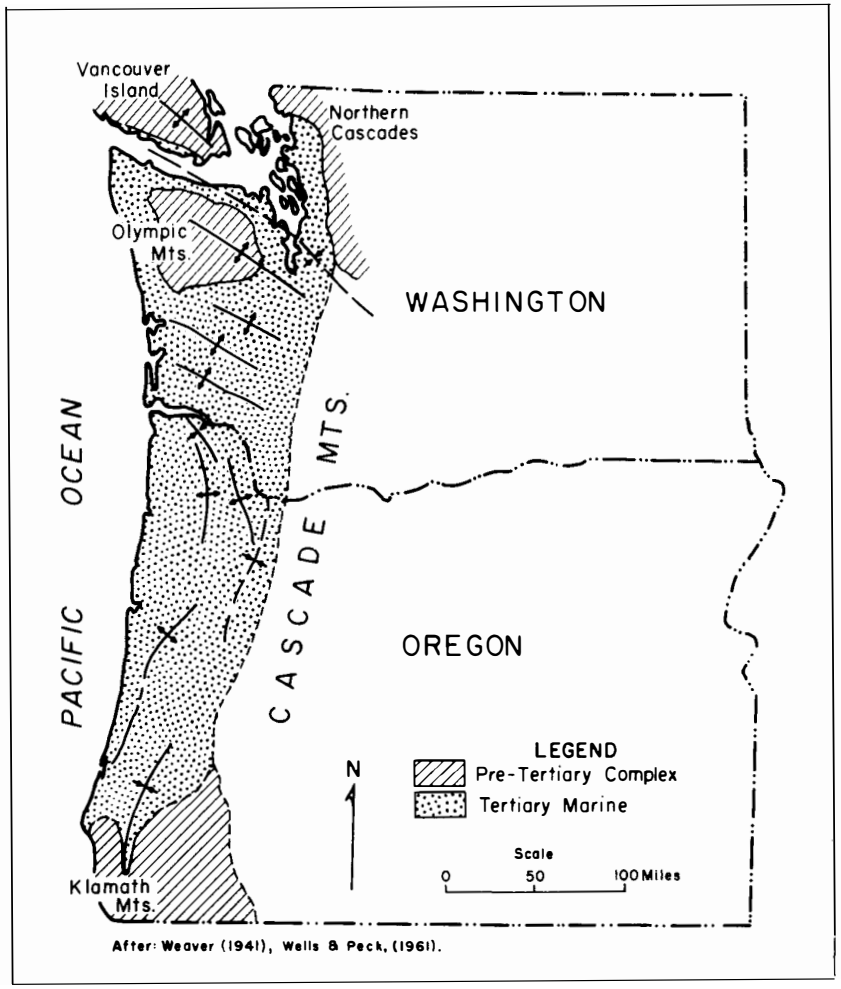


Figure 3. General structural features of western Oregon and Washington.

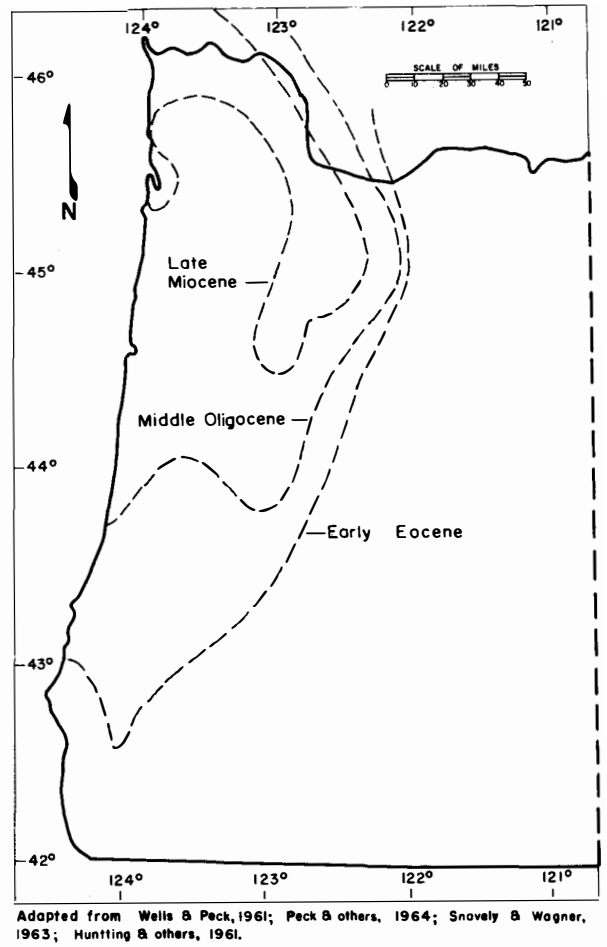


Figure 4. Sketch map of western Oregon showing extent of Tertiary seas.

Historical Geology

Pre-Tertiary

Paleogeographic studies by Eardley (1951) indicate that the Pacific Coast of the United States was a land area during much of the Paleozoic era, while epeiric seas covered the inland region of the continent. Andesitic debris and thick accumulations of graywacke along the western margin of the cordilleran geosyncline suggest that a volcanic archipelago existed through Triassic time.

The existence of a mobile belt along the margin of the continent in western Oregon and Washington may be reflected in the structure of mantle rocks. Studies in seismicity by Chiburis (1966) show the simatic layer to be 5 to 10 km closer to the surface west of the Cascade Mountains. He also found that the basaltic layer thickens beneath the Cascades. This research lends support to the paleogeologic theory that a volcanic orogenic belt formed the western margin of the continent in Paleozoic and Mesozoic time.

Late Jurassic uplift raised the Klamath region above sea level, at which time it became an important sediment-source area. The westwardly arcuate coastal portion of the Klamath Mountains formed as a result of intense compressional force exerted during the Late Jurassic Nevadan orogeny while a northeastward structural terrane was imposed in the east portion of the Klamath Mountains. A similar northeast structural fabric can be seen in rocks of the same age in central Oregon, indicating that they form a continuous body beneath the Cenozoic volcanics of the Cascade Mountains. Gravity studies by Thiruvathukal and others (1967) support this theory. Early Cretaceous orogeny superimposed northwest folding and faulting upon the earlier structures (Koch, 1966). Baldwin (1965) found Late Cretaceous marine sedimentary rock in apparent conformable relationship with early Eocene marine rock and volcanics in the Coos Bay area. Other exposures of Late Cretaceous rocks along the northern fringe of the Klamaths in Oregon indicate that eugeosynclinal conditions prevailed in that region at the time and in the region to the north (Koch, 1966).

The western margin of the North American continent and the adjacent ocean floor were involved in a vast uplift beginning in Cretaceous time. Portions of the present shelf region were raised above sea level in successive archings of the mantle during the Tertiary period along the East Pacific Rise (Menard, 1964).

Tertiary

The inland seaway at the beginning of Tertiary time covered western Oregon and Washington from the Klamath Province as far north as Vancouver Island, British Columbia; the eastern margin of the sea was somewhere beneath the present Western Cascades (Snavely and Wagner, 1963). During early and middle Eocene time submarine lavas and breccia were extruded onto the sea floor. They now are exposed at the surface as pillow basalt and zeolitized flow breccia. The vast outpourings of basic lava are believed to be related to a north-trending fracture system separating the Cascades and the coastal plain (Williams, 1942). Except for scattered volcanic islands in the area now occupied by the Coast Range, most of western Oregon was below sea level until middle Tertiary time (figure 4). Transgression of the sea reached its maximum extent in early Eocene time (Snavely and Wagner, 1963). The presence of probable offshore deposits deep within the Klamath Mountains indicates that the northwestern portion of the Klamaths was also submerged during the lower Eocene epoch (Baldwin, 1965; Dott, 1966).

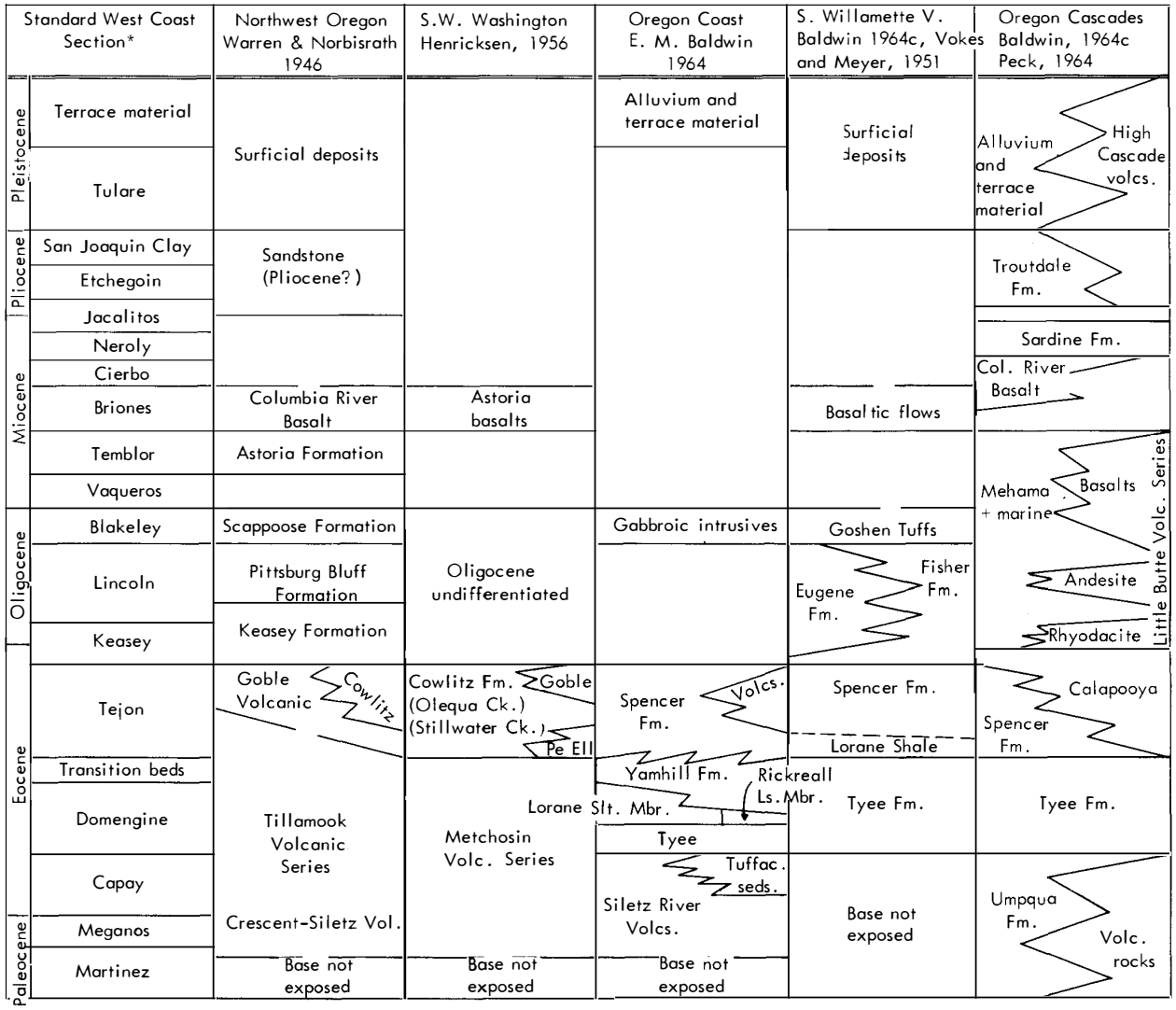
Weaver (1945) considered that the Eocene paleogeography consisted of an elongate inland Arago-Cowlitz gulf in western Oregon and Washington, with peninsulas extending from Vancouver Island to a location west of Coos Bay. His theory is not substantiated by later studies (Dott, 1966, p. 377 and 407). Snavely and Wagner (1963) show that the Tertiary embayment was more open, with short extensions of the headlands and a submerged sill just west of the present shoreline. Dott (1966) believes sediment data indicate the Tertiary sea formed an open shelf adjacent to a broad, low coastal plain, with several volcanic islands lying offshore but with no westward land mass except for the islands. Past geologic studies indicate that the major phases of Tertiary diastrophism occurred in early Eocene, late middle Eocene, late middle Miocene, and late Pliocene time in northwestern Oregon (Weaver, 1937; Snavely and Wagner, 1963; Baldwin, 1965).

Eocene Epoch: In the early part of the Eocene Epoch extensive volcanic centers formed in the eugeosyncline in northwestern Oregon and western Washington. Copious quantities of basaltic lavas poured out on the ocean floor to form the Siletz River and Crescent volcanics (figure 5). More than 60,000 cubic miles of material accumulated, a volume greater than the more publicized Miocene plateau lavas. In some areas the lavas piled high enough to protrude as islands above sea level as evidenced by the development of soil zones at the tops of many flows (Weaver, 1945; Snavely and Wagner, 1963; Snavely and others, 1969). Volcanic rocks and interfingering tuffaceous sediments accumulated to great thicknesses. North of latitude 45° the lower Eocene rocks in Oregon are mainly volcanics; south of latitude 45° they are sedimentary and volcanic. The greatest thickness of lavas is around volcanic centers. Away from these accumulations the lavas intertongue laterally with tuffaceous marine sediments. Uplift and erosion in southwestern Oregon early in Eocene time have been confirmed by Baldwin (1965), while marine conditions prevailed to the north in the geosyncline. Crustal subsidence is estimated to have reached not less than 6000 to 8000 feet in early and middle Eocene time in northwestern Oregon and southwestern Washington; and during late Eocene 8000 feet of mostly marine sediments, with subordinate amounts of volcanics, were deposited on the older volcanics (Warren and others, 1945; Henricksen, 1956, p. 112). Measured sections of rocks in northwestern Oregon total 24,000 feet of marine sediments and 10,000 to 15,000 feet of middle to lower Eocene volcanics (Youngquist, 1961), with as much as 20,000 feet of volcanics near former vents or conduits (Snavely and Wagner, 1964).

Early Eocene uplift in the Klamath Mountains resulted in rapid erosion of the highland areas and lowered the region to a moderate relief. Tremendous quantities of arkosic, volcanic, and lithic debris from the Klamath highlands to the south and from the volcanoes to the east of the geosyncline accumulated to form the Tyee Formation. The abundance of mica, strained quartz crystals, and fragments of metamorphic minerals in the Tyee Formation substantiates a source in the Klamaths (Baldwin, 1964b). Andesitic debris in the Tyee confirms an eastern sediment source as well (Snavely, Wagner, and MacLeod, 1964). Turbidity currents carried the sediments northward into the eugeosyncline to accumulate as graded sandstone and siltstone. The nature and gradation of the deposits suggest that the deeper portion of the sea was north in the Coast Range in middle Eocene time (Baldwin, 1964b; Vokes and others, 1954). Volcanic activity in Oregon was confined mainly to the northwestern portion of the state during middle Eocene time where marine siltstones intertongue with basic lavas and pyroclastics (Snavely and Wagner, 1963). The ancestral Cascades began to form by the end of middle Eocene time (Hoover, 1951; Williams, 1957). Post-Tyee uplift in the central Coast Range was accompanied by considerable erosion, so that when the area was submerged again in late Eocene time these younger sediments were deposited in place on lower Eocene volcanics (Baldwin, 1964b). Local unconformities developed near volcanic accumulations. Upwarps and volcanic accumulations gave rise to the formation of several separate basins of deposition in western Oregon by late Eocene time (Snavely and Wagner, 1964).

The sea withdrew to the northwest in late Eocene time. Marine inundation was less extensive because volcanism had raised the area southeast of the eugeosyncline and upwarping occurred to the northwest in the areas of the Tillamook and Willapa Hills volcanic centers. Volcanic rocks accumulated along the landward margin of the sea in the region now occupied by the Western Cascades (plate 7). In addition, Goble Volcanics issued forth into the lower Columbia River downwarp, while flows of the same age were extruded in the vicinity of Heceta Head on the coast and along the eastern edge of the Dallas quadrangle in the Willamette Valley (Baldwin, 1964b). Flows and pyroclastics of Goble were interbedded with sediments of the Cowlitz Formation, consisting of marine brackish water and continental debris which collected in the lower Columbia River downwarp.

Continued elevation of the Klamath Mountains and bordering Tyee deposits in late Eocene time resulted in further withdrawal of the sea, and much of the Tyee was eroded and redeposited northward as the Spencer Formation. In northwestern Oregon the upper Eocene Nestucca Formation, composed of sandstone interbedded with siltstone, was derived from Tyee sediments and middle-lower Eocene volcanic rocks (Snavely and Wagner, 1963; Vokes and others, 1954). The occurrence of nonmarine sediments in rocks of Spencer age equivalent near Comstock in southwestern Oregon established the location of the southeastern shore line in upper Eocene time (Vokes, Snavely, and Meyers, 1951). Generally, a regional unconformity exists between upper Eocene and middle Eocene formations in the Tertiary eugeosyncline, but there are locations where the unconformity appears slight. Large gabbroic and alkalic masses and sills intruded



* Weaver and others: Geol. Soc. Am. Bull., v. 55, 1944, p. 569.

Figure 5. Correlation chart for the Lower Columbia and Willamette regions.

the sedimentary rock of the central and northern Coast Range in late Eocene and middle Miocene orogenies (Snavely and Wagner, 1964; Baldwin, 1964b). Some erosion of late Eocene rocks in northwestern Oregon and southwestern Washington took place before deposition of Oligocene material (Snavely and Wagner, 1964; Henriksen, 1956). Mild regional uplift continued in the southern part of the eugeosyncline, causing the sea to withdraw northward and westward.

Oligocene Epoch: Gradual subsidence of deformed and eroded Eocene strata accompanied Oligocene deposition in the Willapa Hills of southwest Washington (Henricksen, 1956). In the Astoria-Nehalem basin, fine-grained clastic sediments of the Keasey Formation accumulated. Deposition probably occurred in relatively deep marine waters in early Oligocene time as contrasted to shallow-water conditions later in the epoch. At the close of Keasey time northwestern Oregon was elevated above sea level, but the land surface probably did not stand very high. The land subsided again in later Oligocene time (Warren and Norbisrath, 1946).

The sea extended into the Willamette geosyncline as far south as the present site of Cottage Grove in middle Oligocene time (figure 4), then withdrew northward to approximately the present site of Salem by late Oligocene (Packard, 1935). Increased volcanism in the area that is now the Western Cascades caused pyroclastic and andesitic debris to pour into the receding marine basin. Ash and tuff issued forth in tremendous quantities, being deposited as continental and marine tuffaceous sediment.

Accumulations of tuffaceous marine sediments in northwestern Oregon are represented by: 1800 feet of uppermost Eocene-lower Oligocene Keasey Formation (Warren and others, 1945); 850 feet of middle Oligocene Pittsburg Bluff Formation (Warren and others, 1945); 5000 feet of middle Oligocene Eugene Formation (Schenck, 1927); and 1500 feet of upper Oligocene Scappoose Formation (Warren and Norbisrath, 1946).

Lowry (1947) traced the shore line of the Oligocene sea along the eastern edge of the Willamette Valley on the basis of localities where leaf-bearing beds interfinger with marine sediments. Vokes, Snavely, and Meyers (1951) mapped the southward extent of the Oligocene Eugene Formation in the vicinity of Cottage Grove in a locality where marine and terrestrial rocks overlap.

Further evidence marking the extent of the Oligocene sea was the discovery of halite crystals replaced by quartz in fossil wood from the Sweet Home area of the Western Cascades (Staples, 1950). Marine sediments 20 miles northeast of Salem were described as late Oligocene-early Miocene age (Durham, Harper, and Wilder, 1942, p. 120). Tuffaceous marine sediments and terrestrial coal-bearing beds of the Pittsburg Bluff and Scappoose Formations were deposited in the Astoria and Nehalem basins during late Oligocene time. Scappoose continued to be deposited in early Miocene time.

Portions of the Coast Range in Oregon were above sea level during the Oligocene Epoch. Erosion of lower Oligocene marine sediments from the crest of the Coast Range makes it difficult to project the area that the sea covered at that time with any certainty. Erosion, which began in the Oligocene, continued through middle Miocene in the south-central Coast Range (Baldwin, 1964b).

Miocene Epoch: Regional elevation of western Oregon and Washington occurred at the beginning of Miocene time, and the sea retreated from the continent except for a few coastal embayments. The region was elevated long enough for considerable erosion to occur before deposition again took place (Warren and Norbisrath, 1946).

The lower Columbia River area was downwarped again during middle Miocene time, causing the last encroachment of the sea upon the continent (figure 4). Middle Miocene marine sediments are found at the west end of the Columbia-Willamette seaway (Wells and Peck, 1961), and in the small coastal embayments at Tillamook and Newport. In middle and late Miocene time floods of basaltic lava poured from fissure vents in northwestern and north-central Oregon. This eruptive cycle continued through early Pliocene (Snavely, Wagner, and MacLeod, 1969). Some flows were extruded from vents in the Astoria and Tillamook areas at the same time (Warren and others, 1945). Sheets of lava poured southward into the Willamette Valley and westward down the Columbia River valley. The lavas thin westward and overlap formations ranging in age from Goble to Astoria (Warren and others, 1945). Near Astoria they are no longer well-defined flows but are altered and brecciated as a result of extrusion beneath the sea. Marine beds overlying flows just east of Astoria testify to minor fluctuations of the sea near the close of the Miocene

(Lowry and Baldwin, 1952). Mineral assemblage of near-shore marine and lagoonal deposits of late Miocene age in the Astoria area indicate that the Columbia River flowed near its present course in late Miocene time and was contributing sediments to the marine embayment (Dodds, 1963). Middle Miocene lavas are at least 1000 feet thick in the Nehalem Valley of northwestern Oregon (Warren and Norbisrath, 1946) and 2500 feet thick in the Columbia River Gorge 35 miles east of Portland (Williams, 1916). The original extent of the Columbia River lava has been little changed by erosion in the Cascade Mountains so that its present distribution indicates distance from source vents. North of latitude 45° the Columbia River lava probably extends beneath some of the younger units in the Cascades and is continuous with flows of the same age in eastern Oregon (Peck and others, 1964). The Miocene lavas reached the southern portion of the Willamette Valley during the magmatic outpouring (Wells and Peck, 1961).

Middle to late Miocene time was a period of uplift again in northwestern Oregon and western Washington (Snavely, Wagner, and MacLeod, 1969). Compressive forces formed northwest-trending folds in the eugeosyncline from the Olympic Mountains south to the Columbia River downwarp and northeasterly and northerly trending warps in the Oregon Coast Range (Weaver, 1945; Snavely and Vokes, 1949). Erosion removed sediments from the crests of folds in the Coast Range and cut deeply into the underlying lavas (Weaver, 1945).

Northeast-trending structures of the Western Cascades probably developed intermittently between late Eocene and late Miocene time (Peck and others, 1964). Andesite was extruded alternately with eruptive material from strato-volcanoes in the Cascades. The eruptive debris was carried in part by wind and water to the adjacent lowlands, sometimes as mudflows. Small lakes often formed when damming gave rise to a short lacustrine record (Snavely and Wagner, 1963).

Pliocene Epoch: There is very little marine Pliocene record in northwestern Oregon, indicating that during this geologic interval the region was above sea level and undergoing erosion (Warren and Norbisrath, 1946; Lowry and Baldwin, 1952). By Pliocene time the sea had withdrawn to approximately its present location, except for a shallow embayment in the Coos Bay area of southwestern Oregon.

Continental gravels of the Troutdale Formation of Pliocene age were deposited in the lower Columbia Valley from the gorge westward to the present site of Rainier. An estimated 400 feet to 1000 feet of these Troutdale sediments were deposited in the Portland area (Trimble, 1963). Contemporaneous gravels, silts, and mudstones accumulated along the lower reaches of the Sandy, Clackamas, and Molalla Rivers and in the northern Willamette Valley. Farther south, bordering the east side of the Willamette Valley in the Salem and Stayton areas, Pliocene deposits consist of deeply weathered tuff and volcaniclastic rocks which were derived from the North Santiam River drainage (Lowry and Baldwin, 1952).

Andesitic and basaltic flows were extruded in the High Cascades during late Pliocene time. Rocks of the Western Cascades are older, consisting of Miocene and Oligocene volcanics (Wells and Peck, 1961). Volcanism in the High Cascades in late Pliocene was related to crustal disturbances which folded the Coast Range into a broad, northerly trending anticlinorium (Souza, 1927) while the area to the east was downwarped along a parallel axis (Weaver, 1945; Hoover, 1951).

Late Pliocene deformation in western Oregon may have been related to uplift along the East Pacific Rise. Miocene-Pliocene bathyal siltstones crop out on the banks along the central Oregon continental shelf (Maloney, 1965). Benthic foraminifera in these sediments suggest that the shelf was uplifted as much as 1 km by the end of Pleistocene time (Byrne, Fowler, and Maloney, 1966).

Quaternary

Four world-wide stages of glaciation have been recorded by deposits of till and also by marine terraces cut during the interglacial rise of sea level. Such wave-cut terraces can be seen along the Oregon coast, ranging in elevation from 225 feet to more than 1500 feet. Alluviated estuaries give testimony to times of submergence (Baldwin, 1964c; Snavely and Vokes, 1949). Changes in sea level during the Pleistocene caused alternate downcutting and deposition by the Columbia River and its tributaries, forming alluvial terraces at different levels. Maximum sea-level change due to melting of continental glaciers is estimated to have been between 420 and 460 feet (Russell, 1957; Byrne, 1964).

Regional uplift in late Pleistocene time also contributed to the formation of terraces. Uplift at the close of Pleistocene time is estimated to have been more than 2700 feet in the High Cascades. Corresponding uplift in the Coast Range appears to have been 1100 feet (Lowry and Baldwin, 1952).

Structural Development

The structure of the pre-Tertiary rock in western Oregon is not known outside of the Klamath Mountains, because rock older than Tertiary is not exposed west of the Cascade Mountains in Oregon except in the Klamaths. The dominant northeast structural trends in the Klamath Mountains upland developed during the Late Jurassic Nevadan orogeny. Late Cretaceous and early Eocene eugeosynclinal deposits were compressed into northeast-trending folds in the northern Klamath Mountains at the close of the middle-lower Eocene (Baldwin, 1965).

In northwestern Oregon a major stratigraphic break is recorded between middle and late Eocene rocks (Baldwin, 1964b; Snavely and Wagner, 1964). Most of the geologic studies made thus far indicate that no other major unconformities developed within the western marine basin until middle to late Miocene; however, McWilliams (1968) suggests five significant unconformities in the Tertiary rocks of western Oregon.

After the end of middle Miocene time, compressive forces caused folding of marine rock in western Oregon and Washington. Large northwest-striking folds formed in Washington north of the Columbia River downwarp. South of the downwarp, in Oregon, the trends were mainly north to northeast (Weaver, 1945). Smaller secondary folds developed on the flanks of the larger warps, and normal and high-angle thrust faulting accompanied formation of these secondary flexures (Snavely and Vokes, 1949; Snavely and Wagner, 1964). Compressive forces lessened toward the Western Cascades, as shown by the shallow, broad northeast-trending folds. Minor normal faulting and diorite intrusions occurred in the Western Cascades during the Miocene diastrophism (Thayer, 1936).

Diastrophism in late Pliocene to early Pleistocene time resulted in uplift along the entire western margin of the North American continent (Weaver, 1945). The present main topographic and structural features of western Oregon were determined in this upheaval. They include: the north-to-south alignment of the Coast Range, the similar trend of the Cascade Mountains to the east, and the intervening Willamette lowland. The Coast Range formed as a northward-plunging anticlinorium (Snavely and Wagner, 1964). During this period of diastrophism, north-trending warps were superimposed on the older structures, in some instances partially obscuring them (Weaver, 1945; Hoover, 1951).

Major faults in northwestern Oregon strike northeast, northwest, and east (Wells and Peck, 1961). Principal faults mapped thus far in this region are high-angle normal and reverse. Displacements range from a few tens of feet to several thousand feet (Snavely and Wagner, 1964). Faulting is believed to have played a small role in structural development of the lower Columbia River downwarp. Landsliding and slumping in northwest Oregon give anomalous attitudes and complicate structural interpretation (Henriksen, 1956; Deacon, 1953; Dodds, 1963).

Northeast-striking faults include the Corvallis shear zone, Kings Valley normal fault (Vokes and others, 1951; Baldwin, 1956), and several large faults just south of the Tillamook Highland (Wells and Peck, 1961).

Large northwesterly striking faults have been mapped along the west front of the Chehalem Mountains in T. 2 S., R. 3 W., and along Gales Creek in T. 2 N., R. 4 W., and in T. 3 N., R. 5 W. These two faults probably join to form a break approximately 30 miles long (Wells and Peck, 1961). West-to-northwest faulting commonly exhibits strike-slip movement (Snavely and Wagner, 1964). Schlicker and others (1964) believe a northwest-trending fault of considerable magnitude forms the steep east face of the Tualatin Mountains (Portland Hills) and that it may extend from Scappoose Creek, which is 15 miles northwest of Portland, to the Clackamas River channel some 40 miles to the southeast. Seismic studies of the 1962 Portland earthquake (Dehlinger and others, 1963) substantiate the existence of a fault along the east front of the Tualatin Mountains and suggest an easterly dip.

Several transverse fractures cut the general northerly structural terrane of the Coast Range in Oregon. Large east-striking faults have been mapped in the Yamhill Valley 15 miles west of Salem and generally have the same trend as the downwarped valley (Baldwin and others, 1955; Baldwin and Roberts, 1952). Movement along the Yamhill fault is thought to have been at least 1000 feet, with the north side down. A similar fault 4 miles to the south is believed to have an equally large displacement. Intrusions

of gabbro and diorite sills appear to have been emplaced at the time of faulting (Baldwin, 1964a). A large east-striking fault is postulated by Snavely and Wagner (1964) between Corvallis and the coast, where both ends have been mapped. In the intervening area, where the exposures are poor, fold axes have been offset on either side of the projected fault trace.

Large northerly trending fractures have been indicated in recent studies. The steepness and linear trend of the gravity gradient bordering the western edge of the Willamette Valley suggest the occurrence of major faulting associated with the Coast Range uplift, with the region to the east downthrown (Bromery and Snavely, 1964). A large north-trending fracture system may be indicated by the linearity of the contact between rock of the Western Cascades and that of the younger High Cascades and the north-south alignment of volcanic vents of the High Cascades (Williams, 1942). However, mapping thus far has not substantiated faulting on this scale (Peck and others, 1964).

Stratigraphy of Subsurface Sections

Subsurface information for the lower Columbia-Willamette region is arranged according to the following five areas: Astoria basin, Nehalem basin, Tualatin basin, central Willamette Valley, and southern Willamette Valley. Each area is illustrated by one or more subsurface sections (plates I through VI in pocket), and locations of the sections are shown on the map in the pocket (plate VII). Deep-well correlations and general stratigraphy for the five areas are discussed in the following paragraphs.

ASTORIA BASIN AREA
(Plate I)

General stratigraphy

The Tillamook Volcanics (in part Crescent Formation; Unit B volcanics [?], Wolfe and McKee, 1968) are represented by an estimated 10,000 to 20,000 feet of basaltic lavas and tuffs in northwestern Oregon and southwestern Washington. Tillamook Volcanics have not been mapped in detail in northwestern Oregon and may include flows of late Eocene age (Snavely and Wagner, 1964). Thus flows and related pyroclastics of lower to middle Eocene age are herein referred to as Siletz River Volcanics or Crescent Formation, its equivalent in southwestern Washington (Rau, 1966). The predominant rock type is a dark, greenish-gray, aphanitic-to-porphyritic basalt which is commonly amygdaloidal. Both pillow structure and columnar jointing are common. The series includes a considerable amount of flow breccia and zeolite-cemented extrusive breccia; these are frequently cut by calcite and zeolite veinlets (Snavely and Wagner, 1964).

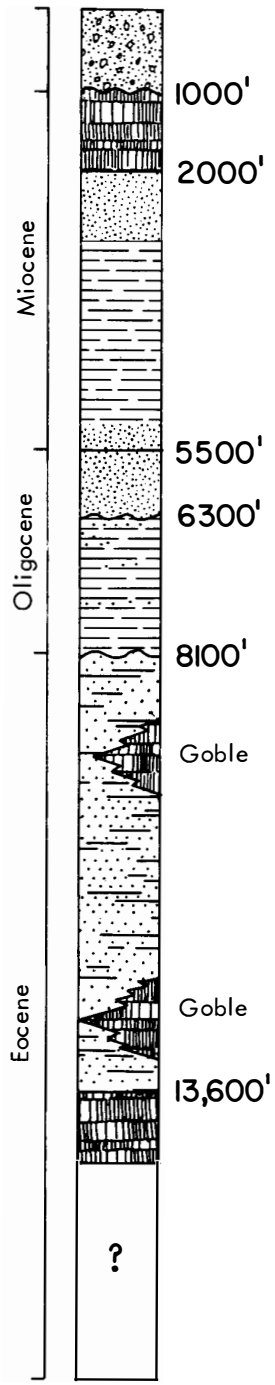
The lavas interfinger with tuffaceous marine claystone and shales which have been identified as middle-early Eocene age by scattered, poorly preserved fossils. Apparently sediments accumulated in the Astoria trough under shallow-water conditions during early Eocene time, and the trough deepened in later Tertiary time (Henriksen, 1956). A generalized stratigraphic column is shown in figure 6.

Units A and B mapped by Wolfe and McKee (1968) in the Grays River area of Washington are correlatives of the Cowlitz Formation. The Cowlitz of northwestern Oregon contains about 120 species of megafossils (Warren and others, 1945).

The Cowlitz Formation is composed of greenish-gray tuffaceous shale, gray massive glauconitic sandstone, gray sandy shale, and micaceous sandstone with a lesser amount of tuff. Cowlitz beds may be as much as 2000 feet thick in the Astoria area (plate I).

Late Eocene volcanics, predominantly basaltic flows and flow breccias, are interbedded with tuffaceous marine and continental sediments of Cowlitz age in the lower Columbia River valley.

Upper Eocene-lower Oligocene Keasey sediments appear to conformably overlie the Cowlitz (Warren and others, 1945) and interbedded volcanics. Total thickness of the Keasey is estimated to be 1800 feet in the Astoria area from the log of Standard "Hoagland 1." Studies by Henriksen (1956) in the Willapa Hills just north of the Astoria-Nehalem downwarp suggest that Oligocene sediments were deposited in relatively deep water, well off shore. In the western half of Clatsop and Tillamook Counties, dark Keasey



Pliocene-Pleistocene. Terrace deposits consisting of basaltic gravels and sandstone with considerable carbonaceous material.

Columbia River Basalt. Basalt flows, agglomerates, and some pillow basalt. Terrestrial flows, often vesicular.

Astoria Formation. Feldspathic, micaceous sandstone and siltstone and intercalated submarine flows. Dark gray indurated siltstone, tuffaceous shaly sandstone. Some beds of coarse micaceous, quartzose sandstone and indurated glauconitic siltstone.

Scappoose, Blakeley, and Pittsburg Bluff Formations. Light gray, fine- to medium-grained sandstone, some tuff layers, abundant woody material.

Keasey Formation. Dark gray, massive siltstone, weathers to tan unctuous clay, layers of calcareous concretions, occasional ash beds.

Goble Volcanics. Porphyritic olivine basalt with fillings of zeolite and calcite. Some interbedded sediments and pyroclastics.

Cowlitz Formation. Greenish gray, tuffaceous shale, gray massive glauconitic sandstone, gray sandy shale and micaceous sandstone. Some tuff beds. Intercalated basaltic flows and flow breccia.

Crescent Formation (in part Tillamook Volcanics, Siletz River Volcanics.) Dark greenish gray, aphanitic to porphyritic basalt, commonly amygdaloidal. Pillow structure and columnar jointing common. Series includes flow breccias which are cemented with zeolite and calcite, and interbedded marine siltstone.

Figure 6. Generalized geologic column for the Astoria basin.

shales (claystones) are not readily distinguishable from Cowlitz sediments. Approximately 100 species of mollusks and other megafossils have been found in the Keasey beds. The Keasey shale is disconformably overlain by the Pittsburg Bluff Formation in northwestern Oregon (Warren and Norbisrath, 1946), but the Keasey and Pittsburg Bluff Formations have not been differentiated as yet in the Astoria area.

The Pittsburg Bluff Formation is lithologically similar to the overlying Scappoose except that it is less tuffaceous. At least 70 species of mollusks have been described from the Pittsburg Bluff sediments. The formation is represented by approximately 850 feet of near-shore brackish and marine beds (Warren and others, 1945). The Pittsburg Bluff is disconformably overlain by the Scappoose Formation in the Nehalem basin.

The Scappoose Formation of late Oligocene to early Miocene age is made up of light gray, poorly bedded, fine-to-medium-grained micaceous sandstone which contains a great deal of woody material. Tuffaceous shaly sandstone and layers of tuffs are interbedded in sandstone. The Scappoose Formation is estimated to be 1500 feet thick in the Tillamook area. Mapping done by Wolfe and McKee (1968) in the Grays River locality of southwestern Washington implies that the Lincoln Creek Formation includes late Keasey, Pittsburg Bluff, and early Scappoose Formations of northwestern Oregon (Snavely, Brown, Roberts, and Rau, 1958).

Miocene Astoria sediments unconformably (?) overlie older rocks in the northern Coast Range (Warren and others, 1945). Howe (1926) divided the Astoria beds near the mouth of the Columbia River into a lower sandstone, middle shale, and upper sandstone. The upper sandstone member is interbedded with breccia believed to be late Miocene age. Dodds (1963) describes the Astoria Formation in the Svensen area as predominantly gray marine siltstone with layers of carbonaceous sandstone. Glauconite pellets are commonly found in the siltstone along the Klaskanine River in Ts. 6 and 7 N., R. 8 W. Dodds believes that the contact between the siltstone and the overlying feldspathic, micaceous sandstone in the Svensen area is not conformable and he describes the upper unit separately as the post-Astoria sandstone. Howe's middle and lower members of the Astoria Formation appear to be missing 16 miles east of Astoria near Clifton (Lowry and Baldwin, 1952).

In the Tillamook area the Astoria Formation is mainly a fine-grained, tuffaceous, shaly sandstone with some layers of coarse, micaceous, quartzose sandstone (Warren and others, 1945). Thickness of the Astoria Formation near Astoria is at least 3500 feet (see plate I). Intrusive dikes and sills of basalt occur in the Astoria and Svensen areas. Dodds (1963) found that porphyritic basalts were probably in part feeders to some Columbia River flows. Miocene Columbia River Basalt may be conformable upon Astoria beds in the vicinity of Astoria, but farther east the lavas rest unconformably on an old surface of moderate relief (Warren and others, 1945).

Columbia River lavas occur as a series of basalt flows, basaltic pillow lavas, and flow breccias in the Svensen quadrangle east of Astoria. The pillows are often surrounded by glassy flow-breccia which is stained red by iron oxide. A thick series of marine flow breccias overlies the pillow lavas. Thick layers of terrestrial flows which are vesicular near the tops are also found in the Svensen area 6 miles east of Astoria. Thickness of the Miocene lavas ranges from tens of feet to as much as 1000 feet.

Massive friable sandstone, bedded carbonaceous sandstone, and sandy shale are exposed 20 miles east of Astoria at the town of Clifton and appear to conformably overlie the Columbia River Basalt. The sandstone is, in turn, unconformably overlain by horizontal Pliocene-Pleistocene beds, indicating that the Clifton beds are correlative with the upper portion of the Astoria Formation (Lowry and Baldwin, 1952). Dodds (1963) did not find Miocene sediments above the Columbia River Basalt in the Svensen area west of Clifton, suggesting that the Svensen area was topographically higher in late Miocene time than the Clifton area.

Horizontally bedded Pliocene-Pleistocene deposits overlie the Columbia River Basalt with slight unconformity in the Svensen quadrangle (Dodds, 1963). Pliocene strata in the lower Columbia River valley, which tentatively correlate with the Troutdale Formation near Portland, are represented by terrestrial massive crossbedded sandstone and shale. These rocks contain a considerable amount of carbonaceous material (Lowry and Baldwin, 1952). The terrace deposits near Svensen contain basaltic gravel and feldspathic sandstone. Maximum thickness of the Pliocene is estimated to be a few hundred feet (Warren and others, 1945). Quaternary alluvium deposits are from 300 to 600 feet thick in the lower Columbia River valley (Lowry and Baldwin, 1952).

Correlation of deep wells

Middle Miocene rocks are exposed at the surface where one deep drilling has revealed that marine sediments are probably more than 10,000 feet thick in the synclinal areas. The Richfield "Weyerhaeuser 1" drilled on the north side of the river near Megler, Wash., in 1955 is believed to have encountered approximately 4000 feet of Miocene, 2750 feet of Oligocene, and 2350 feet of upper Eocene rock. The hole was apparently located in the center of a northwest-trending downwarp. Union Oil Co.'s "McGowan 1," located approximately 7 miles west of the Richfield "Weyerhaeuser 1," was drilled on a northwest-trending volcanic high with middle to upper Eocene volcanics exposed at the surface (Huntting and others, 1961). The Union hole was drilled entirely in volcanic rock (total depth, 4385 feet). The Standard "Hoagland 1," which was drilled in Oregon 14 miles southwest of the Richfield "Weyerhaeuser 1," tested the same northwest-trending high that was drilled by Union, but at this location sediments equivalent in age to the Keasey Formation are exposed at the surface (Wells and Peck, 1961). Upper Eocene rock is marine sedimentary in the Standard "Hoagland 1," but 15 miles to the east in the Richfield "Weyerhaeuser 1" rock of the same age is interbedded with volcanics and intruded by Miocene sills (Richfield Oil Corp., 1955; Wolfe and McKee, 1968). Only minor amounts of sandstone were found in the Richfield hole and it was of low permeability. Sediments encountered were predominantly siltstones and mudstones. Shows of oil and gas were reported in the lower Columbia "Brown 1" at Astoria (see table 1), but incomplete well records prevent any evaluation of the sandstones containing hydrocarbons. The sedimentary rock drilled in Standard's test was also fine grained and lacked the sections of permeable sands which are necessary for storing oil and gas.

NEHALEM BASIN AREA
(Plate II)

General stratigraphy

Analysis of gravity data and deep-well records in the Astoria-Nehalem basins suggests that the relatively dense, lower- to middle-Eocene volcanics may be underlain by less dense Cretaceous(?) rocks (Bromery and Snavely, 1964).

Thickness of the Eocene Tillamook Volcanics in northwestern Oregon is calculated from aeromagnetic and gravity studies to be as much as 20,000 feet (Bromery and Snavely, 1964). Southwestward along the Wilson River Highway (Oregon State Highway 6) poorly preserved fossils of Eocene age have been found in tuffaceous sediments interbedded with the Tillamook Volcanics (Warren and others, 1945). Cowlitz sediments overlie Crescent(?) Volcanics (lower Tillamook Volcanics and Siletz River Volcanics equivalent) unconformably in the Nehalem basin (Warren and others, 1945) (figure 7). Marine sediments of Cowlitz age are interbedded with basaltic lavas and pyroclastics named the Goble Volcanics. These volcanics measure more than 5000 feet in thickness in the Kelso-Longview area of southwestern Washington. Flows are commonly vesicular and the vesicles filled with calcite and zeolite. Middle-late Eocene basalts are typically porphyritic with elongate plagioclase phenocrysts. Composition of the basalt ranges from andesitic to olivine basalt (Henriksen, 1956). The Goble may be in part equivalent to Keasey age sediments (Wilkinson and others, 1946).

The Cowlitz Formation (age equivalent of Goble) consists of basaltic boulder conglomerate; dark, locally glauconitic shale; basaltic sandstone; micaceous, quartzose sandstone; tuffaceous claystone; and siltstone (Warren and others, 1945). Approximately 5600 feet of Cowlitz Formation was encountered in the Texaco "C & W 1." Pyroclastics, breccia, agglomerate, and lapilli tuff are intermixed with lower Cowlitz sediments along the banks of the Chehalis River in Washington (Henriksen, 1956), and the volcanics in the Texcao wells may be related to these extrusives.

Northeast of the Willapa Hills uplift near the town of Ryderwood in southwestern Washington, 8000 feet of marine brackish water and terrestrial sediments with a subordinate amount of volcanic rock have been mapped as Cowlitz by Henriksen (1956). A study of fauna from the Willapa area indicates a relatively quiet, deep-water environment during late Eocene time (Moore and Vokes, 1953).

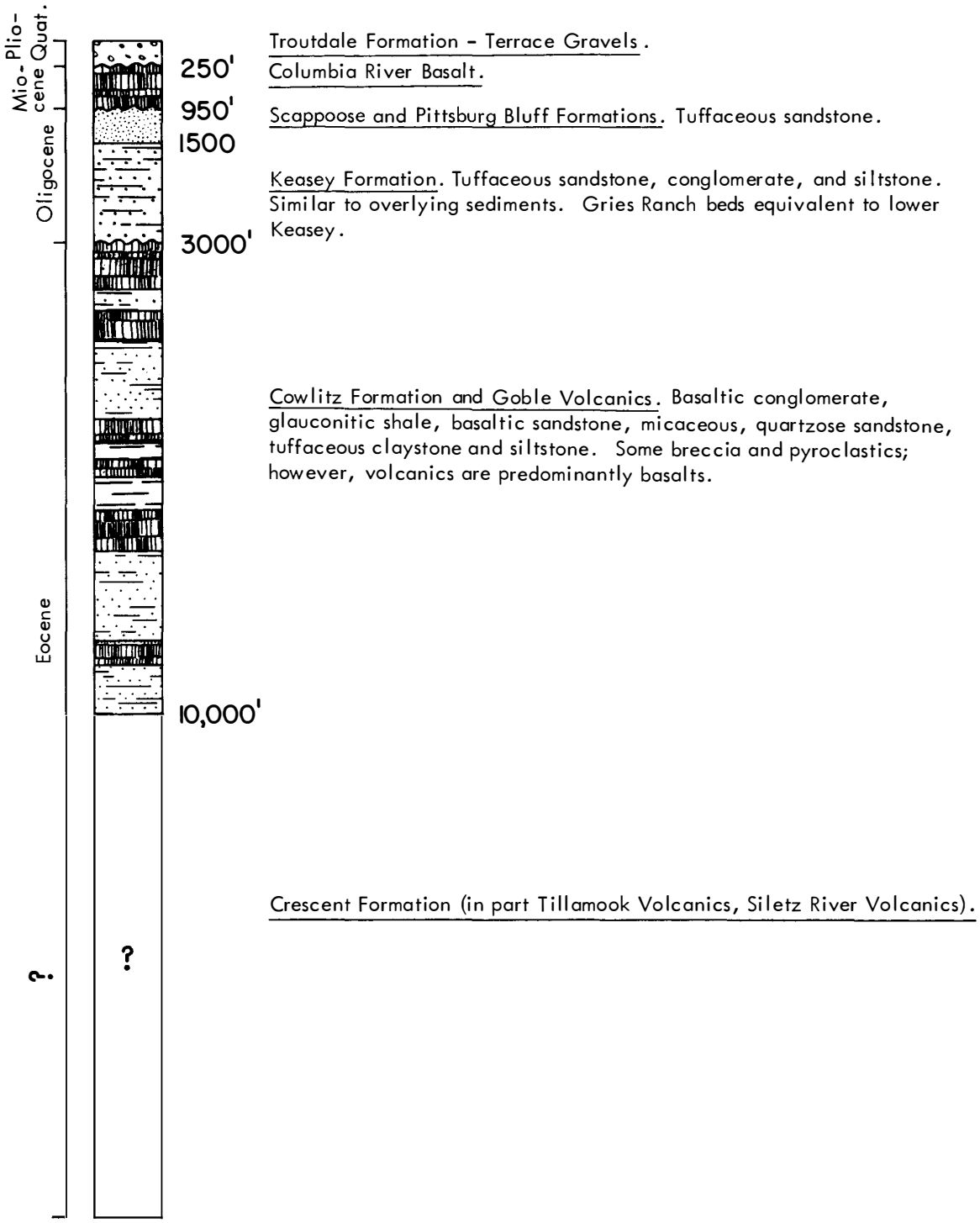


Figure 7. Generalized geologic column for the Nehalem basin.

Massive tuffaceous siltstone of the Keasey Formation of lower Oligocene age overlies Goble Volcanics and Cowlitz sediments in the Nehalem basin. The siltstone is 1800 feet thick in the vicinity of the Sunset Tunnel, T. 3 N., R. 5 W. (Warren and others, 1945). Southwest of Clatskanie, conglomerate and massive sandstone containing fossils unlike those in the Keasey Formation but apparently slightly older than the Pittsburg Bluff fauna are similar to the lower Oligocene Gries Ranch Formation of southwestern Washington (Warren and Norbisrath, 1946). Bedding planes in the Keasey are marked by layers of calcareous concretions and occasional ash beds. Presence of wood fragments and leaves and the coarse texture of Keasey sediments suggest that they were near-shore, brackish and marine, shallow to moderately deep-water deposits (Wilkinson and others, 1946; Warren and Norbisrath, 1946).

Pittsburg Bluff strata disconformably overlie Keasey beds in the Nehalem basin (Warren and others, 1945). In the St. Helens area the Pittsburg Bluff and Scappoose Formations were mapped as one unit, since lithologically the two formations are very similar, as described by Warren and Norbisrath (1946). Probably most of the Oligocene sediments in the St. Helens area are Pittsburg Bluff age and only a minor amount are of Scappoose age (Wilkinson and others, 1946). Oligocene sediments are composed of massive, medium- to fine-grained tuffaceous sandstone and some gritty conglomerate. Sediments are gray but weather to a buff or yellowish-brown color. The sandstone contains feldspar, quartz, volcanic glass, basic rock fragments, mica, and hornblende. Some of the deposits are of the near-shore type, as indicated by the abundance of wood fragments and carbonaceous material. Two coal beds, the larger one 6 feet thick, occur at the south end of Deer Island (Wilkinson and others, 1946). Pittsburg Bluff and Scappoose sediments are estimated to be 2300 feet thick in the Nehalem basin (Warren and others, 1945).

Miocene Columbia River Basalt rests unconformably on strata ranging in age from upper Eocene (Cowlitz Formation) to Oligocene and lower Miocene (Keasey, Pittsburg Bluff, and Scappoose Formations). Miocene basalt rests on Goble Volcanics north and east of the cross section (plate II). A conglomerate of Miocene age underlies the Columbia River Basalt in the Clatskanie River valley (see plate II). Miocene basalt covers a large area in northwestern Oregon, having flowed into a lowland region which had been a seaway in late Oligocene time. The basalt is gray where it is vesicular and black where massive and fine grained. Limonite commonly coats fractured surfaces in the basalt. The basalt is approximately 700 feet thick in the St. Helens area (Wilkinson and others, 1946).

Troutdale gravels of Pliocene age (Lowry and Baldwin, 1952) overlie the Columbia River Basalt with slight unconformity in the lower Columbia River valley. The gravels are made up of quartzite and volcanic clasts. A considerable amount of silt and sandstone is intermixed with the coarse material. Troutdale sediments were derived from Columbia River drainage. The upper portion of the beds is predominantly silt. A massive volcanic breccia is interbedded with Troutdale gravels near Woodland, Wash. (Wilkinson and others, 1946).

Pleistocene terrace gravels and sands mark changes of sea level and record continuing uplift of the continent during late Cenozoic time. The terrace deposits in the Nehalem area are at an elevation of 300 feet above sea level. Thickness of the Pleistocene sediments ranges from approximately 100 feet near St. Helens to 500 feet at Portland (Wilkinson and others, 1946; Lowry and Baldwin, 1952).

Correlation of deep wells

Texaco, Inc., drilled its first test hole, "Clatskanie 1," in the Nehalem basin toward the center of the downwarp. Many clayey sandstone beds were drilled in the "Clatskanie 1" but no good shows of oil or gas were found. The sands appeared to be "wet," so no tests were run. Texaco's second hole in the basin, "Clark & Wilson 1," was drilled on a northwest-trending anticline located updip and south from the first hole. "Clark & Wilson 1" is believed to have reached the Crescent(?) Volcanics at 8400 feet. Sands in the Cowlitz(?) were tested and found to be filled with salt water. Results of the testing showed that the sands had fair to good permeabilities (see table 1).

TUALATIN BASIN - NORTHERN WILLAMETTE VALLEY
(Plate III)

General stratigraphy

In the Tualatin basin area no rocks older than Scappoose age (Blakeley equivalent) are exposed. Hence, the character of older rocks must be deduced from exposures to the northwest in the Nehalem basin (Warren and others, 1945). Rocks lying below the Scappoose Formation are described in well samples from Texaco's "Clark & Wilson 1" and "Clatskanie 1" (see table 2). Scappoose (Blakeley) beds lie disconformably on older rocks west of the Tualatin basin (Warren and others, 1952) (figure 8).

Late Oligocene to early Eocene strata of the Scappoose Formation are made up predominantly of tuffaceous shale and sandstone with some conglomerate. The strata are about 1500 feet thick in the northern Tualatin basin (Trimble, 1963). Some basalt flows are locally intercalated with Scappoose sediments. Under the microscope the sandstones were found to be composed of feldspar, quartz, mica, and glass shards along with carbonized wood fragments. Shale and shaly sandstone make up the bulk of the rocks. A conglomerate consisting of rounded pebbles of chert, quartz, and basalt occurs within the unit. East of the Tualatin basin, Scappoose deposits grade into water-laid pyroclastics (see plate III).

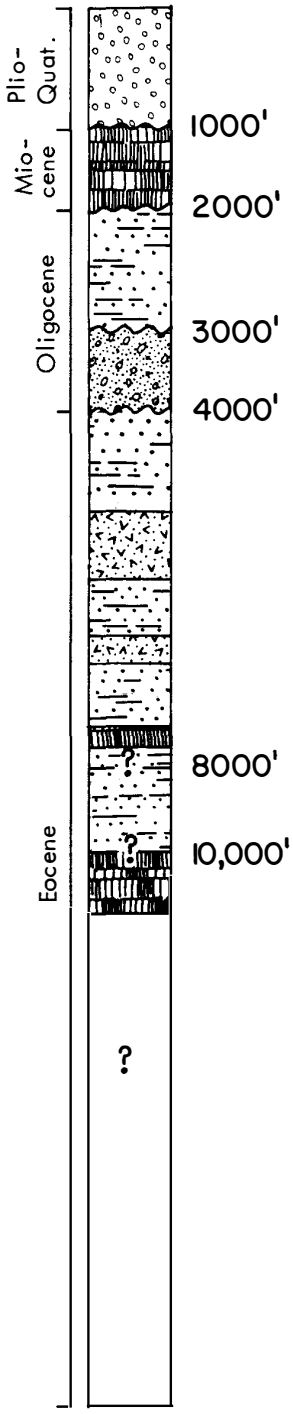
The Columbia River Basalt in northwestern Oregon is a part of the extensive plateau-forming flows of central Oregon and Washington which were extruded from fissures in Miocene time. The basalt is hard and resistant and forms prominent ridges. It lies unconformably on upper Oligocene marine sediments in which considerable relief had been carved. The series of flows in the lower Columbia River valley is on the average 50 feet thick and often exhibit pahoehoe crusts. Thickness of the basalt unit is approximately 1000 feet in the Tualatin basin area and a few miles east reaches a thickness of 2000 feet in the Columbia River Gorge (Lowry and Baldwin, 1952). Some inter-basalt limonitic clays occur in the Tualatin basin area. Columbia River Basalt is generally dark gray to black, fine grained, and commonly vesicular, particularly near the top of flows. Weathering is deep and extensive where the flows have been exposed to the atmosphere. The basalt contains very little olivine and ranges in texture from subophitic to hyalophitic to intergranular or intersertal. Augite composes 30 to 40 percent of the groundmass (Trimble, 1963).

Pliocene gravels and silts unconformably rest on the Columbia River Basalt in the Tualatin basin. Rocks of this age in the Portland area are named the Troutdale Formation and include the Portland Hills Silt and lower quartzite-bearing gravels (Lowry and Baldwin, 1952). Volcanic breccia and basaltic lava (Boring Lava) are intercalated with the Troutdale sediments. Troutdale deposits in the Portland area reach a thickness of 600 feet. In the Portland area a moderately indurated mudstone called the Sandy River Mudstone occurs between the Troutdale and the Columbia River lava. Fossils and leaves in the mudstone date it as early Pliocene (Trimble, 1963). Maximum thickness of the unit is 725 feet.

Holocene deposits in the Tualatin basin are composed of alluvial gravels, silts, and clays ranging in thickness from 100 to 200 feet. Late Pleistocene(?) to Holocene terrace gravels are found in the Estacada area east of Portland and along the western border of the Tualatin Valley (Trimble, 1963; Schlicker and Deacon, 1967). These terraces are 40 to 110 feet above the present river level and are composed mainly of basaltic gravels. Lacustrine beds equivalent in age to the Willamette Silt occur throughout the Willamette Valley up to an elevation of 250 feet. The lacustrine beds overlie Columbia River Basalt in some areas and Troutdale sediments at other locations (Schlicker and Deacon, 1967).

Correlation of deep wells

Texaco, Inc.'s "Cooper Mountain 1" has been projected to the cross-section (plate III) from a structurally higher position; so the thickness of post-Tillamook sediments in the center of the Tualatin basin may be considerably greater than shown if they thin over a high in the Tillamook Volcanics(?) in the vicinity of the Cooper Mountain hole. This present study (plate III) indicates that lower to middle Eocene volcanic rocks underlie the Tualatin basin at depths of between 9000 and 10,000 feet. Rocks encountered in the Tualatin basin holes were predominantly siltstones with intercalated volcanics. Only minor amounts of sandstone were found. Formation tests on sands in the bottom of Texaco's "Cooper Mountain 1" yielded flows of salt water with rates as high as 700 barrels a day. These sands are believed to be of middle Eocene



Terrace Gravels.

Troutdale Formation.

Columbia River Basalt. Dark gray to black, fine-grained augite basalt. Vesicular at top of flows.

Scappoose Formation (perhaps some Pittsburg Bluff Formation). Shale and shaly sandstone consisting of feldspar, quartz mica, and glass shards.

Keasey Formation. Conglomeratic siltstone containing pebbles of basalt, fine sandy indurated siltstone, micromicaceous.

Cowlitz Formation, Nestucca Formation, and Goble Volcanics. Gray tuffaceous siltstone, claystone, and feldspathic sandstone. Some interbedded pyroclastics. Intercalated basalt flows.

Tyee - Yamhill Formations? Greenish-gray sandstone consisting of quartz and some basalt fragments. Claystone, micromicaceous.

Tillamook Volcanics (?)

Figure 8. Generalized geologic column for the Tualatin basin - northern Willamette Valley.

age (Department files; Thoms, 1968). Porosity and permeability of the sands appear to be good. Middle and lower Eocene marine beds may extend beneath the younger volcanics as far east as 122° 30' (Snavely and Wagner, 1963).

CENTRAL WILLAMETTE VALLEY
(Plates IV and V)

General stratigraphy

Lower to middle Eocene Siletz River Volcanics consisting of basaltic flows characterized by pillow structure, breccias, tuffs, and tuffaceous shales are exposed at the surface 10 miles west of Albany. Relationship between the Siletz River Volcanics and pre-Tertiary rocks is not known because the base of this unit is not exposed anywhere in northwestern Oregon. The lavas are dark gray to nearly black, fine grained, partly glassy, and contain zeolite and palagonite as amygdoloidal filling or as filling between flows or pillows. They are also slightly altered to chlorite, epidote, and serpentine (Allison, 1953).

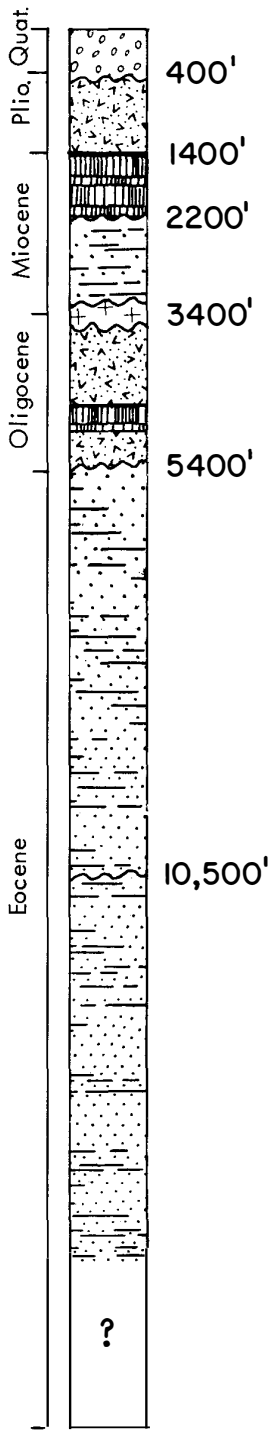
The Siletz River Volcanics form the core of the Coast Range. West of Corvallis they are overlain by middle Eocene Tyee sediments in places with slight angular unconformity but generally in a conformable relationship (Snavely and others, 1964). Yamhill beds conformably overlie or interfinger with the Tyee Formation in northwestern Oregon and in places overlap Siletz River Volcanics unconformably (Baldwin, 1964b) (figure 9).

The Tyee Formation is composed of rhythmically bedded marine siltstone and micaceous sandstone which contains abundant plant remains. The sandstone is arkosic lithic or feldspathic wacke, less commonly volcanic wacke. Siltstones are dark greenish gray, tuffaceous, and contain wrinkled mica flakes, mostly muscovite with some biotite. Clay minerals make up about 10 to 50 percent of the sandstone (Snavely and others, 1964). The basal portion of the sandstone beds is usually medium- to coarse-grained, highly micaceous, arkosic sandstone that grades upward into finer grained sandstone and siltstone. Tyee fossils have been given a middle Eocene age (Vokes and others, 1954). Fossils are rare except in a siltstone member in the upper part (Snavely and others, 1964). Paleocurrent studies and mineral content of the Tyee Formation suggest a southerly source of the sediments (Snavely, Wagner, and MacLeod, 1964; Dott, 1966; and Baldwin, 1964b). Andesitic debris is believed to have come from the Cascades southeast of the Tertiary eugeosyncline.

Upper Eocene sediments in the Albany area include two facies: a lower medium-grained, light-colored, poorly cemented sandstone which contains volcanic glass, feldspar, quartz, and muscovite, and an upper facies which is mainly volcanic and is composed of basic ash, lapilli, and fragments of other eruptive rock. The two facies of upper Eocene sediments appear to have a lithologic sequence similar to the Spencer and Fisher Formations near Eugene (Allison, 1953). The Spencer Formation along the western margin of the Willamette Valley consists of dark, greenish-gray, well-indurated basaltic and arkosic, micaceous sandstone. It lies unconformably on Tyee beds near Corvallis. The Spencer sandstone is very similar to the Tyee sandstone in composition, which suggests that the Spencer was derived largely from erosion of Tyee beds. The main differences in the two formations are in the size of the mica flakes; they are smaller in the Spencer sandstone, as would be expected, and the Tyee Formation is a rhythmically bedded and better graded sandstone. The Spencer is equivalent in age to the upper Nestucca Formation which occurs along the west flank of the Coast Range in Oregon (Baldwin, oral communication, 1968).

Stratigraphic relationships along the eastern border of the Willamette syncline are not well defined because of the large aggregation of volcanic material which lacks definitive unit markers. Upper Eocene marine, and Oligocene marine as well, interfinger with or change facies to volcanic rocks along the eastern margin of the downwarp. The lower portion of the marine Spencer Formation grades laterally to volcanic rock along the front of the Western Cascades (see plates IV, V, and VII). Upper Eocene volcanics of the Western Cascades consist of andesitic lapilli tuff and tuff breccia. There is also a considerable amount of basaltic and rhyolitic material included in the pyroclastics.

The contact between Oligocene and Eocene rocks in the Western Cascades is thought to be unconformable by Thayer (1939). Farther west in the Willamette Valley the contact relationship between late Eocene and early Oligocene marine formations is obscured by Quaternary deposits. Paleontologic evidence



Terrace Gravels, Willamette Silt

Fern Ridge Tuff. Tuffaceous conglomerate, volcanic breccia, water-laid tuff.

Columbia River Basalt. Grayish black, porphyritic to intersertal texture, augite matrix.

Butte Creek Beds (Nye and Scappoose equivalent). Tuffaceous marine sandstone, impure limestone, thin coal beds.

Intrusives. Diorite-gabbro and basalt.

Mehama Volcanics (Keasey and Eugene equivalent). Andesitic and basaltic flows, rhyodacitic tuff, water-laid tuff. Interbeds of fine micaceous, arkosic marine sandstone and firm siltstone.

Spencer Formation (Nestucca equivalent). Greenish gray, well-indurated basaltic and micaceous arkosic sandstone. Similar to underlying Tyee beds. Some interbedded siltstone.

Yamhill - Tyee Formations. Rhythmically bedded siltstone and micaceous, arkosic sandstone, some basaltic sandstone.

Siletz River Volcanics and Kings Valley Siltstone. Probably underlies the valley at depth. Zeolitic pillow lava, basalt flows, and flow breccia. Some interbeds of fine tuffaceous siltstone and occasional layers of tuff.

Figure 9. Generalized geologic column for the central Willamette Valley.

indicates that the inland sea continued to be warm and shallow in the central Willamette lowland in late Eocene and early Oligocene time (Steere, 1958). Keasey age sediments (late Eocene - early Oligocene) occur in a tuffaceous sandstone at Oliver Butte 20 miles south of Corvallis. Fossils are scarce and the outcrop area very limited (Vokes and others, 1954). Middle Oligocene Eugene Formation is widely exposed in the hills along the southern and eastern edges of the Willamette Valley.

An estimated 15,000 feet of Oligocene and early Miocene rocks consisting of tuffs, welded tuff, ash, andesitic conglomerate, breccia, rhyolite, basalt, and andesite are exposed in the Western Cascades. These volcanic rocks have been assigned by several geologists to different formational units: Mehama volcanics, Breitenbush tuff (Thayer, 1939); and Little Butte Volcanics (Peck and others, 1964). Volcanic rocks of the Western Cascades are intercalated with marine sediments in the foothills along the west side of the Willamette Valley. Marine age equivalents of the volcanic rocks in the Willamette Valley are tuffaceous, fossiliferous beds belonging to the Keasey, Eugene, Scappoose, and beds at Butte Creek (Harper, 1946.

Oligocene-Miocene intrusives of gabbroic and basaltic composition cut across the older rocks in the central Coast Range and adjacent areas in the southern Willamette Valley. The intrusions are in the form of dikes, sills, and pipes. Most of the large intrusive bodies are diabase porphyries with phenocrysts of labradorite and pyroxene. Some of the intrusions show well-developed columnar jointing (Vokes and others, 1951).

Oligocene rocks in the Salem area are unconformably overlain by Stayton Lavas of middle Miocene age (Thayer, 1939). These basalt flows are continuous with the Columbia River Basalt and are believed to be contemporaneous extrusions (Schlicker, 1954). The lavas flowed out on gently dipping Oligocene marine and nonmarine sediments. Maximum thickness of the Miocene basalt flows in the Salem area is about 400 feet (Thayer, 1939). The lavas are basaltic, medium to grayish black, and of porphyritic to intersertal texture with glass forming as much as 70 percent of the rock. Augite is the predominant mafic mineral (Baldwin and others, 1955).

Pliocene tuff and tuffaceous gravels of the Fern Ridge Tuff were deposited in the eastern Willamette Valley north of Eugene. These sediments, in part, fell as eruptive material in the Santiam River valley, while the other portion accumulated as debris from abrasion of existing parent rock and through the reworking by the river of eruptive material. Nodules of laterized Columbia River Basalt within the formation establish the unconformity between the Fern Ridge Tuff and the underlying basalt. Fern Ridge beds consist of several terrace levels (Lowry and Baldwin, 1952). Thayer (1939) estimates the tuffs to be 1500 feet thick.

Pleistocene terraces composed of weathered gravels occur along the borders of the Willamette Valley at fairly high elevations. In the lower reaches of the valley, younger lacustrine and fluviatile deposits overlie older rocks. Willamette Silt, which was carried into the valley by many large Columbia River floods, was deposited under ponded conditions during Pleistocene time. The silt rests conformably on locally derived fluvial and lacustrine sediments and conformably overlies glacio-fluvial outwash in the central valley. Along the valley margins the silt unconformably overlies weathered Tertiary bedrock and older glacial outwash (Glenn, 1965). The Quaternary cover in the Willamette Valley ranges in thickness from less than 100 feet to 200 feet (Piper, 1942).

Correlation of deep wells - Plate IV

The Humble "Wicks 1" was drilled on the east limb of a large northeast-trending anticline (Peck and others, 1964) (figure 10). Miocene sedimentary rock in the top portion of "Wicks 1" contains a thick section of tuffaceous, micaceous marine sandstone which did not give any indications of oil or gas while being drilled. Thin Oligocene(?) sand stringers were found at 1170 to 1230 feet and 3290 to 3450 feet, but they, too, gave no indication of hydrocarbons. Shale, mudstone, and pyroclastics dominated the sediments found in this hole. Fine, porous sands of Oligocene-Eocene age were found in the Reserve Oil & Gas Co. "Bruer 1." Tests on the sands proved that they contained gas and salt water. The gas was of suitable quality and if found under favorable structural conditions would undoubtedly be commercial. The structure at the "Bruer 1" site is not known.

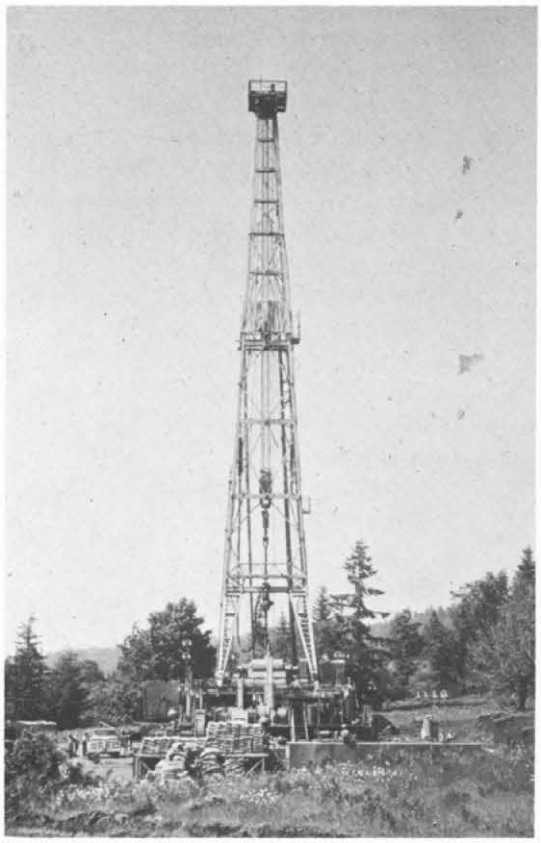


Figure 10. Humble "Wicks 1," 1962. Montgomery Drilling Co., contractor, using National 130 rig.

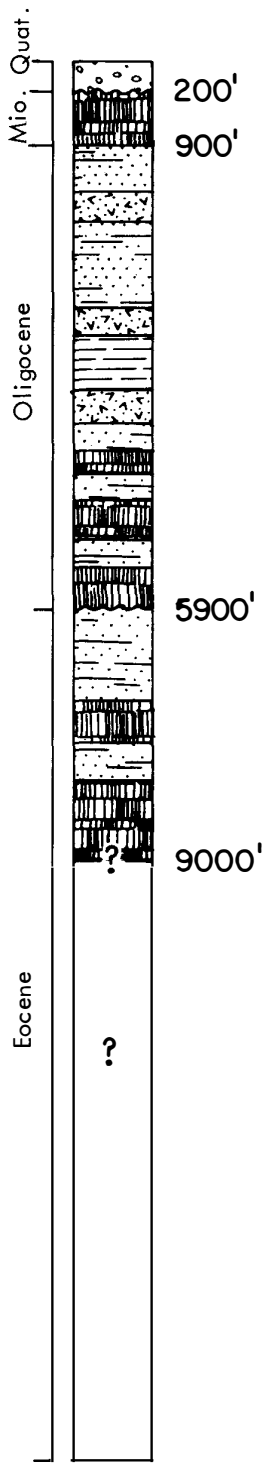
Correlation of deep wells - plate V

The Humble "Miller 1" apparently bottomed in upper Eocene volcanics, so it is possible that lower and middle Eocene marine beds underlie these extrusives (Snavely and Wagner, 1963). Formation tests were made on upper Eocene Spencer sands in "Miller 1" at 2374 to 2425 feet. A 2200-foot rise of salt water was obtained on drill-stem test, indicating that the sands hod good porosity and permeability. Studies by Schlicker (1962) revealed the Spencer sandstone has excellent permeability. At the other end of the cross section, the Oregon Oil & Gas Co. "Roberts 1" discloses the relationship between the Willamette downwarp and the coast uplift. Four drill-stem tests of lower Eocene sands in "Roberts 1" recovered high rises of gassy salt water. The two structural regions shown on plate V, the Coast Range and the Willamette trough, are separated by a major fault system (Peck, 1961; Bromery and Snavely, 1964).

SOUTHERN WILLAMETTE VALLEY
(Plate VI)

General stratigraphy

West of Corvallis the Tyee Formation rests with angular unconformity on Kings Valley siltstone, which is a marine facies of the Siletz River Volcanics. These rocks do not crop out in the Lebanon area on the east side of the valley, but are believed to underlie the area at depth (figure 11). The Tyee probably has an unconformable relationship with the Siletz River in the center of the Willamette Valley as well. Approximately 5000 feet of Tyee sediments were deposited in the Eugene end of the Tertiary geosyncline. Yamhill beds may be included in this section in the southern Willamette Valley, but they have not been differentiated as yet in surface mapping. Tyee sediments consist of rhythmically bedded sandstones and



Quaternary Deposits.

Columbia River Basalt. Porphyritic, tholeitic basalt.

Eugene - Mehama volcanics. Fine- to coarse-grained feldspathic, arkosic, micaceous sandstone. Some shale and light-colored volcanic ash. Mehama volcanics consist of pyroclastics and intercalated basaltic flows.

Fisher and Calapooya Formations. Tuff, basaltic agglomerate, andesitic tuff, and altered zeolitic basalt.

Spencer Formation. Arkosic, micaceous marine sandstone and highly tuffaceous sands with a persistent basal shale member.

Yamhill and Tyee Formations. Rhythmically bedded sandstone and siltstone, medium- to coarse-grained, micaceous arkosic sandstone.

Siletz River Volcanics. Basaltic flow breccias and interbedded tuff probably underlie the valley at depth.

Figure 11. Generalized geologic column for the southern Willamette Valley.

mudstones 3 to 8 feet thick. At the basal portion of each bed is a medium- to coarse-grained, highly micaceous, arkosic sandstone. This sandstone grades upward to siltstone and mudstone at the top of each member. The rocks are composed mainly of angular quartz, feldspar, lesser amounts of volcanic debris, and wrinkled flakes of muscovite and biotite. Sandstones are often partially cemented with lime. Plant fragments are common in the Tyee beds, especially in the mudstones (Vokes and others, 1951). The upper siltstone member is called the Lorane Shale (Baldwin, 1964c).

Upper Eocene marine strata of lithology similar to the Tyee are not exposed in the Lebanon area but are believed to overlie the formation unconformably. These beds are named the Spencer Formation. Spencer sediments are a sequence of arkosic, micaceous, and tuffaceous sandstones with a thin, but extensive, basal shale and mudstone member. The thickness of Spencer beds was estimated to be 3400 feet, including approximately 600 feet of Lorane Shale (Vokes and others, 1951).

An estimated 7000 feet of pyroclastics composed of andesitic lapilli tuff, volcanic breccia, and basaltic and rhyolitic debris rest unconformably on the Spencer Formation in the southern Willamette Valley. This section of pyroclastics is named the Fisher Formation in the Eugene area and the Calapooya Formation in the vicinity of Roseburg. It appears to be of nonmarine origin. Leaves found in the Fisher Formation indicate the age of the rocks is upper Eocene. Deposition of these continental sediments possibly continued through lower Oligocene time and the formation is in part equivalent to the Keasey Formation (Vokes and others, 1951).

The Eugene Formation, which lies conformably on the Fisher near the city of Eugene, is composed of coarse- to fine-grained feldspathic, arkosic, micaceous sandstone containing pyroxene and biotite. Shale and light-gray to white volcanic ash are interbedded with the sandstone. Approximately 8000 feet of Eugene (Little Butte Volcanics equivalent) sediments are exposed in the hills bordering the southern Willamette Valley and in the vicinity of Coburg Hills north of Eugene the beds may be as much as 15,000 feet thick.

Middle Miocene basalt flows totaling 500 feet in thickness rest unconformably on Eugene sediments in the Lebanon area (Hauck, 1962). The flows, referred to as the Stayton Lavas in this region, are composed of porphyritic, tholeiitic basalt (Hauck, 1962). Younger lavas believed to be of upper Miocene age are exposed south of the town of Lebanon and cover an extensive area (Peck, 1961).

Perched remnants of terrace gravels occur along the valley borders. These weathered gravels consist of Cascade-derived volcanic conglomerate which has many carbonized wood fragments (Anderson, 1963). The age of the terraces is believed to be lower middle Pleistocene (Allison, 1953). Later Quaternary deposits in the Lebanon area are much the same as described for the Albany and Salem sections. Willamette silts cover the lowland area and the buttes of older rock project above the valley fill in several places. The valley fill averages 80 feet in thickness in the central part of the valley. Along the east side of the valley Quaternary sediments thin and disappear against the buttress of Oligocene and Miocene volcanics forming the foothills of the Western Cascades.

Correlation of deep wells

Correlation between the Gulf "Porter 1" and Reserve Oil & Gas "Esmond 1" is tentative because of the difficulty in recognizing age units in volcanic rocks. Tyee and Yamhill sediments are shown on plate VI dipping beneath the volcanics of the Western Cascades, but middle Eocene relationships in this region are not yet understood so this may not be the case. Porous sands were encountered in the Reserve "Esmond 1" between 2700 and 4000 feet (figure 12). Good gas shows were logged while this interval was being drilled, but formation tests disclosed that only small flows of gas could be obtained (see table 1). It is possible that fresh-water mud caused permeability block in the sands, since they are tuffaceous and susceptible to swelling. Abnormally high pressures were encountered while volcanics were being drilled at 7060 feet in the "Esmond 1." A formation test on this high-pressure zone flowed frothy salt water at a 2000-barrel-a-day rate. Formation pressure was recorded to be 5475 psi (gradient of .76 psi per foot). A similar high-pressure, gassy saltwater zone was penetrated in the Gulf Oil Corp. "Porter 1" at 5080 feet, but it was not tested. The fault shown between "Esmond 1" and Linn County Oil Development "Barr 1" is suggested in the aeromagnetic interpretations by Bromery (1962). "Barr 1" encountered oil and gas shows in what is believed to be Eugene equivalent. Tests made in "Barr 1" showed only a small

amount of gas; no oil was recovered. Mechanical problems experienced while running and cementing casing may have contributed to conditions which resulted in a negative test.

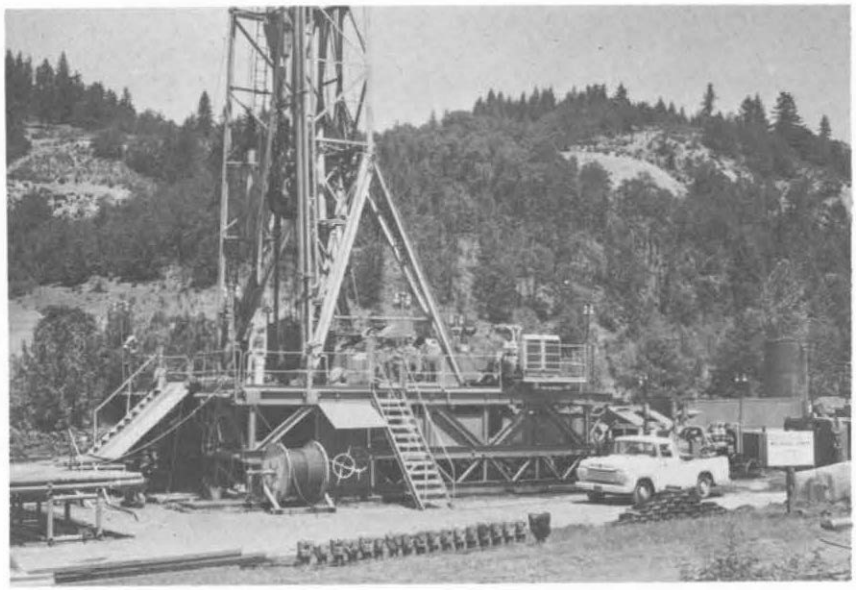


Figure 12. Reserve "Esmond 1," 1962. Montgomery Drilling Co., contractor, using National 75 rig.

Discussion of Prospects

Moore (1969) describes several parameters affecting the generation and emplacement of petroleum; these include the need for fine carbonaceous source beds, coarse reservoir facies and rapid basin subsidence. Most of the oil found in the world thus far occurs in centers of thick and rapid sedimentation. Shallow-water, coarse sedimentary rock is usually the host of oil and gas deposits, while deep-water, fine-grained sedimentary rock deposited in a reducing environmentacts as source material for the hydrocarbons. It is believed that oil is flushed from the source rock early in depositional history due to compressive loading as deposits build up in the basin area. Interstitial fluids squeezed out of the source beds move through porous zones by hydrodynamic processes until they reach a point of equilibrium. There is also evidence that oil con be indigenous to coarse sediments (Levorsen, 1954). Structures that pre-date movement of the formation fluids are the ones most likely to contain petroleum.

Major diastrophisms are believed to have occurred in middle-late Eocene, middle to late Miocene, and late Pliocene time. Structures formed during periods of crustal movement in northwestern Oregon could provide closures which contain hydrocarbons in rocks of Yamhill, Cowlitz, and Astoria age. Unconformable relationships and interfingering of marine and volcanic rock also offer possibility of stratigraphic type reservoirs.

Moore (1969) states that "No other trap can be more timely than one associated with an unconformity where the source of oil is from the overlap. Initial compaction phases of the overlapping beds will force oil into the angularly exposed reservoir beds immediately below the plane of unconformity and/or along the porous/permeable unconformity zone." The three regional unconformities mentioned in northwestern Oregon provide possibilities of overlap. The lower middle Miocene unconformity does not include the Astoria oreo, since Oligocene-Miocene formations appear to have o conformable relationship in that area (Warren and others, 1945).

Lower Columbia River valley

Unconformities between middle and upper Eocene sedimentary rocks in northwestern Oregon and onlapping of sediments around highs in the lower-middle Eocene volcanics provide the elements for stratigraphic traps. Oligocene sedimentary rocks overlap upper Eocene beds in the same region and in other instances unconformably overlie lower Eocene volcanics (Snavely and Wagner, 1963). East of the Astoria area Miocene volcanics unconformably overlie formations ranging in age from late Eocene to lower Miocene (Warren and others, 1945). The geologic section in the northwest corner of the state contains marine rocks ranging in age from Miocene through middle Eocene and measures an estimated 10,000 feet in thickness (see plate I).

Geologic mapping done to date in this area has been on a reconnaissance basis only, but even so many large structures have been recognized (Wells and Peck, 1961). Faults are present but generally not on a major scale (Warren and others, 1945; Dodds, 1963; Deacon, 1953). A combination of stratigraphic and structural elements in this area provides a 20- by 40-mile arcuate strip of marine sediments which may contain commercial amounts of petroleum.

The Eocene volcanic "high" on the Washington side near the mouth of the Columbia River (see plate VII) was tested by Union Oil Co. in 1930 to a depth of 4385 feet. The hole was drilled entirely in volcanic rock. Standard Oil Co. tested the southern end of this structure in 1955, discovering that the volcanics were overlain by 5000 feet of fine-grained marine sediments. Good reservoir sands were not found in the Standard hole. East of Astoria in the Nehalem River valley a series of folds form a 30-mile lineament extending from the mountains surrounding the valley to the east end of the Tuality Mountains (Wells and Peck, 1961). Four deep holes put down on this series of folds encountered saltwater sands.

Tualatin Valley

The Tualatin Valley, just west of Portland, appears to be a separate downwarp within the Tertiary eugeosyncline. Thickness of sediments within the Tualatin basin is estimated from this subsurface data to be 9000 or 10,000 feet at the Texaco "Cooper Mountain 1" location and possibly more than this in the central part of the downwarp (Bromery and Snavely, 1964). "Cooper Mountain 1" was located on an anticline in the southern part of the Tualatin basin (Hart and Newcomb, 1965). Sands encountered in "Cooper Mountain 1" were found to be saturated with salt water (see plate III). The Chehalem Mountains south of the Texaco "Cooper Mountain 1" appear to be structurally higher and separated by major faulting from the Cooper Mountain structure (Schlicker and Deacon, 1967). Therefore, it may be possible that sands drilled in the "Cooper Mountain 1" could be tested at a higher structural position where hydrocarbons could have collected during late Tertiary diastrophism. A large normal fault which trends in a northwesterly direction borders the west side of the Tualatin basin (Schlicker and Deacon, 1967; Bromery and Snavely, 1964; Wells and Peck, 1961). Levorsen (1954, p. 171) relates that, in addition to fold structures, oil accumulations can be entrapped by normal faulting, and that such deposits generally occur on the upthrown side of the fault. Using this as a criterion, the location west of the fault bordering the Chehalem Mountains and extending 20 miles northwesterly to Gales Creek should be investigated to see if closure is present. Upper Eocene sands which have excellent reservoir characteristics were mapped on the surface a few miles west of the fault (Schlicker, 1962).

Willamette Valley

Shallow gas prospects may be good in the vicinity of the Reserve Oil & Gas Co. "Bruer 1" northwest of Salem, provided that structural closure can be found. Upper Eocene sands (Spencer Formation) in "Bruer 1" produced a fair gas flow on test but were found to be saturated with salt water. On the east side of the valley, opposite "Bruer 1," marine beds interfinger with volcanics (plates IV and VII). The eastern margin of the Willamette downwarp offers many possibilities for stratigraphic traps, although at present the eastern shorelines have not been defined. Middle Tertiary marine sediments interfinger with volcanics of equivalent age and are overlapped by Late Tertiary volcanics along the border of the Western Cascades. In situations such as these where reservoir rocks, if present, tend to be lenticular and variable,

any minor local deformation may provide suitable closure (Levorsen, 1954). The presence of volcanics should not be discouraging when they are associated with marine sediments. Cenozoic rhyolitic tuff overlying Mississippian marine sediments in southeastern Nevada produce oil (Oil and Gas Journal, p. 243-251, April 1, 1957), as does a syenite sill intruded into marine beds of Pennsylvanian age in Arizona (World Oil, p. 81-83, July 1967). Oil pools have also been found in basaltic intrusives in the interior coastal plain of Texas. The basalts were intruded into Cretaceous sediments (Levorsen, 1954, p. 210). Oil has been found beneath lavas at the Tejon Ranch Field and at Oxnard Plains in southern California. There are other examples of oil-producing horizons associated with igneous rocks throughout the world.

Plate V shows conditions in the central part of the Willamette syncline. The Humble Oil & Refining Co.'s "Miller 1" was reportedly drilled on a large anticlinal structure which may be an extension of a drag fold (Logsden Ridge anticline) adjacent to the Corvallis fault zone, which was mapped by Vokes and others in 1954. "Miller 1" is shown on the east limb of the structure in plate V. Porous sands were found in upper Eocene beds (Spencer Formation) in "Miller 1." A test of the sands indicated that they were saturated with salt water at this location. It is unfortunate that drilling on "Miller 1" was not continued for another few hundred feet, since the hole apparently bottomed in upper Eocene volcanics and other Tertiary marine beds may underlie them. Spencer age sediments are exposed on the surface southwest and up structure(?) from "Miller 1," so it is possible that no closure exists for the sands found in the hole. Vokes and others (1954) found evidence of post-Eocene movement along the Corvallis fault, and the fact that the fault zone parallels the regional structural trend implies that movement took place along this fracture zone during most of the Tertiary when folding occurred. Faults mapped in Miocene basalt at Salem Hills (Peck, 1961) also trend in the direction of the gross regional structure and appear to align with the Corvallis fault zone to the south. If this major fracture system continues northward, then the area along the fault between Salem and Corvallis may be a likely place to explore. Movement on the Corvallis fault has been described as being of reverse type by Vokes and others (1954). If this is so, then both sides of the fracture system are worth investigating (Levorsen, 1954, p. 171). Anticlinal structures in the Willamette basin may also be good prospects.

At the south end of the Willamette Valley (plate VI) the Gulf Oil Corp.'s "Porter 1" was drilled to Siletz River Volcanics(?). Sands encountered in Gulf's hole were tuffaceous and generally of low permeability. Gas shows were logged from 3800 feet to 5200 feet and very strong shows were recorded at 5085 to 5110 feet, 5180, and 5185 feet. Formation testing on the sands indicated that they were filled with salt water. "Porter 1" was drilled on a structure located by seismic studies. At the other end of the cross-section potential reservoir sands were found in Eugene age rocks of the Reserve Oil & Gas Co. "Esmond 1" between 2780 and 3990 feet. Good gas shows were logged in this interval and oil fluorescence noted. Formation tests yielded only a small flow of gas and no fluids. The sands were tuffaceous and contained a considerable amount of volcanic ash in the matrix. It is possible that the water-base mud used in drilling caused blocking of pore spaces in the sand, resulting in a negative test. A "kick" of 1000 units of gas was recorded on the logging chart in the intervals 3980 feet and 4000 feet, but only a small gas flow was obtained on test of this interval (see table 1). A formation test was made at 7060 feet in "Esmond 1" as a result of logging gas shows. Rocks at this level were volcanic and apparently impermeable, but the test flowed very gassy salt water at a rate of 2000 barrels per day. If detailed structural studies in this area should indicate a favorable location, it appears worth while to do more testing. The Linn County Oil Development Co. drilled a 4500-foot hole on the Barr ranch approximately 2 miles north of the "Esmond 1" location. This wildcat is believed to have been responsible for generating the 1962 Willamette Valley activity. Shows of gas and oil were obtained in the Linn County Oil Development Co. "Barr 1" at 4300 feet, but production tests were disappointing; only a small amount of gas was recovered. The electric log was the most promising survey recorded thus far in Oregon oil exploration. The "Barr" sands are believed to belong to the Eugene Formation (plate VI). Gas shows were also logged in the Mehama Volcanics (Little Butte Volcanics) at 2250 feet, but they too proved noncommercial in testing. Although structural information is scarce, it is believed that the "Barr 1" is lower than the "Esmond 1." Sands in the bottom of the "Barr 1" contained brackish marine water and traces of hydrocarbons.

No doubt there are other prospects in the Willamette and lower Columbia River valleys. Their locations will depend upon further studies and new interpretations of subsurface conditions. The discovery of oil and gas in Oregon ultimately depends upon the drilling of many more deep holes.

Selected References

Allen, J. E., 1946, Reconnaissance geology of limestone deposits in the Willamette Valley, Oregon: State of Oregon Dept. Geology and Mineral Industries Short Paper 15.

Allison, Ira S., 1953, Geology of the Albany quadrangle, Oregon: State of Oregon Dept. Geology and Mineral Industries Bull. 37.

Allison, Ira S., and Felts, W. M., 1956, Reconnaissance geologic map of the Lebanon quadrangle, Oregon: State of Oregon Dept. Geology and Mineral Industries map.

Anderson, R., W., 1963, Geology of the northwest quarter of the Brownsville quadrangle, Oregon: Univ. Oregon master's thesis.

Armentrout, J. M., 1967, The Tarheel and Empire Formations, geology and paleontology of the type sections, Coos Bay, Oregon: Univ. Oregon master's thesis.

Baldwin, Ewart M., 1950a, A geologic reconnaissance of the Scotts Mills-Molalla area: Geol. Soc. Oregon Country News Letter, v. 16, no. 11, p. 91-92, November 1950.

_____, 1950b, A reconnaissance of the geology of the Eugene area: Geol. Soc. Oregon Country News Letter, v. 16, no. 6, p. 46-47, June 1950.

_____, 1955, Geology of the Marys Peak and Alsea quadrangles, Oregon: U.S. Geol. Survey Map OM-162.

_____, 1956, Geology of the lower Siuslaw River area: U.S. Geol. Survey Map OM-186.

_____, 1964a, Thrust faulting in the Roseburg area: State of Oregon Dept. Geology and Mineral Industries The ORE BIN, v. 26, no. 10, p. 176-184, October 1964.

_____, 1964b, Geology of the Dallas and Valsetz quadrangles, Oregon: State of Oregon Dept. Geology and Mineral Industries Bull. 35, rev.

_____, 1964c, Geology of Oregon: Eugene, Oregon, Univ. Oregon Coop. Book Store, 2nd ed.

_____, 1965, Geology of the south end of the Oregon Coast Range Tertiary basin: Northwest Sci., v. 39, no. 3, p. 93-103, August 1965.

_____, 1966a, Geology of the Columbia River Gorge: Northwest Sci., v. 40, no. 4, p. 121-128, November 1966.

_____, 1966b, Revision of the geology of the Coos Bay area: State of Oregon Dept. Geology and Mineral Industries The ORE BIN, v. 28, no. 11, p. 189-203, November 1966.

Baldwin, Ewart M., Brown, R. D., Gair, J. E., and Pease, M. H., 1955, Geology of the Sheridan and McMinnville quadrangles, Oregon: U.S. Geol. Survey Map OM-155.

Baldwin, E. M., and Roberts, A. E., 1952, Geology of the Spirit Mountain quadrangle, northwestern Oregon: U.S. Geol. Survey Map OM-129.

Barlow, J. L., 1955, Geology of the central third of the Lyons quadrangle: Univ. Oregon master's thesis.

Beck, R. Stanley, 1946, Highlights of Washington and Oregon biostratigraphy [abst.]: Oil and Gas Jour., v. 45, no. 2, p. 92, November 9, 1946.

Berg, J. W., Jr., and Thiruvathukal, J. V., 1967, Free-air gravity anomaly map of Oregon: State of Oregon Dept. Geology and Mineral Industries Map GMS-4a.

Bretz, J. H., 1919, Late Pleistocene submergence in the Columbia Valley, Oregon and Washington: Jour. Geology, v. 27, no. 7, p. 489-506.

Bromery, R. W., 1962, Geological interpretation of the aeromagnetic map of the Lebanon quadrangle: U.S. Geol. Survey Map GP-212.

_____, 1965, Aeromagnetic map of the Albany-Newport area, Oregon, and its geological interpretation: U.S. Geol. Survey Map GP-481.

Bromery, R. W., and Snavely, P.D., Jr., 1964, Geological interpretation of reconnaissance gravity and aeromagnetic surveys in northwest Oregon: U.S. Geol. Survey Bull. 1181-N.

Brown, R. D., 1950, Geology of the McMinnville quadrangle: Univ. Oregon master's thesis.

Buddenhagen, H. J., 1950, Symposium on possible future petroleum provinces of North America [abst.]:

American Assn. Petroleum Geologists Bull., v. 34, no. 12, p. 2382.
Byrne, J. V., 1962, Geomorphology of the continental terrace off the central coast of Oregon: The ORE BIN, v. 24, no. 5, p. 65-74, May 1962.
_____, 1964, The oceans, a neglected mining frontier: The ORE BIN, v. 26, no. 4, p. 57-69, April 1964.
Byrne, J. V., Fowler, G.A., and Maloney, N.J., 1966, Uplift of the continental margin and possible continental accretion off Oregon: Science, v. 154, p. 1654-1656.
Chiburis, E. F., 1966, Crustal structures in the Pacific Northwest from phase-velocity dispersion of seismic surface waves: Oregon State Univ. doctoral dissertation.
Cohee, G. V., 1962, Tectonic map of the United States: U.S. Geol. Survey and American Assn. Petroleum Geologists, 2 sheets.
Condon, Thomas, 1880, Astoria shales: American Naturalist, v. 14, p. 457.
Deacon, R. J., 1953, A revision of the upper Eocene and lower Oligocene stratigraphy in the upper Nehalem basin: Oregon State Univ. master's thesis.
_____, 1962, Pacific Northwest headed for active year: Oil and Gas Journal, March 26, 1962.
Dehlinger, P., Bowen, R. G., Chiburis, E. F., and Westphal, W. H., 1963, Investigations of the earthquake of Nov. 5, 1962 north of Portland: The ORE BIN, v. 25, no. 4, p. 53-68.
Diller, J. S., 1896, A geological reconnaissance in northwestern Oregon: U.S. Geol. Survey 17th Ann. Rept., Pt. 1, p. 441-520.
_____, 1905, Coal in Washington near Portland, Oregon: U.S. Geol. Survey Bull. 260, p. 411-412.
Dodds, K. R., 1963, Geology of the western half of the Svensen quadrangle: Univ. Oregon master's thesis.
Dott, R. H., 1965, Mesozoic-Cenozoic tectonic history of southwestern Oregon coast in relation to the Cordilleran orogenies: Jour. Geophys. Res., p. 4687-4707.
_____, 1966, Eocene deltaic sedimentation at Coos Bay: Jour. Geology, v. 74, no. 4, p. 373-420, July 1966.
Dunbar, C. O., 1944, Paleontology of the marine Tertiary formations of Oregon and Washington by C. E. Weaver [a review]: Am. Jour. Sci., 5th Ser., v. 242, no. 7, p. 397.
Durham, J. W., Harper, H., and Wilder, J. R., 1942, Lower Miocene in the Willamette Valley: Geol. Soc. America Bull., v. 53, no. 12, pt. 2, p. 1817.
Eardley, A. J., 1951, Structural Geology of North America: New York, Harper and Bros., 624 p.
Etherington, T. J., 1931, Stratigraphy and fauna of the Astoria Miocene of southwest Washington: Univ. Calif. Publ. Geol. Sci., v. 20, no. 5, p. 31-142.
Felts, W. M., 1936, Geology of the Lebanon quadrangle, Oregon: Oregon State Univ. master's thesis.
Fisk, N. H., 1931, The history and petrography of basalts of Oregon: Univ. Oregon master's thesis.
_____, 1935, A microscopic study of basalt flows: Cincinnati Univ. doctoral dissertation.
Glenn, J. L., 1965, Late Quaternary sedimentation and geologic history of the north Willamette Valley: Oregon State Univ. doctoral dissertation, 235 p.
Halstead, P. N., 1955, Geology of the northern third of the Lyons quadrangle: Univ. Oregon master's thesis.
Hampton, E. R., [in press], Geology and ground water of the Molalla-Salem slope areas: U.S. Geol Survey Water-Supply Paper.
Harper, H. E., 1946, Preliminary report on the geology of the Molalla quadrangle: Oregon State Univ. master's thesis, 28 p.
Harrison and Eaton (consultants), 1920, Investigation of oil and gas possibilities of western Oregon: Oregon Bur. Mines Mineral Res. of Oregon, v. 3, no. 1, March 1920.
Hart, D. H., and Newcomb, R. C., 1965, Geology of ground water of the Tualatin Valley: U.S. Geol. Survey Water-supply Paper 1697.
Hauck, S. M., 1962, Geology of the southwest quarter of the Brownsville quadrangle, Oregon: Univ. Oregon master's thesis.
Heacock, R. L., 1952, Stratigraphy and foraminifera of the upper part of the Nye Formation, Yaquina Bay: Oregon State Univ. master's thesis.
Henricksen, D. A., 1956, Eocene stratigraphy of the lower Cowlitz River, Washington: Wash. Div. Mines and Geology Bull. 43.

Henry, Chas. S. B., 1933, Gas and oil possibilities of the lower Willamette Valley: Gas Age Record, v. 71, no. 6, p. 145-146, Feb. 11, 1933.

Herron, J. E., 1953, Stratigraphy of the Miocene Agate Beach Formation in Lincoln County, Oregon: Oregon State Univ. master's thesis.

Hertlein, L. G., and Crickmay, C. H., 1925, A summary of the nomenclature and stratigraphy of the marine Tertiary of Oregon and Washington: Am. Philosophical Soc. Proc., v. 64, no. 2, p. 224-282.

Hodge, E. T., 1933, Age of the Columbia River and lower canyon [abst.]: Pan American Geol., v. 58, no. 1, p. 70, Aug. 1932; [abst.] Geol. Soc. America Bull., v. 44, p. 156, 1933.

Hogenson, G. M., and Foxworthy, B.L., 1965, Ground water in the east Portland area, Oregon: U.S. Geol. Survey Water-supply Paper 1793.

Hoover, Linn, 1951, Stratigraphy and structural geology of Oregon and Washington: Mich. Univ. master's thesis.

Howe, Henry Van W., 1922, Miocene of Clatsop and Lincoln Counties: Stanford Univ. doctoral diss.

_____, 1926, Astoria mid-Tertiary type of the Pacific Coast: Pan American Geol.,v. 45, no. 4, p. 295-306.

Huntting, M. T., Bennett, W.A.G., Livingstone, V. E., Jr., and Moen, W. S., 1961, Geologic map of Washington: Wash. Div. Mines and Geology.

Irwin, W. P., 1964, Late Mesozoic orogenesis in the ultramafic belts of northwestern California and southwestern Oregon: U.S. Geol. Survey Prof. Paper 501-C.

Kay, Marshall, 1951, North American geosyncline: Geol. Soc. America Memoir 48.

Kleinpell, R. M., and Weaver, D. W., 1963, Oligocene biostratigraphy of the Santa Barbara embayment, Calif.: Univ. Calif. Pubs. Geol. Sci., v. 43, p. 165-250.

Koch, J. G., 1966, Late Mesozoic stratigraphy and tectonic history of the Port Orford-Gold Beach area: Am. Assn. Petroleum Geologists Bull., v. 50, no. 1, p. 25-71.

Lewis, R. Q., 1950, Geology of the southern Coburg Hills, including the Springfield-Goshen area: Univ. Oregon master's thesis.

Levorsen, A. I., 1954, Geology of Petroleum: San Francisco, Freeman & Co., 703 p.

Livingston, V. E., Jr., 1958, Oil and gas exploration in Washington, 1900-1957: Wash. Div. Mines and Geol. I.C. 29.

Lowry, W. D., 1947, The extent of the Oligocene sea in northwestern Oregon: Geol. Soc. Oregon Country News Letter, v. 13, no. 1, p. 2-7.

Lowry, W. D., and Baldwin, E. M., 1952, Late Cenozoic geology of the lower Columbia River Valley: Geol. Soc. America, v. 63, no. 1, p. 1-24.

McWilliams, R. G., 1968, Paleogene stratigraphy and biostratigraphy of central western Oregon: Univ. Washington doctoral dissertation.

MacKay, A. J., 1969, Continuous seismic profiling investigation of the southern Oregon continental shelf: U.S. Geol. Survey in cooperation with Oregon State Univ., open-file rept.

MacPherson, B., 1953, Geology of the Halsey quadrangle: Univ. Oregon master's thesis.

Mallory, V. S., 1959, Lower Tertiary biostratigraphy of the California Coast Ranges: American Assn. Petroleum Geologists Bull., v. 43, no. 1.

Maloney, N. J., 1965, Geology of the continental terrace off the central coast of Oregon: Oregon State Univ. doctoral dissertation.

Menard, H. W., 1964, Marine Geology of the Pacific: New York, San Francisco, Toronto, London, McGraw-Hill, Inc.

Moore, C. A., 1969, The occurrence of oil in sedimentary basins: World Oil Magazine, v. 168, no. 1, p. 69-72; v. 168, no. 2, p. 48.

Moore, E. J., 1963, Miocene marine mollusca from the Astoria Formation in Oregon: U. S. Geol. Survey Prof. Paper 419.

Moore, R. C., and Vokes, H. E., 1953, Lower Tertiary crinoids from northwestern Oregon: U.S. Geol. Survey Prof. Paper 233-E.

Mundorff, M.J., 1939, Geology of the Salem quadrangle, Oregon: Oregon State Univ. master's thesis.

O'Neill, T.F., 1939, Geology of the Stayton quadrangle, Oregon: Oregon State Univ. master's thesis.

Oregon State Board of Higher Education, 1940, Physical and Economic Geography of Oregon, 319 p.
Packard, E.L., 1927, Marine Oligocene of Oregon: Univ. Cal. Dept. Geol. Sci., Bull. v. 16, no. 12, p. 449-460; [abst.]: Geol. Soc. America Bull., v. 38, no. 1, p. 202, March 30, 1927.
_____, 1928, Stratigraphic relationships of western Oregon Oligocene formations: Univ. Cal. Dept. Geol. Sci., Bull. v. 18, no. 1, p. 1-50.
_____, 1933, Stratigraphic and faunal relationships of the Keasey Formation of the Oligocene of Oregon [abst.]: Geol. Soc. America Bull., v. 44, pt. 1, p. 217, Feb. 28, 1933.
_____, 1935, Marine Oligocene of northwestern Oregon: Geol. Soc. Oregon Country News Letter, v. 1, no. 6, p. 41, 43; no. 7, p. 46-47.
Peck, D. L., 1960a, Geological reconnaissance of the western Cascades in Oregon north of latitude 43°: Harvard Univ. doctoral dissertation.
_____, 1960b, Cenozoic volcanism in the Oregon Cascades: U.S. Geol. Survey Prof. Paper 400-B, p. B308-B310.
Peck, D.L., Griggs, A. B., Schlicker, H. G., and Dole, H. M., 1964, Geology of the central and northern parts of the Western Cascades: U.S. Geol. Survey Prof. Paper 449.
Piper, A. M., 1942, Ground-water resources of the Willamette Valley: U.S. Geol. Survey WSP 890.
Price, Don, and Johnson, N. A., 1965, Selected ground-water data in the Eola-Amity Hills area, northern Willamette Valley: Oregon State Engineer, Ground-water Rept. No. 7.
Rau, W. W., 1948, Foraminifera from the Miocene Astoria Formation of southwestern Washington: Jour. Paleont., v. 22, no. 6, p. 774-782.
_____, 1966, Stratigraphy and foraminifera of the Satsop River area, southern Olympic Peninsula, Washington: Wash. Div. Mines and Geology, Bull. 53.
Russell, R. J., 1958, Geological geomorphology: Geol. Soc. America Bull., v. 69, p. 3.
Schlicker, H. G., 1954, Columbia River Basalt in relation to the stratigraphy of northwestern Oregon: Oregon State Univ. master's thesis.
_____, 1962, The occurrence of Spencer sandstone in the Yamhill quadrangle: State of Oregon Dept. Geology and Mineral Industries The ORE BIN, v. 24, no. 11, p. 173-184.
Schlicker, H.G., and Deacon, R.J., 1967, Engineering geology of the Tualatin Valley region: State of Oregon Dept. Geology and Mineral Industries Bull. 60, 103 p.
Schlicker, H. G., Deacon, R. J., and Twelker, N.H., 1964, Earthquake geology of the Portland area: The ORE BIN, v. 26, no. 12, p. 209-230.
Schlicker, H. G., and Dole, H. M., 1957, Reconnaissance geology of the Marcola, Leasburg, and Lowell quadrangles: The ORE BIN, v. 19, no. 7, p. 57-62.
Schenck, H.G., 1927, Marine Oligocene of Oregon: Calif. Univ. Publ. Geol. Sci., v. 16, no. 12, p. 449-460.
Seitz, J. F., 1948, An investigation of the type locality of the Astoria Formation: Washington Univ. master's thesis.
Shaw, J. H., 1964, Petrography and petrology of some intrusive bodies in the southern Willamette Valley: Univ. Oregon master's thesis.
Smith, Hampton, 1947, Oil and gas prospects of Washington and Oregon: Oil and Gas Jour., v. 45, no. 47.
Smith, W. D., 1924, Petroleum possibilities of western Oregon: Econ. Geol., v. 19, no. 5, p. 455-465.
_____, 1925, Physical and economic geology of the Oregon Willamette Valley: Univ. Oregon Commonwealth Review, v. 7, no. 4, p. 136-195.
Snavely, P. D., Jr., and Baldwin, E. M., 1948, Siletz River Volcanic series of northwestern Oregon: Am. Assn. Petroleum Geologists Bull., v. 32, no. 5, p. 806-812.
Snavely, P. D., Jr., Baldwin, E. M., Roberts, A. E., and Isotoff, A., 1954, Large intrusive bodies in the central Coast Range of Oregon [abst.]: Oregon Acad. Sci. Proc., v. 3, p. 31.
Snavely, P. D., Jr., Brown, R. D., Sr., Roberts, A. E., and Rau, W. W., 1958, Geology and coal resources of the Centralia-Chehalis district, Washington: U.S. Geol. Survey Bull. 1053.
Snavely, P. D., Jr., and Wagner, H.C., 1963, Tertiary geologic history of western Oregon and Washinton: Wash. Div. Mines and Geol. R.I. 22.

Snavely, P. D., Jr., and Wagner, H. C., 1964, Geologic sketch of northwestern Oregon: U.S. Geol. Survey Bull. 1181-M.

Snavely, P.D. Jr., Wagner, H. C., and MacLeod, N.S., 1964, Rhythmically bedded eugeosynclinal deposits of the Tyee Formation, Oregon Coast Range: Kansas Geol. Survey Bull. 169, p. 461-480.

_____, 1965, Preliminary data on compositional variations of Tertiary volcanic rocks in the central part of the Oregon Coast Range: The ORE BIN, v. 27, no. 6, p. 101-117.

_____, 1969, Geology of western Oregon north of the Klamath Mountains: in Mineral and Water Resources of Oregon: State of Oregon Dept. Geology and Mineral Industries Bull. 64, p. 32-52.

Souza, M. E., 1927, Physiography and structure of the Oregon Coast Range province: Univ. Oregon master's thesis.

Staples, L. W., 1950, Cubic pseudomorphs of quartz after halite in petrified wood: Am. Jour. Sci., v. 248.

Steere, M. L., 1958, Fossil localities of the Eugene area, Oregon: The ORE BIN, v. 20, no. 6, p. 51-59.

_____, 1959, Fossil localities of the Salem-Dallas area: The ORE BIN, v. 21, no. 6, p. 51-58.

Thayer, T. P., 1936, Structure of the North Santiam River section of the Cascade Mountains: Jour. Geol., v. 44, p. 701-716.

_____, 1939, Geology of the Salem Hills and North Santiam River basin: State of Oregon Dept. Geology and Mineral Industries Bull. 15.

Thiruvathukal, J.V., 1968, Regional gravity of Oregon: Oregon State Univ. doctoral dissertation, 92p.

Thiruvathukal, J.T., Berg, J.W., Jr., and Dehlinger, Peter, 1967, Gravity maps of Oregon: State of Oregon Dept. Geology and Mineral Industries Maps GMS-4.

Trimble, D. E., 1963, Geology of Portland, Oregon, and adjacent areas: U.S. Geol. Survey Bull. 1119, 119 p.

Vokes, H. E., 1948, Age relationships of the Eugene and Fisher Formations: Geol. Soc. Oregon Country News Letter, v. 14, no. 5, p. 38-41.

Vokes, H. E., Myers, D. A., and Hoover, Linn, 1954, Geology of the west-central border area of the Willamette Valley, Oregon: U.S. Geol. Survey Map OM-150.

Vokes, H. E., Snavely, P.D., Jr., and Myers, D.A., 1951, Geology of the southern and southwestern border area of the Willamette Valley, Oregon: U.S. Geol. Survey Map OM-110.

Warren, W.C., and Norbisrath, Hans, 1946, Stratigraphy of the upper Nehalem River basin: American Assn. Petroleum Geologists Bull., v. 30, no. 2, p. 213-237.

Warren, W. C., Norbisrath, Hans, and Grivetti, R. M., 1945, Geology of northwestern Oregon west of the Willamette River and north of Lat. 45° 15': U.S. Geol. Survey Map OM-42.

Washburne, C. W., 1914, Geology and oil prospects of northwestern Oregon: U.S. Geol. Survey Bull. 590.

Waters, A.C., 1933, Summary of sedimentary tectonics, igneous and metalliferous history of Washington and Oregon: Ore deposits of the United States: A.I.M.E. Lindgren Volume 1933, p. 253-265.

Weaver, C. E., 1913, Tertiary paleontology and stratigraphy of southwestern Washington [abst.]: Geol. Soc. America Bull., v. 24, p. 131-132.

_____, 1930, Eocene lavas in western Washington [abst.]: Geol. Soc. America Bull. v. 41, p. 87.

_____, 1937, Tertiary stratigraphy of Washington and northwestern Oregon: Univ. Wash. Publ. in Geol., v. 4.

_____, 1939, Metchosin volcanic rocks in Oregon and Washington [abst.]: Geol. Soc. America Bull., v. 50, no. 12, pt. 2, p. 1961.

_____, 1940, Geologic history of the Tertiary in the Pacific Northwest [abst.]: Geol. Soc. America Bull., v. 51, no. 12, pt. 2, p. 2035-2036.

_____, 1945, Geology of Oregon and Washington and its relation to the occurrence of oil and gas: American Assn. Petroleum Geologists Bull., v. 29, no. 10, p. 1377-1415.

Wells, F. G., and Peck, D.L., 1961, Geologic map of Oregon west of the 121st meridian: U.S. Geol. Survey Misc. Geol. Inv. Map I-325.

Wilkinson, W. D., and others, 1941, Geology of the Butte Falls quadrangle: State of Oregon Dept.

Geology and Mineral Industries map.
Wilkinson, W. D., Lowry, W. D., and Baldwin, E. M., 1946, Geology of the St. Helens quadrangle, Oregon: State of Oregon Dept. Geology and Mineral Industries Bull. 31.
Williams, Howel, 1942, Geology of Crater Lake National Park, Oregon: Carnegie Inst. Wash. Publ.540.
_____, 1957, Reconnaissance geologic map of the Bend quadrangle and the central portion of the High Cascade Mountains: State of Oregon Dept. Geology and Mineral Industries map.
Williams, I. A., 1916, Columbia River Gorge, its geologic history: Oregon Bur. Mines Mineral Resources of Oregon, v. 2, no. 3.
Wolfe, E. W., and McKee, E. H., 1968, Geology of the Grays River quadrangle, Wahkiakum and Pacific Counties, Washington: Wash. Div. Mines and Geology Map GM-4.
Youngquist, Walter, 1961, Annotated lexicon of names applied to Tertiary stratigraphic units in Oregon and Washington west of the Cascade Mountains, with bibliography: Ann Arbor, Mich. Edwards Bros., Inc.
Zimmerman, D. Z., 1927, The geology of the Long Tom area: Univ. Oregon master's thesis, 62 p.

APPENDIX

PALEONTOLOGICAL EXAMINATION OF FOUR DEEP WELLS IN NORTHWESTERN OREGON

By Richard E. Thoms*

Introduction

The stage terminology used in this report follows usage of most modern biostratigraphers. References which define such usage include Mallory, 1959, "Lower Tertiary biostratigraphy of the California Coast Ranges," and Kleinpell and Weaver, 1963, "Oligocene biostratigraphy of the Santa Barbara Embayment, California." Samples studied in this project came from the following wells:

Standard	-	Hoagland No. 1
Texaco	-	Clatskanie No. 1
Texaco	-	Clark and Wilson No. 6-1
Texaco	-	Cooper Mountain No. 1

The faunal diagnoses for samples from each well are given in descending stratigraphic order (see figure 13).

Age of the Samples

Standard - Hoagland No. 1

No samples older than Refugian were observed. Samples 200 and 220 are of probable Refugian age, Sample 580 is definitely Refugian, the last definite Refugian sample is 3900-4000, and the last diagnostic sample in the well is 4920, which is probably Refugian. The determination of Refugian age is based upon the association of Planulina haydoni, Cibicides hodgei, and Uvigerina atwilli, which seem to be restricted to this interval in the California Tertiary; as well as several forms which range upward into the Refugian from the subjacent Narizian.

Texaco - Clatskanie No. 1

Probably no older than Narizian. Questionable Narizian age samples begin at 628 and continue to 652. Probable Narizian age samples begin at 1227-37 and continue to 1684. The lowest diagnostic sample in the hole (5615-21) is again of questionable Narizian age. The determination of Narizian age is based upon the association of Narizian-Refugian forms such as Quinqueloculina imperialis, Plectofrondicularia packardi, Cibicides natlandi; and ? Virgulina californiensis with Ulatisian-Narizian forms such as Cyclammina samanica, Pseudoglandulina ovata, Eponides umbonata, Eponides mexicana, and Robulus pseudovortex.

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Correlation of Standard West Coast Time-Rock Units with Northwestern Oregon Formations

Series	Laiming's Zones	West Coast (1) Foram. Stages	West Coast (2) Molluscan Stages	NW Oregon Formations Warren et al., 1945(2)
Pliocene			San Joaquin	Portland Hills Silt
			Etchegoin	Boring Lavas
				Troutdale Fm.
			Jacalitas	
Miocene		Delmontion	Neroly	"Clifton Beds"
		Mohnian	Cierbo	
		Luisian	Briones	Col. River Basalt
		Relizian	Temblor	Astoria Fm.
		Saucesian	Vaqueros	
Oligocene		Zemorian	Blakeley	Scappoose Fm.
			Lincoln	Pittsburg Bluff Fm.
		Refugian	Keasey	Keasey Fm.
Eocene	A-1	Narizian	Tejon	Cowlitz Fm.
	?			
	A-3			
	?			
	A-2		"Transition Beds"	Yamhill Fm.
	B-1A	Ulatisian	Domengine	
	B-1 - B-4		Capay	Siletz River Vols.
	C	Penutian		
				?
Pal-eocene	D	Bulitian	Meganos	
	E	Ynezian	Martinez	
Cretaceous				

1. Kleinpell, 1938; Schenck and Kleinpell, 1936; Mallory, 1959; Rau, 1966.
2. Weaver, 1944; Lowry and Baldwin, 1952.

Texaco - Clark and Wilson No. 6-1

Probably no older than upper Ulatisian. Questionable upper Ulatisian samples begin at 705 and continue to 8140. The first appearance of a form (Vaginulinopsis mexicana) known to range no higher than the Ulatisian in the California Tertiary is at 1332. The last diagnostic sample is 8140. The upper Ulatisian age is based upon the association of Ulatisian-Narizian forms, such as Quinqueloculina imperialis, Plectofrondicularia packardi, Eponides mexicana, and Gyroidina planata; with forms no younger than Ulatisian, such as Vaginulinopsis californica, Trifarina advena californica, Cibicides sandiegensis, and Uvigerina lodoensis miriamae.

Texaco - Cooper Mountain No. 1

Probably no older than upper Ulatisian. A probable upper Ulatisian fauna first occurs at 1980, a definitely upper Ulatisian fauna first occurs at 4730 and continues to 4948. Probable upper Ulatisian faunas again show up at 7282 and 7812, with the lowest diagnostic sample (8598), which is also the lowest sample in the hole, being also probably upper Ulatisian in age. The probable upper Ulatisian age for samples in this well is based upon the data given above for the Clark and Wilson well. Definite upper Ulatisian identifications are based upon the further occurrence of Amphimorphina californica which seems to be restricted to the upper zone of that stage in the California Tertiary.

Reserve Oil & Gas - Esmond No. 1

Only one sample (2875) yielded foraminifera, and these were not sufficiently preserved to be identifiable.

Diagnoses of Samples

Standard - Hoagland No. 1

50 - 160	Not diagnostic
200	Probably Refugian Epinides kleinpelli
220	Probably Refugian Uvigerina atwilli
160 - 260	Not diagnostic
260 - 340	Not diagnostic
380 - 480	Not diagnostic
480 - 580	Not diagnostic
580	Refugian Uvigerina atwilli Cibicides hodgei Planulina haydoni Plectofrondicularia packardi
600	Same fauna as above
618	Same fauna as above
580 - 680	Not diagnostic
760	Probably Refugian Uvigerina atwilli
680 - 780	Not diagnostic
719 - 734 (core)	Probably Refugian Plectofrondicularia packardi Eponides umbonata Gyroidina condoni Cassidulina globosa ? Eponides keenani Bolivina marginata Buliminella curta
780 - 880	Probably Refugian Nodogenerina wegemanni Eponides umbonata Gyroidina condoni ? Cibicides hodgei
880 - 980	Probably Refugian Eponides umbonata Cyclammina pacifica ? Bulimina decurtata
980 - 1080	? Narizian-Refugian Haplophragmoides obliquicameratus ? Cibicides sp. Bulimina sp.
988 - 1000 (core)	Not diagnostic
1080 - 1180	Probably Refugian Cibicides hodgei Eponides mexicana ? Uvigerina atwilli ? Uvigerina garzaensis
1083 - 1100 (core)	Not diagnostic
1180 - 1280	? Narizian-Refugian Eponides umbonata ? Cibicides hodgei Gyroidina planata Globigerina triloculinoides ? Uvigerina atwilli

1200	? Narizian-Refugian Uvigerina garzaensis
1220	? Narizian-Refugian Plectofrondicularia packardi
1240	? Narizian-Refugian Uvigerina garzaensis
1280 - 1380	Refugian ? Uvigerina garzaensis Pseudoglandulina ovata Cibicides hodgei Planulina haydoni
1297 - 1307 (core)	Refugian Nodogenerina wegemanni Gyroidina condoni Plectofrondicularia packardi Planulina haydoni Cibidices hodgei Eponides lodoensis martini Bulimina sp.
1380 - 1480	Refugian Planulina haydoni Gyroidina condoni Globigerina triloculinoides ? Uvigerina atwilli Haplophragmoides obliquicameratus Eponides umbonata Nonion pompiloides
1480 - 1580	Refugian Planulina haydoni Cibicides hodgei Plectofrondicularia packardi Gyroidina condoni Globobulimina pacifica Cyclammina pacifica ? Uvigerina atwilli Eponides lodoensis martini Eponides umbonata
1512 - 1522 (core)	Refugian Nodogenerina wegemanni Plectofrondicularia packardi Planulina haydoni Gyroidina condoni Eponides umbonata
1580 - 1700	Refugian Eponides lodoensis martini Cibicides hodgei Gyroidina condoni ? Uvigerina atwilli
1727 - 1737 (core)	Refugian Planulina haydoni Eponides mexicana ? Valvulinoria tumeyensis
1700 - 1800	Refugian Cibicides hodgei Uvigerina atwilli Globigerina sp. Cyclammina pacifica
1800 - 1900	Not diagnostic
1900 - 2000	Not diagnostic
1971 - 1980 (core)	Not diagnostic
2000 - 2100	Not diagnostic
2100 - 2200	Not diagnostic
2188 - 2198 (core)	Not diagnostic
2200 - 2300	Not diagnostic
2300 - 2400	Not diagnostic
2408 - 2418 (core)	Not diagnostic
2408 - 2500	Not diagnostic
2500 - 2600	Not diagnostic
2600 - 2700	Not diagnostic
2653 - 2663 (core ?)	Not diagnostic
2700 - 2800	Not diagnostic
2800 - 2900	Not diagnostic
3300 - 3393	Not diagnostic
3393 - 3400 (core)	Not diagnostic
3420 - 3540	Not diagnostic
3500 - 3609	Not diagnostic
3608 - 3700	Not diagnostic
3700 - 3880	Not diagnostic
3800 - 3900	Not diagnostic
3900 - 4000	Not diagnostic
4000 - 4100	Probably Refugian Uvigerina atwilli
4100 - 4200	Not diagnostic
4200 - 4300	Not diagnostic
4338 - 4348 (core)	Not diagnostic
4300 - 4400	Not diagnostic
4400 - 4500	Not diagnostic
4500 - 4600	Not diagnostic
4600 - 4700	Not diagnostic
4700	Probably Refugian Planulina haydoni
4700 - 4800	Not diagnostic
4800 - 4900	Not diagnostic
4920	Probably Refugian Cibicides hodgei
5500 - 5520	Not diagnostic
5520 - 5540	Not diagnostic

Texaco - Clatskanie No. 1

628	? Upper Narizian ? Virgulina californiensis
631	? Upper Narizian ? Virgulina californiensis
637	? Upper Narizian ? Virgulina californiensis Robulus sp.
646	? Upper Narizian ? Virgulina californiensis Robulus sp.
652	? Upper Narizian ? Virgulina californiensis Robulus sp.
1220 - 1227	Not diagnostic

1227 - 1237	Probably Narizian Plectofrondicularia packardi Pseudoglandulina ovata Quinqueloculina imperialis Robulus sp. Eponides sp. Cyclammina samanica Cibicides natlandi
1237 - 1247	Probably Narizian Quinqueloculina imperialis Cibicides natlandi Cyclammina samanica Eponides umbonata
1250	Probably Narizian Quinqueloculina imperialis
1253	Probably Narizian Same fauna as above
1253	Probably Narizian Same fauna as above
1259	Probably Narizian Same fauna as above Haplophragmoides obliquicameratus
1262	Not diagnostic
1265	Probably Narizian Same fauna as 1227-1237
1270±	Probably Narizian Same fauna as 1227-1237
1275	Probably Narizian Same fauna as 1227-1237 Eponides mexicana
1277	Probably Narizian Same fauna as 1227-1237 Eponides mexicana
1280	Probably Narizian Same fauna as 1227-1237 Eponides mexicana
1283 through 1355	Probably Narizian Same fauna as 1227-1237 Eponides mexicana
1358	Probably Narizian Same fauna as above, but fewer bugs Eponides mexicana Spirillina
1361 through 1394	Probably Narizian Same fauna as 1227-1237
1370	Probably Narizian Robulus pseudovortex Robulus sp. Pseudoglandulina ovata Quinqueloculina imperialis Plectofrondicularia packardi Bathysiphon sp.
1374 through 1394	Probably Narizian Same fauna as 1227-1237
1397	Probably Narizian Same fauna as 1227-1237 Cibicides susanaensis
1400 through 1583	Probably Narizian Same fauna as 1227-1237
1684	Probably Narizian Quinqueloculina imperialis Robulus pseudovortex ? Robulus sp. Plectofrondicularia packardi ? Cibicides susanaensis Nonion sp. Nonionella sp. Eponides mexicana Eponides sp.
1687 through 5608	Not identifiable, poorly preserved
5615 - 5621	? Narizian Cyclammina pacifica
5621 through 5644-5650	Not identifiable, poorly preserved

Texaco - Clark & Wilson No. 6-1

705	? Upper Ulatisian Trifarina advena californica Bolivina sp. Lagena conscripta Quinqueloculina sp. Cibicides fortunatus ?
915	? Upper Ulatisian Cibicides natlandi Globobulimina pacifica Cassidulina globosa Plectofrondicularia garzaensis Robulus sp. Spirillina sp.
919	? Upper Ulatisian Cibicides natlandi Cassidulina globosa Robulus sp. Globobulimina pacifica Plectofrondicularia garzaensis Quinqueloculina sp. Globigerina sp. Bulimina ovata Nonionella sp.
920	? Upper Ulatisian Same fauna as 919 Cibicides sandiegensis
925	? Upper Ulatisian Same fauna as 915, 919
1104	? Upper Ulatisian Same fauna as 915, 919, but fewer bugs
1110	? Upper Ulatisian Same fauna as 915, 919 Trifarina advena californica Uvigerina garzaensis Bolivina pisciformis ? Lagena hexagona Gyroidina planata Cibicides sandiegensis

1332	? Upper Ulatisian Same fauna as 915, 919 Vaginulinopsis mexicana Plectofrondicularia packardi ? Quinqueloculina imperialis
1335	? Upper Ulatisian Same as above
1549	? Upper Ulatisian Same as above
1556 - 1557	? Upper Ulatisian Same as 1332
1808	? Upper Ulatisian Same as 1332
1813	? Upper Ulatisian Same as 1332
2079	Poorly preserved
2081	Poorly preserved
2347 ±	? Upper Ulatisian Same fauna as 915, 919 Bulimina garzaensis
2362	? Upper Ulatisian Same fauna as 915, 919 Haplophragmoides sp. Bulimina garzaensis
2408 ±	? Upper Ulatisian Same fauna as 915, 919 Bulimina garzaensis Uvigerina lodoensis miriamae
3002	? Upper Ulatisian Same fauna as 915, 919 Vaginulinopsis mexicana
3011	? Upper Ulatisian Sparse 915, 919 fauna Vaginulinopsis mexicana
3691 through 4077	Not diagnostic
4612	? Upper Ulatisian Poorly preserved 915, 919 fauna
4616	? Upper Ulatisian Poorly preserved 915, 919 fauna Verneuilina triangulata
6020 ±	Not diagnostic
6175 (ditch)	? Upper Ulatisian 915, 919 fauna Vaginulinopsis mexicana Bulimina garzaensis
6245 (ditch)	? Upper Ulatisian 915, 919 fauna Vaginulinopsis mexicana Eponides mexicana Uvigerina churchi demicostata
6255 (ditch)	? Upper Ulatisian 915, 919 fauna Vaginulinopsis mexicana Vaginulinopsis saundersi Quinqueloculina imperialis
6360 (ditch)	? Upper Ulatisian 915, 919 fauna Vaginulinopsis mexicana Robulus pseudovortex Bulimina garzaensis Quinqueloculina imperialis
6370 (ditch)	? Upper Ulatisian Same as above
6470 - 6475 (ditch)	? Upper Ulatisian Same as above
6690 - 6700 (ditch)	? Upper Ulatisian Same as above Uvigerina churchi demicostata
7025	Not diagnostic
7040	? Upper Ulatisian Vaginulinopsis mexicana
7055	? Upper Ulatisian Same as 6360
7175	Not diagnostic
7190	Not diagnostic
7675 - 7695 (ditch)	? Upper Ulatisian 915, 919 fauna Eponides mexicana Uvigerina churchi demicostata
7730 ± through 8060	Not diagnostic
8080	? Upper Ulatisian 915, 919 fauna Bulimina garzaensis
8110	? Upper Ulatisian 915, 919 fauna
8140	? Upper Ulatisian 915, 919 fauna
8207 through 8318	Not diagnostic
8335	? Eggerella sp. Cyclammina sp. Various agglutinated forms
8343	? As above Bulimina garzaensis
8380	? Same as 8335
8392	? Same as 8335
8395	? Same as 8335 Globobulimina pacifica Bulimina garzaensis
8400	? Same as 8335
8408	? Same as 8335
8425 through 8451	Not diagnostic

Texaco - Cooper Mountain No. 1

1082 - 1092	Poorly preserved
1098	Poorly preserved
1110	Not diagnostic
1114	Poorly preserved
1125 ±	Not diagnostic
1127	Poorly preserved
1367	Poorly preserved
	? Anomalina sp.
1369	? Anomalina sp.
1371	Quinqueloculina imperialis ?
1373	Poorly preserved
1375	Gastropods
1381 through 1440	Not diagnostic
1980	Upper Ulatisian
	Bulimina sp.
	Cassidulina globosa
	Cibicides natlandi
	Eponides mexicana
	Globobulimina pacifica
	Nonion pompiloides
	Nonionella sp.
	Plectofrondicularia packardi
	Robulus sp.
	? Gumbelina cubensis
	Uvigerina lodoensis miriamae
1984	Upper Ulatisian
	Same as above
	Cibicides sandiegensis
	Verneuilina triangulata
1986 through 2000	Upper Ulatisian
	Same as above
2192 - 2204	Upper Ulatisian
	Some of the 1980 fauna is recognizable
2206	Upper Ulatisian
	Some of the 1980 fauna is recognizable
2435	Cibicides susanaensis
2439	Poorly preserved
2443	Cibicides susanaensis
	Eponides mexicana
2745 through 4283	Poorly preserved
4287	Not diagnostic
4290	Poorly preserved
4404 - 4411	Upper Ulatisian
	Bulimina sp.
	Cibicides natlandi
	C. susanaensis
	Eponides mexicana
	Cyclammina pacifica
	Gyroidina planata
	Verneuilina triangulata
	Nodosaria latejugata
	Nonion pumpiloides
	Quinqueloculina imperialis
	Robulus sp.
	Anomalina sp.
	Marginulina sp.
4411 - 4414	Upper Ulatisian
	Same as above.
4490	Upper Ulatisian
	Same as above
4492	Upper Ulatisian
	Same as above
4494	Upper Ulatisian
	Same as above
	Vaginulinopsis mexicana
4498 through 4506	Upper Ulatisian
	Same as 4404 - 4411
4511	Upper Ulatisian
	Same as 4404 - 4411
	Robulus pseudovortex
4720	Upper Ulatisian
	Same as 4404 - 4411
4724	Upper Ulatisian
	Same as 4404 - 4411
4730	Upper Ulatisian
	Same as 4404 - 4411
	Vaginulinopsis mexicana
	Pseudoglandulina ovata
	Amphimorphina californica
	? Valvulineria wilcoxensis
4732	Upper Ulatisian
	Same as above
	Robulus pseudovortex
4734	Upper Ulatisian
	Same as 4732
4736	Upper Ulatisian
	Same as 4732
4738	Upper Ulatisian
	Same as 4732
4740	Upper Ulatisian
	Same as 4732
	Globobulimina pacifica
4742 through 4948	Upper Ulatisian
	Same as 4732
5087 - 5099	Bathysiphon sp.
5279	Cyclammina sp.
5285 ±	Cyclammina sp.
5293 - 5300	? Upper Ulatisian
	Bathysiphon sp.
	Cyclammina pacifica
	Haplophragmoides obliquicameratus
	Verneulina triangulata
5300	? Upper Ulatisian
	Cyclammina pacifica
	Haplophragmoides obliquicameratus
	Verneuilina triangulata
5754	Poorly preserved
5759	Poorly preserved
5763	? Upper Ulatisian
	Cibicides sandiegensis
	Gyroidina planata
	Verneulina triangulata
	Robulus sp.
5768 through 7258	Not diagnostic

7282	? Upper Ulatisian
	Bathysiphon sp.
	Dentalina sp.
	Robulus sp.
	Quinqueloculina imperialis
	Bulimina sp.
	? *Vaginulinopsis mexicana*
7812	Upper Ulatisian
	Bathysiphon sp.
	Pseudoglandulina ovata
	Robulus pseudovortex
	Nodosaria latejugata
	Eponides mexicana
7816	Poorly preserved
7820	Upper Ulatisian
	Same as 7812
7952	Upper Ulatisian
	Same as 7812
7954	Poorly preserved
7957 through 7961	Upper Ulatisian
	Same as 7812
8596	Upper Ulatisian
	Bulimina sp.
	Eponides mexicana
	Vaginulinopsis mexicana
	Pseudoglandulina ovata
	Cyclammina sp.
	Bolivina sp.
8598	Upper Ulatisian
	Same as above
	Robulus sp.

TABLE 1. DRILLING AND TEST INFORMATION

Company	Well Name	Location	Year Drilled	Total Depth	Well Data
Alexander	?	Sec. 14, T7S, R5W., Polk County	1931	1440'	Gas in salt water sand (see gas analysis Table No. 3.)
Birdseye Cannery	Water well	SE¼ Sec. 36, T1N, R3W. Washington Co.	1929	1619'	Top Columbia River Basalt 1480'. U.S.G.S. Water Supply Paper 1697, p. 133
Castle Rock O&GCo.	Quigley 1	Center Sec. 18, T9N, R2W. Cowlitz County, Wn.	1925	2893'	Traces of oil reported.
V. Erntson	Schermacher No. 1	NE¼ Sec. 27, T9S, R2W. Marion County	1958	2426'	Probably marine sediments below 1650'. No oil or gas shows.
Fairview, City of	Water well	SW¼ Sec. 27, T1N, R3E. Multnomah Co.	1956	1060'	Top of Columbia River Basalt at 800', penetrated 260' of Eagle Creek Formation(?) (U.S.G.S. WSP 1793, p. 63)
Gulf Oil Corp.	Porter 1	NE¼ Sec. 27, T13S., R4W. Linn County	1963-1964	8470'	Gas shows in mud; 4010-4025, 4410-4780, 5080-5120, 5176-5184 (120 units). Well began flowing while drilling at 5080'. Mud contaminated with gassy salt water. FT (3811-3877) Test 1 hr. 15 mins. Recovered 3250' rise of gassy salt water, 19,228 ppm NaCl.
Hilleke, Louis	Water well	NE¼ Sec. 19, T1S, R2W. Washington Co.	1950	903'	Top of Columbia River Basalt at 818'. (U.S.G.S. WSP 1697, p. 137).
Humble Oil & Refining Co.	Miller 1	SE¼ Sec. 10, T 10S, R3W. Linn County	1962	4951'	Gas shows in mud; 670-680', 1200-1300', 2040-2060', 2560-2600', and 2665-2690'. FT (2374-2425) Test 90 minutes. Recovered 2200' of salt water, 12,100 ppm NaCl. IHH 1200 psi, FHH 1100 psi, ISIP 1000 psi, FSIP 900 psi, IFP 300 psi, FFP 800 psi. (See Water Analysis Table No. 4)
Humble Oil & Refining Co.	Wicks 1	NE¼ Sec. 11, T7S, R1E. Marion County	1962	7797'	Marine sediments to 2936', below this depth predominantly volcanics. No oil shows. Traces of gas, 4780-5540' in volcanics.
Johnson Lumber Co.	Water well	NE¼ Sec. 18, T11S, R10W Lincoln County	1948	1900'	Strong gas show at 1330'.

Table 1. Drilling and Test Information, continued

Company	Well Name	Location	Year Drilled	Total Depth	Well Data
Ladd	Water well	NE¼ Sec. 36, T1N, R1E. Multnomah Co.	1885	1700'	Top Columbia River Basalt 1300'. (U.S.G.S. WSP 1793, p. 61)
Lakin, Dick	No. 2	NW¼ Sec. 31, T10S., R7W. Benton County	1931	700'	Derrick reportedly destroyed by gas blow-out. (See Gas Analysis Table No. 3, gas from Well No. 1.)
Lease Holding Syndicate	Dutch Canyon well	NW¼ Sec. 17, T3N, R2W. Columbia Co.	1925-1927	4426'	Salt water in black sand at 1740-1780'. Gas sand at 1850-1872' reportedly blew mud and water 20' above the derrick floor. A few traces of oil were reported. (See Gas Analysis Table 3.)
Linn County Oil Devel. Company	Barr 1	NW¼ Sec. 32, T11S, R1W. Linn County	1958	4529'	Oil shows reported in mud while drilling at 4320-4500'. 5½" casing cemented at 4422'. DST (4298-4321) No. 1 Test 1 hr., 5 min. Recovered 620' net rise; 440' of gas cut mud and 180' of fresh water (operator spotted fresh water before perforating the casing). Acidized perforations 4298-4321'. DST (4298-4321') Test 1 hr. recovered 620' net rise; 440' of mud and 180' of mud acid. DST (2233-2267') Test 38 min. Recovered 78' rise of mud. Swab test (2233-2267') Ran 2½" tubing. Swabbed until fluid level stood at 4300' inside 5½" casing. Only a small amount of gas bubbled through the fluid. (See Gas Analysis Table No. 3.)
Lower Columbia Oil & Gas Co.	Brown 1	NW¼ Sec. 25, T8N, R10W. Clatsop Co.	1921-1922	4808'	Gas shows at 2380-3690'. Oil sands reported at 3723', 3796', and between 3854' and 3877'.
A. L. McKee	Water well	NW¼ Sec. 6 T6S, R4W. Polk County	1922	2985'	Flows 500 ppm slightly gassy salt water. (State Engineer's Ground-water Report No. 7)
Miriam Oil Co.	Bliven 1	SW¼ Sec. 11, T8S, R5W. Polk County	1957	1300'	Some salt water encountered below 400'. No oil or gas shows.
Miriam Oil Co.	Bliven 3	SE¼ Sec. 10, T8S, R5W. Polk County	1957	1801'	Traces of oil reported.
Miriam Oil Co.	Elliott 1	SW¼ Sec. 9, T8S, R5W. Polk County	1955-1958	1835'	5½" casing driven to 1256'. 2½" tubing was run into the hole and a packer set in open hole at 1700'.

Table 1. Drilling and Test Information, continued

Company	Well Name	Location	Year Drilled	Total Depth	Well Data
Miriam Oil Co	Elliott 1 (cont.)				Swab Test (1700'-1835') Swabbed salt water. Fluid level was 960' before the test. The hole filled slowly after being "swabbed-down", indicating a tight formation. A few rainbows of oil could be seen in the salt water, no gas.
R.Mitchell & Associates	Bliven 1	NW¼ Sec. 15, T8S, R5W. Polk County	1959	1347'	Small flow of gas encountered (see Gas Analysis Table No. 3)
Oregon Oil & Gas Co.	Roberts 1	NE¼ Sec. 25, T.10S, R8W. Lincoln County	1958	2630'	Small gas shows on ditch while drilling at 1515-1520' and 1670-1700'. Salt water contamination of mud while drilling at 2405-2425'. Twisted off left bit and two drill-collars in the hole at 2562-2630'. FT (2389-2569') Test 1 hr. 10 min. Recovered 810' rise of gassy, muddy salt water, 9150ppm NaCl. IFP 190 psi, FFP 380 psi, FHH 1300 psi. FT (2158-2178') Test 1 hr. 30 min. Recovered 1880' rise of slightly gassy, muddy salt water, 13,100 ppm NaCl. IFP 210 psi, FFP 985 psi, FHH 1200 psi. FT (1739-1817') Test 3 hr. 30 min. Recovered 1495' net rise; 995' mud and 500' of gassy salt water, salinity not tested. FT (1152-1232') Test 45 min. Gas surfaced in 12 min., dead after 30 min. Recovered 1025' rise of muddy salt water, 5050 ppm NaCl. IFP 225 psi, FFP 510 psi, FHH 685 psi. (See Gas Analysis Table No. 3)
Portland Gas & Coke Co.	Steiwer 1	NW¼ Sec. 14, T9S, R3W. Marion County	1933-1935	2845'	Reportedly encountered oil and gas shows in salt water sand at 2535-2845'.
Portland Gas & Coke Co.	Wiedehker 1	NW¼ Sec. 24, T9S, R3W. Marion County	1935-1936	3617'	Gas shows reported in sands between 487-1678' (sands wet below 830' - salt water). Light oil reported in a wet sand at 1000-1040'. Well bottomed in basalt?
Prescott, City of	Water well	SW¼ Sec. 25, T7N, R2W. Columbia Co.	1925	1008'	Top of basalt at 15', bottom at 972'(?).

Table 1. Drilling and Test Information, continued

Company	Well Name	Location	Year Drilled	Total Depth	Well Data
Reserve Oil & Gas Co.	Bruer 1	NE¼ Sec. 31, T6S, R4W. Polk County	1960	5549'	Gas shows in mud 680-880', 1150-1585'. Strong show (70 units) at 1570-1580. FT (1550-1586) Test 22 mins. Gas surfaced in 5 min., weak blow. Recovered 358' of gassy, muddy salt water, 16,100ppm NaCl. IHH 800 psi, ISIP 500psi, IFP 125psi, FFP 125psi, FSIP 250psi, FHH 750psi.
Reserve Oil & Gas Co.	Esmond 1	SW¼ Sec. 7, T12S, R1W. Linn County	1962	8603'	FT (2891-2941) Test 41 min. Recovered 144' rise of watery mud, salinity 7000 ppm NaCl. IHH 1625psi, ISIP 100 psi, IFP 100psi, FFP 125psi, FHH 1625psi. FT (3974-4010) Test 50 mins. Gas surfaced in 7 min., weak blow. Recovered 70' of slightly gas-cut mud. IHH 2500psi, ISI 440psi, IFP 72psi, FFP 122psi, FHH 2500psi. (See Gas Analysis Table 3) FT (4790-4875) Test 50 min. No water cushion. Gas surfaced in 4 min., medium to fair, decreasing blow. Recovered 377' net rise; 60' watery mud, 60' of gas-cut mud and 257' of very gassy mud. IHH 3150psi, ISIP 1652psi, IFP 178psi, FFP 118psi, FHH 3146psi. (See Gas Analysis Table 3) FT (7055-7106) Test 1 hr. 16 min. Used a 2000' water cushion. Well flowed very gassy salt water at a 2000 B/D rate, 47,500 ppm NaCl. IHH 5779psi, ISIP 5475psi, IFP 3863psi, FFP4482psi, FSIP 5332psi, FHH 5680psi. FT (8027-8045) Test 1 hr. 16 min. Used 2000' of water cushions. Gas surfaced in 41 min., medium gas blow. Recovered 839' net rise; 455' of gassy, muddy salt water, 385' of clear salt water, 42,000ppm NaCl. IHH 6561psi, ISIP 3939psi, IFP 1237psi, FFP 1338psi, FSIP 2361 psi, FHH 6557psi. (See Gas Analysis Table 3)

Table 1. Drilling and Test Information, continued

Company	Well Name	Location	Year Drilled	Total Depth	Well Data
Richfield Oil Corp.	Barber 1	SE¼ Sec. 23, T1N, R1W. Multnomah Co.	1946	7885'	No oil or gas shows.
Richfield Oil Corp.	Weyerhauser No. 1	SW¼ Sec. 31, T10N, R8W Wahkiakum County, Wn.	1955	9110'	Mostly fine-grained sediments. Brown staining and yellow fluorescence in cores (7577-7582') and (8288-8298'). No formation tests run.
J. Romig	Water well	SE¼ Sec. 17 T6S, R4W. Polk County	1956	270'	Brackish water encountered. Well produced a small amount of volatile gas upon completion. (State Engineer's Ground Water Report No. 7.)
Standard Oil Co.	Hoagland Unit 1	SE¼ Sec. 11, T7N, R10W. Clatsop Co.	1955	7101'	Spotty fluorescence on fracture planes in sandstone core, 5464-5471'.
Sunray Mid-Continent Oil Company	Kappler 1	NW¼ Sec. 12, T2N, R2W. Multnomah Co.	1957	1666'	No oil or gas shows
Texaco, Inc.	Benson-Clatskanie No. 1	NE¼ Sec. 36, T7N, R4W. Columbia Co.	1945	5650'	Oily odor in volcanic breccia 730-780', no cut. Gas and oil show 1394-1401'. Gas show 2159-2170'. Light yellow ether cut after several hours from sample 5114-5146'. Core had no odor. No formation tests run. Reamer stuck in the hole at 5640'. Hole had to be abandoned.
Texaco, Inc.	Clark & Wilson	NE¼ Sec. 19, T6N, R4W. Columbia County	1946-1947	8500'	Gas shows: 2034-2042', 3064-3084', and 3221-3241' (no fluorescence noted, however, mud contaminated with oil as a result of fishing operations during drilling from 8159-8500'.) FT (2017-2076) Packer failed. FT (2042-2076) Packer failed. FT (2036-2076) Test 45 min. Recovered 85' rise of mud. FT (3064-3094) Test 40 min. Recovered 620' net rise; 100' of mud and 520' of brackish water, 6000ppm NaCl. FT (3214-3241) Test 45 min. Recovered 1250' net rise; 270' mud and 980' of brackish water, 5140ppm NaCl. 5½" cashing cemented at 8100'. WNSO 7835 - Squeezed. WNSO 7950 - Squeezed. WSO 7833. WSO 7950.

Table 1. Drilling and Test Information, continued

Company	Well Name	Location	Year Drilled	Total Depth	Well Data
Texaco, Inc.	Clark & Wilson (cont.)				DST (7965-8000) Test 7 hours. Well flowed salt water at 70 B/D rate, no trace of oil or gas. Salinity tested 12,200ppm NaCl. IFP 600psi, FFP 3550psi, FSIP 3950psi. DST (7880-7900 and 7920-7937) Test 10 hours, 22 min. Fluid surfaced in 4 hours, 53 min. Well flowed salt water at a 68 B/D rate, slight amount of flammable gas, no oil. Salt water tested 17,500ppm NaCl. IFP 500psi, FFP 3500psi, FSIP 3900psi.
Texaco, Inc.	Cooper Mt. 1	SE¼ Sec. 25, T1S, R2W. Columbia Co.	1945-1946	9263'	Non-flammable gas in salt water at 7862-9263'. FT (2793-2845) Test 20 min. Recovered 35' rise of mud. FT (3505-3534) Test 30 min. Recovered 312' rise of muddy salt water, 57,400 ppm NaCl. 7" casing cement at 7862'. DST (7862-9263) Test 8½ hours. No water cushion used. Mud surfaced in 2 hours, 25 min. Salt water surfaced in 5 hours. Well flowed frothy salt water at a 29 B/hr rate. Water temperature was 88.5°F. Gas in salt water was nonflammable. Salinity tested 80,400ppm NaCl. FFP 3700psi.
Texaco, Inc.	Potter 1 core hole	SE¼ Sec. 8, T4N, R3W. Columbia Co.	1940	608'	A small flow of gas was encountered. (See Gas Analysis Table No. 3)
Union Oil	McGowan 1	S½ Sec. 22, T9N, R10W. Pacific Co., Wash.	1929	4385'	Slight gas show reported. Drilled entirely in Eocene volcanics.
Willamette Valley Petrol. Syndicate	?	NW¼ Sec. 11, T12S., R5W. Benton County	1932-1934	2150'	Gas encountered in salt water sand at 120' and in a carbonaceous sand at 1560-1565'.

TABLE 2. DESCRIPTIONS OF DRILL CUTTINGS AND CORES.

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Company	Well Name	Map Reference	Text Page
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CASTLE ROCK OIL & GAS CO.

Quigley No. 1

Center Section 18, T. 9 N., R. 2 W., Cowlitz County, Wash.

1	to 10	Sandstone.
10	24	Shale, dark brown.
24	82	Shale, dark gray to brown.
82	88	Sand, dry.
88	110	Shale, gray, fossils.
110	128	Sand, soft, fossils.
128	154	Sand, gray, harder.
154	256	Shale, sandy, gray to brown.
256	295	Sand, gray.
295	356	Sandy, gray shale.
356	390	Sand, gray, trace oil.
390	448	Sand, gray, soft.
448	460	Shale.
460	520	Sand, water at 460.
520	678	Shale, brown to light gray.
678	690	Sand, coarse gray, many fossils.
690	704	Shale, sandy.
704	736	Sand, gray.
736	765	Shale, sandy.
765	824	Sand, gray, fossils.
824	840	Shale, brown.
840	855	Shale, blue.
855	932	Shale, sandy, traces coal.
932	937	Sand.
937	995	Shale, sandy, traces coal water.
995	1014	Sand, water.
1014	1023	Shale, sandy blue.
1023	1040	Sand.
1040	1048	Broken, sand, pebbles, water.
1048	1060	Sand.
1060	1116	Shale, brown, traces oil.
1116	1128	Sand, water.
1128	1305	Shale, brown, some sandy and thin shells.
1305	1372	Shale, gray.
1372	1376	Lime, hard.
1376	1410	Shale, gray, trace oil.
1410	1504	Shale, gray, mostly sandy, show oil.
1504	1524	Shale, gray.
1524	1526	Sand, hard, coarse.
1526	1606	Shale, blue with thin lime streaks.
1606	1618	Sand.
1618	1620	Shale, mud?

Castle Rock Oil & Gas Co. (cont.)

1620	1640	Sand, water.
1640	1644	Shale.
1644	1715	Sand.
1715	1720	Shale, soft.
1720	1763	Sand, mostly very hard, dark.
1763	1770	Shale, sandy.
1770	1784	Sand.
1784	1789	Shale, brown and blue.
1789	1795	Sand.
1795	1840	Shale, brown.
1840	1885	Shale, gray, sandy.
1885	1930	Shale, brown.
1930	2115	Shale, gray with lime shells (altered volcanics?).
2115	2125	Shale, black.
2125	2165	Shale, green.
2165	2195	Shale, gray.
2195	2265	Sand, gray, salt water.
2265	2304	Tuff and ash.
2304	2320	Shale, gray.
2320	2335	Sand, very coarse, quartz.
2335	2360	Shale, brown.
2360	2380	Tuff with thin shales.
2380	2392	Shale, gray.
2392	2442	Shale, gray mostly, sandy.
2442	2446	Lime, hard, black (altered basalt?).
2446	2476	Shale, gray with lime shells (altered basalt?).
2476	2488	Sand, water.
2488	2515	Shale with thin shells.
2515	2635	Sand, brackish water at 2550'.
2635	2643	Shale.
2643	2647	Coaly.
2647	2724	Shale, gray, sandy.
2724	2782	Sand, gray, water.
2782	2808	Lime, sandy.
2808	2852	Sand, water.
2852	2856	Shale, soft.
2856	2862	Sand, good show oil.
2862	2885	Sand.
2885	2890	Shale, blue.
2890	2893	Lime, hard, black (altered basalt?).

COMMONWEALTH, INC.
Water Well

Section 2, T. 1 S., R. 1 W., Washington County, Oregon.

	Soil and mantle (undifferentiated):
0- 9'	Clay and soil
	Boring lava (basalt):
9- 27	Rock, broken
27- 36	Rock, gray, medium hard
36-109	Rock, gray, hard
109-151	Rock, gray, hard (some broken crevices with brown seams)
151-158	Rock, gray, crevices
158-214	Rock, gray, hard
214-231	Rock, gray, very hard
231-239	Rock, brown
	Troutdale Formation:
239-253	Conglomerate
253-297	Clay, yellow
297-304	Clay, blue
304-316	Clay, yellow
316-329	Clay, blue
329-364	Clay, yellow
364-493	Clay, blue
493-527	Clay, red
527-593	Clay, blue
593-627	Clay, red and yellow
627-673	Conglomerate
	Columbia River Basalt:
673-717	Rock, decomposed
717-770	Rock, brown and gray, hard
770-777	Rock, brown, hard, broken
777-854	Rock, gray and black
854-872	Rock, black, water bearing
872-875	Rock, gray, hard

V. V. ERNTSON & ASSOCIATES
Schermacher No. 1

Section 22, T. 9 S., R. 2 W., Marion County, Oregon

Composite Sample Descriptions

0- 190	Sand and gravel; fragments of volcanic rocks, basaltic.
190- 240	Andesite; medium greenish gray, hard.
240- 725	Basalt; dark grayish black and pinkish black, hard, aphanitic to microcrystalline, some zeolite, weathered dull brownish green olivine(?).
725- 920	Shale; grayish, pinkish, very firm, silty, tuffaceous with thin interbeds of friable, medium to fine grained sandstone composed mainly of subangular pieces of basalt.
920-1110	Siltstone; medium grayish brown, very firm, sandy, tuffaceous.
1110-1150	Shale; medium gray, firm, silty.
1150-1430	Siltstone; medium gray and brownish gray, very firm, tuffaceous.
1430-1640	Tuff; brownish gray, firm, fine, with small fragments of dark volcanic rock.
1655-1680	Mudstone; medium greenish gray, firm, with occasional pieces of basalt.
1680-1710	Sandstone; dark gray, firm, fine grained, silty basaltic.
1710-2115	Siltstone; medium gray, firm, tuffaceous.
2115-2180	Mudstone; brownish gray, firm, silty, tuffaceous.
2180-2350	Sandstone; medium greenish gray, very firm, medium to fine grained, composed of subangular basalt fragments.
2350-2385	Siltstone; medium greenish gray, hard, tuffaceous.
2385-2419	Sandstone; medium greenish gray, hard, medium to fine grained, subangular fragments of basalt.

*Core No. 4 rec'y 2419-2426'	Siltstone; medium gray, hard, composed of fine pieces of basalt and feldspar grains.

* Cores 1, 2, and 3 were not available for description.

CITY OF FAIRVIEW
Water Well

Section 27, T. 1 N., R. 3 E., Multnomah County, Oregon*

Driller"s Log*

	Troutdale Formation:
0- 5'	Clay
5- 20	Boulders and gravel
20- 59	Gravel
59- 83	Gravel, cemented
83-105	Clay, blue
105-125	Silt
125-140	Gravel, sandy, water bearing
140-203	Gravel, cemented, bottom 12" casing at 182'.
203-265	Silt
265-320	Gravel, clean
320-345	Gravel, muddy
345-360	Gravel, cemented, static water level 110'.
	Sandy River Mudstone:
360-380'	Clay, yellow, sandy
380-420	Sand, fine, heaving
420-445	Rock (gravel), coarse
445-495	Silt, sandy
495-535	Sand, heaving
535-540	Shale, blue
540-560	Sand, black
560-575	Sand, some gravel
575-625	Sand, fine, white, static water level dropped to 120' at depth of 585'.
625-626	Gravel, water bearing
626-670	Sand, fine, white
670-690	Sand, fine, and gravel
690-705	Sandstone, hard, sharp (abrasive)
705-715	Shale, blue
715-735	Sand, fine
735-745	Gravel, small, sandy, caving
745-755	Clay, gray, sandy
755-800	Clay, yellow, bottom of 10" casing at 800'
	Columbia River Basalt:
800-810'	Rock, gray, hard
810-826	Rock, broken
826-827	Clay
827-850	Rock, black, hard
850-875	Rock, hard, some blue clay
875-900	Rock, black
900-915	Clay, blue
915-920	Rock, gray
	Older rocks:
920-935'	Clay, blue, static water level 90'
935-937	Shell, hard
937-950	Clay
950-965	Sand rock (tuffaceous (?) sandstone)
965-967	Clay, blue
967-975	Sandstone, gray, hard, water bearing
975-998	Rock, hard, black
998-1002	Clay, red and pink
1002-1030	Rock, broken, hard, drilled muddy
1030-1045	Rock, broken, and blue clay
1045-1060 T.D.	Sand, gray and clay

* U.S. Geological Survey Water-Supply Paper 1793, p. 63.

GULF OIL CORP.
Porter No. 1

Section 27, T. 13 S., R. 4 W., Linn County, Oregon

Composite Descriptions

0- 80	Gravel; multicolored pebbles, predominantly basalt, some volcanic clastic sediments.
80- 130	Siltstone; light gray, clayey, soft to friable, some fine sandy siltstone also.
130- 175	Sandstone; medium greenish gray, bentonitic, tuffaceous, friable, subangular, fine to coarse. Contains grayish black basalt pebbles and rounded pieces of grayish-white pumice. Some interbedded light gray shale and siltstone.
175- 220	Siltstone; light to medium greenish gray, clayey, friable, some thinly interbedded fine tuffaceous sandstone.
220- 370	Pebbly sand; medium gray, loose, coarse, subrounded grains of basalt and pyroclastic rock fragments. Interbedded fine clayey sand containing volcanic pebbles. Sands contain some lignitic material.
370- 500	Sandstone; light gray to greenish gray, fine to coarse, friable, subrounded pieces of multicolored basalt, bentonitic matrix, clear euhedral quartz.
500- 515	Sandstone; as above, fine grained.
515- 570	Sandstone; light greenish gray, friable, poorly sorted, clayey, fine to medium grained, composed of subangular and subrounded grains of black basalt and other multicolored volcanic rocks.
570- 680	Siltstone; light gray, clayey, fine to coarse sandy, friable to loose, with coarse grains of basalt. Some thinly interbedded claystone.
680- 890	Siltstone; light gray, clayey, fine sandy and medium gray, firm, tuffaceous silty sandstone composed of subrounded pieces of basalt, feldspar, and quartz. Also fragments of black mineral.
890-1080	Siltstone; medium brownish gray, friable, clayey, fine sandy with scattered subrounded pieces of basalt.
1080-1150	Siltstone; above described and thin interbeds of friable, fine-grained, silty, clayey, sandstone composed of black and green grains, some feldspar and quartz.
1150-1170	Lithic tuff; medium gray, firm, fine.
1170-1220	Sandstone; microconglomeratic coarse, subrounded basalt fragments, subangular to angular quartz and feldspar in clayey matrix.
1220-1485	Siltstone; medium gray, dark gray and brownish gray, due to the color of the clay portion, firm. Calcite veining at 1290' -1350', and 1410-1425'. Occasional disc-shaped foraminifera.
1485-1725	Siltstone; medium to dark gray, firm, clayey, tuffaceous, fine sandy, some micromicaceous. Occasional foraminifera. Some pyrite.
1727-1755	Clayey siltstone; medium to dark gray, firm, many foraminifera.
1755-1820	Siltstone; medium to dark gray, firm, slightly sandy, few foraminifera.
1820-1860	Siltstone; light to medium gray, firm, fine sandy, subangular to angular, dark green altered basalt grains, feldspar, and fragments of volcanic rocks.
1860-1890	Siltstone; light gray, firm to friable, clayey, micromicaceous, tuffaceous. Rare foraminifera.
1890-1915	Sandstone; light gray, firm, silty, fine grained, micromicaceous, tuffaceous, contains feldspar and some quartz.
1915-1945	Sandstone; light gray, firm, tuffaceous, subangular feldspar and quartz, coarse grained.
1945-1980	Sandstone; light gray, friable, clayey, tuffaceous, poorly sorted, fine to coarse grained.
1980-2005	Siltstone; medium gray, firm, micromicaceous, tuffaceous.
2005-2025	Crystal tuff; whitish, with bentonitic matrix. Some pieces of tuff breccia, basalt, and andesite.
2025-2045	Tuff breccia; whitish, yellowish brown, firm, with angular pieces of basalt and andesite.
2045-2190	Shale; brownish gray, very firm, tuffaceous, silty. Interbedded firm clayey, pebbly siltstone and sandstone containing coarse, rounded grains of black basalt. Rare foraminifera.
2200-2210	Sandstone; medium to dark gray, fine to medium grained, basaltic with clayey matrix, firm.
2210-2300	Siltstone; olive gray, firm, tuffaceous. Rare foraminifera. Some coarse, rounded basalt fragments.
2300-2325	Siltstone; dark brownish gray, firm to friable, fine sandy, basaltic.
2325-2480	Shale and siltstone; dark brownish gray, firm; medium

greenish gray, tuffaceous, and dark gray silty shale. Some interbeds of medium gray, tough, fine-grained, clayey, basaltic sandstone.

2480-2610 Siltstone; medium to light gray, firm, clayey, tuffaceous, with scattered rounded basalt grains. Some milky quartz veining and quartz-lined vugs. Some medium gray tough, fine-grained basaltic clayey sandstone.

2610-2650 Siltstone; dark gray, purplish gray, very firm, fine sandy, tuffaceous, clayey. Pieces of pumice and altered greenish basalt.

2650-2870 Basalt; grayish black, fine crystalline with few veinlets of zeolite.

2870-2915 Sandstone; medium gray and light gray, hard, fine, some coarse sections, silty, tuffaceous, some portions silicified. Interbedded brownish gray, hard, fine sandy tuffaceous siltstone.

2915-2940 Basalt; brownish black, fine crystalline, hard, slightly altered.

2940-3100 Sandstone; tuffaceous, tough - hard.

3100-3155 Silicified tuff; light gray, fine to glassy, microcrystals of ferromagnesian minerals, partly altered, brownish and greenish.

3155-3305 Basalt; medium and dark gray, hard, fine to microcrystalline augite.

3305-3410 Diorite(?); medium gray, hard, fine to coarse crystalline. Feldspar and hornblende.

3410-3857 Conglomerate; tuffaceous greenish and pinkish gray, hard, composed of altered subrounded basalt fragments and other volcanic rocks. Sandy to silty matrix, some zeolitic cementation. Interbedded pinkish and greenish-gray tuffaceous siltstone with some zeolite veining.

Core No. 1
3857-3877'

4' Conglomerate; medium dark greenish gray, hard, tuffaceous, composed of subrounded pebbles of reddish and greenish gray altered basalt and other pyroclastic fragments. Matrix of coarse silty wacke. Break generally across pebbles. Somewhat calcareous.

2' Sandstone; medium greenish gray, hard, very coarse to fine, subrounded, tuffaceous. Somewhat calcareous.

10' Conglomerate; as above. Shear plane 20°.

6' No recovery.

3877-4390' Conglomerate; as above, and interbedded dark gray tuffaceous siltstone and silty shale with some carbonaceous material.

4390-4570 Sandstone; medium greenish gray, hard to firm, fine silty wacke and interbedded brownish gray, sandy, tuffaceous shale and siltstone. Some greenish and pinkish volcanic ash.

4570-4760 Basalt; grayish black, microcrystalline, partly altered, zeolitic.

4760-4900 Siltstone; medium gray, firm to very firm, silty, tuffaceous, and some interbeds of black, firm shale. Some layers of carbonaceous material and calcite. Some interbedded medium gray, firm, fine subrounded, silty, basaltic sandstone.

4900-5230 Siltstone; dark to light gray, firm to friable, partly very fine sandy, very tuffaceous, silty, some mica. Fine pieces of subrounded basalt. Some zeolite filling of minute openings in the siltstone. Carbonaceous material 5100-5120'.

5230-5315 Crystal ash; medium greenish gray, slightly altered.

5315-5360 Siltstone; as above described.

5360-5490 Crystal ash; light gray, firm to very firm, calcareous. Some portions partly altered. Clayey.

5490-5680 Basalt; dark gray, hard, fine to medium grained, commonly porphyritic, feldspar phenocrysts, augite plentiful, slightly altered. Some zeolite.

5680-5710 Crystal ash; light gray, firm to friable, slightly altered, clayey.

5710-5800 Siltstone; light to dark gray, firm, thinly bedded(?), micromicaceous. Some quartz grains, traces of pyrite.

5800-5820 Sandstone; white, fine, friable, well sorted, micromicaceous, calcareous.

5820-5880 Siltstone; dark gray, brownish black, carbonaceous, firm to friable, some fine sandy, micromicaceous. Coal layer cut by calcite veinlets, 5840-5860'.

5880-5900 Sandstone; light gray, firm to friable, silty, slightly tuffaceous, calcareous.

5900-5950 Siltstone; medium gray, firm, clayey, tuffaceous, with very fine subangular pieces of quartz and basalt.

5950-6050 Shale; medium gray, firm, silty, calcareous, rare foraminifera, disc shaped. Scattered medium grained, rounded black basalt particles, some grains of quartz and altered feldspar.

6050-6165 Sandstone; light gray, bentonitic, silty, very fine to medium grained, calcareous, trace to abundant mica.

Gulf Oil Corp. Porter No. 1 (cont.)

Slightly tuffaceous, composed mainly of quartz and feldspar. Interbedded medium to light gray, firm calcareous siltstone and shale. Some carbonaceous material.

Core No. 2

6165-6168'	1'	Siltstone; grayish black, firm to very firm, fine sandy, fairly calcareous. Poor bedding. Dip ± 35°.
	2'	No recovery.
6168-6370		Sandstone and siltstone; as described above.
6370-6990		Siltstone; medium to dark gray, firm, very firm, clayey, micromicaceous, slightly tuffaceous. Interbedded sandy siltstone, some minute carbonaceous fragments, portions slightly calcareous.
6990-7085		Claystone; dark gray, very firm to hard, slightly silty, some slickensiding. Some portions very micromicaceous; interbedded fine sandy siltstone.
7085-7126		Basalt; medium to dark gray, some greenish gray, fine crystalline, zeolite and calcite veining, hard, part altered.

Core No. 3

7126-7146'	20'	Basalt; dark gray, pinkish gray, hard to crumbly, altered, sheared, with zeolite and calcite veining. Probably a submarine flow.
7146-7340		Basalt; as described in Core No. 3.
7340-7380		Siltstone; medium gray, clayey, fine sandy, tuffaceous, friable.
7380-7460		Tuff; medium gray to reddish brownish gray, firm, composed of fine angular pieces of basalt, occasional fragments of white ash, light gray bentonitic matrix.
7460-8091		Basalt; grayish black, some pinkish gray, brownish black, fine to medium grained, abundant zeolite. Some interbeds of brownish gray crystal ash with zeolite veining.

Core No. 4

8091-8113'	22'	Basalt; greenish black, fine to coarse grained, altered, chloritized, hard to crumbly, slightly sheared. Probably submarine flow.
8113-8380		Basalt; as above described but a little zeolite. Some thin interbeds of brownish gray basaltic siltstone.
8380-8460		Basalt; black, greenish black, hard to crumbly, altered, chloritized, aphanitic to coarse grained, zeolite veining.
8460-8470 T.D.		Basalt; grayish black, hard, slightly altered, fine grained, with considerable zeolite veining, some calcite veining.

LOUIS HILLEKE
Water Well

Section 19, T. 1 S., R. 2 W., Washington County, Oregon

Driller's Log*

	Valley fill:
0- 15	Clay, brown
15- 25	Clay, sandy
25- 60	Quicksand
60- 90	Mud, blue
90-138	Clay and sand, blue
138-143	Clay and boulders, blue
143-260	Clay, with gravel, blue and yellow
260-267	Gravel and sand
267-693	Clay, varicolored
693-761	Clay, red
761-792	Clay, yellow
792-818	Clay, varicolored
	Columbia River Basalt:
818-832	Rock, decomposed
832-841	Sand, and clay, gray
841-864	Rock, decomposed, red and brown
864-873	Rock, gray
873-903 T.D.	Rock, brown

* U.S. Geological Survey Water-Supply Paper 1697, p. 137.

HUMBLE OIL & REFINING CO.
Miller No. 1

Section 10, T. 10 S., R. 3 W., Linn County, Oregon

Composite Sample Descriptions

0- 60	Gravel and sand; yellowish brown and gray, composed of volcanic rocks; andesite, basalt, and tuff. Some carbonaceous material.
60- 80	Shale; rust brown and dark brown, with some scattered small mica flakes, some carbonaceous material.
80- 120	Shale; dark brownish gray, firm, tuffaceous and some interbeds of greenish gray, fine subangular, tuffaceous, micaceous, sandstone.
120- 175	Basalt; dark greenish gray and dark gray, hard, aphanitic-microcrystalline.
175- 270	Siltstone; light gray, firm, fine sandy.
270- 335	Sandstone; whitish, firm to friable, medium grained, calcareous, micaceous, feldspathic, somewhat tuffaceous, subangular.
335- 350	Siltstone; light brown, firm, sandy, argillaceous.
350- 420	Basalt; dark brownish gray, hard, microcrystalline.
420-1020	Siltstone; light gray, black and tan, argillaceous, carbonaceous, interbedded with whitish, friable, fine-grained, feldspathic, micaceous sandstone. Gas shows in cuttings, 50 units.
1020-1140	Sandstone; light gray, friable to firm, medium grained, micaceous, composed of subangular grains of feldspar, quartz, and scattered mafic minerals. Portions of the sandstone are calcareous.
1140-1265	Siltstone; light brown, firm, slightly calcareous, argillaceous, sandy.
1265-1540	Mudstone; brownish gray, with some shell fragments.
1540-1650	Siltstone; light gray and greenish gray, firm, calcareous, fine sandy, some carbonaceous material.
1650-2280	Sandstone; whitish, friable, fine grained, some fine mica, calcareous, composed of subangular feldspar, quartz, and scattered pieces of basalt. Some interbedded dark gray sandy siltstone.
2280-2470	Sandstone; light gray, firm, fine to medium grained, micaceous, calcareous, tuffaceous, composed of mainly feldspar and quartz, lesser amount of volcanic fragments. Some interbedded, grayish black, firm, silty shale containing thin coal seams.
2470-2700	Siltstone; dark gray to grayish black, firm, argillaceous, rare shell fragments. Interbedded grayish black carbonaceous shale with thin coal seams. Gas in cuttings, 25 units.
2700-2725	Sandstone; light gray, firm, fine to coarse grained, calcareous, micaceous, feldspathic.
2725-2780	Siltstone; light gray and greenish gray, firm, fine sandy, tuffaceous.
2780-2915	Sandstone; whitish, firm to friable, fine grained, micaceous (mostly biotite), feldspathic.
2915-2960	Siltstone; brownish gray, firm, fine sandy, with trace of coal and pyrite.
2960-3110	Sandstone; light gray and brownish gray, firm, fine to medium grained, micaceous, slightly tuffaceous, subangular.
3110-3150	Siltstone; pale brown and brownish gray, argillaceous, few scattered shell fragments (clams?).
3150-3510	Sandstone; whitish, firm to friable, fine grained, subangular, feldspathic, with scattered mafic minerals. Interbedded light brown and dark gray carbonaceous siltstone and mudstone.
3510-3790	Siltstone; dark grayish brown, firm to very firm, tuffaceous.
3790-3870	Lithic tuff; medium greenish gray, very firm, some red rock fragments intermixed with volcanic debris.
3870-3990	Siltstone; dark grayish brown, firm to very firm, sandy, tuffaceous.
3990-4285	Siltstone; greenish gray and brownish gray, firm, tuffaceous, few scattered shell fragments, some interbedded brown silty shale.
4285-4350	Lithic tuff; light greenish gray, very firm.
4350-4800	Siltstone; dark brownish gray and greenish gray, firm, tuffaceous, with some carbonaceous material and thin seams of shaly coal. Some interbedded brownish gray silty shale. Also some interbeds of light greenish gray, fine to very fine, very tuffaceous, silty, micaceous sandstone.
4800-4948	Basalt; grayish black to brownish black, aphanitic - microcrystalline, calcite veining near bottom, some chloritized portions.

HUMBLE OIL & REFINING CO.
Wicks No. 1

Section 11, T. 7 S., R. 1 E., Marion County, Oregon

Composite Sample Descriptions

0- 880'	Shale; tuffaceous and shaly sandstone.
880- 950	Shale; medium dark gray, firm, silty, tuffaceous.
950-1010	Tuff breccia; medium gray, hard, with some interbedded tuffaceous shale.
1010-1065	Shale; medium gray to grayish black, firm, tuffaceous.
1065-1170	Basalt; medium to dark gray, hard, pumiceous lava and dull black, partially altered basalt.
1170-1180	Sandstone; medium gray, firm - friable, fine to medium grained, silty, tuffaceous.
1180-1215	Shale; grayish brown, firm, silty, tuffaceous.
1215-1230	Sandstone; whitish gray, firm, medium to coarse grained, tuffaceous, composed of subangular pieces of volcanic rock.
1230-1260	Crystal ash; light gray, firm, fine.
1260-1300	Mudstone; reddish brown, firm, silty, tuffaceous.
1300-1410	Lithic tuff; pinkish dark gray, greenish gray, and dark gray with some interbedded brownish mudstone.
1410-1480	Lithic and lapilli tuff; grayish green and dark gray, firm to very firm, some calcite.
1480-1585	Shale; dark gray to grayish black, firm, tuffaceous, silty.
1585-1680	Sandstone; greenish and brownish gray, firm, fine, silty, tuffaceous.
1680-1800	Siltstone; light gray and brownish gray, firm, tuffaceous, some layers of dull to shiny black coal.
1800-2020	Shale; grayish brown, firm, silty, tuffaceous, carbonaceous.
2020-2180	Shale; medium gray and reddish brown, tuffaceous.
2180-2500	Altered lava; medium gray, very firm, zeolitic and greenish gray and pinkish gray lithic tuff.
2500-2900	Lithic tuff; medium greenish gray and reddish brown, firm, silty, some zeolite.
2900-2990	Basalt; dark gray, hard, microcrystalline, porphyritic, partially altered.
2990-3010	Lithic tuff; light green and pink, firm to hard, with scattered grains of feldspar and basalt fragments.
3010-3065	Altered basalt; dull black, very firm, some calcite veining, some chlorite.
3065-3290	Lithic tuff; medium greenish gray and yellowish brown, firm.
3290-3450	Sandstone; greenish gray, firm to very firm, fine to medium grained, subangular, tuffaceous.
3450-3495	Basalt; medium dark gray, hard, microcrystalline.
3495-3815	Lithic tuff; dark greenish gray and pinkish gray, firm to very firm, with scattered basalt fragments.
3815-3860	Basalt; dark greenish gray, hard, porphyritic with phenocrysts of whitish feldspar.
3860-3885	Shale; reddish brown, tuffaceous.
3885-3940	Lithic tuff; greenish gray, firm. Some interbedded green and pink tuffs.
3940-4065	Altered basalt; greenish - grayish black, hard, porphyritic (phenocrysts of white altered feldspar), occasional reddish altered hornblende crystals, some zeolite and calcite.
4065-4300	Lithic tuff; multicolored, firm to very firm, some zeolite, interbedded tuffaceous, carbonaceous mudstone.
4300-4410	Mudstone; dark greenish and gray, firm, tuffaceous, internally sheared.
4410-4520	Andesite; medium greenish gray, hard, altered.
4520-4550	Basalt; dark greenish gray, hard to firm, altered, porphyritic, phenocrysts of altered feldspar.
4550-4600	Andesite; medium gray and reddish brown, porphyritic with phenocrysts of altered white feldspar, some chlorite, some slickensides.
4600-4710	Lithic tuff and tuff breccia; greenish, pinkish and brownish gray; firm to very firm.
4710-4780	Tuffaceous shale and siliceous tuff; pinkish brown and greenish gray, hard.
4780-4820	Andesite; greenish gray, hard, altered, porphyritic with phenocrysts of altered feldspar.
4820-4845	Basalt; grayish black, hard, porphyritic with phenocrysts of feldspar.
4845-4890	Basalt; dull black, firm, partially altered.
4890-4915	Shale; reddish brown, firm to soft, crumbly, tuffaceous with calcite veining.
4915-4970	Andesite; greenish gray, hard, altered, porphyritic.
4970-5150	Lithic tuff; pinkish dark gray and grayish black, some calcite veinlets, some carbonaceous material and coal.
5150-5235	Crystal tuff; dark greenish, purplish and pinkish gray, hard, siliceous with calcite and zeolite.

Humble Oil & Refining Co. Wicks No. 1 (cont.)

5235-5510	Basalt; greenish gray, hard, microcrystalline, partly altered with some zeolite and calcite veining.
5510-5590	Tuff; reddish brown, grayish brown, pink, and light green with veinlets of calcite.
5590-5610	Basalt; dark greenish gray, hard, microcrystalline.
5610-5750	Lithic tuff; pink, white and dark greenish gray with calcite veining.
5750-5805	Basalt; dark greenish gray, firm, partially altered with some calcite veining.
5805-5880	Lithic tuff; brown, pink, reddish brown and greenish gray, some calcite. Dark greenish gray flows of basalt at 5810-5840'and 5845-5865'.
5880-6000	Lithic tuff; as above, some interbedded grayish brown tuffaceous shale.
6000-6035	Sandstone; light gray, firm, fine to medium grained, carbonaceous, composed of subangular grains of quartz, feldspar, and fragments of volcanics.
6035-6050	Lithic tuff; as described 5880-6000'.
6050-6155	Sandstone; as described 6000-6035'; some interbeds of reddish brown and light brown, firm shale.
6155-6390	Andesite-basalt; medium gray, hard, microcrystalline, partially altered; portions are porphyritic dark gray basalt, also some fine-grained basalt gabbro.
6390-7300	Tuff breccia and conglomerate; dark gray, pink and green, some interbedded brownish fine-grained sandstone and carbonaceous siltstone, some calcite, some dull black pieces of asphalt (?), burned readily.
7300-7635	Lithic tuff; dark gray and grayish brown, firm.
7635-7700	Basalt; dark gray and pinkish dark gray, firm, altered, porphyritic.
7700-7790	Basalt; dull black and dark greenish gray, firm, altered porphyritic, some calcite veining.

LADD ESTATE
Water Well

Section 36, T. 1 N., R. 1 E., Multnomah County, Oregon

Driller's Log*

	Fluviolacustrine Deposits:
0-100'	Sand and clay
100-120	Sand, clay, and gravel
	Troutdale (?) Formation:
120-140'	Sand containing boulders
140-180	Gravel containing boulders and layers of white sand
180-200	Gravel, sandy
200-220	Boulders and grit
220-280	Gravel containing layers of white sand.
	Troutdale Formation:
280-330'	Conglomerate, sandy
330-360	Sand, fine, and gravel
360-405	Clay, sand, and gravel in alternating layers
	Sandy River Mudstone:
405-720'	Marl, olive colored, and shale with some basaltic grit and sand. Some fossilized plant remains.
720-730	Sand, fine and gravel
730-850	Marl and clay, some layers of fine soft sandstone.
850-1000	Shale and marl, some layers of sand, and much fossilized plant debris.
1000-1200	Conglomerate, fine, some shale and marl, some fossil plants.
1200-1250	Gravel and coarse grit.
1250-1300	Marl and clay, some gravel and plant fossils.
	Columbia River Basalt:
1300-1700	"Granite" (basalt?)

* U.S. Geological Survey Water-Supply Paper 1798, p. 61.

LEASE HOLDING SYNDICATE

Dutch Canyon well

Section 17, T. 3 N., R. 2W., Columbia County, Oregon

Driller's Log

0- 16'	Surface sand and boulders.
16-110	Gray shale and sandstone (Base of Scappoose Formation probably at 110'.)
110-1380	Hard blue shale, some sandy shale (Base of Keasey Formation probably at 1380'.)
1380-1760	Black limestone (Probably altered volcanics. Top of upper Eocene approximately 1380'.) Interbedded with shale, dark brown mudstone.
1760-1955	Basaltic sandstone containing salt water interbedded with shale. Hit gas at 1850'.
1955-2003	Shale, some sand, claystone. Water 5 g.p.m.
2003-2605	Gray, red, and dark brown shale.
2605-2845	Shale is more indurated.
2845-2948	Blue shale.
2948-2955	Blue shale and sand.
2955-2981	Sand, gravel, hard sandstone, and conglomerate.
2981-3450	Black, gray, blue, and brown shale, some shells.
3450-3527	Hard blue shale.
3527-3547	Sandy shale, some water.
3547-3555'	Brown shale.
3555-3569	Agglomerate?
3569-3598	Blue shale.
3598-3626	Gray sand and shale.
3626-3638	Brown mudstone.
3638-3647	Sandy shale.
3647-3690	Gray sandy lime, showing trace of oil and gas.
3690-3725	Hard gray sand, oil showing.
3725-3760	Hard brown sand.
3760-3802	Blue, brown, and gray shale.
3802-3885	Hard gray sandstone.
3885-3900'	Sandy gray shale.
3900-4028	Hard gray sand, showing oil.
4028-4262	Hard gray sand and lime, traces of oil.
4262-4426	Gray shale.
4426 T.D.	Hard basalt?

LINN COUNTY OIL DEVELOPMENT CO.

Barr No. 1

Section 31, T. 11 S., R. 1 W., Linn County, Oregon

Composite Descriptions

0-1455'	Tuff, and tuffaceous shale.
1455-1690	Sandstone; medium gray, medium to coarse grained, tuffaceous, containing subrounded pieces of andesite, grayish white ash, altered basalt, and red jasper. Fine sandy matrix. Some interbeds of tuffaceous shale, medium gray to tan, firm, some thin layers of grayish white ash.
1690-1820	Sandstone; dark color, tuffaceous, coarse to medium grained, predominantly basaltic, also fragments of above-described volcanics, few thin interbeds of tuffaceous shale.
1820-1915	Sandstone; medium gray, tuffaceous, coarse to pebble conglomerate composed of quartz and feldspar, silty matrix, bentonitic, also medium gray pieces of andesite. Contains clusters of fine pyrite crystals, fragments of varicolored tuffs, brownish black microcrystalline basalt, some small quartz-lined cavities in andesite fragments, some of the quartz contains minute magnetite(?) crystals.
1915-1945	Shale; medium gray, tuffaceous.
1945-1995	Sand; tuffaceous, containing coarse pebbles of volcanic fragments described in the interval 1820-1915; pieces are subangular.
1995-2040	Basalt; dark grayish black, aphanitic, some zeolite.
2040-2090	Sandstone; medium gray, coarse pieces of andesite, purplish basalt and tuff, some grains of sanidine(?) and quartz.
2090-2120	Siltstone; medium gray, tuffaceous.
2120-2215	Sandstone; tuffaceous, loose, contains subrounded pieces of varicolored volcanic rocks, and tuff. Angular fragments of medium-gray andesite, fine white ash and basalt.
2215-2235	Tuff; medium gray, firm, fine grained, contains small angular pieces of red and dark gray volcanic rock, bentonitic matrix.
2235-2270	Pebble conglomerate and coarse sandstone; light to medium gray, firm, tuffaceous, contains subrounded fragments of light-gray welded tuff, brown tuff, andesite, polished pieces of brownish red jasper and basalt,

some quartz grains with included small magnetite crystals, some sanidine(?).

2270-2300 Shale; medium gray, tuffaceous.

2300-2340 Tuff; medium greenish gray, occasional medium to coarse angular fragments of purplish volcanic rock, some pieces of grayish black basalt, some quartz grains.

2340-2440 Tuff; medium gray, fine, silty, with scattered subangular pieces of purplish volcanic rock, brownish-red jasper, and light-colored tuff.

2440-2460 Pebble conglomerate; silty matrix, pebbles of andesite, dark gray basalt, white welded tuff, and tuff.

2460-2500 Andesite; medium gray, contains sanidine(?) and quartz.

2500-2545 Siltstone; tuffaceous, scattered subangular pieces of volcanic rock.

2545-2650 Sandstone; tuffaceous, silty matrix, contains subangular, coarse grain to pebble size, fragments of grayish-black basalt and medium-gray andesite.

2650-2693 Shale; tuffaceous, medium to dark gray, fairly bentonitic, contains subangular pieces of andesite, andesite contains a considerable amount of quartz and sanidine(?).

2693-2735 Conglomerate; coarse grained to pebble size, contains pieces of purplish-gray andesite and reddish-brown jasper. Fragments are subangular, jasper is dull to polished, matrix of the conglomerate is fine volcanic debris, some small grains of quartz and magnetite, some pieces of brownish-black basalt with occasional olivine crystals.

2735-2780 Altered andesite; dark gray to greenish gray, hard, with dull, light-green mineralization (altered iron minerals?), some small, irregular quartz-filled cavities.

2780-2892 Shale; medium gray, hard, tuffaceous, interbedded fine, tuffaceous sandstone which contains pieces of purplish-gray andesite, pumice, crystal tuff and lithic tuff.

2892-2940 Tuff; dark color, fine to medium grained, pumice, greenish-gray andesite, purplish andesite, reddish-brown jasper, and some black basalt.

2940-3110 Siltstone; gray and greenish gray, tuffaceous, scattered subangular pieces of volcanic rocks, bentonitic matrix, occasional thin layer of red shale.

3110-3320 Tuff; dark to medium gray, firm, composed of angular pieces of purplish andesite, black basalt, white ash and pumice, some interbedded tuffaceous shale, occasional thin layers of black shale, scattered small grains of quartz and sanidine(?).

3320-3400 Basalt; dark grayish black, hard.

3400-3430 Shale; medium gray to dark gray, firm, tuffaceous.

3430-3443 Conglomerate; dark-colored, pebble size, firm sandy matrix, particles consist of pinkish-gray andesite, grayish-green andesite, and brownish-red andesite.

3443-3520 Basalt; grayish-black, hard, microcrystalline, occasional small olivine crystal.

3520-3546 Tuff; medium gray, very firm, fine grained.

3546-3650 Basalt; grayish black, microcrystalline, occasional small olivine crystal.

3650-3750 Tuff; dark colored, very firm, fragments of purplish and greenish gray andesite in a fine silty matrix.

3750-3910 Basalt; grayish black, hard, microcrystalline.

3910-3960 Tuff; tan and pink, fine grained, partially cemented.

3960-4160 Basalt; black, hard, microcrystalline.

4160-4225 Shale; medium to dark gray, very firm.

4225-4300 Tuffaceous siltstone and sandstone.

4300-4325 Sandstone; medium color, very firm, consisting of coarse, well-sorted pieces of volcanic rock, subangular grains of quartz and feldspar. The sandstone contained salt water and a small amount of gas.

4325-4435 Siltstone; medium to dark gray, very firm, fine sandy, interbedded with slightly tuffaceous shale, occasional mica flakes, portions have a bentonitic matrix. Some thin layers of firm, very fine, light gray, arkosic, slightly tuffaceous sandstone, some small pyrite crystals in the siltstone.

4435-4529 Siltstone; medium to dark gray, tuffaceous, some pyrite, some interbedded very fine, firm, arkosic sandstone, partially cemented, scattered rounded pieces of dark volcanic rock, partially cemented.

LOWER COLUMBIA OIL CO.

Brown No. 1
Sec. 25, T. 8 N., R. 10 W.
Columbia County, Oregon

Driller's Log

1-30	Surface
100	Fine-grained sand, logs, and roots.
150	Gray water sand and boulders.
175	Yellow clay.
250	Brown shale and boulders.
332	Brown shale, hard shells, and boulders.
390	Soft gray shale.
420	Dark gray shale.
447	Gray shale and boulders.
450	Dark gray shale, sticky - some hard shale.
465	Gray shale and shells
475	Hard shells, gray and sandy shale.
489	Hard shells, shale and boulders.
495	Shale and boulders
500	Hard shells.
525	Coarse sandstone and shells - oil and gas show.
528	Tough blue shale.
531	Soft gray sandstone.
538	Hard sandstone shells.
579	Brown shale.
582	Boulders.
589	Sandy gray shale.
617	Soft brown shale and boulders.
618	Hard shell of shale.
647	Sandy shale, some streaks of green shale.
649	Boulders.
661	Brown sandy shale.
665	Hard shale and conglomerate.
675	Soft brown shale.
690	Boulders, tough brown shale, and shells.
700	Black shale.
720	Tough, light-brown shale.
726	Coarse light-brown sand shale.
728	Hard sand shale.
757	Sticky brown shale.
758	Boulders.
772	Light-brown soft shale.
779	Boulders.
780	Tough brown shale and shell.
800	Sticky brown shale.

808	Boulders.
810	Hard shell and hard brown shale.
812	Boulders.
815	Shell of hard shale.
839	Hard brown shale.
841	Boulders.
850	Hard brown shale.
865	Boulders.
873	Soft brown shale.
880	Hard brown shale.
890	Boulders.
892	Hard brown shell.
912	Hard brown shale.
918	Boulders and hard shells.
940	Hard brown shale and shells.
965	Hard brown shale.
975	Boulders.
996	Soft, light-brown shale.
998	Hard shell.
1010	Light brown shale, tough.
1017	Hard shell and shale.
1022	Hard shell, blue lime.
1045	Brown shale and boulders.
1050	Brown shale.
1053	Boulders.
1056	Hard blue limestone.
1085	Hard shell cement gravel.
1095	Soft (sloughing) brown shale.
1120	Brown shale.
1140	Hard brown shale - some boulders.
1177	Hard brown shale - boulders.
1200	Alternating hard brown shale and boulders.
1225	Light-brown shale.
1250	Soft sandy shale.
1270	Boulders.
1375	Soft brown sandy shale.
1430	Hard shell, brown sandy shale.
1435	Hard sand, shell, brown shale.
1445	Soft shale, brown sloughing.
1450	Firm brown sandy shale.
1497	Boulders in brown sandy shale.
1540	Soft brown sandy shale.
1545	Boulders.
1610	Brown shale, alternating streaks of sandy shale.
1615	Hard shell gray limestone.
1675	Alternate streaks gray and brown shale.

1696	Boulders and hard shells, gray and brown shale.
1697	Hard lime shell.
1710	Hard gray sandy shale.
1715	Hard shell, gray limestone.
1725	Gray and brown sandy shale.
1735	Gray and brown sandy shale.
1741	Soft brown sloughing shale
1745	Hard shell, fine gray sandstone.
1780	Alternating hard gray sandstone and brown sandy shale.
1810	Gray lime shale - soft and hard.
1839	Gray and blue shale, hard shells, gray and white limestone.
1847	Alternating streaks gray and brown shale, thin streaks lime.
1850	Hard shell, gray limestone.
1875	Blue shale, hard shells, limestone and sandstone.
1922	Blue lime - streaks of hard shells.
1926	Hard shell, blue limestone.
1935	Shell, gray sandstone - blue limestone.
1940	Gray sandstone, hard shell.
1945	Soft blue shale sloughing.
1980	Blue shale, small brown sandstone boulders.
2000	Blue shale.
2010	Gravelly brown shale.
2020	Shell of hard brown shale.
2035	Blue shale and kidneys of hard blue shale.
2045	Light blue shale streaks and hard shells.
2275	Blue shale.
2350	Hard sandstone and gray limestone (10" landed at 2300).
2378	Hard sandstone and gray limestone.
2380	Coarse brown gas sand.
2444	Hard blue sandstone.
2445	Gas sand - strong pressure.
2480	Hard blue sandstone.
2521	Blue sandstone.
2530	Blue shale and shell, sandstone and shale - some gas.
2600	Blue sandstone.
2610	Light blue sandstone - sandy shale - some gas.
2615	Hard blue sandstone.
2634	Dark blue sandstone, coarse.
2685	Soft blue-gray sandstone.
2690	Blue-gray sandstone - hard.
2705	Brown and gray shale.
2735	Hard shells, sandy shale - blue and gray shale.
2761	Hard shells of sandstone and blue and gray shale.
2784	Blue and gray shale - sandstone and shale shells.
2785	Hard shells, sandy shale.
2790	Hard shells, gray and brown shale.

2818	Gas sand - hard to put in mud to drill through.
2824	Sandy gray shale and hard shells.
2836	Sandy gray shale.
2844	Hard sandstone, shell and sandy gray shale.
2846	Sandy gray shale.
2852	Sandy gray shale, sandstone shells.
2858	Blue and brown shale, sandstone shells.
2930	Blue and brown shale - some sandstone shells.
2941	Hard brown shale.
2948	Brown shale.
2952	Brown shale.
2955	Brown shale, lime streaks.
2957	Brown shale, lime streaks.
2959	Brown shale.
2962	Brown shale.
2965	Brown shale, lime streaks.
2970	Brown shale.
2974	Brown shale.
2981	Brown shale, soft - gas show.
2990	Brown shale.
2992	Brown shale, lime streaks.
3017	Brown shale, sandy - gas show.
3020	Brown shale, lime streaks.
3027	Sandy coarse brown shale.
3046	Brown shale, lime streaks.
3057	Hard and soft streaks of brown shale.
3060	Hard shell, brown shale.
3079	Firm brown shale.
3090	Brown shale.
3092	Soft brown shale - gas show.
3099	Brown shale.
3100	Brown shale, hard shell.
3104	Brown shale and gypsum.
3121	Brown shale and lime.
3128	Brown shale, gypsum and lime.
3131	Brown shale, hard.
3142	Brown shale, lime streaks.
3160	Brown shale, hard and soft.
3189	Brown shale, hard.
3201	Brown shale, hard.
3208	Brown shale, firm.
3210	Sandstone shell, pyrites.
3220	Brown shale, soft.
3342	Hard and soft streaks, soft brown shale and shells, hard shale.
3354	Sand shale sloughing.
3375	Blue shale.

3380	Blue shale and shells.
3385	Sand shale and brown platy shale.
3442	Tough blue shale.
3451	Sand shale.
3454	Brown platy shale sloughing.
3475	Blue shale.
3500	Blue shale and shells, blue sandstone.
3524	Sandy formation, gray sandstone & sand shale - gas and oil colors.
3534	Blue-black shale.
3554	Gray sandstone and dark blue shale - colors.
3553(?)	Hard shell, sandstone.
3560	Black shale.
3565	Gray sandstone & gray sandstone shale, blue-black shale - colors.
3675	Blue-gray sand shale.
3690	Coarse gray sandstone - oil and gas show.
3693	Blue shale.
3723	Fine and coarse oil sand.
3729	Streaks of blue shale.
3796	Coarse oil sandstone.
3799	Blue shale streaks.
3854	Oil sandstone - landed the 6 1/4".
3877	Oil sandstone.
3968	Sand shale.
3970	Gas sandstone.
3986	Sand shale.
4005	Hard sand shale - gas show.
4016	Dark sand shale and shell of dark sandstone.
4035	Black sandstone - hard.
4046	Blue shale.
4053	Hard dark shale, shell, dark sandstone.
4063	Hard dark shale.
4079	Hard dark sand shale.
4095	Hard sand shale.
4100	Black sandstone, hard.
4155	Dark sand shale.
4134(?)	Hard sandy shale.
4174	Gray sandstone, shale hard and soft.
4181	Dark gray sand shale, very hard.
4185	Hard dark gray sand shale.
4191	Hard shale, dark gray sandstone.
4500	Dark gray black sandstone shale - hard and soft streaks.
4545	Gray dark sandy lime shale - gas.
4704	Dark lime shale.
4711	Hard shell of lime.
4772	Dark lime shale, gas at 4740.
4808 T.D.	Soft sloughing lime shale ($4\frac{1}{2}$" carried to 4559).

MORRISON 13 Q-1
Water Well

Section 13, T. 1 S., R. 2 W., Washington County, Oregon

0-700'	Alluvium
700-900	Weathered basalt
900-960	Hard basalt

OREGON OIL & GAS CO.
Roberts No. 1

Section 25, T. 10 S., R. 8 W., Lincoln County, Oregon

Composite Sample Descriptions

0- 46	Sandstone and shale.
46- 84	Shale and blue clay.
84- 148	Shale; dark gray, very firm.
168- 200	Shale; bluish gray, firm.
200- 228	Shale; dark gray, silty, firm.
228- 240	Sandstone; firm to friable, whitish gray, fine, silty, feldspathic.
240- 250	Shale and siltstone; whitish gray, firm, slightly calcareous, slightly tuffaceous.
250- 275	Siltstone; pinkish-gray to light gray, hard, slightly tuffaceous, slightly calcareous.
275- 295	Gabbro-diorite(?); medium gray, microcrystalline to fine crystalline.
295- 355	Sandstone and siltstone; whitish gray and pinkish gray, hard, fine to medium grained, silty arkosic, cemented with lime.
355- 380	Shale; medium greenish gray, hard, occasional fish scale, slightly tuffaceous. Interbeds of black shale.
380- 410	Siltstone; light gray, firm to friable, some mica.
410- 430	Shale; grayish black, firm.
430- 450	Basalt; brownish black, hard, aphanitic.
450- 495	Sandstone; greenish white, firm to hard, very fine grained; arkosic, some mica, some interbedded dark gray micaceous siltstone.
495- 730	Shale; grayish black, firm and layers of silty shale, occasional cluster of small pyrite crystals. Some layers of interbedded medium greenish gray, hard, fine, feldspathic, micaceous sandstone partially cemented with lime. Some layers of silty sandstone composed of feldspar, basalt, and a minor amount of quartz.
730- 790	Sandstone; whitish, friable, medium to coarse grained composed of subrounded grains of feldspar, quartz and scattered pieces of basalt in a silty matrix. Some layers of dark gray, firm, silty shale and pinkish silty shale. Also pieces of milky white and pink chert.
790- 795	Limestone; medium gray to greenish gray, hard, sandy.
795- 800	Shale; grayish black, firm, silty.
800- 835	Limestone; hard, silty.
835- 855	Sandstone; light gray, firm to friable, fine, arkosic, silty, micaceous.
855- 880	Shale; medium gray and grayish black, firm, some interbedded siltstone.
880- 935	Siltstone; whitish gray, hard, some pyrite, slightly tuffaceous.
935-1055	Basalt-gabbro; grayish to brownish black, hard, fine crystalline, portions of the rock resemble diorite(?). Portions of the basalt contain zeolites.
1055-1160	Basalt; brownish black, hard, microcrystalline, weathered, lower portion fine grained - gabbroic, some interbedded pink siliceous ash.
1160-1180	Diorite(?); light gray, hard, fine crystalline.
1180-1205	Ash; pinkish gray, hard, siliceous.
1205-1260	Basalt; brownish black, hard, microcrystalline, lower portion partly weathered.
1260-1300	Siltstone and shale; grayish black, firm, some fine calcite veining.
1300-1370	Shale; dark greenish gray, firm, with thin interbeds of medium to dark gray siltstone.
1370-1395	Oil shale(?); black, brittle, yielded waxy substance when heated.
1395-1408	Siltstone; pinkish gray, hard, fine sandy, tuffaceous.
1408-1420	Limestone; white to medium gray, firm to hard, fine sandy.
1420-1510	Sandstone; light gray, hard, fine to medium grained, arkosic, silty, tuffaceous.
1510-1530	Limestone; whitish, firm to hard, silty.
1530-1540	Siltstone; light gray, hard, calcareous.
1540-1725	Shale; grayish black, firm, some interbedded medium-gray tuffaceous siltstone.
1725-1745	Basalt; dark gray, hard, fine grained, partly weathered.
1745-1820	Basalt; grayish-brownish black, hard, microcrystalline, partly weathered, some zeolite.
1820-1835	Limestone; whitish, firm, silty.

1835-2080	Shale; grayish black, firm, silty with interbedded medium to light-gray siltstone, some of the siltstone layers quite limy.
2080-2100	Limestone; whitish gray, firm, silty.
2100-2165	Shale; dark gray and greenish gray, firm, with interbeds of light-gray silty limestone.
2165-2220	Limestone; whitish, firm, silty, with interbedded dark gray to black shale, shale cut by calcite veinlets.
2220-2330	Basalt; grayish black, hard, some zeolite, some pyrite.
2400-2410	Siltstone; dark gray, friable, few scattered medium size quartz grains, saturated with paraffin-like oil, faint odor (apparently fluorescence not checked during drilling - sample described 3 years after abandonment, no fluorescence), light straw-colored CCl_4 cut, sample burned readily when ignited with a match.

2410-2569 T.D. No samples.

Note: Samples were mixed considerably and as much as 60' of lag noted in a few instances.

CITY OF PRESCOTT

Water Well

Section 25, T. 7 N., R. 2 W.
Columbia County, Oregon

Driller's log

0 to	15	Clay and rock.
15	27	Rock, brown.
27	37	Lava and blue rock.
37	50	Lava rock.
50	70	Lava rock, black.
70	113	Rock, black.
113	121	No record.
121	291	Rock, black.
291	301	Rock, black, some red rock.
301	309	Rock, black, hard.
309	319	Rock, black.
319	325	Basalt, black.
325	344	Rock, black.
344	354	Rock, red.
354	364	Rock, black.
364	388	Rock, black, crevice at 375'.
388	390	Shale.
390	395	Rock, black.
395	400	Shale.
400	415	Rock, black.
415	425	Rock, interbedded with shale.
425	444	Rock, red.
444	460	Rock, gray.
460	484	Rock, red.
484	489	Basalt.
489	494	No record.
494	537	Basalt.
537	552	No record.
552	606	Rock.
606	615	Rock and shale.
615	625	Rock.
625	633	Rock and shale.
633	661	Shale with some rock.
661	688	Rock.
688	698	Rock, red.
698	716	Rock, brown
716	724	Rock, black.
724	732	Rock.
732	738	Rock, gray.
738	972	Rock.
972	980	Shale, brown, interbedded with rock.
980	984	Shale, as above.
984	1008	Shale and rock.
	T.D.	

RESERVE OIL & GAS CO.
Bruer No. 1

Section 31, T. 6 S., R. 4 W., Polk County, Oregon

Composite Sample Descriptions

0- 360'	Siltstone; light gray, firm, some bentonite, slightly tuffaceous, scattered pieces of white volcanic ash and interbedded light gray, very fine grained, firm to very firm, arkosic, somewhat tuffaceous sandstone. Scattered subrounded fragments of basalt. Occasional small fragments of shells.
360- 510'	Sandstone; light gray, very firm, very fine grained, arkosic with scattered pieces of subrounded basalt, occasional mica flakes, portions more tuffaceous than others. Few small fragments of shells and microfossils.
510- 620'	Siltstone; light gray, somewhat tuffaceous, firm, some limy layers. Some interbedded fine silty, arkosic sandstone, portions quite tuffaceous. Eponites?
620- 805'	Shale; medium gray, firm, silty and some greenish gray sandy shale, tuffaceous.
805- 885'	Sand; whitish, loose to firm, fine grained, feldspathic, very micaceous, uniform, portions tuffaceous.
885- 893'	Limestone; light gray, hard, fine sandy, some mica, somewhat tuffaceous.
893- 910'	Sand; whitish, loose to friable, fine, subangular feldspathic, micaceous.
910-1040'	Shale; light to medium gray, somewhat tuffaceous, firm, silty, some sandy shale.
1040-1320'	Siltstone and fine sandstone; light to medium gray, firm, somewhat tuffaceous, a few fine, scattered mica flakes. Some streaks of medium, silty, micaceous sand.
1320-1360'	Sandstone; light gray, medium grained, arkosic, somewhat tuffaceous, partially cemented with lime, friable to firm.
1360-1480'	Sandstone; medium gray, firm to hard, tuffaceous, arkosic, micaceous, and pieces of altered basalt. Some layers of whitish friable feldspathic sand.
1480-1548'	Siltstone; fine sandy, light gray, hard, with interbedded fine, firm, quartz sandstone with pyroxene and occasional magnetite particles, limy layers.
1548-1560'	Limestone; fine sandy, grayish white, hard.
1560-1600'	Siltstone; medium gray, firm, some fine mica, occasional carbonaceous material.
1600-3530'	Shale; medium to dark grayish black, firm, few microfossils: (1720-1740) Dentalium fragments? (1980-2000) Globobulimina pacifica (2160-2180) Robulus inornatus? (2540-2560) Cyclammina pacifica? (3380-3400) Glandulina sp.?
3530-3630'	Basalt; grayish black, vitreous, aphanitic, hard. Some interbedded dark grayish-black shale.
3630-3815'	Shale; medium gray and grayish black, firm to brittle, some fine, sandy shale.
3815-3835'	Sandstone; light gray, friable, shaly, very fine grained, with medium-sized pieces of dark shale and basalt.
3835-4440'	Shale; dark gray to grayish black, firm, some silty sections, few microfossils; (4060-4080') Robulus inornatus?
4440-4550'	Shale and marl; some sandy portions.
4550-4690'	Volcanic agglomerate; zeolitized altered flow rock, shale, volcanic debris, calcite veining.
4690-4765'	Basalt; dull black, crumbly, weathered.
4765-4840'	Shale; medium to dark gray, hard, silty.
4840-4860'	Sandstone; rusty-gray, silty, containing subrounded shale fragments and partly cemented with limonite.
4860-4905'	Tuff; hard to firm, red and green with quartz and calcite, sandy.
4905-4965'	Basalt; dull black, crumbly, weathered with chlorite, zeolite and calcite.
4965-5380'	Volcanic agglomerate, tuff, and some interbedded dark-gray shale. Volcanics are cut by calcite veins and pockets of zeolite. Numerous pieces of altered basalt containing chlorite and zeolite.
5380-5485'	Basalt; dull black, partly weathered, contained some olivine and pyroxene crystals. Also small miarolitic structures filled with zeolite. Zones of hard, unweathered microcrystalline basalt containing small miarolitic cavities filled with zeolite.
5485-5529'	Basalt; dull black, altered zeolitic basalt.
5529-5549	Basalt; black, hard, microcrystalline only slightly altered, contained olivine and numerous small miarolitic cavities filled with zeolite and calcite.

RESERVE OIL & GAS CO.
Esmond No. 1

Section 7, T. 12 S., R. 1 W., Linn County, Oregon

Composite Descriptions

0- 20'	Gravel.
20- 360	Tuff; medium gray, some alteration to clay, scattered pieces of basalt and volcanic ash, some sandy tuffaceous shale, shale contains small quartz-lined cavities.
360- 375	Sand; fine to medium grained, contains pieces of tuff, basalt, quartz, and feldspar.
375- 435	Tuff; dark gray, hydrothermally altered, quartz-lined cavities, zeolite veining, fragments of pumice and basalt with zeolite, some fine-grained sandstone composed of basalt, quartz, and weathered feldspar.
435- 465	Sand; fine to medium grained, composed of tuff fragments, and angular grains of quartz and feldspar.
465- 750	Andesite porphyry; medium dark gray, with phenocrysts of quartz and pyroxene.
750- 765	Basalt; grayish black, some zeolite.
765- 795	Sand (?); fine- to medium-sized angular fragments of basalt.
795- 810	Andesite; grayish-black, some quartz.
810- 825	Sand; fine grained, loose, composed of subangular grains of quartz, feldspar, and some olivine.
825- 870	Basalt; brownish black, some olivine and zeolite.
870- 885	Shale; grayish brown, firm, tuffaceous.
885- 910	Basalt; grayish black, some olivine and some calcite, thin interbeds of reddish-brown shale.
905- 955	Shale; medium to dark gray, very firm, quite bentonitic.
955- 975	Sandstone; medium grained, friable, composed of quartz, feldspar, and pieces of volcanic rock, matrix of silt.
975- 990	Shale; dark gray, firm to soft, some basaltic gravel.
990-1020	Sand; dark gray, basaltic, some angular quartz and feldspar.
1020-1120	Shale; medium gray, firm, tuffaceous, some greenish-gray shale and brownish-red shale, occasional scattered pyrite mineralization.
1120-1130	Sandstone; light gray, fine grained, very firm, composed of basalt fragments cemented with lime.
1130-1225	Shale; medium greenish-gray, firm, altered red volcanic rock and dark grayish-red tuff.
1225-1410	Shale; light greenish gray, soft, tuffaceous with interbeds of pinkish-red tuff and brownish-red shale, portions of the shale being calcareous.
1410-1445	Basalt; brownish black, hard, aphanitic, some quartz-lined cavities.
1445-1485	Shale; light gray, green, and pink, tuffaceous, some purplish red.
1485-1505	Basalt; brownish black, hard, aphanitic.
1505-1525	Shale; light grayish green, very firm, tuffaceous, some pinkish-red shale.
1525-1535	Basalt; brownish black, hard, aphanitic, some quartz fillings.
1535-1555	Altered basalt; reddish dark gray, with quartz- and calcite-filled cavities.
1555-1600	Volcanic agglomerate; dark gray, hard, with calcite filling and veining.
1600-1640	Basalt; brownish black, hard, aphanitic.
1640-1675	Basalt; medium gray, porphyritic, phenocrysts of subhedral feldspar, some pyrite, interbeds of medium-gray tuffaceous shale.
1675-1695	Basalt; brownish black, microcrystalline, containing a few olivine crystals.
1695-1720	Sandstone; light to medium gray, firm, silty, tuffaceous, subrounded grains of quartz, feldspar, and pieces of basalt.
1720-1770	Basalt; grayish black, hard, quartz- and calcite-filled fractures and cavities.
1770-1805	Siltstone; light gray, tuffaceous, with coarse, angular pieces of basalt, quartz grains.
1805-1830	Basalt; brownish black, hard, aphanitic.
1830-1915	Shale; light gray, tuffaceous, with subrounded fragments of basalt, quartz grains, and feldspar, some white ash, some pyrite.
1915-1925	Basalt; brownish black, hard, aphanitic.
1925-1940	Shale; clayey, tuffaceous, subangular pieces of grayish black and pinkish gray basalt.
1940-1950	Basalt; grayish black and brownish black, some calcite.
1950-1970	Shale; medium greenish gray, scattered pieces of quartz and feldspar.
1970-2010	Shale; light gray, hard, limy, slightly tuffaceous.
2010-2150	Sandstone; dark gray, coarse grained, tuffaceous, silty, friable, some thin interbeds of tan-colored tuff and brick-red shale.

2150-2160	Shale; green and greenish black, partly altered basalt.
2160-2235	Basalt; brownish black, microcrystalline, lower portion of flow containing chert-filled cavities and quartz veining.
2235-2265	Tuff; medium gray, firm, and some greenish-gray shale.
2265-2350	Basalt; grayish black, hard, aphanitic.
2350-2370	Tuff; dark gray, some brick-red shale.
2370-2400	Basalt; grayish black, partly weathered, hard.
2400-2605	Basalt; black, unweathered, aphanitic, hard.
2605-2635	Basalt; medium gray, hydrothermally altered, quartz veining.
2635-2695	Tuff; brick red to pinkish red, fine to medium grained, quartz and some feldspar.
2695-2740	Sand; medium gray, medium grained, composed of subangular grains of quartz and feldspar.
2740-2780	Basalt; grayish black, partly altered.
2780-2820	Sandstone; medium gray, fine to medium grain, hard, feldspathic, cemented with lime, some quartz and basalt fragments, some pyrite.
2820-2850	Sand; whitish, medium grained, loose, feldspathic, some mica, fairly uniform.
2850-2920	Siltstone; medium gray, sandy, tuffaceous, some pyrite, thin layers of shiny black coal.
2920-2965	Sand; whitish, fine to medium grained, composed of subangular grains of feldspar and quartz, friable, some mica. Gas shows on mud logger.
2965-2980	Shale; black,carbonaceous and layers of coal.
2980-2990	Siltstone; medium greenish gray, hard, tuffaceous.
2990-3070	Sandstone; light gray, hard, tuffaceous, feldspathic, some mica.
3070-3280	Sand; whitish, fine grain, friable to firm, micaceous, composed of quartz and feldspar. Slightly oil stained(?). Subangular grains. Thinly interbedded carbonaceous shale and coal layers. Gas shows on mud logger.
3280-3295	Altered basalt; greenish gray and rust-red volcanic rock.
3295-3305	Basalt; grayish black, microcrystalline.
3305-3310	Altered basalt; dark grayish green and some pinkish-red volcanic rock.
3310-3415	Sand; whitish, friable, fine grain, composed of feldspar, quartz, and scattered pieces of volcanic rock. Some thin interbeds of coal and black shale. Some layers of pumice and ash. Sand is somewhat micaceous in portions of the section.
3415-3430	Basalt; and altered volcanic rock.
3430-3655	Sand; light gray, fine grain, loose, slightly micaceous, composed of feldspar and quartz. Some scattered small pieces of volcanic rock. Many thin interbedded coal seams.
3655-3770	Shale; dark gray, silty, hard with interbeds of whitish fine grain, firm sandstone, partly cemented with lime.
3770-3825	Sandstone; whitish, firm, fine grain, partly cemented with lime, subangular grains of feldspar and quartz. A fair amount of volcanic fragments. Some thin coal layers.
3825-3855	Siltstone; medium gray, firm to hard, fine sandy, limy. Few scattered small mica flakes.
3855-3885	Sandstone; whitish, silty, firm, partly cemented with lime, fairly abundant mica and abundant pieces of serpentinized basalt.
3885-3965	Siltstone; medium gray, somewhat calcareous, firm, and muddy gray tuffaceous shale.
3965-3990	Sandstone; medium gray, fine silty. Good gas show on mud logger.
3990-4010	Gabbro(?); dark gray.
4010-4135	Volcanic rock; pinkish red, altered. Light green and gray, firm, tuffaceous shale.
4135-4250	Altered volcanic rock; light greenish gray, hydrothermal alteration, quartz veining.
4250-4260	Crystal tuff; whitish gray, feldspar and pyroxene.
4260-4295	Tuff; light to medium gray, firm to hard.
4295-4380	Altered volcanic rock; medium gray, hydrothermally altered.
4380-4490	Shale; medium gray, silty, tuffaceous. Some brick red pyroclastic, some white ash. Thin layer of whitish, fine sandstone.
4490-4510	Altered volcanic rock; greenish gray, hard.
4510-4585	Tuff; medium gray to gray, hard, some tuffaceous shale and brick-red shale.
4585-4630	Lithic tuff; andesitic, medium to dark gray, some grayish green, some with quartz-filled cavities.
4630-4875	Altered volcanic rock (andesite?); dark greenish gray and dark brownish gray, altered basalt. Some pinkish and greenish altered volcanic rock with zeolite.
4875-5005	Volcanic agglomerate; brownish black basalt, pink and greenish altered volcanic rock, secondary quartz, some zeolite. Good gas shown on mud logger.

5005-5030	Siltstone; dark gray, micaceous.
5030-5120	Basalt; grayish black, weathered, some quartz and zeolite.
5120-5190	Basaltic conglomerate; and medium grain, silty, angular basaltic sand.
5190-5205	Shale; brownish black, with small subrounded pieces of basalt scattered throughout.
5205-5725	Volcanic agglomerate and conglomerate; brownish black, weathered basalt, greenish dark gray, pinkish gray altered volcanic rock, hydrothermally altered. Occasional sulfide mineralization. Some zeolite veining. Some thin interbeds of tuffaceous siltstone.
5725-5915	Basalt; grayish black, portions partially altered showing quartz and calcite veining, a little zeolite, aphanitic, rare olivine. A few interbeds of tuffaceous shale, some thin coal seams.
5920-5935	Tuff; medium gray, firm.
5935-5965	Basalt; grayish black, altered, quartz and calcite veining.
5965-5980	Shale; dull black, hard, and dark greenish gray tuffaceous shale.
5980-6040	Basalt; grayish black altered, and dark greenish gray and pinkish gray altered volcanic rock with quartz and zeolite.
6040-6080	Tuff; greenish gray, hard.
6080-6340	Altered basalt and volcanic rock; as described above. Few interbeds of dark gray and reddish gray shale.
6340-6435	Basalt; grayish black, fair amount of zeolite. Some interbeds of red and green tuff.
6435-6460	Tuff and tuffaceous siltstone; pinkish dark gray, brownish red and greenish gray.
6460-6765	Basalt; brownish black, partially altered, with zeolite, some of the basalt being microcrystalline. A little interbedded pinkish-gray tuffaceous shale.
6765-6780	Shale; dark grayish red, hard.
6780-6980	Basalt; dark gray, partly altered, zeolitic. Some interbedded reddish-gray tuff. Gas shown on mud logger.
6980-7000	Shale; tuffaceous.
7000-8010	Basalt; grayish black, hard, alteration varies, some zeolite. Occasional beds of white ash. Also, beds of red tuff. Some quartz filling in the basalt.
8010-8588	Basalt; grayish black, hard, microcrystalline, less alteration than above, some quartz and calcite veining. Few zones of pinkish and reddish alteration. Occasional sulfide mineralization in quartz vein. Some zeolite. Some portions contain olivine. Gas show on mud logger, high pressure salt water.
Core No. 1	
8588-8595'	Basalt breccia; dark greenish gray, hard, fine grain, contains fragments of chloritized basalt. Partings with slickensides.
Core No. 2	
8595-8603 T.D.	Basalt; dark greenish black, dense, hard, chloritized.

RICHFIELD OIL CORPORATION
Barber No. 1

Section 23, T. 1 N., R. 1 W., Multnomah County, Oregon

Core Descriptions

0- 97'	Shale and boulders
97-181	Boulders, hard sand and basalt
181-681	Basalt
681-706	Basalt and shale
706-793	Basalt
793-865	Basalt and shale with hard streaks

Core No. 1 rec'y

865- 875' 10' 10'		Sand; firm, dull gray, fine-grained, fairly well sorted, silty, tuffaceous, thinly laminated, few red-colored grains, tight.
875-1801		Shale and silt with streaks of sand.
1801-2025'		Shale and sand.

Core No. 2 rec'y

2025-2035' 9'	3'	Sand; firm, dark grass-green, massive, fine to medium grained, consisting of pellets of basalt and a few small brick-red grains in bentonitic clay matrix, probably impervious and of volcanic origin.
	3"	Sand; ditto; but with abundant large gastropod and pelecypod shell fragments.
	2'9"	Sand; as in top of core with abundant large pelecypod impressions.
	2"	Sand; as in top of core with abundant large pelecypod fragments.
	2'10"	Sand; firm, dark green, massive, composed of black grains and pellets and lesser amounts of red grains in matrix of bentonitic clay; several small pelecypod impressions and of volcanic origin.

Core No. 3 rec'y

2035-2045' 9'	9'	Sand; as above; one fragment of large pelecypod.

Core No. 4 rec'y

2045-2055' 7'	5'	Volcanic sand; as above; with abundant large pelecypods at 2047' (3" thick bed) and 2049' (5" thick bed).
	2'	Volcanic sand; as above; but indicates breccia fragments of basalt up to ½" in length.

Core No. 5 rec'y

2055-2065' 10'	10'	Volcanic agglomerate; firm, dark green, sharp angular basalt fragments in matrix of impure bentonitic clay; clay contains streaks of white tuffaceous material.

Core No. 6 rec'y

2065-2075' 10'	10'	Same as above.

Core No. 7 rec'y

2075-2082' 6'	6'	Same as above.
2082-2534'		Sand and shale.
2534-2690'		Basalt, shale and conglomerate.
2690-2907'		Sand and shale.
2907-3080'		Shale, sand and conglomerate.
3080-3235'		Volcanic shale and conglomerate.

Core No. 8 rec'y

3235-3244' 9'	9'	Volcanic agglomerate; firm to hard, dark gray-green, massive, consisting mostly of dark green to black, finely crystalline angular fragments up to 1" of basalt in matrix of green muddy clay, and vitreous silica, and several light-gray veins of lime-silicate.

Core No. 9 rec'y

3244-3254' 4'	4'	Same as above.

Core No. 10 rec'y

3254-3264' 4"	4"	Same as above.

Core No. 11 rec'y

3264-3268' 0'	0'	No recovery.

Core No. 12 rec'y

3268-3278' 0'	0'	No recovery.

Core No. 13 rec'y		
3278-3289'	0'	0' No recovery.
Core No. 14 rec'y		
3289-3292'	0'	0' No recovery.
3292-3357'		Volcanic shale and conglomerate.
3357-3508'		Volcanic shale, basalt and conglomerate.
3508-3689'		Volcanic shale and agglomerate.
3689-3814'		Volcanic agglomerate.
Core No. 15 rec'y		
3814-3819'	2'	2' Volcanic agglomerate; broken and mixed-up fragments of brick-red, impure bentonitic clay and hard green volcanic agglomerate containing angular fragments of volcanic rocks. Core may consist of wall cuttings.
Core No. 16 rec'y		
3819-3820'	1'	6" As above, but may be wall cuttings.
		6" Basalt; hard, dark green, dense.
Core No. 17 rec'y		
3820-3823'	2'	2' Basalt; hard, dark green, dense, common small veins of white chalcedonic (?) silica.
Core No. 18 rec'y		
3823-3827'	1'	1' Basalt; as above.
Core No. 19 rec'y		
3827-3832'	1½'	1½' Basalt; as above.
Core No. 20 rec'y		
3832-3834'	1'	1' Basalt; as above.
Core No. 21 rec'y		
3834-3836'	2'	2' Basalt; as above.
3836-3861'		Basalt and agglomerate
3861-3904'		Basalt
3904-4211		Volcanic agglomerate

Core No. 22 rec'y		
4211-4218'	5'	5' Volcanic agglomerate; firm, olive-green, bentonitic with common chunks of white ash, veinlets of chalcedonic silica, and a few calcite veins.
Core No. 23 rec'y		
4218-4223'	4'	2' Same as above; several slickensides.
		2' Same as above; but firmer with several rose-colored chalcedonic silica veins.
Core No. 24 rec'y		
4223-4231'	8'	8' Andesite; hard, green, dense, veins of silica, scattered quartz.
Core No. 25 rec'y		
4231-4240'	6'	6' Same as above.
Core No. 26 rec'y		
4240-4250'	7'	7' Same as above.
Core No. 27 rec'y		
4250-4260'	4'	4' Same as above.
Core No. 28 rec'y		
4260-4265'	2½'	2½' Same as above.
Core No. 29 rec'y		
4265-4270'	4'	4' Same as above.
4270-4927'		Volcanic agglomerate and shale.
Core No. 30 rec'y		
4927-4937'	9'	6' Volcanic clay; dark red to blood red, firm, greasy.
		3' Basalt; hard, dark gray, vesicular, more dense than basalt cored above this depth.
Core No. 31 rec'y		
4937-4947'	10'	10' Basalt; hard, variegated green, gray and rusty brown, showing a few slickensides and white veins mostly vertical, one vertical fault contact of basalt and volcanic agglomerate.

Core No. 32 rec'y			
4947-4955'	4'	4'	Same as above.
Core No. 33 rec'y			
4955-4960'	2'	2'	Same as above.
Core No. 34 rec'y			
4960-4966'	2'	2'	Same as above.
Core No. 35 rec'y			
4966-4973'	1'	1'	Basalt; broken-up pieces.
4973-5237'			Volcanic agglomerate, basalt and shale.
Core No. 36 rec'y			
5237-5243'	3'	3'	Basalt; hard, black to green, dense and aphanitic.
Core No. 37 rec'y			
5243-5253'	6'	2'	Basalt; hard, gray, black, and green, dense, several white veins.
		4'	Basalt; hard, gray, black, green, and reddish-brown with rounded and elliptical inclusions of snow-white zeolites including natrolite.
Core No. 38 rec'y			
5253-5263'	7'	7'	Same as above, but with a few calcite veins.
Core No. 39 rec'y			
5263-5273'	2'	2'	Basalt; hard, black, dense and aphanitic.
Core No. 40 rec'y			
5273-5276'	2½'	2½'	Same as above.
5276-5745'			Volcanic agglomerate.
Core No. 41 rec'y			
5745-5748'	2'	2'	Basalt; hard, black, dense.
Core No. 42 rec'y			
5748-5750'	1'	1'	Same as above.
Core No. 43 rec'y			
5750-5751'	1'	1'	Same as above.
Core No. 44 rec'y			
5751-5753'	1'	1'	Same as above.
Core No. 45 rec'y			
5753-5754	1'	1'	Same as above.
Core No. 46 rec'y			
5754-5755'	1'	1'	Same as above.
5755-5899'			Volcanic agglomerate.
Core No. 47 rec'y			
5899-5909'	7'	7'	Volcanic agglomerate; hard, green, angular basalt fragments up to 1 inch; few slickensides and white veins, matrix olive green, and aphanitic.
Core No. 48 rec'y			
5909-5919'	1'	1'	Same as above.
Core No. 49 rec'y			
5919-5929'	1½'	1½'	Same as above.
Core No. 50 rec'y			
5929-5939'	3'	3'	Same as above.
Core No. 51 rec'y			
5939-5949'	½'	½'	Same as above.
5949-6680'			Volcanic agglomerate.
Core No. 52 rec'y			
6680-6690'	9'	9'	Volcanic agglomerate; intermixed and poorly bedded; 1) hard olive-green volcanic agglomerate with sharp, angular pieces of basalt in matrix of grayish-green impure bentonitic clay; 2) dark gray volcanic agglomerate consisting mostly of hard shale with small fragments of basaltic debris showing several slickensides.

Core No. 53 rec'y			
6690-6697'	2'	1'	Volcanic breccia; hard, dark green, numerous slickensides, chloritized, several veins of chalcedonic silica.
		1'	Basalt; hard, dark gray, dense.
Core No. 54 rec'y			
6697-6707'	9'	3½'	Basalt; hard, variegated red and gray.
		5½'	Same, but mostly gray-colored, one 1/32" thick vein of calcite.
Core No. 55 rec'y			
6707-6713'	6'	2'	Same as above.
		3'	Variegated red and green clay; some gouge, fragments of chloritized basalt.
		1'	Basalt; hard, green, several slickensides, several veins of chalcedonic silica.
Core No. 56 rec'y			
6713-6723'	6'	6'	Intermixed fragments of basalt and variegated green and red clay, possibly some gouge.
Core No. 57 rec'y			
6723-6731'	6'	2'	Fragments of basalt; chloritized basalt and gouge.
		4'	Basalt; hard, dark gray and green, several calcite veins and several slickensides.
6731-7517'			Volcanic agglomerate and basalt.
Core No. 58 rec'y			
7517-7527'	3'	3'	Andesite; hard, varicolored gray, red, and purple, dense, aphanitic, with many veins of calcite.
Core No. 59 rec'y			
7527-7537'	2'	2'	Same as above.
Core Nos. 60 & 61			
7537-7547'			Same as above. Recovered 3' each.
Core Nos. 62 & 63			
7547-7560'			Same as above. Recovered 4' each.
Core No. 64 rec'y			
7560-7565'	5'	5'	Same as above.
Core No. 65 rec'y			
7565-7570'	3'	3'	Same as above.
Core No. 66 rec'y			
7570-7575'	1'	1'	Same as above.
7575-7829'			Volcanic agglomerate.
Core No. 67 rec'y			
7829-7837'	1'	1'	Andesitic breccia; firm to soft, varicolored gray and red, angular fragments of andesite up to 1", common calcite veins.
Core No. 68 rec'y			
7837-7844'	6'	6'	Andesitic breccia; firm to friable, varicolored gray and red, angular fragments of andesite up to 1", common calcite veins, good evidence of flow structure showing dip of 80° between contacts of breccia and weathered breccia.
Core No. 69 rec'y			
7844-7851'	7'	7'	Same as above.
Core No. 70 rec'y			
7851-7859'	2'	2'	Same as above.
Core No. 71 rec'y			
7859-7867'	7'	7'	Red muddy clay; with fragments of andesite, a few calcite veins.
Core No. 72 rec'y			
7867-7877'	5'	4'	Red muddy clay; as above.
		1'	Andesite; hard, gray, finely crystalline.
Core No. 73 rec'y			
7877-7885'	3'	3'	Andesitic breccia; hard, portions fractured, common calcite veins.

RICHFIELD OIL CORPORATION

Weyerhaeuser No. 1
Sec. 31, T. 10 N., R. 8 W.
Pacific County, Washington

Core Descriptions - Driller's Log*

0 - 1008	Clay and clay silt: lost circulation at 305' - gravel?
1008 - 2022	Shale.
2022 - 2293	Sand and shale.
2954 - 3780	SIDEWALL SAMPLES:
2954	Clayey siltstone, dark gray, soft, apparently massive, no odor, stain, or fluorescence.
3010	Clayey siltstone, dark gray, firm but friable, massive, with very thin calcite veins, no odor, stain, or fluorescence.
3024	Clayey siltstone, dark gray, soft, massive, no odor, stain, or fluorescence.
3112	Siltstone, dark gray soft, ashy, with common pyrite, massive, no stain,odor, or fluorescence.
3128	Siltstone, dark gray, soft, very micaceous, massive, no stain, odor,or fluorescence.
3186	Claystone, dark gray, soft, ashy, massive, no stain, odor, or fluorescence.
3197	Claystone, dark gray, soft massive, no stain, odor, or fluorescence.
3355	Shale, dark gray, firm, appears to be bedded, no stain, odor, or fluorescence.
3728	Tuff, light gray, firm to hard, no stain or fluorescense, fleeting gas odor, very tight with what appears to be very low permeability.
3742	Ashy tuff, light gray, firm but brittle and easily friable, very tight with low permeability, no stain, odor, or fluorescence.
3751	Ash, light gray, soft, tight, no odor, stain, or fluorescence.
3769	Ash, light gray, soft, tight, no odor, stain, or fluorescence.
3775	Ash, light gray as above.
3777	Ash,light gray as above.
3780	Ash, light gray, soft, tight, no stain or fluorescence, but with very fleeting gas odor.

Core No. 1 rec'y

2293 - 2303	6'	6' Siltstone: dark gray, massive, firm, micaceous, 15°-20° dip on rough fracture surfaces.
2303 - 3265		Shale.
Core No. 2 3265 - 3275	6'	6' Siltstone: dark gray, finely micaceous, firm to hard, massive, but with few light-gray stringers of siltstone, dip 15°-17°, good. Top 4" is a light gray, firm claystone that shows a good 17° dip on contact. Top 3' of core is fractured and slickensided into pieces 1"-10" long. Dips on fractures vary between 20° and 60°.
3275 - 3820		Shale.

Core. No. 3

3820 - 3822	1'	1' Basalt: black, very fine grained, dense, some pyrite.
3822 - 3867		Hard shale and basalt.

* Richfield Oil Corp.

3867 - 3911		Hard sand, hard shale, and basalt.
3911 - 4084		Basalt.
4804 - 4145		Basalt and hard shale.
Core No. 4	rec'y	
4145 - 4156	4'	6" Fragments of siltstone and shale. 3' Siltstone: dark gray, hard, generally massive, fractured and slickensided, dip 36° on partings, bedding indistinct. 3" Claystone: medium gray, firm - very hard, bedding well defined by color variations, dip 30°-33°, good. 3" Sandy siltstone; grayish brown, friable, micaceous, with interbedded fine sand.
4156 - 4492		Hard shale.
Core No. 5	rec'y	
4492 - 4502	0'	No recovery.
4502 - 4719		Hard shale.
Core No. 6	rec'y	
4719 - 4729	8'	8' Claystone: dark gray, massive, hard, silty, pyrite common, dip 5°-10°, good. A 1" siliceous layer at 4722 gave a fleeting gasoline odor on fresh fracture. The claystone had an irregular pod of fine, gray, silty sandstone at 4721½'. Core had several vertical fractures and slickensides, some gas bled from core, no odor.
4729 - 5212		Hard shale.
5212 - 5740		Shale.
5740 - 5765		Hard shale.
Core No. 7	rec'y	
5765 - 5770	0'	No recovery.
Core No. 8	rec'y	
5770 - 5779	8'	8' Silty claystone: dark grayish brown, massive, hard, with tan concretions which are very hard and show a good 4°-7° dip. Fracture surfaces dip 0°-6°; three slickensided surfaces dip 45°. Few small megafossils and rare black plant remains.
5779 - 6015		Hard shale.
Core No. 9	rec'y	
6015 - 6025	6"	2" Sandy siltstone: medium gray, massive, micromicaceous, very firm. 4" Claystone: light brownish gray, dense, hard, flat. Dip indicated by thin silty streaks, slickensides dip 10°, calcite filled, one small pelecypod.
6025 - 6036		Hard shale.
6036 - 6204		Shale.
6204 - 6209		Hard shale.
Core No. 10	rec'y	
6209 - 6219	0'	No recovery.
6219 - 6368		Hard shale.
6368 - 6462		Shale.
Core No. 11	rec'y	
6462 - 6467	0'	No recovery.
Core No. 12	rec'y	
6467 - 6472	9'	9' Silty sandstone and sandy siltstone: light gray, very fine grained, poorly sorted, low permeability, hard, with rare glauconite grains. Individual beds (¼"-4" thick), lenses grayish brown, clayey siltstone, hard. Core is 80% light gray silty sandstone and sandy siltstone, 20% grayish-brown siltstone, dip 0°-3°, very good.

6472 - 6535		Clayey siltstone: dark gray, very firm, massive, micromicaceous.
6535 - 6548		Hard shale.
6548 - 6646		Sand and shale.
6646 - 6803		Hard shale.
Core No. 13		
6803 - 6810	rec'y 3'	3' Basalt: black, very fine grained, very hard, dense; fresh appearance.
6810 - 7003		Basalt.
7003 - 7034		Hard shale.
Core. No. 14		
7034 - 7039	rec'y 4"	3" Siltstone: dark gray, firm to hard, massive, micromicaceous. 1" Claystone: light grayish-brown, massive, very hard, calcareous cement.
7039 - 7219		Hard shale.
Core No. 15		
7219 - 7224	rec'y 5'	5' Sandy siltstone and silty claystone: thinly interbedded, sandy siltstone is greenish-gray with some glauconite. Silty claystone is brownish gray. Core is very hard, no permeability; dip 11°-18°, excellent.
7224 - 7253		Basalt.
7253 - 7458		Hard shale.
7458 - 7506		Shale and basalt.
7506 - 7577		Hard shale.
Core No. 16		
7577 - 7582	rec'y 3'	3' Claystone and sandy siltstone: finely interbedded. Claystone is grayish brown, massive, very hard, several low-angle slickensides with calcite filling. Sandy siltstone is grayish green, hard, stringers as much as ½", dip 8°, good. Spotty medium brown staining on calcite-filled slickenside, spotty golden fluorescence.
7582 - 7898		Hard shale.
Core No. 17		
7898 - 7903	rec'y 2'	2' Silty claystone: grayish brown, with very thin stringers of light-brown siltstone, dip 3°. Core is very hard.
7903 - 7959		Hard shale.
7959 - 8031		Shale.
8031 - 8080		Hard shale.
8080 - 8244		Shale.
Core No. 18		
8244 - 8249	rec'y 1'	Clayey siltstone: dark gray, hard, massive, fractured, fractures filled with calcite, some fractures slickensided. Dip 25°-30°, fair.
8249 - 8288		Shale.
Core. No. 19		
8288 - 8298	rec'y 4'	4' Sandy textured tuff: green lapilli tuff, fine grained, massive, no dip, zeolitic cement, abundant chlorite, altered? Scattered brick-red, microscopic volcanic fragments, greenish gray to light gray, microcrystalline volcanic rock, very tight, firm but friable, fractures filled with calcite. Core shows widely separated small patches of yellow fluorescence, some brown staining in calcite veins; parts of core bled a small amount of gas, no odor.

Core No. 20

	rec'y	
8298 - 8316	1½'	1½' Sandy textured tuff: as above described.

Core No. 21

	rec'y	
8316 - 8333	12'	12' Sandy textured tuff: greenish gray with zeolitic matrix, massive, medium to coarse grained, occasional calcite veinlets, hard to friable, tight, poorly sorted. No fluorescence, no cut.

8333 - 8421 Shale.

4106 - 8408 SIDEWALL SAMPLES:

4106	Sandy siltstone; gray, firm.
4136	Siltstone; dark gray, friable.
4384	No recovery.
4770	Siltstone; dark gray, firm.
4867	Siltstone; dark gray, firm.
6801	No recovery.
6863	Fragments; dark gray siltstone and calcite.
7566	Siltstone; grayish brown, very hard, fractured?
7596	No recovery.
7988	Siltstone; gray, ashy.
8080	Siltstone and claystone, gray, hard.
8250	No recovery.
8259	Ash and tuff; greenish gray, firm, fine sandy texture, very tight.
8275	Ash and tuff; greenish gray, firm, fine-medium sandy texture, very tight.
8306	No recovery.
8320	Same as sample at 8275'.
8355	Same as sample at 8275'.
8365	No recovery.
8374	Same as sample at 8355'.
8384	Same as sample at 8355'.
8396	No recovery.
8408	Siltstone, ashy, medium gray, firm.

8421 - 8450 Shale.

Core No. 22

	rec'y	
8450 - 8469	19'	19' Amygdaloidal basalt: altered, dark greenish gray, some brownish red, hard amygdules filled with zeolite, small amygdule of chlorite. Fractures filled with calcite, some brick-red volcanic fragments.

8469 - 8527 Shale.

Core No. 23

	rec'y	
8527 - 8548	21'	21' Amygdaloidal basalt: altered greenish gray, thin layers of brick-red tuff, dip fairly flat, large amygdules filled with zeolite, smaller amygdules of chlorite. Many calcite-filled fractures.

8548 - 8620 Shale.

Core No. 24

	rec'y	
8620 - 8642	3'	3' Amygdaloidal basalt: altered, weathered? Dark gray with reddish cast, fractured, fractures filled with calcite, amygdules of zeolite and chlorite.

Richfield Oil Corp. Weyerhaeuser No. 1 (cont.)

8642 - 8720		Shale.
Core No. 25		
8720 - 8736	rec'y 14'	14' Volcanic breccia: altered, dark gray, microcrystalline, dense, increase of brownish red fragments near bottom of the core. Occasional streaks of chlorite anygdules, between fragments.
8736 - 8802		Shale.
Core No. 26		
8802 - 8807	rec'y 2'	2' Altered basalt: greenish gray, altered, fractured, top 6" lined with zeolite and chlorite amygdules, entire core shows chloritization. Grades into a sandy textured tuff or breccia in bottom 1'.
8807 - 8959		Shale.
Core No. 28		
9041 - 9055	rec'y 12'	12' Basalt: dark gray to greenish gray, hard, amygdaloidal, in part brecciated, abundant amber-colored glass fragments, brick-red fragments, abundant euhedral olivine crystals, amygdules filled with zeolite and chlorite.

STANDARD OIL CO. OF CALIFORNIA

Hoagland I

Sec. 11, T. 7 N., R. 10 W.
Clatsop County, Oregon

Composite Sample Descriptions

0 - 250	Siltstone: medium gray, very firm, some light gray, fine sandy siltstone.
250 - 540	Shale: grayish tan, firm to hard, silty.
540 - 560	Sandstone(?): fragments of basalt, calcite, quartz, and feldspar; fine grained.
560 - 570	Siltstone: dark gray, tuffaceous.
570 - 660	Shale: light to medium gray, hard to firm and dark gray hard shale. Some thin seams of whitish silty limestone.
660 - 719	Shale: medium gray, hard, few fragments of basalt scattered throughout shale.
719 - 734	Core No. 1- Shale: medium gray, firm to brittle, silty with fairly common fossil fragments, some fine carbonaceous material, some thin interbeds of clayey sandstone, dip approximately 11°.
734 - 988	Shale: above described.
988 - 1000	Core No. 2 - Siltstone and claystone: medium greenish gray, firm to brittle, cross-bedded with a few streaks of silty fine sandstone.
1000 - 1020	Siltstone and claystone: as above described.
1020 - 1070	Mudstone and shale: medium gray, firm to brittle, silty.
1070 - 1083	Shale: medium gray, firm, silty; containing fragments of altered volcanic rock, some interbeds of hard, limy siltstone.

1083 - 1100	Core No. 3 - Siltstone and some sandstone: light gray, firm, slightly calcareous siltstone, micromicaceous, and some fine silty sandstone; porosity 22.6% and permeability 1 md. Dip 5° to 15°.
1100 - 1297	Siltstone and sandstone: as above. Few thin layers of firm silty limestone.
1297 - 1307	Core No. 4 - Silty sandstone, siltstone, and mudstone: pale greenish gray, firm, slightly calcareous, fine silty sandstone, feldspathic, some fossils, thinly bedded. Interbedded siltstone and claystone, hard to brittle, very thin beds, some fossils. Dip approximately 5°.
1307 - 1350	Silty sandstone, siltstone, and mudstone: as above.
1350 - 1445	Shale: medium gray, firm to very firm, silty.
1445 - 1512	Siltstone: pale greenish gray, hard, brittle, with interbeds of fine silty sandstone.
1512 - 1522	Core No. 5 - Silty sandstone: greenish gray, firm to very firm, feldspathic, some fossil fragments, with interbedded siltstone and mudstone.
1522 - 1690	Siltstone and silty sandstone: as above.
1690 - 1727	Shale and mudstone: medium gray, firm to hard, subconchoidal fracture.
1727 - 1737	Core No. 6 - Mudstone: medium gray, hard, some fossils, some pyrite, slightly calcareous. Two thin interbeds of silty, hard, coarse to medium grained graywacke. Dip approximately 5°.
1737 - 1805	Siltstone: medium gray, firm to hard.
1805 - 1971	Silty sandstone and siltstone: medium gray, firm to very firm, thinly bedded, some portions calcareous.
1971 - 1981	Core No. 7 - Mudstone and sandy siltstone: dark brownish gray, hard, faintly micromicaceous mudstone and greenish gray, firm to hard, tuffaceous, calcareous, tight, finely micaceous sandy siltstone. Average dip 5°.
1981 - 2183	Shale: medium gray, silty, hard, calcareous.
2183 - 2198	Core No. 8 - Mudstone and sandy siltstone: similar to core No. 7, except siltier and more fossiliferous, locally calcareous. Dip approximately 5°.
2198 - 2350	Shale: medium greenish gray, silty, hard, locally calcareous to shaly limestone.
2350 - 2408	Shale: dark gray, firm to very firm, not calcareous.
2408 - 2418	Shale and sandy siltstone: medium gray, hard, tuffaceous, locally calcareous. Dip approximately 5°.
2418 - 2653	Shale and interbedded sandy siltstone: as above.
2653 - 2663	Shale and interbedded sandy siltstone: as described in cores 7, 8, and 9. Occasional small areas of pyritization. Dip between 5° and 10°.
2663 - 2885	Shale and interbedded sandy siltstone: seam of hard, silty limestone 2820.
2885 - 2900	Coal: dull black, shaly.
2900 - 2904	Shale and siltstone: medium gray, hard.
2904 - 2914	Core No. 11 - Shale and interbedded siltstone: medium gray, as described in cores 7, 8, 9, and 10. Dips approximately 7° to 11°.
2914 - 3143	Shale: dark gray, silty, hard, brittle, locally calcareous, some small black fragments of carbonaceous material.
3143 - 3153	Core No. 12 - Sandy siltstone and some shale: similar to description of cores 7, 8, 9, 10, and 11. Dips 10° to 15°.
3153 - 3160	Sandy siltstone: as above.
3160 - 3175	Tuff shale: medium to light gray, firm with subangular grains of quartz and feldspar, some zeolite.
3175 - 3370	Shale and siltstone: medium to dark gray, firm to very firm, slightly tuffaceous siltstone.

3370 - 3393	Sandy siltstone.
3393 - 3400	Core No. 13 - Sandy siltstone: medium gray to dark gray, extremely fractured, some interbedded dark gray silty shale. No dips.
3400 - 3455	Siltstone and interbedded shale: medium gray, hard, slightly tuffaceous siltstone and dark gray, firm shale.
3455 - 3465	Core No. 14 - Siltstone: medium greenish gray, sandy, locally calcareous, some small scattered mica flakes, occasional thin laminae of partially pyritized carbonaceous material. Some thinly interbedded dark gray siltstone. Dip 15°. Calcite-filled fracture, dip 60°.
3465 - 3650	Siltstone: above described.
3650 - 3652	Mudstone.
3652 - 3662	Core No. 15 - Mudstone: medium to dark brownish gray, very firm, brittle, thinly bedded. Some thin interbeds of medium gray siltstone. Scattered fine carbonaceous material in mudstone, pyritization in thin laminae along bedding. Dip 15°.
3662 - 3844	Mudstone and siltstone.
3844 - 3852	Core No. 16 - Mudstone and siltstone: mudstone is dark brownish gray, contains rare fish scales and fragments of shells, rare foraminifera, some fine carbonaceous material, and in places is replaced by pyrite. Siltstone, medium gray, slightly calcareous, some carbon material. Dip 15°.
3852 - 4087	Mudstone and siltstone.
4087 - 4097	Core No. 17 - Mudstone: medium grayish brown, firm, brittle, thinly bedded. Some thin beds of light gray siltstone, showing slight cross-bedding. One smooth-surfaced vertical fracture. Carbonaceous material is fairly abundant. Few fish scales and shell fragments. Dip 10°.
4097 - 4328	Mudstone.
4328 - 4338	Core No. 18 - No recovery.
4338 - 4348	Core No. 19 - Mudstone: medium to dark brownish gray, hard, brittle, locally fossiliferous, streaks and small pods of carbonaceous material, streaks of pyritized carbonaceous material. Some thin streaks of light greenish-gray, hard, calcareous, tuffaceous sandy siltstone. Dip 8° to 10°.
4348 - 4490	Mudstone.
4490 - 4545	Shale: medium to dark gray, very firm, silty with layers of light gray silty limestone. Some tuffaceous shale with veinlets of calcite, zeolite, and quartz.
4545 - 4583	Mudstone.
4583 - 4587	Core No. 20 - No recovery.
4587 - 4790	Mudstone.
4790 - 4795	Core No. 21 - Mudstone: as described in core 19, except less fossiliferous; contains thin streaks of graywacke and tuff. Dip 10°.
4795 - 4860	Shale: medium to dark gray, very firm, with veinlets of calcite, some thin interbeds of medium greenish gray, hard, limy, tuffaceous, fine sandstone.
4860 - 4905	Shale: grayish black, hard, brittle.
4905 - 5048	Altered tuff: dark greenish gray, hard, brittle, veins and fillings of calcite and zeolite, some pyrite.
5048 - 5058	Core No. 22 - Altered tuff: as above, upper 3' of core is composed of dark gray to grayish black marl.
5058 - 5250	Altered tuff: as above described.
5250 - 5357	Basalt: dull black, part altered, zeolitic, very firm to hard, microcrystalline.
5357 - 5364	Core No. 23 - Basalt: medium to dark grayish green, hard, amygdules filled with calcite, zeolite, and

aragonite, some finely disseminated pyrite; basalt slightly altered.

5364 - 5370 Basalt: as above described.

5370 - 5388 Sandstone and mudstone.

5388 - 5398 Core No. 24 - Interbedded sandstone and mudstone: Sandstone is light gray, hard, micaceous, composed of subrounded fragments of basic minerals and feldspar, not calcareous. Mudstone is dark grayish black, hard, micromicaceous, carbonaceous, some pyrite. Dip 15°.

5398 - 5464 Sandstone and mudstone.

5464 - 5471 Core No. 25 - Interbedded sandstone and mudstone: Similar to core 24, except there is more mudstone. Contacts between sandstone and mudstone are dotted with small carbonaceous fragments. Fractures in the mudstone and sandstone are filled with calcite. Several yellow fluorescent spots on fracture surfaces at 5465 - 5470. Dip 10°.

5471 - 5492 Interbedded sandstone and mudstone: above described.

5492 - 5550 Basalt: dullish black, partly altered, with veining and fillings of zeolite and calcite; very firm to hard.

5550 - 5600 Shale: grayish black, firm, shale.

5600 - 5772 Basalt: dullish black, altered basalt, with zeolite- and calcite-filled seams and amygdules.

5772 - 5781 Core No. 26 - Basalt: dark greenish gray, hard, finely crystalline, some pyrite.

5781 - 6269 Basalt: as above described.

6269 - 6281 Core No. 27 - Felsite: medium gray, hard, numerous small dark spherulites, some pyrite, some calcite.

6281 - 6310 Felsite: as above described.

6310 - 6410 Altered basalt: and some interbeds of dark gray shale.

6410 - 6420 Core No. 28 - Basalt: dark greenish black, amygdaloidal, zeolite filling, microcrystalline, hard.

6420 - 7101 T.D. Basalt: dark gray to black, zeolitized, microcrystalline, local pyritization. Some thin interbeds of dark gray, silty shale and graywacke.

TEXACO, INC.

Clark & Wilson 1

Section 19, T. 6 N., R. 4 W.
Columbia County, Oregon

Composite Sample and Core Descriptions

30'	15%	Siltstone; yellowish brown, iron stained.
	85%	Siltstone; light gray, firm and friable, fine sandy, slightly tuffaceous.
120	30%	Sandstone; whitish, firm-friable, fine silty, with scattered medium-coarse pieces of rounded chert.
	70%	Sand; dark gray, loose, medium grained, composed of dark brownish gray and black chert(?).
215	100%	Siltstone; light gray, firm-friable, fine sandy.
305	100%	Sandstone; light gray, firm, fine, silty, sub-angular-subrounded grains of feldspar, quartz and mafic minerals, partially cemented with lime.
395	100%	Siltstone; light gray, firm, faintly calcareous.
485	100%	Siltstone; light gray, firm, fine sandy.
575	100%	Siltstone; light gray, firm, brittle, slightly tuffaceous.
665	100%	Siltstone; light gray, firm, fine sandy, slightly calcareous.

Core No.1	rec'y		
700- 710'	6'	6'	Shale; medium gray, very firm, silty, micromicaceous, some medium size sand grains, many fragments of shells, occasional foraminifera. Layers of well-cemented coarse tuffaceous sand, some glauconite?, some quartz and chalcedony, some included siltstone fragments in sand layers. Flat dip.

755'	15%	Shale; firm-friable, silty.
	85%	Siltstone; light gray, firm, very fine sandy, slightly calcareous.
840	100%	Siltstone; medium gray, crumbly, argillaceous.

Core No. 2	rec'y		
915- 926'	11'	11'	Siltstone; medium gray, firm, small fossil fragments abundant, micro-micaceous. Flat dip.

940	100%	Siltstone; light-medium gray, firm, slightly calcareous.
1030	100%	Claystone; medium gray, crumbly, silty.

Core No.3	rec'y		
1103-1113'	9'	9'	Siltstone; medium gray, firm, fine sandy, micromicaceous, scattered shell fragments, common foraminifera, some ash 1105-1106'.

1130	100%	Shale; medium gray, firm, silty.
1220	30%	Siltstone; medium gray, firm, very fine sandy.
	70%	Claystone; dark gray, silty, crumbly.
1310	100%	Siltstone; medium gray, firm, friable, fine sandy, fairly calcareous.

Core No.4	rec'y		
1325-1335	10'	1½'	Siltstone; above, micromicaceous, locally calcareous, occasional coarse grains of basalt and quartz.
		1½	Siltstone; very firm limy, with black basalt grits.

		6	Siltstone; medium gray, firm, micromicaceous, fine sandy, few foraminifera, occasional fish scale, scattered small pieces of light gray ash.
1410		100%	Siltstone; medium gray, firm-very firm; fine sandy, slightly calcareous.
1500		25%	Sandstone; whitish gray, firm, fine silty, feldspathic, considerable amount of mafic mineral fragments, partially cemented with lime, fair permeability.
		75%	Shale; medium gray, firm - friable, silty, slightly calcareous.
Core No. 5	rec'y		
1548-1558	10'	10'	Siltstone; medium gray, firm, sandy, micromicaceous, some criss-crossing hairline fractures coated with black carbonaceous material and calcite, abundant shell fragments, occasional foraminifera, scattered light gray ash fragments.
Core No. 6	rec'y		
1558-1568	0	0	No recovery.
Core No. 7	rec'y		
1568-1574	6'	6'	Slough material.
1590'		100%	Siltstone; dark-medium gray, firm-friable, sandy.
1680		100%	Siltstone; light gray, fine sandy.
1770		30%	Siltstone; medium gray, firm.
		70%	Claystone; medium gray, crumbly, silty.
Core No. 8	rec'y		
1804-1814	10'	10'	Sandstone; medium gray, firm, silty, fine grained, somewhat micaceous. Dip nearly flat.
Core No. 9	rec'y		
1814-1818	4'	4'	Sandstone; above described, about 5% mafic minerals. No cut. A 3" zone of well-cemented conglomerate at 1816, ½" pebbles of quartz and acid igneous rock.
Core No. 10	rec'y		
1818-1819	1'	1'	Sandstone; fine-grained, ashy matrix, similar to above. No cut.
Core No. 11	rec'y		
1819-1824	5'	5'	Silty sandstone and siltstone; sheared material and drilling mud.
Core No. 12	rec'y		
1824-1829	3½'	3½'	Siltstone; dark gray, firm, sandy, ash fragments common, core sheared by coring.
1870		100%	Siltstone; medium gray, firm, fine sandy-very sandy.
1960		10%	Shale; brownish black, argillaceous with small pieces of weathered basalt.
		25%	Mudstone; dark brownish gray, silty, crumbly, some shell fragments, some white ash fragments.
		65%	Siltstone; light-medium gray, firm, fine sandy.
2005		100%	Siltstone; medium gray, firm, brittle, fine sandy, calcareous.
2090'		100%	Siltstone; light gray, very firm, faintly calcareous.
Core No. 13	rec'y		
2014-2024	10'	10'	Sandstone; dark gray, fine grained, firm-friable, micaceous, argillaceous, 10% mafic minerals, angular-subangular grains of feldspar, quartz and glass. No cut.
Core No. 14	rec'y		
2024-2029	5'	5'	Sandstone; medium gray, firm-friable, fine grained; micaceous, clayey matrix, has pinkish and purplish zones of coloration, dark brownish-black splotches of carbonaceous material. Low permeability. No cut.
Core No. 15	rec'y		
2029-2034	3'	3'	Sandstone; similar to above but slightly coarser, some glauconite.

Core No. 16	rec'y		
2034-2042	8'	8'	Sandstone; dark gray, firm, fine to medium grained, angular, composed of feldspar, quartz, mica, and glassy light green and black fragments - about 5% dark minerals, occasional rounded pieces of basalt. Claystone layers thinly interbedded with sandstone. Gas from core flashed with 4" flame. No cut.
Core No. 17	rec'y		
2042-2052	10'	10'	Sandstone; light gray, very firm, fine grained, feldspathic, angular-subrounded, 15% mafic minerals. Gas show on ditch in this interval, gas from core barrel gave a good flame. No cut.
Core No. 18	rec'y		
2052-2062	10'	10'	Sandstone; brownish, light gray, firm, slightly argillaceous, fine grained; slightly micaceous, feldspathic, 20% mafic minerals. No cut, no appreciable gas. Good permeability.
Core No. 19	rec'y		
2062-2072	9'	9'	Sandstone; as described above but few small shell fragments.
Core No. 20	rec'y		
2072-2076	4'	2'	Sandstone; gray, hard, fine-very fine, argillaceous, with irregular inclusions of hard black claystone.
		2'	Sandstone; gray, firm, micaceous, fine grained as in interval 2052-2072.
Core No. 21	rec'y		
2076-2082	5'	1'	Sandstone; dark gray, hard, fine grained, layers of coarse tuff fragments in clayey matrix, also pumice and glass.
		2'	Sandstone; gray, firm, very fine grained, silty, slightly micaceous, some carbonaceous fragments, few coarse basalt fragments.
		2'	Siltstone; dark gray, friable, slightly micaceous, sandy.
Core No. 22	rec'y		
2082-2085	1½'	1½'	Claystone; firm, silty, briny at bottom.
2180'		100%	Siltstone; whitish, friable, calcareous.
Core No. 23	rec'y		
2242-2252	1½'	1½'	Sandstone; light gray, firm - very firm, fine grained, silty, slightly micaceous, considerable amount of glassy material, occasional pink or red volcanic fragment, locally cemented with lime.
2260		100%	Siltstone; light gray, crumbly, argillaceous, fine sandy, some micromicaceous, calcareous.
2335		35%	Siltstone; as described above.
		65%	Shale; medium gray, firm silty.
Core No. 24	rec'y		
2340-2348	3'	0.7'	Sandstone; medium gray firm, fine-very fine-grained, micaceous, common mollusk remains, occasional pyrite-filled foraminifera cast, bedding 15°-poor, fracture plane 60°.
		1.3'	Claystone; friable, fine sandy, micaceous, locally limy.
		1.0'	Sandstone; as described above, criss-crossing fractures 45° and 50°.
Core No. 25	rec'y		
2348-2358	1.5'	1.5'	Shale; medium-dark gray, firm, foraminifera abundant, micromicaceous, few echinoid spicules?
Core No. 26	rec'y		
2358-2363	3'	3'	Siltstone; medium gray, firm, micromicaceous; gas from core barrel flashed with 3" flame. Good foraminifera.
2420		100%	Claystone; medium gray, friable, with occasional coarse grains of feldspar.
Core No. 27	rec'y		
2464-2475	0	0	No recovery.
Core No. 28	rec'y		
2475-2481	10.5'	10.5'	Siltstone; medium gray, very firm, shaly, micromicaceous, tuffaceous, abundant foraminifera and mollusk fragments. Gas from core flashed with an 8" flame.

Core No.	rec'y		
2481-2491	10'	10'	Claystone; dark gray, firm, silty, micromicaceous, abundant foraminifera and mollusk fragments, sponge spicules, pelecypods, crab and scaphopod remains.
2505		15%	Claystone; described above.
		85%	Siltstone; light-medium gray, firm, brittle, few mica flakes.
2580		35%	Shale; medium gray, crumbly, silty - slump material?
		65%	Siltstone; light gray, firm, slightly calcareous.
2655		100%	Siltstone; as described above.
2730		100%	Claystone; dark gray, firm, brittle.
2805		100%	Claystone; as described above.
2880		100%	Claystone; as described above, some inclusions of dark gray silty shale - slump material?
2940		40%	Claystone; as described above.
		60%	Shale; medium gray, firm, silty, fairly limy.
Core No. 30	rec'y		
2992-3002	5'	5'	Siltstone; medium gray, very firm, micromicaceous, good foraminifera and scattered fish scales.
Core No. 31	rec'y		
3002-3012	10'	10'	Siltstone; medium-dark gray firm-tough, micromicaceous, fragments of gastropods and pelecypods, some small pyrite crystals.
3030		30%	Siltstone; whitish, very firm, slightly tuffaceous, calcareous.
		70%	Shale; medium-dark gray, silty, firm.
Core No. 32	rec'y		
3064-3074	10'	10'	Sandstone; medium-gray, firm-friable, very micaceous, angular-subangular grains, feldspathic, somewhat argillaceous, streaks of biotite and carbonaceous material, very thin coal seams. No cut. Fair permeability.
Core No. 33	rec'y		
3074-3084	10'	3'	Sandstone; as described above.
		3'	Siltstone; medium-dark gray, sandy.
		4'	Sandstone; as described above.
Core No. 34	rec'y		
3084-3094	10'	10'	Sandstone; whitish-gray, friable - firm, micromicaceous, somewhat silty, fine, feldspathic, subangular, approximately 15% mafic minerals, excellent permeability.
Core No. 35	rec'y		
3094-3104	10'	10'	Sandstone; as described above.
Core No. 36	rec'y		
3104-3114	10'	10'	Sandstone; as described above, 3' limy layer at 3105-3108'.
Core No. 37	rec'y		
3114-3124	10'	6'	Sandstone; as described above; no lime, however.
3155'		100%	Sandstone; as described above; some portions quite silty.
3200'		100%	Siltstone; light-medium gray, hard, calcareous.
Core No. 38	rec'y		
3211-3221	10'	0.5'	Siltstone; dark brown - dark gray, micromicaceous.
		9.5'	Sandstone; light gray, friable, fine - medium grained, feldspathic, micaceous, approximately 10% mafic minerals. Core had a strong sulfurous odor. No cut.
Core No. 39	rec'y		
3221-3231	10'	10'	Sandstone; as described above but firmer, 1' lime layer at 3230'. Core flashed a 2' flame. No cut.
Core No. 40	rec'y		
3231-3241	10'	10'	Sandstone; light gray, friable - crumbly, fine-medium grained, angular - subrounded, feldspathic, micaceous with woody and other carbonaceous material. Good flash from core. No cut. Sulfurous odor as before.

3280		50%	Shale; dark gray, firm.
		50%	Siltstone; light gray, firm, fine sandy.
Core No. 41	rec'y		
3282-3292	10'	10'	Sandstone; light gray, firm - friable, feldspathic, micaceous, fine grained, approximately 15% mafic minerals, occasional olivine (?) crystal fragments. Some thin, hard limy layers, some carbonaceous fragments. No flash, faint sulfurous odor.
Core No. 42	rec'y		
3292-3302	10'	4'	Siltstone; medium gray, fine, sandy with thin layers of fine sandstone. Dip 4°.
		6'	Sandstone; light - medium gray, firm, feldspathic, micaceous, 15-20% mafic minerals, thin layers of dark minerals and comminuted carbonaceous material, dip nearly flat.
Core No. 43	rec'y		
3302-3312	10'	10'	Sandstone; whitish-gray, friable - firm, fine-grained, somewhat silty, feldspathic, subangular, approximately 15% mafic minerals. Excellent permeability. No cut.
3360'		100%	Limestone; grayish white, firm - friable, sandy.
3435'		25%	Siltstone; whitish gray, friable, tuffaceous, calcareous.
		75%	Shale; dark gray, firm.
3510'		25%	Claystone; dark brownish gray, firm, brittle.
		75%	Siltstone; whitish gray, very fine sandy, calcareous.
3585'		100%	Sandstone; white, loose - friable, clean, feldspathic, subangular, slightly micaceous. Appears to have excellent permeability.
3645'		40%	Siltstone; light gray, very fine sandy, firm.
		60%	Sandstone; light gray, friable, medium grained, feldspathic, slightly micaceous. Approximately 5% mafic minerals, subangular. Very good permeability.
Core No. 44	rec'y		
3664-3674	0'	0	No recovery.
Core No. 45	rec'y		
3674-3684	0'	0	No recovery.
Core No. 46	rec'y		
3684-3686	2'	2'	Siltstone; medium - dark gray, firm, fine sandy, micaceous, bentonitic, with angular pieces of glass, sand grains, white ash or pumice and scattered pieces of carbonaceous material.
Core No. 47	rec'y		
3686-3696	5'	5'	Siltstone; as described above, dip 3 - 5%.
3725		10%	Shale; dark gray, firm.
		90%	Siltstone; light gray, firm, fine sandy, slightly calcareous.
3800'		100%	Claystone; medium - dark gray, crumbly, silty.
3870'		100%	Shale; medium gray, firm, silty.
3945'		15%	Claystone; medium brownish gray, crumbly, silty.
		85%	Siltstone; medium brownish gray, slightly micaceous, firm.
4015'		100%	Shale; brownish black, firm - friable, silty, argillaceous.
Core No. 48	rec'y		
4050-4058	8'	2'	Siltstone; as described above.
		6'	Tuff; gray-black, water-laid hard, composed of feldspar, quartz, glass, pumice basalt and red, brown and green altered tuff fragments.
Core No. 49	rec'y		
4058-4068	10'	10'	Tuff; as above described. Dip on contact 2° - 10°.
Core No. 50	rec'y		
4068-4078	9'	9'	Siltstone; dark grayish black, hard, micro-micaceous, few shell fragments, high angle-vertical fracture planes, coated with calcite.

Core No. 51	rec'y		
4080-4086	3.5'	3.5'	Siltstone; medium gray, firm, micaceous, ashy, scattered coarse pieces of dark-colored tuff.
4100'		100%	Shale; medium gray, firm, silty.
4175'		100%	Siltstone; light gray, firm, fine sandy micro-micaceous, calcareous.
4250'		100%	Siltstone; as above described.
4325'		100%	Shale; medium - dark gray, firm silty, slightly calcareous.
4400'		10%	Shale; black, firm.
		90%	Siltstone; medium gray, friable, sandy with scattered medium-size pieces of feldspar, basalt, and quartz.
Core No. 52	rec'y		
4403-4412	3.5'	1.5'	Tuff; medium-dark gray, very firm, slightly micaceous, ashy matrix, scattered pieces of altered volcanic material, glass, pumice, and basalt, slightly calcareous.
		2.0'	Siltstone; medium-dark gray, fractured, tuffaceous, fractures filled with calcite.
Core No. 53	rec'y		
4412-4418	5'	5'	Basalt breccia (?); altered, core badly broken, cut by many veins of calcite.
Core No. 54	rec'y		
4418-4423	5'	5'	Basalt; dark gray, hard, aphanitic, small round amygdules of zeolite and calcite.
Core No. 55	rec'y		
4423-4433	10'	10'	Basalt; dark gray-black, hard, aphanitic-microcrystalline, few small zeolite and calcite-filled amygdules.
Core No. 56	rec'y		
4433-4435	0'	0'	No recovery.
4480'		100%	Siltstone; dark brownish gray, friable.
4545'		100%	Shale; hard, compact, calcareous.
4595'		15%	Shale; above described.
		85%	Siltstone; whitish gray, friable - firm, fine sandy.
Core No. 57	rec'y		
4600-4606	6'	6'	Siltstone; light gray, friable, fine sandy, some thin interbeds of claystone; one high-angle fracture filled with calcite.
Core No. 58	rec'y		
4606-4616	10'	10'	Siltstone; light gray, firm, sandy, tuffaceous, moderately micaceous, locally calcareous.
Core No. 59	rec'y		
4616-4619	0'	0'	No recovery.
4680'		100%	Siltstone; medium gray, firm, slightly tuffaceous, slightly calcareous.
4740'		30%	Tuff(?); grayish black, very firm, some micro-biotite flakes.
		70%	Siltstone; medium - light gray, firm.
Core No. 60	rec'y		
4747-4757	10'	7'	Basalt; (core broken) greenish black, aphanitic, few small amygdules of calcite and zeolite.
		3'	Siltstone; hard, ashy.
Core No. 61	rec'y		
4757-4760	3'	0.3'	Basalt; as above described.
		2.7'	Sandstone; light gray, hard, fine, tuffaceous, finely micaceous. Several high-angle fractures; fracture planes coated with green chloritic material.
Core No. 62	rec'y		
4760-4771	8'	8'	Sandstone; medium gray, hard, occasional thin layers of dark gray siltstone, slightly micaceous, angular to subangular, tuffaceous, fragments of vari-colored tuff, basalt, and mafic minerals. High angular fractures, often filled with calcite or chlorite. Dip 8°-10°, poor. No cut.

Core No.	rec'y			
4771-4774	3'	3'		Sandstone and siltstone; dark brownish gray tuffaceous, hard, fairly abundant bits of carbonaceous material, micromicaceous.
4820'			40%	Basalt; dark gray-black, firm, altered, many veins of calcite, some olivine.
			60%	Siltstone; medium gray, firm, slightly tuffaceous.
4895'			100%	Siltstone; as described above.
4970'			20%	Shale; light - medium gray, firm, silty, tuffaceous with subangular pieces of black basalt.
			80%	Shale; light - medium gray, firm, silty.
Core No. 64	rec'y			
5102-5112	0.3'	0.3'		Basalt and breccia; remainder of core not recovered.
Core No. 65	rec'y			
5112-5122	5'	5'		Breccia; green, reddish brown, black pieces of volcanic rock cut by numerous calcite veins.
5135'			15%	Siltstone; medium - light gray, firm.
			85%	Basalt; black and brownish black, partially altered basalt, calcite veining.
5210'			100%	Basalt; dark grayish black, altered, very firm - crumbly, with zeolite and calcite.
5280'			30%	Siltstone; medium gray, firm.
			70%	Basalt; as described above, microcrystalline, some olivine.
5355'			40%	Siltstone; medium gray, firm, slightly tuffaceous.
			60%	Basalt; as described above.
5425'			15%	Siltstone; as described above.
			85%	Basalt; dark grayish black, partly altered, microcrystalline, some calcite veining.
5500'			35%	Siltstone; as described above.
			65%	Basalt; dark grayish black, very firm, partly altered as described at 5425'.
5575'			30%	Andesite; medium gray, hard, fine anhedral pyroxene?
			70%	Basalt; brownish black, as described above.
5650'			40%	Siltstone; brownish black, hard, microbiotite.
			60%	Basalt; as described above.
5725'			100%	Basalt; brownish black, as described.
5800'			20%	Siltstone; medium - light gray, firm, slightly calcareous.
			80%	Basalt; black, very firm, partly altered, considerable amount of calcite.
5875'			40%	Siltstone; brownish gray, firm, slightly tuffaceous.
			60%	Basalt; as described above.
5950'			100%	Basalt; brownish-black, very firm, partly altered, microcrystalline, cut by many calcite veins.
Core No. 66	rec'y			
6017-6023	2'	2'		Siltstone; medium gray, hard, tough, sandy, slightly micaceous, with angular pieces of white, gray, and green tuff, ash and pumice. Basalt; few pieces in lower core barrel, greenish black aphanitic with olivine.
6115'			15%	Shale; black, very firm, silty.
			85%	Basalt; brownish black, hard, aphanitic - microcrystalline.
6195'			100%	Basalt; black and brownish black, hard, partly altered, occasional coarse euhedral phenocrysts of dark green olivine, some small calcite veinlets.
Core No. 67	rec'y			
6255-6265	4.5'	4.5'		Basalt; medium - dark greenish gray with phenocrysts of olivine, some pyroxene, fine - microcrystalline, several small hairlike calcite veins dipping 70°.

Core No.	rec'y			
6265-6275	10'	10'		Basalt; as described above.
6290'			100%	Basalt; as described above.
6355'			100%	Basalt; brownish blocky, waxy - dull, crumbly - firm, altered with some weathered olivine crystals.
6430'			100%	Basalt; black, firm - crumbly, altered with a considerable amount of calcite, some phenocrysts of olivine.
6505'			10%	Siltstone; medium - light gray, firm, slightly calcareous.
			90%	Basalt; black, firm - crumbly, altered with considerable amount of calcite, some olivine.
6580'			35%	Siltstone; as described above.
			65%	Basalt; dull - shiny black, very firm, altered, considerable amount of calcite.
6655'			100%	Basalt breccia; dark gray, altered, broken, with a considerable amount of calcite.
6730'			20%	Siltstone; medium gray, firm, slightly tuffaceous.
			80%	Basalt; dark gray-black, firm - crumbly, cut by calcite veins, some olivine crystals.
6820'			100%	Basalt; as described above.
6895'			100%	Basalt; as described above but firmer.
Core No. 69	rec'y			
6900-6910	2'	2'		Basalt breccia; green, red and brownish black, altered, broken, fractured, interstitial filling of chloritic material and fine material derived from brecciated lava.
6980'			30%	Siltstone; light gray, firm.
			70%	Basalt; black, very firm - hard, altered, some calcite.
7070'			20%	Siltstone; light - medium gray, firm.
			80%	Basalt; black and brownish black, firm - crumbly, altered, with numerous calcite veins.
7160'			100%	Basalt; black, hard, partly altered, with scattered euhedral phenocrysts of olivine and pyroxene, some calcite veining.
7235'			100%	Basalt; as described above.
Core No. 70	rec'y			
7248-7258	2'	2'		Basalt breccia; dark greenish black, fractured and sheared, chloritic material on fracture surfaces, fine interstitial material derived from basalt.
Core No. 71	rec'y			
7258-7268	2.5'	2.5'		Basalt porphyry; dark greenish gray, hard, with phenocrysts of olivine and pyroxene in an aphanitic groundmass, small segregations of calcite.
Core No. 72	rec'y			
7268-7278	1.5'	1.5'		Basalt porphyry; as described above.
Core No. 73	rec'y			
7278-7285	7.3'	7.3'		Basalt porphyry; as described above.
7325'			15%	Siltstone; light - medium brownish gray, firm.
			85%	Basalt; brownish black, partly altered, some phenocrysts of pyroxene and olivine, some calcite.
7400'			35%	Basalt; as described above.
			65%	Siltstone; medium brownish gray, slightly tuffaceous, firm.
7475'			20%	Basalt; dark brownish gray, crumbly, altered, some calcite.
			30%	Siltstone; light - medium gray, fine sandy, firm.
			50%	Andesite-basalt; medium gray, microcrystalline, hard.
7545'			30%	Siltstone; medium gray, firm, fine sandy, tuffaceous, micromicaceous.

		70%	Basalt; dark gray and brownish gray, partly altered; some quartz and calcite veining.
7620'		100%	Basalt; brownish black, hard, partly altered, some olivine and some calcite.
7700'		100%	Basalt; dark gray, hard, scattered small segregations of calcite.
Core No. 74	rec'y		
7719-7729	7'	7'	Siltstone; medium - dark gray, firm - hard, massive, sandy, argillaceous, micaceous, scattered grains of dark minerals, rare foraminifera, occasional calcite-filled fractures dipping 70°±.
Core No. 75	rec'y		
7729-7739'	6'	6'	Siltstone; similar to above, fine sandy, hard, massive, occasional small leaf or stem fragments, few scattered pieces of shells. A 2" limy sandstone layer at 7738', dip 15°.
Core No. 76	rec'y		
7739-7749	6'	6'	Siltstone; as described above but more fracturing.
7780'		40%	Shale; dark green, firm, silty, tuffaceous.
		60%	Basalt; black, altered, with calcite.
Core No. 77	rec'y		
7814-7824	6.5'	0.5'	Basalt breccia; or cavings?
		6'	Siltstone; dark brownish gray, hard, micromicaceous, some scattered ash and volcanic glass fragments. Few leaf or shell fragments.
Core No. 78	rec'y		
7824-7833	9'	2'	Siltstone; as described above, a 2" claystone band at 7826', dip 3°.
		2'	Sandstone; medium gray, hard, cemented with lime, micaceous feldspathic, considerable amount of ash and pumice fragments, dip 3°±.
		5'	Siltstone; as above.
7860		35%	Siltstone; medium gray, very firm - hard.
		65%	Basalt(?); dark brownish gray, very firm, altered, few scattered olivine crystals.
7920		25%	Sandstone; whitish, firm, very fine grained, feldspathic with subangular grains of mafic minerals, some fine mica.
		35%	Siltstone; dark gray, hard.
		40%	Basalt; dark grayish brown, firm, altered, waxy appearance on fractures, crystalline structure partly evident.
Core No. 79	rec'y		
7925-7935	4.5'	4.5'	Sandstone; medium gray, very firm - hard, massive, fine grained, feldspathic, micaceous, 15% dark minerals. No cut.
Core No. 80	rec'y		
7935-7945	5'	4'	Sandstone; as described above.
		1'	Claystone; dark gray - black, hard, massive, silty, micaceous.
Core No. 81	rec'y		
7945-7952	7'	0.3'	Siltstone; dark gray, hard, tough, slightly sandy, micromicaceous.
		6.7'	Basalt breccia; dark greenish gray, with calcite and fine material derived from basalt in the interstices.
Core No. 82	rec'y		
7952-7962	4'	3.7'	Basalt breccia.
		0.3'	Sandstone; similar to Core No. 80.
Core No. 83	rec'y		
7962-7972	1.5'	1.5'	Sandstone; light gray, firm, fine grained, micaceous, with 15% mafic minerals. No cut.
Core No. 84	rec'y		
7972-7982	2'	0.3'	Cavings.
		1.7'	Sandstone; medium gray, hard, tight, feldspathic, micaceous, fine grained, subangular, dark mineral approximately 25%, locally calcareous, few high-angle fractures filled with calcite. No cut.
Core No. 85	rec'y		
7982-7992	1.5'	1.5'	Sandstone; as in Core No. 84.

Core No.	rec'y		
7992-8000	1.5'	1.5'	Sandstone; as in Core No. 84.

Core No.	rec'y		
8000-8009	3'	3'	Sandstone; as in Core No. 84 but more dark minerals, especially biotite, dip 25° (may be cross bedding).

Core No.	rec'y		
8009-8019	3'	2'	Sandstone; as described above.
		1'	Siltstone; dark gray-black, firm, micromiceous, angular grains of mafic materials and quartz.

Core No.	rec'y		
8019-8024	5'	5'	Siltstone; dark gray, hard, tough, sandy, finely micaceous, scattered fine grains of feldspar, quartz, and mafic minerals, few shell fragments (mollusk and crab?). Mica mostly muscovite.

Core No.	rec'y		
8024-8034	0.2'	0.2'	Siltstone; as in core No. 89.

Core No.	rec'y		
8034-8044	3'	3'	Siltstone; as in Core No. 89 but slightly argillaceous, some poorly preserved foraminifera.

Core No.	rec'y		
8042-8052	10'	10'	Siltstone; dark gray-black, hard, micaceous, occasional shell fragments, parting 50°, some fracture planes coated with calcite. Dip 3°-4°, poor.

Core No.	rec'y		
8052-8062	10'	10'	Siltstone; as in Core No. 92. Dips 3°-6°, poor.

Core No.	rec'y		
8062-8072	10'	7'	Siltstone; as in Core No. 92.
		2'	Sandstone; medium gray, hard, massive, flattened pieces of pumice and volcanic ash, some calcite, occasional dark gray or black pieces of carbonaceous material.
		1'	Siltstone; as in Core No. 92, occasional high angle fractures.

Core No.	rec'y		
8149-8159	0'	0'	No recovery.

Core No.	rec'y		
8159-8169	6'	6'	Sandstone; light gray, firm to hard, micaceous, arkosic, poorly sorted, angular to subangular, fine grained. (Used oil-base mud below 8100') Dip 2°, fair, slight petroleum odor in inner portion of core, none on outside after mud washed off.

Core No.	rec'y		
8169-8175	6'	0.5'	Sandstone; firm to hard, tuffaceous, coarse pieces of basalt, ash, and pumice.
		5.5'	Sandstone; as in Core No. 96.

Core No.	rec'y		
8175-8180	3'	3'	Sandstone; as in Core No. 96, but harder.

Core No.	rec'y		
8180-8190	6'	6'	Sandstone; medium gray, hard, tight, fine grained, micaceous, arkosic, massive to poorly bedded, some high-angle calcite and quartz filled fractures, approximately 20% dark minerals, dip 6°, poor. No cut.

Core No.	rec'y		
8190-8200	10'	10'	Sandstone; as described above.

Core No.	rec'y		
8200-8208'	6.5'	5'	Sandstone; as described above but 30% dark minerals, locally calcareous.
		1.5'	Claystone; dark gray-black, silty, very hard, brittle, with common fractures and slickensided surfaces. Pyrite common in minute cracks.

Core No.	rec'y		
8208-8218'	10'	10'	Claystone; as described above. Locally tuffaceous; volcanic fragments and carbonaceous material, poorly preserved foraminifera?

Core No. 103 rec'y
8218-8228' 7'
1.5' Claystone; as described above.
4.5' Claystone; light gray, hard, silty, calcareous.
1.5' Claystone; as in Core No. 102.

Core No. 104 rec'y
8228-8238' 6'
2' Siltstone; medium to dark gray, hard, tough to brittle, massive - poorly bedded, locally calcareous, angular pieces of light-colored igneous rock.
1' Siltstone; light gray, tough, micromicaceous, scattered pieces of white ash and pumice.
3' Recovered fragments of siltstone above and some dense, gray, calcareous siltstone.

Core No. 105 rec'y
8238-8248' 2'
2' Claystone; black to grayish black, hard, dense, badly fractured, some carbonaceous material.

Core No. 106 rec'y
8248-8258' 7.5'
5.6' Claystone; above described, occasional carbonized stem and leaf fragments, pyrite. High and low angle fracturing 70° and 25°. Core badly fractured, some shearing.
1.4' Sandstone; light to medium gray, hard, dense, fine grained, silty, cemented with lime, massive. A few high-angle fractures. Lower 6" coarse to medium grained, tuffaceous.

Core No. 107 rec'y
8258-8263' 4.5'
4.5' Claystone; dark gray to black, hard, dense, badly fractured, massive to poorly bedded, few sandy stringers, dip 18°-25°, slightly micromicaceous.

Core No. 108 rec'y
8263-8271 7'
7' Claystone; as in Core No. 107, nearly vertical, hair-like fracture filled with calcite and quartz, slickensided surfaces in core, some carbonaceous material and pyrite, dip 3°-12°, poor.

Core No. 109 rec'y
8271-8278 7'
7' Claystone; as in Core No. 107, hard, fine-grained limey sandstone layer 8276-8277'. Contact dips 5-12°.

Core No. 110 rec'y
8278-8288 10'
10' Claystone; dark to medium gray, hard, silty, fairly well bedded, micromicaceous, some pyrite, some woody material, some very thinly interbedded calcareous sandstone layers, dips 8°-15°.

Core No. 111 rec'y
8288-8298 6'
1' Siltstone; light bluish gray, hard, tough, very calcareous, fractured and broken with calcite veinlets.
5' Claystone; dark gray-black, hard, silty, tough, massive to poorly bedded, numerous irregular fractures and slicksided surfaces.

Core No. 112 rec'y
8298-8303 1.5'
1.5' Recovered pieces of hard, calcareous siltstone and limy, hard to medium grained tuffaceous sandstone, high-angle calcite filled fractures common.

Core No. 113 rec'y
8303-8313 5.5'
5.5' Claystone; dark gray-black, hard, silty, badly fractured, micromicaceous, some fracture surfaces coated with calcite, some slickensides, few very thin sandy seams.

Core No. 114 rec'y
8313-8321 7.5'
2.5' Claystone; as described above, very thinly interbedded, light bluish gray, hard, ash fine-grained sandstone, dip 7°-8°, high angle fractures filled with calcite, low-angle slickensided shear surfaces.
1.3' Sandstone; light gray, hard, very fine grained partly calcareous lower portion contains pieces of ash and pumice.
3.7' Claystone; as at top of core.

Core No. 115 rec'y
8321-8331' 6.1'
6.1' Claystone; as above described.

Core No. 116 rec'y
8331-8332' 0
0 No recovery.

Core No.	rec'y		
8332-8334'	0	0	No recovery.
8334-8344'	10'	10'	Claystone; dark gray-black, hard, tough, silty, slightly micromicaceous, with thin interbeds of light gray claystone and fine-grained sandstone, few carbonized wood fragments, occasional foraminifera, dip 12°, good.
8344-8351'	2.5'	2.5'	Claystone; as in Core No. 118.
8351-8359'	8'	4'	Claystone; as in Core No. 118.
		4'	Siltstone; medium gray, hard, tough, limy, many calcite-filled high-angle fractures.
8359-8369'	3'	3'	Claystone; as in Core No. 118, both micromica and larger mica flakes (muscovite), some scattered dark mineral grains, common pyrite crystals.
8369-8379'	2'	2'	Basalt; greenish black, very hard, finely crystalline, feldspar and pyroxene, some olivine.
8379-8387'	8'	8'	Siltstone; dark gray to black, argillaceous, hard, poorly bedded to massive, very thinly interbedded light gray siltstone and fine sandstone. Some carbonized woody fragments, many steeply dipping fractures, commonly filled with calcite, pyrite fairly common, dip 5°±.
8387-8397'	9'	9'	Siltstone; similar to core No. 123.
8397-8399'	3'	3'	Siltstone; as above described.
8399-8409'	10'	2'	Siltstone; dark gray-black, hard, micromicaceous, carbonaceous material fairly abundant, poorly bedded to massive, argillaceous.
		7'	Sandstone; light gray, hard, tight, silty, very fine grained with a few thin layers of dark siltstone, some layers of pea-sized fragments of andesite, basalt, pumice, quartz, and bentonitic ash.
		1'	Siltstone; as in top 2'.
8409-8419'	0	0	No recovery.
8419-8425'	0	0	No recovery.
8425-8431'	0	0	No recovery.
8431-8441'	9'	9'	Siltstone; dark gray, hard, massive to poorly bedded, argillaceous, micromicaceous, thinly interbedded light bluish gray claystone and hard, calcareous silty sandstone. Many steeply dipping fractures filled with calcite. Minute faulting on some fractures, dip average 5°.
8441-8451'	5.5'	3'	Sandstone; light to medium gray, hard, silty, very fine grained, fairly limy, several steeply dipping calcite-filled fractures, slightly micaceous, some cross bedding.
		2.5'	Claystone; dark gray to black, hard, tough, massive to poorly bedded, slightly micaceous, dip 3°-5°, poor. Occasional woody material, stems or leaf fragments, as pyritized or carbonized casts and molds.
8451-8461'	10'	7'	Claystone and siltstone; dark gray-black, hard, tough, occasional light gray very thin sandy partings, slightly micaceous.

3' Claystone; as above, grades into light grayish gray, hard, fine-grained, slightly calcareous tuffaceous sandstone in last foot of core.

Core No. 133 rec'y
8461-8471' 3' 1' Tuff; light grayish tan, very hard, with 1/8" fragments of basalt, pumice and some chalcedony, calcareous.

1.3' Sandstone; light to medium gray, hard, locally calcareous, cross bedded, very fine grained, some steeply dipping fractures filled with calcite in bottom of core.

0.7' Siltstone and silty sandstone; medium to dark gray, hard, slightly calcareous, argillaceous.

Core No. 134 rec'y
8471-8479' 2.5' 1' Siltstone and silty sandstone; as described above.

0.5' Tuff; medium gray, hard, with angular quartz and ash, some pyrite.

1' Andesite-basalt; dark greenish gray, hard, finely crystalline, few phenocrysts of feldspar and mafic minerals. Few steeply dipping high-angle fractures which are filled with calcite.

Core No. 135 rec'y
8479-8490' 6' 6' Andesite-basalt; as described above.

Core No. 136 rec'y
8490-8500' 4.5' 4.5' Basalt; grayish black, hard, microcrystalline with some fine quartz and calcite veining.

TEXACO, INC.

Clatskanie 1

Sec. 36, T. 7 N., R. 4 W.
Columbia County, Oregon

Composite Core Descriptions

Core No. 1 rec'y
628- 638' 10' 10' Fine sand and argillaceous siltstone; light gray-greenish, fine, silty, micaceous, carbonaceous, well-sorted friable sand. Mafic minerals, black and green, fairly common. No odor or cut. Interbedded, mottled gray and light brown, highly micaceous and carbonaceous, argillaceous siltstone, firm to friable, no foraminifera evident. Good dips 14° to 19°.

Core No. 2 rec'y
638- 648' 10' 10' Fine sand and argillaceous siltstone; as described above.

Core No. 3 rec'y
648- 658' 10' 10' Fine sand and argillaceous siltstone; as described above. One 2" layer of hard calcareous sandstone.

Core No. 4 rec'y
730- 740' 9' 9' Breccia; dark grayish brown, silty, sheared mudstone with angular fragments of basalt, light to medium gray tuff, white pumice and fragments of pyroxene and olivine crystals. Slight oil odor, possibly due to contamination.

Core No. 5 rec'y
740- 750' 2' 2' Breccia; as described above.

Core No. 6 rec'y
750- 760' (fragments) Breccia; as described above.

Core No. 7 rec'y
760- 770' 3' 3' Breccia; brownish black, silty sheared shale with angular fragments of basalt.

Core No. 8 rec'y
770- 780' 3' 3'

Breccia; brownish black as described.

Core No. 9 rec'y
1005-1010' 1' 1'

Basalt porphyry; black, fine crystalline with euhedral phenocrysts of augite and olivine.

Core No. 10 rec'y
1143-1154' 2' 2'

Basalt porphyry; as above but sheared, fractured.

Core No. 11 rec'y
1154-1155' 3" 3"

Basalt porphyry; as above described.

Core No. 12 rec'y
1227-1237' 3' 3'

Siltstone; medium gray, very firm, some micromica, occasional foraminifera (Cyclammina) and fish scales, scattered pyritized and carbonized plant remains. Common fragments of pelecypods and gastropods (Dentalium). Bedding poor, 12° dip.

Core No. 13 rec'y
1237-1247' 3.5' 3.5'

Argillaceous siltstone and silty claystone; medium gray, firm, locally hard, calcareous, some fine sandy portions. Foraminifera common, some megafossils. Bedding poor. Dip 16°.

Core No. 14 rec'y
1247-1257' 10' 10'

Argillaceous siltstone and silty claystone; as described above, sheared, shear plane 10° ±. Bedding poor, dip 10-16°, some very fine mica flakes.

Core No. 15 rec'y
1257-1267' 10' 10'

Siltstone; light gray, very firm, some micromica, few pieces of elongate carbonaceous material, some foraminifera, one large crab fragment at 1265'; occasional shear fractures - slickensided. Some layers of pumice, ash and basalt. Dip 18-20°.

Core No. 16 rec'y
1267-1277' 10' 10'

Siltstone; medium gray, very firm, fine sandy, micromicaceous. Contact with grayish-black silty shale - 20-25°.

Core No. 17 rec'y
1277-1287' 10' 1½'

Silty claystone; dark gray, firm, organic, white ash fragments with brown staining.

8½'

Siltstone; light to medium gray, hard, tuffaceous, finely micaceous. Common fossil and plant remains, scattered foraminifera.

Core No. 18 rec'y
1287-1297' 7' 7'

Argillaceous siltstone and silty claystone; medium gray, very firm with common streaks and mottlings of light-gray fine sand, locally concentrations of volcanic grit.

Core No. 19 rec'y
1297-1307' 13' 13'

Sandstone; whitish gray, very fine grained, silty, micaceous, scattered small shell fragments -- poor permeability.

Core No. 20 rec'y
1307-1317' 12' 12'

Siltstone; light gray, firm, includes 1" streak of limestone with shaly laminae at 1313'. Reed fragments fairly common, dip 22°.

Core No. 21 rec'y
1317-1327' 9' 9'

Siltstone; light gray, firm to friable, finely micaceous, scattered black elongate pieces of reed and a few shell fragments. Shear zone at 1322-23'.

Core No. 22 rec'y
1327-1338' 12' 12'

Siltstone; light gray, very firm, finely micaceous, local thin layers of volcanic grits in yellowish clay. White limestone streak at 1337'.

Core No. 23 rec'y
1338-1349' 11' 11'

Shale; medium gray, firm, micromicaceous, irregular thin layers of organic material, some foraminifera, dip 8-10°, poor.

Core No. 24 rec'y
1349-1360' 11' 11'

Claystone; dark gray, hard, foraminifera fairly abundant, fracture irregular.

Core No. 25 rec'y
1360-1371' 7' 7'
Claystone; medium gray, firm, white ash fragments, finely micaceous, scattered fossil fragments, foraminifera, fish remains and pyritized carbonaceous material.

Core No. 26 rec'y
1371-1381' 5' 5'
Claystone; as above described.

Core No. 27 rec'y
1381-1391' 2' 2'
Claystone; as above described.

Core No. 28 rec'y
1391-1401' 12' 7'
Siltstone; brownish gray, hard, fine sandy, some mica, irregular thin laminae of carbonaceous material, small pieces of shell.
1' Tuff; fine, hard, composed of pieces of white ash, pumice and lava.
4' Silty claystone; brownish gray, very firm, tuffaceous. Burned with 6" flame when core barrel was opened. Mud carried free oil, possibly due to contamination. Faint acetone cut.

Core No. 29 rec'y
1401-1411' 3' 3'
Siltstone; medium gray, hard, tuffaceous, occasional weathered mica flakes.

Core No. 30 rec'y
1411-1421' 0' 0'
No recovery.

Core No. 31 rec'y
1421-1427' 4½' 4½'
Siltstone; dark brownish gray, hard, occasional coarse piece of vesicular basalt, occasional shell fragment. Dip 25°.

Core No. 32 rec'y
1427-1438' 4' 4'
Siltstone; dark grayish brown, hard, fine tuffaceous, locally thin layer of basaltic sandstone.

Core No. 33 rec'y
1438-1449' 10' 10'
Siltstone; grayish brown, very firm, tuffaceous, scattered leached fossil fragments, rare fish remains, common carboniferous material, occasional foraminifera. Dip 10-15°, fair.

Core No. 34 rec'y
1540-1551' 10' 10'
Sandstone; light gray, very firm, fine, fossiliferous, small black carbonaceous fragments, some foraminifera and scattered shell remains. Petroleum odor (sweet) ? No cut.

Core No. 35 rec'y
1551-1562' 0' 0'
No recovery.

Core No. 36 rec'y
1562-1573' 14' 11'
Siltstone; light to medium gray, very fine sandy, finely micaceous.
3' Sandstone; light gray, firm, very fine, feldspathic, micromicaceous, 10% mafic minerals, occasional shell fragment. No cut.

Core No. 37 rec'y
1573-1584' 9' 9'
Siltstone; light to medium gray, fine sandy, hard, some fine mica, occasional shell fragment.

Core No. 38 rec'y
1684-1696' 14' 14'
Shale; dark brownish gray, very firm, silty, micaceous (biotite), some fish remains, some foraminifera, common fragments of carbonaceous material.

Core No. 39 rec'y
1696-1708' 12' 12'
Shale; dull grayish brownish black, hard, subconchoidal fracture, micromicaceous, some foraminifera, tuffaceous layers at 1701-1703' and 1705-1706'. Dip 10-20°.

Core No. 40. Rec'y
1708-1720' 4' 4'
Shale; as above described, some megafossil remains. Dip 21-26°.

Core No. 41 rec'y
1820-1830' 4' 4'
Breccia; hard, sheared, black, basalt fragments in a fine shaly matrix; light gray micromicaceous tuff fragments, some zeolite, probably amygdaloidal material.

Core No. 42 rec'y
1830-1840' 3' 3'
Breccia; above described. Locally calcite veining.

Core No. 43 rec'y
1879-1889' 2' 2'
Breccia; above described, irregular veins and amygdules of calcite and zeolite.

Core No. 44 rec'y
1977-1989' 9' 8'
Shale; dark gray, very firm, silty, argillaceous, with pebble-size subrounded inclusions of black shale, some interbedded coarse argillaceous sandstone.
1'
Claystone; dark gray, firm, internally sheared, micromicaceous, some carbonaceous fragments, dip 25-30°.

Core No. 45 rec'y
1989-2001' 3' 3'
Siltstone; dark gray, firm, argillaceous, calcareous, coarse sandy, composed of subrounded coarse basalt grains.

Core No. 46 rec'y
2001-2013' 12' 12'
Conglomeratic siltstone; dark brownish gray, very firm, with subrounded pebbles of basalt, some inclusions of black carbonaceous material, occasional fragment of a megafossil, scattered broken pieces of augite.

Core No. 47 rec'y
2013-2025' 13' 13'
Conglomeratic sandstone; as above but sandstone matrix, small fragments of white ash.

Core No. 48 rec'y
2025-2037' 8' 8'
Siltstone; medium to dark gray, fine sandy, very firm, with many small shell fragments. Occasional fine veinlets of calcite. Dip 14-28°.

Core No. 49 rec'y
2037-2049' 0' 0'
No recovery.

Core No. 50 rec'y
2049-2061' 1" 1"
Sandstone; greenish-gray, firm to friable, silty, clayey. No staining, low permeability.

Core No. 51 rec'y
2124-2136' 7' 7'
Sandstone; light gray, friable, fine, fairly uniform, feldspathic, some mafic minerals, grains are subangular, occasional muscovite flake, good permeability. No staining, no cut. Dip 42°, good - may be cross-bedding.

Core No. 52 rec'y
2159-2170' 3½' 1½'
Sandstone; whitish gray, friable to very firm, argillaceous, micaceous, feldspathic, lignitic, occasional fossil fragments, scattered mafic minerals, good permeability. No cut, core burned with a 6" blue flame.
2'
Sandstone; whitish gray, firm to friable, some very firm, slight fetid or marsh-gas odor. Thin layers of claystone, bentonitic, containing fish scales and fossil fragments. Dip 35-37°, good.

Core No. 53 rec'y
2340-2352' 2' 2'
Sandstone; whitish gray, friable, fine, silty, feldspathic, fairly abundant mafic minerals, some micromicaceous, fair permeability. No odor, no cut, no stain.

Core No. 54 rec'y
2352-2354' 1½' 1½'
Limestone; dark gray, hard, silty to fine sandy.

Core No. 55 rec'y
2450-2462' 8' 8'
Siltstone; brownish-black, hard, tuffaceous, some fine mica.

Core No. 56 rec'y
2462-2474' 6' 6'
Siltstone; above described.

Core No. 57 rec'y
2510-2514' 4' 4'
Siltstone; dark grayish brown, tuffaceous fractured, fractures dip 45-53°, some calcite veining.

Core No. 58 rec'y
2622-2634' 12' 12'
Sandstone; whitish gray, firm, fine silty, feldspathic, scattered small flakes of weathered mica, some thin, irregular layers of

carbonaceous material, top $1\frac{1}{2}$' calcareous. No cut, no odor, few gas bubbles in mud sheath. Dips 35-45°, fair.

Core No. 59 rec'y
2634-2645' $8\frac{1}{2}$' $8\frac{1}{2}$'

Sandstone; light to medium gray, very firm, highly micaceous, mafic minerals fairly abundant, some thin, wavy bands of black shale. No stain or cut. Dip 32-35°, good.

Core No. 60 rec'y
2645-2656' 10' 10'

Sandstone; as described above.

Core No. 61 rec'y
2656-2667' $10\frac{1}{2}$' $\frac{1}{2}$'
10

Sandstone; as described above.
Lignitic claystone; dark brown, firm, with numerous black lignite seams and abundant carbonized plant remains, micromicaceous, silty. Dip 31-39°, good. Streak of white ash and pumice at 2665'.

Core No. 62 rec'y
2690-2698' 8' 8'

Sandstone; whitish, firm, fine, silty, feldspathic, considerable biotite, scattered grains of mafic minerals, calcareous, good permeability. Dip 20-40°, fair. No staining, no cut. One 80° calcite-filled fracture at 2695'.

Core No. 63 rec'y
2698-2710' 12' 12'

Sandstone; light gray, medium to coarse, silty, hard, calcareous, tuffaceous, composed of subangular to subround basalt and chert, locally lignitic. Dip 26-48°, fair.

Core No. 64 rec'y
2805-2817' 4' 4'

Sandstone and siltstone; interbedded, light gray, fine to very fine, very firm, micaceous sandstone and light gray fine sandy siltstone. Occasional irregular streaks of brown lignitic material. Brown claystone layer in middle of core. Dip 25°, good. No odor, no stain.

Core No. 65 rec'y
2817-2827' 10' 10'

Siltstone; medium gray, hard, tuffaceous, scattered small pieces of white ash, some micromica with lenses of brown claystone, locally calcareous. Dip 20°, fair.

Core No. 66 rec'y
2827-2839' $5\frac{1}{2}$' $5\frac{1}{2}$'

Siltstone; as described above.

Core No. 67 rec'y
2954-2966' 6' 6'

Sandstone; whitish, firm, silty, feldspathic, occasional weathered mica flake, interstices partially cemented with lime, some inclusions of black shale. Core shows numerous fractures, dip 36-44°, poor.

Core No. 68 rec'y
2966-2978' 4' 4'

Tuff; medium gray, hard, siliceous.

Core No. 69 rec'y
2995-2999' $3\frac{1}{2}$' $3\frac{1}{2}$'

Sandstone, siltstone, and claystone; light to medium gray, thinly bedded, lignitic, fractured, locally slump material or reworked. Dip 24-33°, fair.

Core No. 70 rec'y
3132-3143' 9' 9'

Basalt; black, hard, microcrystalline, few subhedral black pyroxene crystals, some olivine, some small pyrite clusters, fractured, fracture planes dip 50°$\pm$.

Core No. 71 rec'y
3143-3150' $6\frac{1}{2}$' $6\frac{1}{2}$'

Basalt; as described above, badly fractured, calcite veining common.

Core No. 72 rec'y
3334-3345' 9' 9'

Siltstone and silty shale; dark gray - black, hard, carbonaceous, tuffaceous, scattered fragments of megafossils, sponge spicules and foraminifera. A few calcite veins.

Core No. 73 rec'y
3395-3401' $6\frac{1}{2}$' 1'

Silty claystone; dark brown - dark gray, hard, thin-bedded, carbonaceous, micaceous, scattered fossil fragments and fish remains,

some foraminifera. Dip 18-22°, good.

5½' Breccia; medium to dark greenish gray, basaltic mixed with pumice, common phenocrysts of altered pyroxene and olivine, hard, some calcite veining.

Core No. 74 rec'y
3804-3816' 11' 11' Basalt; black, hard, aphanitic, some phenocrysts of augite and feldspar, some pyrite. Intercalated layers of tuff, fractured.

Core No. 75 rec'y
4336-4348' 8' 8' Basalt; as described above, but less fracturing, some calcite veinlets and zeolite.

Core No. 76 rec'y
4540-4550' 9½' 9½' Basalt; black, hard, aphanitic - microcrystalline.

Core No. 77 rec'y
4760-4772' 4' 4' Breccia; green-black, sheared, serpentinized basalt, silty matrix, some light gray tuff fragments or inclusions.

Core No. 78 rec'y
4772-4784' 12' 2' Tuff, light gray, silty, hard, scattered fragments of basalt.

10' No recovery.

Core No. 79 rec'y
4858-4870' 12½' 1' Breccia; dark greenish gray, sheared, basaltic.

1' Siltstone; medium gray, firm, tuffaceous, very thinly bedded, micromicaceous, fragments of pyroxene crystals.

2' Breccia; dark greenish gray, basalt and tuff fragments. Dip 6-14°, fair.

1' Siltstone; tuffaceous.

2' Breccia; basalt and tuff fragments.

6' Siltstone; tuffaceous.

Core No. 80 rec'y
4870-4882' 12' 12' Siltstone; medium gray, very firm, tuffaceous, very thinly bedded, partings show nearly horizontal dip.

Core No. 81 rec'y
4882-4887' 5' 4½' Siltstone; above described.

½' Tuff; hard, silty, basaltic, common fragments of pyroxene, some calcite and zeolite.

Core No. 82 rec'y
4887-4891' 12' 12' Tuff breccia; green and gray mottled, silty with angular fragments of green and gray volcanics, some calcite and zeolite veining, some pyrite.

Core No. 83 rec'y
5114-5126' 6' 6' Sandstone; medium gray, very firm, fine silty, feldspathic, some black mineral grains, some biotite, a little muscovite, vertically faulted, offsetting grayish-black carbonaceous siltstone. Light yellow cut after several hours in ether. Bubble rose to surface of core for several minutes after the core was removed from the barrel.

Core No. 84 rec'y
5126-5138' 8' 8' Sandstone; as described above. Dip varies between 45° and 70°. Weak ether cut after several hours.

Core No. 85 rec'y
5138-5144' 7' 1½' Sandstone; as described above, but partially cemented with lime.

5½' Siltstone; with sandstone streaks, sheared, shear surfaces coated dark brownish gray, very micaceous, faint yellowish cut in ether after several hours. Dip 55°, fair.

Core No. 86 rec'y
5144-5156' 9' 9' Shale; black, hard, calcareous, silty with streaks of sandstone. Shale gives a faint yellow cut in ether.

Core No. 87 rec'y
5275-5287' 10' 10' Basalt; greenish black, sheared, shiny slickensided shear surfaces, abundant pyroxene crystals, some calcite veining.

Core No. 88 rec'y
5287-5299' 8' 8' Basalt; as described above.

Core No. 89 rec'y
5441-5454' 7' 3' Sandstone; light gray, friable to firm, tuffaceous, slightly calcareous. No cut. Includes 2" claystone layer at base. Dip 36°.

2½' Siltstone and claystone; fine sandy, micaceous, firm to hard, siltstone and dark brown hard claystone, fractured, common calcite veining. Dip 46-52°, good.

1½' Sandstone; as above, but cemented with lime, occasional calcite veinlets.

Core No. 90 rec'y
5454-5461' 4½' 4½' Sandstone; as described above, contains many pieces of thick-shelled pelecypods. No cut or stain.

Core No. 91 rec'y
5551-5563' 6' 6' Siltstone; dark chocolate brown, hard, micaceous, clayey, fractured and polished, slickensided. A 2" layer of sandstone near base, calcareous, fine to medium grained, with subangular siltstone pebbles. Dip 32-46°, fair.

Core No. 92 rec'y
5563-5564' 0' 0' No recovery.

Core No. 93 rec'y
5564-5576' 3' 3" Sandstone; grass-green to light gray, medium to coarse grained, feldspathic, tuffaceous. Dip 28°, good.

2'9" Siltstone; clayey, chocolate brown, hard, micaceous, a 6" layer of pebbly sandstone in center of core. Pebbles of dark-gray bentonitic shale. Dip 28-36°, fair. Fractured, some calcite veining.

Core No. 94 rec'y
5576-5582' 4' 4' Siltstone; chocolate brown, hard, clayey, micaceous, badly broken, slickensided.

Core No. 95 rec'y
5584-5592' 4' 4' Siltstone; similar to above.

Core No. 96 rec'y
5592-5604' 5' 2' No recovery.

3' Siltstone; similar to that at 5576-5582'.

Core No. 97 rec'y
5604-5615' 5' 2" Sandstone; (cavings?) medium gray, hard, argillaceous, feldspathic, tuffaceous.

10" Siltstone; chocolate brown.

1' Claystone; medium gray, very firm, fractured bentonitic. Dip 45-50°, poor.

3' Siltstone; dark brown, hard, fractured and sheared, micaceous, scattered fish remains and small pelecypods. Dip 30-40°, poor.

Core No. 98 rec'y
5615-5626' 3' 3' Shale; black, hard, fractured and sheared, slickensided. Fracture plane 75°, bedding 30°, poor, calcite coating on some fractures.

TEXACO, INC.
Cooper Mountain No. 1

Section 25, T. 1 S., R. 2 W., Washington County, Oregon

Composite Core and Cuttings Descriptions
(Texaco core descriptions were used except where interpretations differed.)

Core No. 1 rec'y
981- 986' 2' 2' Basalt; hard, dark gray to black, highly vesicular, occasional phenocrysts.

Drilled interval 986-1072' - Probable base Columbia Lava at 1037 (d) Miocene? sandstone 1037-1078(d). (Hard 1037-1051'; soft 1051-1078'.)

Core No. 2 rec'y
1072-1082' $3\frac{1}{2}$' $3\frac{1}{2}$' Possible top Keasey? at 1078'. Claystone; firm, yellowish, tan with common mottlings of dark gray bentonitic claystone in upper part and ocherous and reddish mottlings throughout. Scattered sand grains of basalt, varicolored volcanics and quartz. Massive to poorly bedded with 18° to 27° dips ave. 22°. Common irregular high-angle slickensided fractures in upper 1'. No foraminifera or fossil fragments noted. Looks barren. Top 6' of interval was soft. No flash.

Core No. 3 rec'y
1082-1094' 3" 2" Claystone; same as above, yellowish tan, ashy. One wood fragment noted.
1" Claystone; steel gray, bentonitic, tough, loc. fine sandy (ashy?). Apparently barren. No flash.

Core No. 4 rec'y
1094-1106 13' 13' Claystone; medium gray, locally laminated with light gray ashy streaks and interbeds. Hard, massive to well bedded. Good 0-5° dips. Occasional brown streaks. Common mollusk fragments, rare foraminifera, rare glauconite. Occasional ornate golden-brown fish scales. No flash from barrel. No cut with CCl_4 (Keasey?).

Core No. 5 rec'y
1106-1118' 13' 13' Claystone; as last above, generally well bedded, varying from light to dark gray with occasional greenish and brownish casts. Locally gritty with volcanic rock fragments. Scattered foraminifera, common mollusks and fragments, scattered fish remains. Locally silty to fine sandy with clayey matrix. No flash from barrel. Good 2-7° dips.

Core No. 6 rec'y
1118-1129' 8' (2' recovered in outer barrel)
6' Claystone; as above, locally gritty and with scattered coarse muscovite flakes.
2' (rec. in outer barrel). As above, but including 1' of grit, principally basalt grains and grits and white ash fragments in a calcareous matrix. Hard and tight. No cut with CCl_4. No flash from barrel.

Core No. 7 rec'y
1133-1145' 5' 5' Conglomerate; dark gray with greenish cast. Pebbles to $1\frac{1}{2}$" of basalt (75%), green volcanics (20%), red volcanics (5%). Pebbles water worn flat to rounded. Matrix dark green to dark gray, sandy siltstone with occasional quartz grains. Conglomerate is generally tight but locally friable and mud impregnated. No flash from barrel. No CCl_4 cut in permeable streaks.

Core No. 8 rec'y
1145-1151' 4" 4" Conglomerate; (as above) including 1" hard dove-gray dense limestone. (All cored rough). No flash from barrel.

1151-1361' Drilled interval.
Base of conglomerate - 1278' (d)

Core No. 9 rec'y
1361-1381' 21' 2½' Claystone; medium gray with greenish cast, calcareous, slightly silty, micromicaceous, massive, conchoidal fracture, firm to hard. Apparently barren. Becomes sandy to gritty in lower 1" and rests with sharp but apparently conformable contact on:

12' Siltstone; chocolate brown, clayey, sandy to gritty. Common mollusk fragments, occasional foraminifera, common coarse mica flakes. Common carbonaceous bits. Locally well bedded and thin bedded. Dips 4-7°. Rests with sharp but apparently conformable contact on:

3' Sandstone; brownish gray, very silty and highly micaceous, hard, tight, occasional red and green grains, common tan tuff pellets, massive with poor bedding indicating 3-5° dips. No odor, no stain, no CCl_4 cut. Locally friable on edges. Rests with sharp but apparently conformable contact on:

2" Sandstone; light gray, as last above, but calcareous, tight, hard, grades to:

34" Claystone; medium greenish gray, hard locally bedded, rare sand grains, compact, poorly developed conchoidal fracture, indicated 3-5° dips. Occasional sand-filled borings near top. Apparently barren. No flash from barrel. Few fragments of pelecypods. Scattered lenticular carbonaceous fragments.

Core No. 10 rec'y
1430-1450' 18' 12' Siltstone; dark brown, firm, clayey, fine sandy, carbonaceous, micromicaceous, well bedded, some thinly interbedded medium gray, firm to friable, very fine silty, feldspathic sandstone, some mica (biotite predominates over muscovite), a few fragments of shells, some lenticular pieces of carbonaceous material. Grades to sand below.

6' Sand; medium to light gray, loose, fine to medium grained clean and well sorted, micaceous, tuffaceous; composed of subangular grains of feldspar, quartz, and varicolored volcanic fragments, some scattered shell fragments. No CCl_4 cut, no stain, no odor.

Core No. 11 rec'y
1594-1614' 20' 20' Sand; grayish brown, loose, silty, feldspathic; composed of subangular feldspar and angular quartz, small amount of mafic minerals, occasional mica flakes, scattered shell remains. No cut, no stain, no odor.

Core No. 12 rec'y
1980-2000' 20' 20' Siltstone; sandy, approaches silty sandstone, green when fresh, a rather dark gray, grades locally to fine silty sandstone, common white ash fragments, common varicolored grains (black, green and red principally), quartzose, massive, hard, fairly common mollusks and mollusk fragments including large pelecypod (Venericardium-like), foraminifera (?). One 1" bed of ash fragments at 1983' with indicated 20° dip. Local conc. of pyrite. Looks tight, no odor, no stain, no cut.

2000-2192' Drilled.

Core No. 13 rec'y
2192-2204' 5' (3' recovered in drill collars)
Siltstone; medium grayish brown, firm to hard, clayey, micaceous, scattered red and green grains, massive to locally poorly bedded, generally as last described but fine grained, occasional Sigmoilina-like foraminifera, scattered mollusks including small dark-brown gastropod, poor indicated 4-12° dips. No flash from barrel.

Core No. 14 rec'y
2204-2209' 5' 5' Siltstone; as last described.

Core No. 15 rec'y
2435-2447' 12' 12' Siltstone; medium greenish gray to grayish brown when fresh, weathering medium gray, very fine sandy, somewhat micaceous, firm to hard, massive locally poorly bedded with indicated 5-10° dips, common varicolored grains, including black, red and green - all very fine, abundant fine quartz grains. Occasional mollusk fragments, foraminifera (?). No odor, no stain. Core looks tight.

Core No. 16 rec'y
2447-2457' 12' 12' Siltstone; as last described. No flash from barrel.

Core No. 17 rec'y
2457-2467' 10' 10' Siltstone; as described above. No flash.

Core No. 18 rec'y
2467-2477' 10' 10' Siltstone; as described above. No flash.

Core No. 19 rec'y
2477-2488' 11' 11' Siltstone; as described above. No flash.

Core No. 20 rec'y
2488-2498' 10' 10' Siltstone; as described above. No flash.

Core No. 21 rec'y
2498-2508' 10' 10' Siltstone; as described above. No flash.

2508-2744' Drilled.

Core No. 22 rec'y
2744-2754' 9' 1' Siltstone; as above but sandier. Still looks tight. Grades to:

6' Fossil reef conglomerate; light green-gray, gritty to pebbly, silty to locally clayey, dirty and poorly sorted, hard, low permeability and porosity to tight, contains abundant thick-shelled pelecypods. Grits and pebbles principally basaltic, somewhat calcareous. No odor, no stain. Interval includes some fairly well sorted sand (probably permeable) and one grass-green siltstone streak near center. 10° dip at top. Rests with sharp and apparently disconformable contact on:

2' Lignitic siltstone; interbedded and thinbedded medium brownish gray, siltstone and highly lignitic brown siltstone with some green-gray bentonitic silty claystone. Occasional oily spots. Foraminifera (?).

Core No. 23 rec'y
2754-2764' 11' 2' Shaly coal; black, brittle, firm.

9' Conglomeratic claystone; medium greenish gray, silty tuffaceous with subrounded to angular pebbles of partially chloritized basalt, dark gray claystone and white ash, bedding indistinct.

Core No. 24 rec'y
2764-2775' 9' 3' Conglomeratic claystone; above described, poor dips 5-10°, foraminifera?

1' Lignitic siltstone; dark greenish brown, common woody fragments, locally abundant white ash fragments, siltstone is thinly bedded, foliate to crumbly.

5' Claystone; medium to light greenish gray, bentonitic, soft, internally sheared.

1' Lignitic siltstone; as above described.

Core No. 25 rec'y
2775-2784' 9' 3' Conglomeratic claystone; as above but becoming silty to sandy, hard, greenish-gray, grades to:

1' Lignitic siltstone; dark brown, common woody fragments, locally abundant white ash fragments, thin bedded and flaky to crumbly. Apparently grades to:

5' Claystone; medium light gray with greenish cast, bentonitic, plastic, internally sheared and locally polished. Ashy and probably represents an altered ash. Grades to:

1' Lignitic siltstone; as above described. No flash from barrel. Occasional bubbles through mud sheath. No odor.

Core No. 26 rec'y
2784-2796' 12' 1' Lignitic siltstone; as last above. Rests with sharp contact (dip 8°) on:

3½' Claystone; gray green, silty to sandy, firm,

poorly bedded, common carbonaceous material and white ash. Becomes gritty near base and grades to:

$1\frac{1}{2}$' Grit, light greenish gray, light gray to green ash and volcanic rock grits in a silty sandy matrix. Massive, hard, looks tight. One large carbonized wood fragment at top. Rests with sharp but apparently conformable contact (dip 5°) on:

1' Lignitic siltstone; siltier and less lignitic than those above, grades to:

5' Sandstone; green, weathers medium gray, hard, low permeability, principally altered volcanic (ash and flows) debris in a silty calcareous matrix, medium to coarse and gritty, locally pebbly, ill-sorted, dirty, poorly bedded in 2' to 3' beds of varying grain size. Common bubbles on mud sheath, no flash from barrel, no odor, no cut, no stain.

Core No. 27 rec'y
2796-2808' 12' 12' Sandstone; as last described, locally well sorted, medium grained. Locally somewhat permeable. Contain peculiar green soapy but hard pelecypod-shaped fragments below 2802'. May be replaced mollusk shells. No flash, no odor, common bubbles.

Core No. 28 rec'y
2808-2820' 12' 12' Sandstone; medium grayish tan, firm to friable, fine, feldspathic; composed of subangular grains of feldspar, quartz and mafic minerals, abundant shell fragments (pelecypod Thyasira?). No stain, no cut, no odor.

Core No. 29 rec'y
2820-2832' 12' 7' Sandstone; as above described.

3' Lignitic coal and lignitic siltstone; black and medium brown, brittle to firm, calcareous, some slightly tuffaceous siltstone with small carbonaceous inclusions.

2' Conglomeratic claystone; greenish gray, firm to brittle, with coarse pieces of altered basalt and other volcanic rocks.

Core No. 30 rec'y
2832-2845' 13' 13' Conglomeratic claystone; as above but interval includes some lignitic streaks and pebbly zones.

Core No. 31 rec'y
3139-3150' 11' 11' Congomeratic claystone; green, gray, reddish brown, some brown conglomerate particles 1/16" up to several inches. Same texture as matrix often same color, or contrasting in shade of color. Noncalcareous. Poor apparent dips 10° on partings.

Core No. 32 rec'y
3150-3158' 8' 8' Same as above, but browner.

Core No. 33 rec'y
3158-3170' 8' 8' Ground-up core top 4' apparent same as above. Contact no shown.

7' 7' Amygdaloidal basalt (top contact not shown). 1' highly amygdaloidal with amygdules filled secondarily with crystalline calcite (white). 2-3' 1/16" calcite veins (vert). Then scattered on down through the basalt. Only a few amygdules are filled, the rest of the vesicles (up to $\frac{1}{2}$") are lined with black, dull opaque material. Matrix, black finely crystalline, some crystals up to 1/8".

Core No. 34 rec'y
3170-3180' 5' 4' Same as above; only few vesicles filled.

1' Flow structure gradually appearing, ranging from 30-50°. Basalt becoming very dense at bottom, also some black augite(?) crystals. Slight movement on some of the fractures.

Core No. 35 rec'y
3310-3321' 11' 11' Claystone; brownish black, hard, fractured, some iron staining on fracture surfaces.

Core No. 36 rec'y
3321-3333' 6" 6" Same as above. Fractures make core recovery poor.

Core No. 37 rec'y
3500-3512' 12' 3' Claystone; silty, dark green when fresh; weathers to greenish gray; grades locally to clayey siltstone. Massive. One 6" grit 1' from top, hard calcareous, basalt grits to white ash fragments.
Claystone; hard, micaceous, somewhat ashy, foraminifera(?). High-angle slickenside (horizontal) near top. Indefinite bedding. Indicated 10-14° dips. Rests with sharp but conformable contact on sand below.
9' Sand; medium grained, green to light greenish gray, firm, easily friable to loose clean and well sorted, massive, feldspar and quartz with common black and green grains, common to abundant muscovite. Has good permeability. No odor, stain, cut.

Core No. 38 rec'y
3512-3524' 12' 12' Sandstone; grayish tan, firm to friable, fine, silty, micaceous (medium-size muscovite, fine-size biotite); composed mainly of feldspar and quartz, some mafic minerals. No odor, no cut, no stain.

Core No. 39 rec'y
3524-3534' 9' 9' Sand; as in No. 37 above. No odor, no stain.

Core No. 40 rec'y
3625-3637' Volcanic breccia; red, black and green, altered and sheared. Fragments of basalt with amygdules of palagonite and nontronite(?).

Core No. 41 rec'y
3637-3649' Volcanic breccia; as above, some veining.

Core No. 42 rec'y
3657-3668' Volcanic breccia; as above.

Core No. 43 rec'y
3668-3680' Tuff breccia; green, altered, fine to coarse grained.

Core No. 44 rec'y
3790-3794' 5' 5' Tuff breccia; greenish gray weathers grayish brown to black, angular subrounded, basalt. Tuffaceous siltstone and claystone, grains to pebbles in an ashy clayey, siltstone matrix. Contains common euhedral crystals of augite and olivine. Locally cut with irregular secondary calcite veinlets hard, dense, massive.

Core No. 45 rec'y
4247-4258' 7' 7' Conglomeratic siltstone; medium-brownish gray, containing rounded pebbles of black, partially altered basalt, andesite, claystone, siltstone, and varicolored volcanic fragments. No odor, no cut, no stain.

Core No. 46 rec'y
4258-4268' 11' 7' Siltstone; greenish, hard, fine sandy to coarse sandy, some mica, slightly tuffaceous. Zone of pebbles near bottom.
4' Tuff; brownish black, hard, argillaceous with feldspar, quartz, and ferromagnesian minerals.

Core No. 47 rec'y
4268-4278' 12' 2' Siltstone; greenish, hard, above described.
10' Siltstone; medium gray, hard, some micromica, some pyrite and carbonaceous material, indistinct bedding, dip 15° ± .

Core No. 48 rec'y
4278-4290' 12' 12' Siltstone; as above, but becoming gradually more argillaceous downward and tan gray in color. Common small pelecypods, gastropods, crab, and fish remains. Scattered Cyclammina. Occasional large bronze, highly ornamented fish scales. No odor, no stain.

Core No. 49 rec'y
4404-4411' 1' 1' Siltstone; tan gray, hard clayey, nonfriable, micaceous, rare black and red grains massive to locally bedded with sandy streaks, indicated 14° dip. This material essentially as above but more argillaceous. Arenaceous foraminifera. No odor.

Core No. 50 rec'y
4411-4414' 3' 3' Shale; dark gray to grayish black, hard, brittle, scattered micro mica. Fairly distinct bedding, dip 10-14°.

Drilled interval 4414-4490'.

Core No. 51 rec'y
4490-4501' 11' 1' Cavings.
10' Siltstone; tan-gray, firm to hard, locally crumbly, more micaceous than last core, slightly sandy, quite clayey, common thin-shelled small mollusks, arenaceous foraminifera, calcareous foraminifera? Poorly bedded with 10-14° dips. No odor.

Core No. 52 rec'y
4501-4511' 10' 10' Shale; medium gray to grayish black, very firm, silty, some micromica, a few clusters of small pyrite crystals.

Core No. 53 rec'y
4720-4732' 12' 12' Shale; medium gray, very firm, argillaceous, micromicaceous, silty to fine sandy, containing arenaceous and calcareous foraminifera, common small thin-shelled pelecypods and gastropods, poor bedding, dip 10-14°.

Core No. 54 rec'y
4732-4744' 12' 12' Shale; as above, but dark gray.

Core No. 55 rec'y
4906-4918' 6' 6' Shale; grayish black, hard, micromicaceous, argillaceous, poorly bedded, dip 10°±, fracture plane 45°. Shale contains scattered fragments of mollusks, common diatoms, occasional fish remains and foraminifera.

Core No. 56 rec'y
4918-4930' 15' 15' Shale; as above described.

Core No. 57 rec'y
4930-4938' 7' 5' Shale; as above described.
2' Claystone; brownish-gray, silty, micromicaceous, hard, some fracturing, scattered pyritized and carbonized plant remains, foraminifera and diatoms.

Core No. 58 rec'y
4938-4948' 10' 10' Claystone; above described, fair dip 10°, cast of a small gastropod.

Core No. 59 rec'y
5087-5099' 2' 2' Siltstone; light gray with tan cast, locally mottled medium gray, tuffaceous micromicaceous, hard, mass. to poorly bedded, rare carbonaceous bits, no foraminifera noted, fossil fragments? Fish remains? No cut. Distinct but fleeting sulfur odor when freshly broken, occasional calcite? veinlets at 80° indicated. Dip 15°±.

Core No. 60 rec'y
5099-5111' 12' 1' Siltstone; as last described, becomes very ashy, hard, dense and pyritic at base, sharp, apparently disconformable contact on -
8' Volcanic ash; light gray with medium gray mottled, fine crystalline micromicaceous with both muscovite and biotite, medium gray mottlings bentonitic with common pyrite crystals, mass., very hard, cut with high-angle calcite veinlets. Scattered amygdules of white zeolite? Occasional black water-worn basalt grits, locally bedded with 15-24° dip. Distinct but fleeting sulfurous-to-fetid odor when freshly broken.
2' Volcanic ash; somewhat silty, reddish gray, micromicaceous, hard, generally as last above, contact apparently gradational.

Core No. 61 rec'y
5111-5123' 10' ½' Volcanic ash; reddish gray as last described, rests with sharp disconformable contact on -
9½' Volcanic breccia; (could be called pumice) green with common black phenocrysts pyroxene very hard, massive. No flash. No bubbles. Scattered white amygdules of zeolite? with veinlets of same material.

Core No. 62 rec'y
5271-5283' 9' 3'

Volcanic ash; interbedded pink to mottled buff, mottlings are medium gray, hard, tight, fine crystalline, slightly micaceous, very slightly calcareous, becomes silty near base, cut with high-angledcalcite veinlets and apparently grades to -

6' Siltstone; dark gray, hard, mass.ashy impermeable common fine mica, common fine disseminated pyrite scattered fine carb. bits scattered foraminifera, some pyritized fair 9° dip, common bubbles in top 3', scattered bubbles in lower 6'. No flash from barrel. Core has distinct but fleeting marshy odor when freshly broken.

Core No. 63 rec'y
5283-5293' 5' 5'

Siltstone; dark gray, hard, generally mass. as last above with scattered dark gray nodules which contain pyrite and euhedral crystals which appear volcanic. Locally black micromicaceous, very hard and dense, argillaceous cut with high-angle calcite veinlets, rare foraminifera.

Core No. 64 rec'y
5293-5300' 1' 1'

Shale; dull grayish black, hard, tough.

Core No. 65 rec'y
5300-5310' 8' 8'

Siltstone; dark gray, very hard, mass. quite clayey generally as above. Indicated dip 10° somewhat micromicaceous, scattered foraminifera occasionally pyritized. Very faint marshy odor.

Core No. 66 rec'y
5587-5599' 9' ¼'

Claystone; brown ashy-silty, mass. firm to hard, micromicaceous.

8½' Volcanic breccia; agglomerate gray-green mass. hard compact ashy, angular crystals of light-green minerals and black basalt fragments and subrounded to well-rounded quartz grains, silty and ashy matrix light to dark brown and patches secondary calcite throughout core in irregular seams.

¼' Volcanic breccia; dark, br.-mass., ashy with siltier matrix than last above. Contact between last above gradational with approximately 15° dip. No flash. Common bubbles.

Core No. 67 rec'y
5599-5611' 15' 10'

Volcanic conglomerate; dull gray, green with local brown cast in patches, hard, compact silty ashy matrix with abundant small, well-rounded pebbles and coarse grit, mass. lower 1½ very coarse with pebbles up to 3/4", sharp contact between.

5' Siltstone; dull gray with local brown cast. Firm to hard, compact, mass. micro-micaceous. Ashy, common small, dull black well-rounded mineral grains, probably magnetite contact shows dip 12-15° lignitic mat. Slightly pyritized, calcareous.

Core No. 68 rec'y
5754-5766' 13' ½'

Siltstone; dull gray, hard, very fine sandy, very ashy mass. compact micromicaceous impermeable common small well-rounded black mineral grain. Local light-tan patches, possible fish scales.

9' Siltstone; as above, but fine, sandy sandgrains more common and slightly coarser, grains well rounded and evenly distributed throughout abundant mica flakes and common biotite. Two megafossils noted, but very poorly preserved. Locally mottled brown, gray, and greenish gray in patches. Water-thin streaks, dark and silty claystone. Common small black mineral grains and rare coarse well-rounded grains ashy. Tight and impermeable. Silty fine sand, hard, light impermeable common coarse grains and small subrounded inclusions of dark green volcanic breccia and dull gray-green volcanic breccia ashy scattered fragments of pelecypods. Dip 10-12° (good) rests conformably on -

1½' Siltstone; dull green gray - very sandy and ashy-mass.,hard, tight impermeable, even textured - common biotite and mica flakes - common inclusions of green well-weathered volcanic breccia giving a mottled appearance.

Occasional well-rounded quartz grains. Grades sharply to -

2' Siltstone; dull gray - hard, mass, ashy micromicaceous - biotitic common black grains, scattered, vary through streaks of dark gray-brown claystone, giving apparent 18-20° dip. No flash. Common bubbles throughout core. No cut with CCl_4.

Core No. 69 - rec'y
5766-5778' 12' 12'

Siltstone; dull gray - hard - tight - generally massive few local streaks showing good bedding, micaceous, occasional biotite flakes and glauconite grain, ashy and very fine sandy in streaks locally occasional thin wave brown claystone streak. 3" streak carrying pelecypod cast and some preserved shells with fragments and shells at 5778'. Two parallel streaks $\frac{1}{2}$" apart at 5777$\frac{1}{2}$ show dip of 57° this time also shows calcite-filled fracture, irregular in character. A few gradation abundant carbonaceous fragments. Slightly pyritized noted coarse quartz grain and well-rounded black basalt grits. Dip good 1°. No flash - no odor - no cuts - 5769-5776'. Few bubbles. Core not held in barrel on first run. Picked up on second run.

Core No. 70 rec'y
5778-5787' 5' 5'

Siltstone; as above 5768-5780'. Somewhat less sandy - common mica and biotite flakes - pelecypod shell poorly preserved top of core. Local thin streaks of brown claystone. Slightly ashy occasional inclusion of blue-gray weathered fine-grained igneous rock. Generally massive, occasional thin bed and parting indicate a fair dip 10-12°. Scattered carb.

Core No. 71 rec'y
5787-5797' 14' 14'

Siltstone; as above 5778-5787', occasional poorly preserved pelecypod casts. Generally massive to roughly bedded. Poor indicated dips 5-10°. Calcite-filled fractures with slickensided faces with dip of 10-15°. Common small well-rounded black grains. Tight impermeable, core very dry appearing when freshly broken.

Core No. 72 rec'y
5797-5809' 6" 6"

Volcanic breccia; green - ashy phenocrysts of dark green minerals and fragments of brown weathered fine-grained igneous rock well rounded. Core very badly crushed and generally fine ground having silty ashy appearance. Fragments of breccia very hard, showing possible zone of weathering or fracturing.

Core No. 73 rec'y
5809-5819' No recovery.

Core No. 74 rec'y
5819-5824' No recovery.

Core No. 75 rec'y
5824-5829' No recovery.

Cuttings Descriptions

6519'	55%	Shale; dark gray, very firm silty.
	30%	Shale; medium greenish gray, firm, silty.
	15%	Shale; brownish green, friable, silty, slightly tuffaceous.
6559'	70%	Shale; dark gray-grayish black, very firm, silty, some calcite veining.
	15%	Shale; medium brown, friable, argillaceous, tuffaceous.
	15%	Siltstone; medium gray, firm, with scattered subrounded, medium-sized pieces of basalt.
6599'	75%	Shale; dark gray-grayish black, firm, some calcite.
	15%	Shale; medium gray, silty, occasional piece of dark greenish-gray clayey shale inclusions.
	10%	Shale; greenish gray, hard, silicified.
6639'	60%	Shale; dark gray, firm to hard, silty with calcite veining.
	30%	Siltstone; medium to dark gray, firm, silty, tuffaceous.
	10%	Shale; medium greenish gray, friable, silty with scattered medium size inclusions of grayish-black shale.

6679'	50%	Shale; dark gray, very firm silty, with small limey spots, some calcite veining.
	40%	Shale; medium greenish-gray, firm, silty, calcareous.
	10%	Shale; medium brown, friable, clayey, tuffaceous.
6729'	45%	Shale; dark to medium gray, firm, calcareous.
	25%	Siltstone; light gray, firm to friable, calcareous.
	15%	Basalt; brownish black, hard, microcrystalline, partially altered.
	10%	Siltstone; medium brownish gray, firm, tuffaceous.
	5%	Shale; grayish black, hard, silicified.
6759'	100%	Basalt; brownish black, very firm to hard, altered, microcrystalline.
6799'	75%	Shale; dark gray, very firm to hard, silty, calcite veining, some portions of the shale silicified.
	15%	Basalt; above described.
	10%	Shale; brownish black, very firm.
6839'	40%	Shale; light gray, friable, calcareous, slightly tuffaceous.
	40%	Shale; grayish black, very firm.
	15%	Tuff; light brown, firm to friable, silty, with subangular pieces of basalt, feldspar grains.
	5%	Shale; olive green, friable, clayey, some calcite veining.
6879'	90%	Shale; medium to dark brown, firm, brittle, silty.
	10%	Shale; dark gray, very firm, some zeolite.
6919'	65%	Siltstone; medium gray, very firm, micaceous.
	20%	Shale; light gray, friable, silty containing inclusions of grayish-black shale.
	15%	Basalt; brown, very firm, weathered microcrystalline.
6959'	70%	Shale; grayish black, very firm, crumbly, some calcite veining.
	15%	Basalt; above described.
	15%	Siltstone; light gray, firm, calcareous.
6999'	65%	Shale; grayish black, very firm.
	20%	Siltstone; brown, firm, tuffaceous.
	15%	Shale; medium gray, friable, silty, with medium-coarse pieces of black shale and altered volcanic rock.
7039'	100%	Shale; grayish black, hard, with some small zeolite fillings, some quartz veins.
7079'	100%	Shale; above described.
7119'	60%	Shale; medium gray, friable, silty with medium-coarse fragments of black shale and other sedimentary particles, some pyrite.
	25%	Shale; grayish black, above described.
	15%	Siltstone; brown, tuffaceous.
7159'	55%	Shale; grayish black, above described.
	30%	Coarse pieces of quartz and feldspar.
	10%	Shale; brown, clayey, tuffaceous.
	10%	Tuff; medium gray, firm.
7207'	100%	Shale; grayish black, above described.
7225'	100%	Shale; grayish black, very firm, silty, showing some shearing, some calcite.
7247'	100%	Shale; above described.

Core No. 76 rec'y

7258-7270'	12'	6'	Sandstone; brownish gray, hard, very fine to fine grained, well cemented, bentonitic, micromicaceous; composed of feldspar, quartz, and mafic minerals, calcite filling irregular fractures, indistinct cross bedding.
		4'	Shale; medium gray, hard, silty, slightly tuffaceous, calcareous.

Core No. 77 rec'y

7270-7282'	12'	12'	Siltstone; br. very hard, locally very fine sandy with occasional medium grains of quartz and black minerals, mass, to very poorly cross bedded, cut by numerous calcite-filled fractures varying from wafer thin and irregular to 1/8" in thickness with dip up to 38°. Occasional strk. with ashy to bentonitic which is rather easily crushed between fingers when wet. Locally crushed in coring.

Cuttings Descriptions

7325'	50%	Shale; dark gray, friable to firm, zeolite, calcite veining.
	35%	Siltstone; brownish gray, firm, tuffaceous, micromicaceous.
	15%	Shale; grayish black, very firm.
7365'	55%	Siltstone; light gray, friable to firm, tuffaceous.
	30%	Shale; grayish black, very firm.
	15%	Siltstone; brown, firm, tuffaceous.
7405'	60%	Shale; light gray, firm to friable, with inclusions of black shale.
	40%	Shale; grayish black, very firm.
7445'	60%	Shale; grayish black, very firm.
	35%	Shale; medium brown, firm, tuffaceous, silty.
	5%	Marl; light gray, very firm.
7485'	50%	Siltstone; medium gray, firm, slightly tuffaceous, some zeolite.
	35%	Shale; grayish black, very firm.
	15%	Siltstone; olive gray, friable, fine sandy, tuffaceous.
7525'	100%	Shale; black, very firm to hard, few fine mica flakes.
7565'	65%	Shale; grayish black, firm to friable, micromicaceous.
	25%	Shale; medium gray, hard, tuffaceous, with fine pieces of dark, altered volcanic rock, some chlorite, some zeolite.
	15%	Wacke; dark rust brown, firm to friable, fine with clayey matrix.
7605'	80%	Shale; grayish black, crumbly, some calcite and zeolite.
	10%	Wacke; dark rust brown, fine, firm.
	10%	Shale; dark olive gray, firm.
7655'	55%	Shale; dark grayish black, firm, silty, micromicaceous.
	30%	Shale; dark grayish brown, friable, clayey, with few scattered fine mica flakes.
	15%	Siltstone; medium gray, friable, tuffaceous with medium sized particles of basalt, some feldspar.
7695'	60%	Siltstone; medium gray, as above but with coarser basalt particles.
	40%	Shale; dark grayish black, firm, silty, micromicaceous.
7735'	65%	Siltstone; medium greenish gray, friable.
	25%	Crystal ash; white, bentonitic, firm.
	15%	Claystone; dark olive gray, crumbly with medium sized pieces of altered basalt, some zeolite veining.
7775'	80%	Siltstone; medium gray, firm with medium size subangular pieces of feldspar and ferromagnesian minerals.
	20%	Shale; dark grayish black, very firm.

Core No. 78 rec'y

7808-7816' 11'	1.5'	Shale; dark gray, hard, silty, some micromica, small cast of dentalium(?).
	0.5'	Sandstone; very fine, limy, hard.
	4'	Sandstone; silty, tight, cemented with lime, fine to coarse grained, composed of pieces of claystone, siltstone, basalt, and quartzite.
	2'	Siltstone; hard, limy, sponge spicule, echinoid spines(?), foraminifera(?).
	1½'	Sandstone; as above.
	1½'	Siltstone; as above.

Core No. 79 rec'y

7816-7820' 3'	3'	Shale; dark gray, hard, silty, calcareous, with thin, sandy parting planes, good dip 6°.
7830'	70%	Shale; medium greenish gray, friable, tuffaceous, argillaceous with small fillings of zeolite.
	30%	Shale; dark gray, hard, silty, calcareous, with thin sandy parting planes.
7872'	75%	Clear quartz and white feldspar; coarse to subangular.
	25%	Shale; medium to dark gray, firm to very firm.
7910'	95%	Shale; medium to dark gray, as described in Core No. 79; considerable quartz and zeolite veining.
	5%	Basalt; black, hard.

Core No. 80 rec'y
7950-7967' 11' 3½'

Claystone; dark brownish gray, very hard, massive, micromicaceous silty with locally very fine sandy patches, scattered, poorly preserved pelecypod shells and fragments. Two large reed fragments at 7952'. Rare, poorly preserved foraminifera(?) scattered carbonaceous material. Two high-angled calcite seams 1" to 6".

2½' Ash; blue, gray, very hard, massive, fine sandy very ashy with common angular fragments of black basalt and crystals of calcite. Top 6" almost pure ash brown mottled with occasional crystals of calcite.

5' Claystone; as above, with scattered fragments of pelecypod shells.

7980' 100% Shale; dark gray and greenish gray, firm to hard, with clear quartz grains, some zeolite.

8020' 100% Shale; dark gray and greenish gray, as above, some quartz and zeolite veining.

8060' 95% Shale; medium greenish gray, firm to hard, silty, slightly tuffaceous, some zeolite and quartz veining.

5% Basalt; black, aphanitic (large angular fragments).

8100' 100% Shale; greenish gray, as above.

Core No. 81 rec'y
8596-8607' 3' 3'

Claystone; brown, hard, brittle, limy, micromicaceous inclusion of gray-blue, basalt, locally coarse grains of quartz common to abundant, cut with intersecting, irregular white calcite seams, some at high angles, pyrite common to abundant in seams and patches, locally claystone mottled with blue ashy patches, scattered fragments of green ashy claystone at top of core with inclusions of light green vitreous mineral. Claystone shows a zone of fracturing and core shows slickensides when broken, core crushed and broken in coring, some foraminifera noted.

Core No. 82 rec'y
8694-8714' 14' 14'

Gritstone; greenish gray, hard, well cemented with calcite, very coarse well-rounded grits and small pebbles up to 3/4" - silty clayey matrix with common inclusions of blue-black basalt and green claystone, common calcite-filled fractures up to ½" thick, tight and impermeable, generally fine to medium sandy.

Core No. 83 rec'y
8812-8832' 20' 5'

Sandstone; green to gray, hard to friable, medium to coarse grained with fine to very fine matrix, poorly sorted, with common very coarse well-rounded quartz grains and rare, well-rounded fragments of basalt and green claystone, locally common green vitreous mineral grains and rare red rock fragments, well cemented with calcite, tight and impermeable, massive grades to

6' Sandstone; dull gray, hard friable to hard, medium to fine, silty, ashy, fairly well sorted, well cemented, common fine black mineral grains, rare very coarse quartz grains, rare to common green, vitreous mineral grains, and rare red rock fragments, very tight and impermeable core broken into coarse ½" to 3/4" poker chips. Grades to

7' Gritstone; dull green gray, hard, with abundant well-rounded coarse grits of black basalt with pyrite crystals, well-rounded quartz grains, green, fine-grained crystalline rock fragments, red rock fragments, matrix of very fine to fine, silty sand poorly sorted, well cemented with calcite, tight and impermeable, massive, lower 6" with scattered patches of black, irregular fragments of very fine hard crystalline rock highly biotitic, grades to

2' Sandstone; green, hard, dense, fine to medium, well sorted with common biotite, black mineral grains, green vitreous mineral grains, red rock fragments and rare coarse fragments of well-rounded black basalt, well cemented with calcite, massive impermeable, slightly silty.

Core No. 84 rec'y
8832-8833' 9" 9"

Sandstone; same as last 2' interval in No. 83.

Core No. 85 rec'y
8891-8911' 14' 14'

Sandstone; gray-green, medium to coarse, hard, massive, well cemented with calcite, and a light green, silty to fine sandy, ashy matrix. Common very coarse grains and small well-rounded grits of blue-black basalt. Some light pink ash containing abundant black grains, red and brown finely crystalline igneous rock, abundant fine black vitreous mineral grains and scattered biotite flakes and local small patches of very fine pyrite crystals. Lower 2' of ash bed becomes medium well-sorted with black mineral grains becoming 50% in number, very tight and impermeable. A 6"-streak of volcanic breccia at 8899', purple with euhedral crystals of feldspar, quartz and black mineral (augite) imbedded in fine crystalline matrix of volcanic ash; black mineral crystals have red iron oxide coating. A 4' of sandstone from 8899 to 8903' becomes very ashy and contains euhedral crystals of feldspar and secondary pink vitreous mineral (zeolite) in fractures. A 6" streak of green waxy bentonite at 8903' core contains calcite and zeolite filled fractures throughout.

Core No. 86 rec'y
9247-9257' 9' 9'

Basalt breccia; red-purple finely crystalline ground mass with angular to rounded fragments of green, black, and dull gray basalt with crystals of plagioclase feldspars fresh to well weathered, crystals of green-black augite. Hard, fractured throughout.

Core No. 87 rec'y
9257-9263' 3' 3'

Basalt breccia; as above.

UNION OIL CO. OF CALIFORNIA

McGowan Well No. 1

S½ Sec. 22, T. 9N., R. 10 W.

Pacific County, Washington

Driller's Log

0	50	50	Surface sand.
50	425	375	Blue volcanic ash.
425	426	1	Hard brown shale.
426	640	214	Hard blue volcanic ash.
640	671	31	Hard volcanic ash shell.
671	802	131	Hard volcanic ash.
802	837	35	Hard brown shale.
837	855	18	Hard volcanic ash.
855	860	5	Hard brown shale.
860	979	119	Hard blue volcanic ash.
979	984	5	Hard brown shell.
984	1290	306	Volcanic ash.
1290	1316	26	Black water sand.
1316	1551	235	Volcanic ash.
1551	1556	5	Hard brown shale.
1556	1712	156	Hard blue volcanic ash (about 50% lime from 1680).
1712	1723	11	Fine blue sand.
1723	1790	67	Hard blue volcanic ash.
1790	1792	2	Hard shell.
1792	2060	269	Hard blue volcanic ash.
2060	2065	5	Hard brown shale.
2065	2214	149	Hard blue volcanic ash.
2214	2325	111	Hard blue volcanic ash with streaks of hard brown shale.
2325	2372	58	Hard blue volcanic ash.
2372	2485	113	Hard volcanic ash shell.
2485	2560	75	Hard black basalt.
2560	3720	1160	Hard blue volcanic ash (cored 3429-3435) (cored 3652-3653 no core)
3720	3765	45	Hard volcanic ash with streaks of hard brown shale.
3765	3820	85	Hard volcanic ash (about 25% lime) (cored 3767-3772)
3820	4255	435	Hard volcanic ash (cored 3825-3829 & 4016-4022)
4255	4385	130	Altered basalt, very hard (considerable lime) cored 4383-4385.

TABLE 3. GAS ANALYSES

Company	Well	Zone	Methane	Ethane	Heavy Fractions	Nitrogen	Carbon Dioxide	Hydrogen	Oxygen
Lakin, Dick	Koehler 1	500'±	97.87	1.13	(Air contamination 1.00)				
Texaco, Inc.	Potter 1 core hole	600'	51.8	-	-	46.7	0.4	0.2	0.2
Oregon Oil & Gas Co.	Roberts 1	2170'	56.5	-	-	42.99	0.08	-	0.43
		1200'	55.89	-	-	43.71	-	-	0.40
Gulf Oil Corp.	Porter 1	3800'	1.4	-	-	98.3	0.1	-	0.2
Linn County Oil Develop.	Borr 1	2200'	48.0	0.8	0.3	50.4	0.5	-	-
Reserve Oil & Gas Co.	Esmond 1	8030'	77.2	3.7	2.2	16.8	-	-	0.1
		4800'	58.2	0.12	-	41.22	0.28	-	0.18
		4000'	63.82	0.05	-	35.74	0.03	-	0.36
Alexander	?	1000'	99.80	0.17	0.03	-	-	-	-
Mitchell, Ross	Bliven 1	340'	63.8	-	-	36.1	-	-	0.1
Reserve Oil & Gas Co.	Bruer 1	1500'	57.0	-	-	43.0	-	-	-

TABLE 4. WATER ANALYSES

Company	Well	Depth of Sample	Analysis (ppm) Ca	Mg	Na	K	CO_3	HCO_3	SO_4	Cl	Li	I
Gulf Oil Corp.	Porter 1	3800'	4,794	0	2,440	6	0	98	0	12,200	1	-
Humble Oil & Ref. Co.	Miller 1	2400'	4,570	37	2,700	10	0	16	31	11,870	-	10
Lease Holding Syndicate	Dutch Canyon	4100'	1,610	24	8,340	28	0	16	4.4	15,200	-	-
Marvin Lewis	Crossley-Jennings 1	1500'	1,370	309	9,800	33	4,690	52	7	18,800	-	20
Reserve Oil & Gas	Esmond 1	7055'	8,430	305	4,400	40	0	100	181	21,460	-	5
Texaco, Inc.	Cooper Mt. 1	8000'	15,900	10.5	4,180	75	0	28.1	25.2	35,490	-	-
A.L. McKee*	?	2000'	11,500	51	4,060	22	0	14	12	26,000	-	14
J. Romig	Water well	200'	34	5	770	5.8	0	194	2.6	1,160	-	-

* Also 63 ppm Bromide.

ASTORIA BASIN SUBSURFACE SECTION

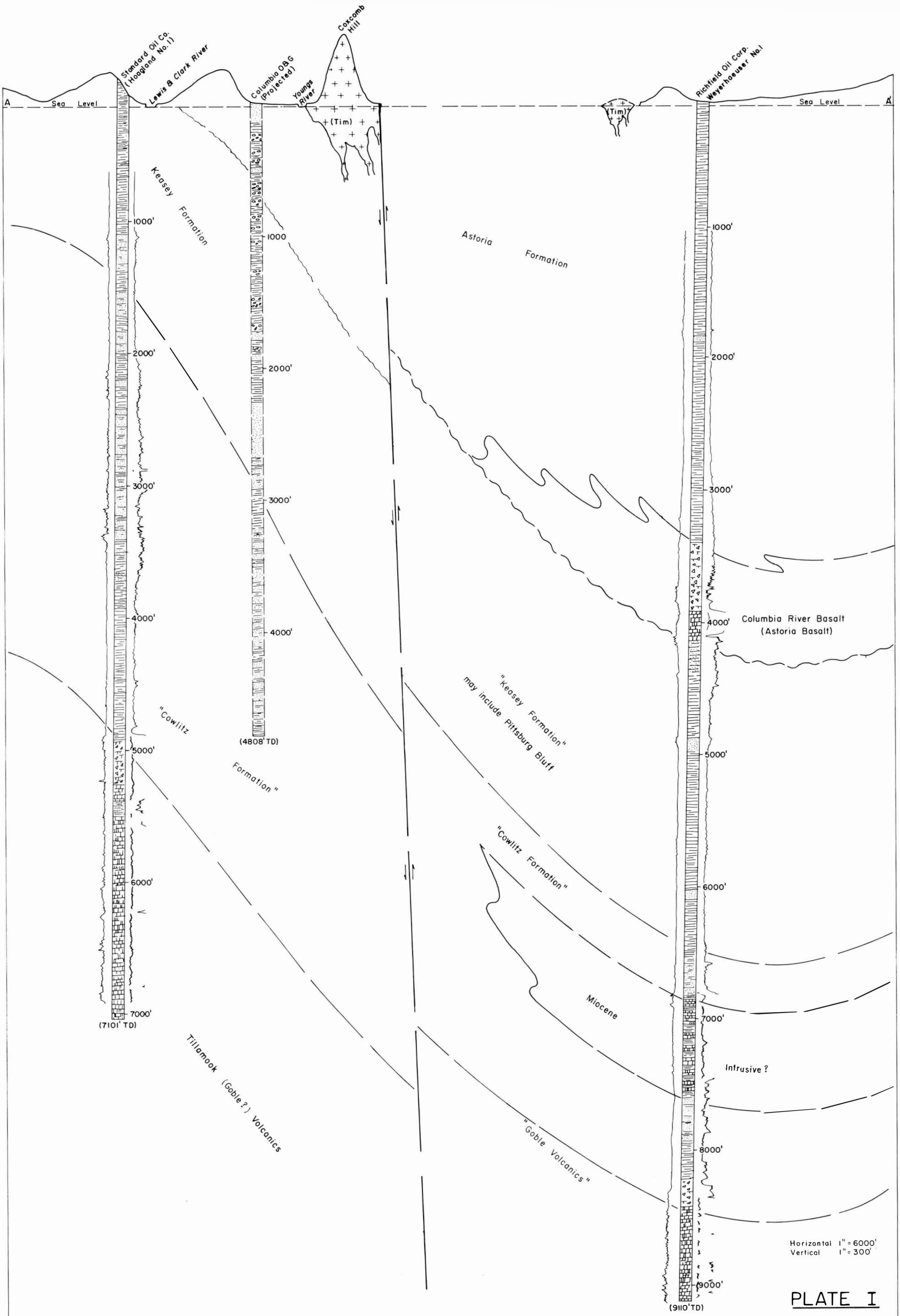


PLATE I

NEHALEM BASIN SUBSURFACE SECTION

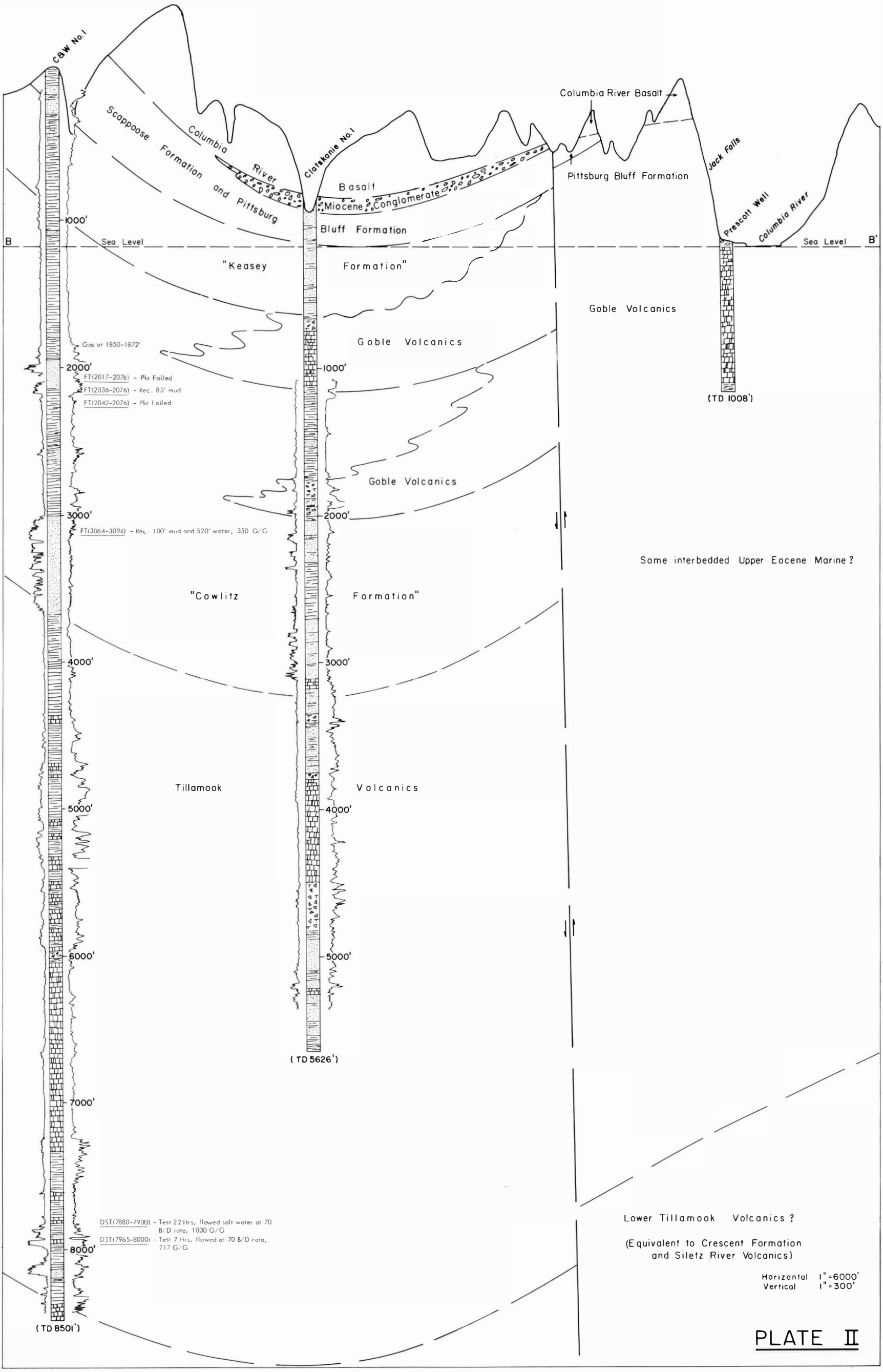


PLATE II

TUALATIN BASIN-NORTHERN WILLAMETTE VALLEY SUBSURFACE SECTION

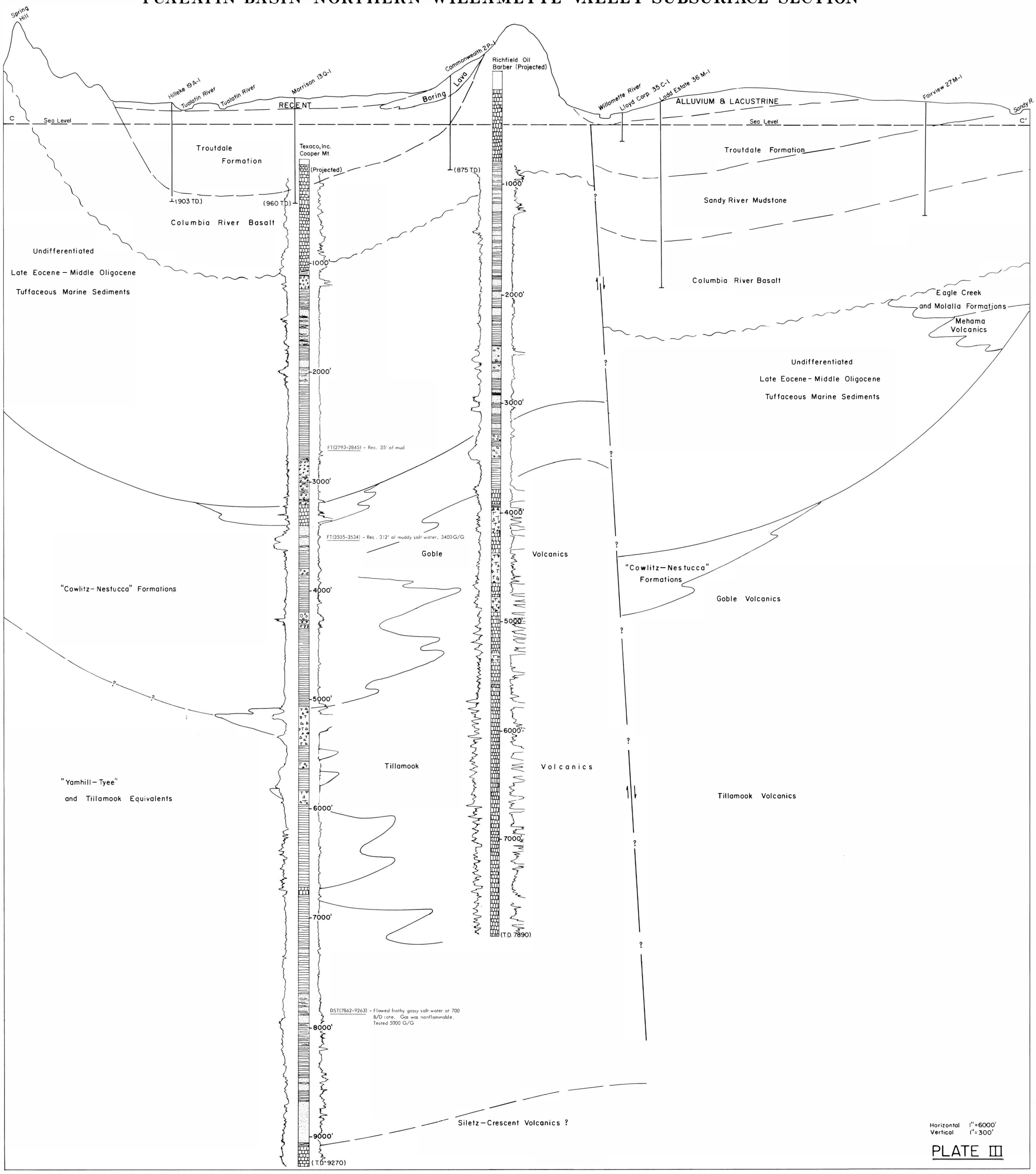
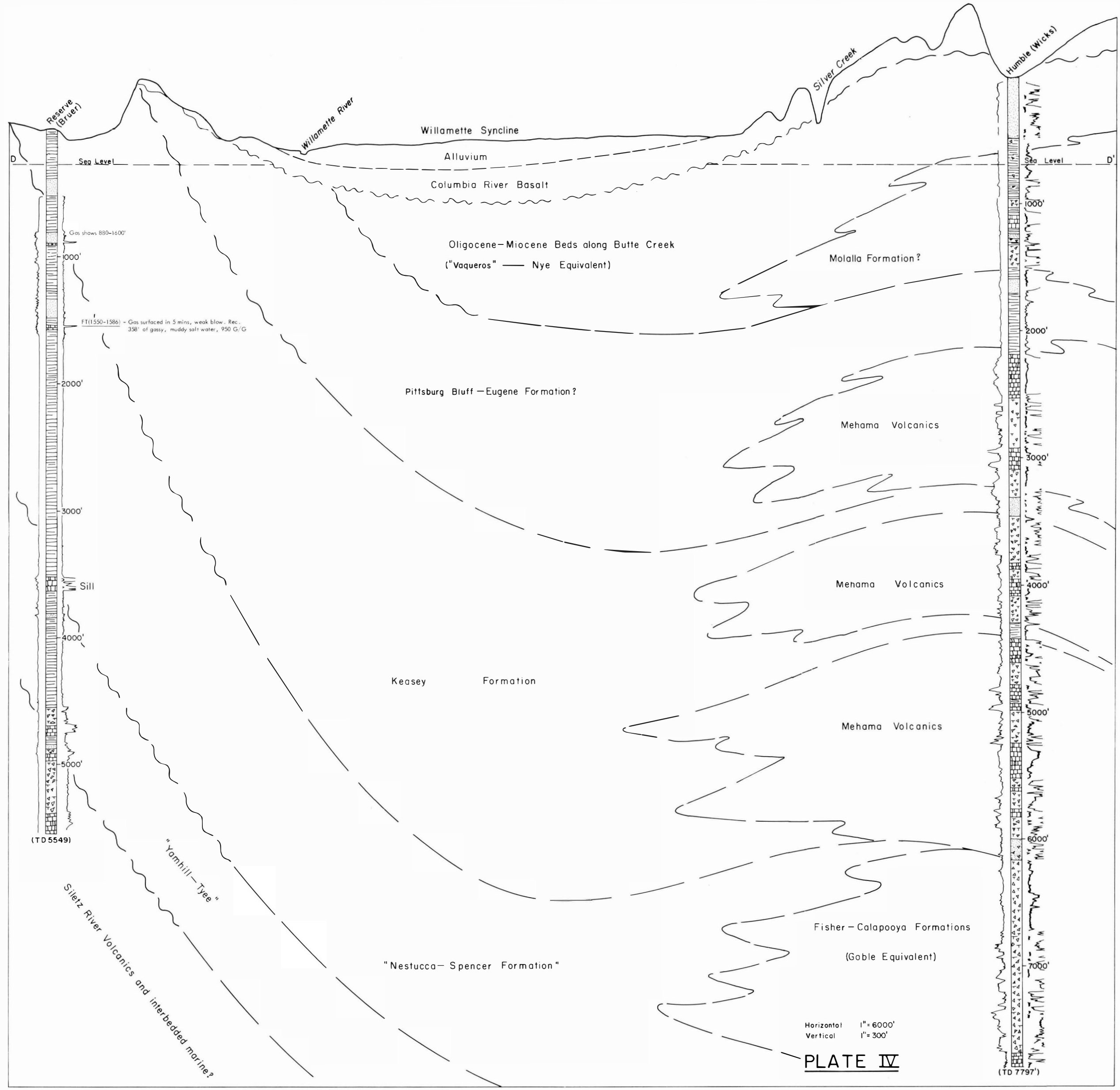


PLATE III

CENTRAL WILLAMETTE VALLEY (SALEM) SUBSURFACE SECTION.



CENTRAL WILLAMETTE VALLEY (ALBANY) SUBSURFACE SECTION.

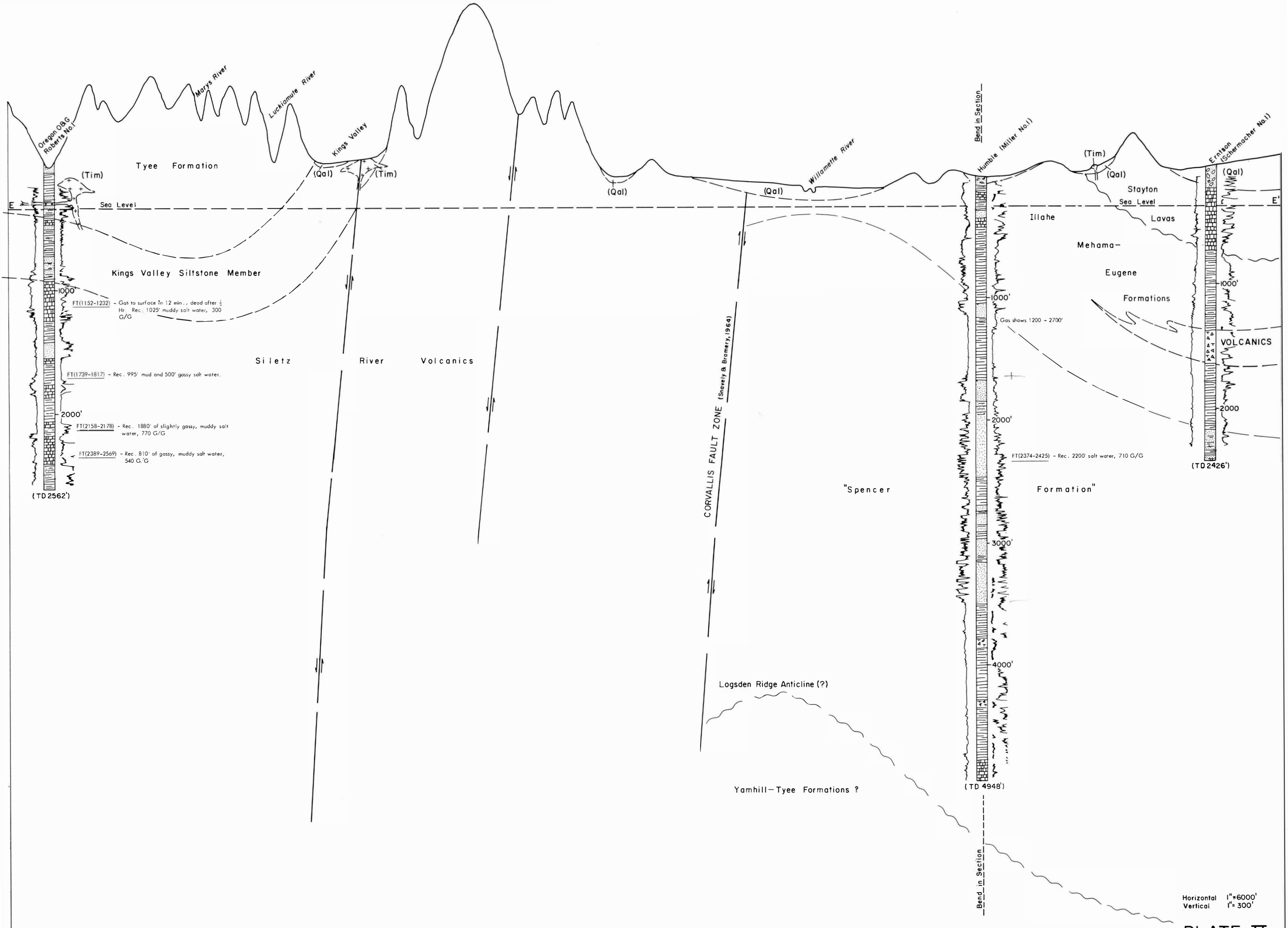
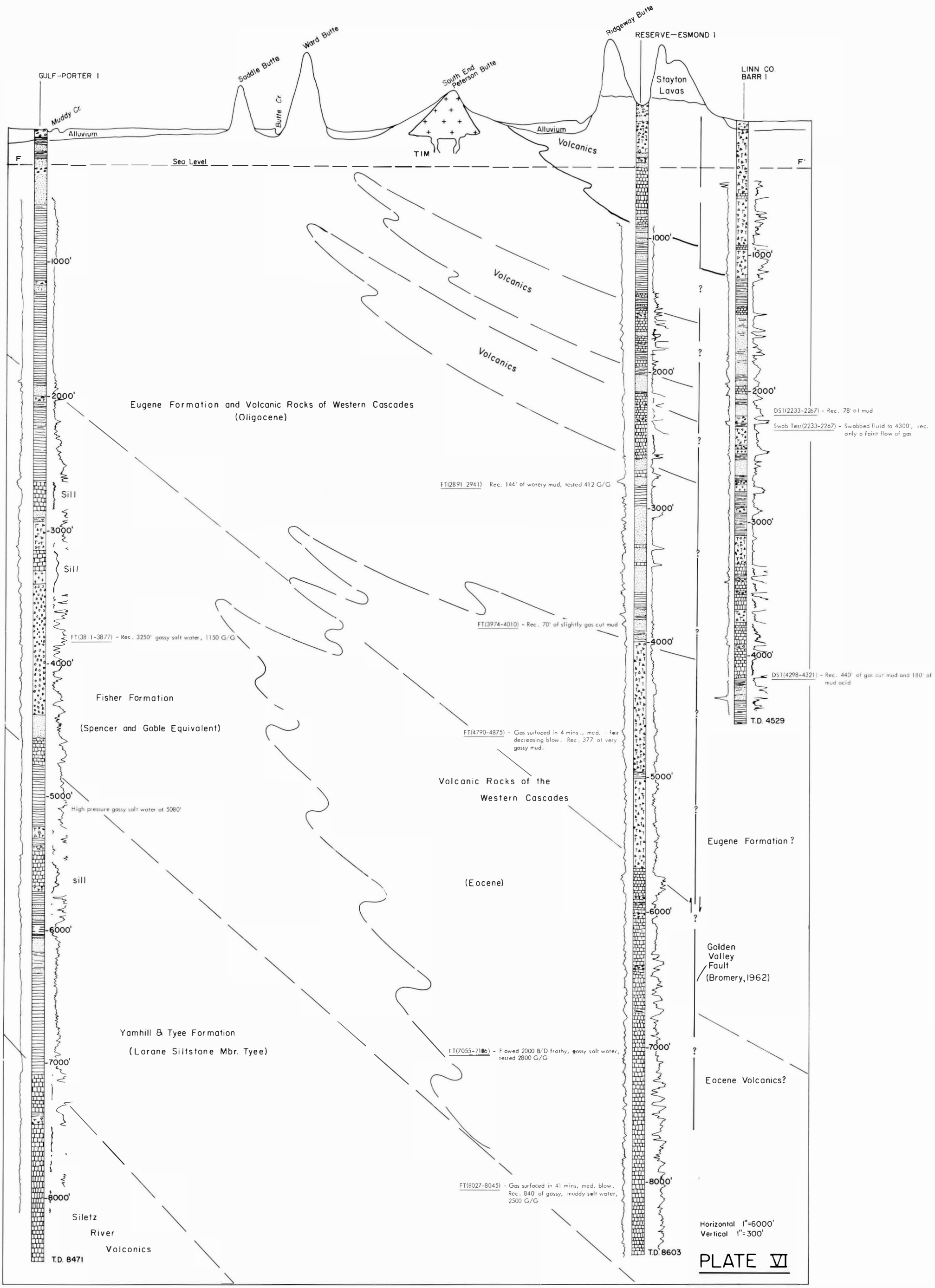


PLATE V

SOUTHERN WILLAMETTE VALLEY SUBSURFACE SECTION



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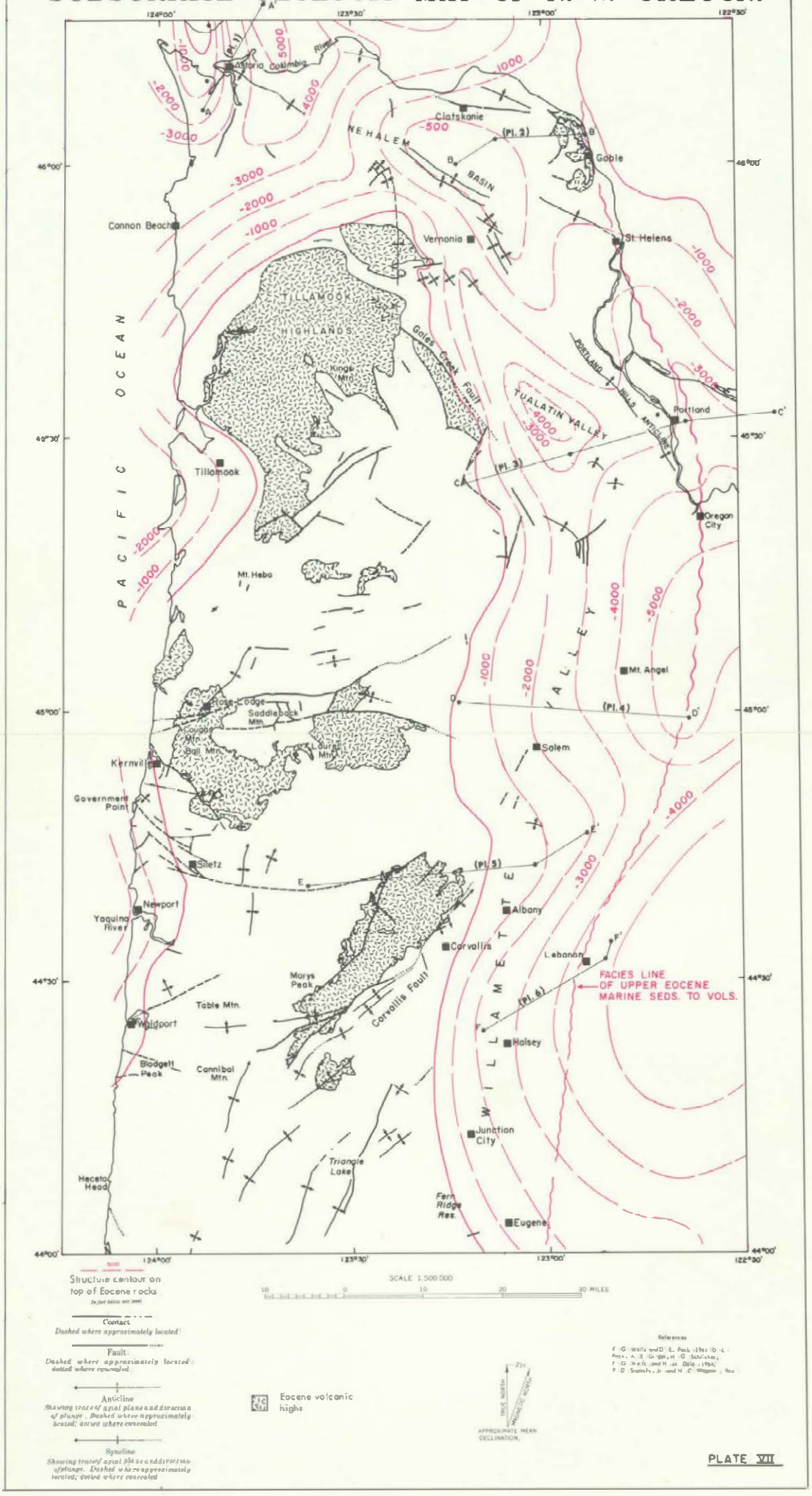
SUBSURFACE GEOLOGIC MAP OF N. W. OREGON.