

# **SUBSURFACE BIOSTRATIGRAPHY OF THE EAST NEHALEM BASIN, COLUMBIA COUNTY, OREGON**

**1983**

**STATE OF OREGON  
DEPARTMENT OF GEOLOGY AND MINERAL INDUSTRIES  
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**OIL AND GAS INVESTIGATION 9**

**SUBSURFACE BIOSTRATIGRAPHY OF THE  
EAST NEHALEM BASIN,  
COLUMBIA COUNTY, OREGON**

By

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1983

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## SECTION I. OVERVIEW

### INTRODUCTION

Shortly after the birth of Mist Field, American Quasar began an active drilling program southeast of production. Ten of Quasar's wells are included in this report. They were drilled from September 1979 to January 1981. Aside from one 7000 ft test the wells were shallow. The remaining nine averaged 2850 ft in depth.

Five other wells are included in this study. One is the Reichhold Columbia County No. 1, OH in Mist Field, drilled in 1977 and redrilled for Oregon's first discovery in May, 1979. The other four are deeper tests, averaging 6500 ft. They are: Texaco Clark & Wilson No. 6-1, southeast of production amid Quasar's play; Reichhold Crown Zellerbach Nos. 2 and 4, farther southeast; and Texaco Benson Clatskanie No. 1, northeast of Mist Field.

This report provides detailed biostratigraphy of strata adjacent to Oregon's only production. Hopefully, the data here presented will help place the history of Mist Field in perspective with its surroundings.

Section II includes individual foraminiferal reports for each of the 15 wells. Each well report contains an introductory summary followed by sample-by-sample listings of fossil and key lithologic highest occurrences. Highest occurrences only are used because of extensive downhole contamination in ditch samples. Each well report is concluded by interpretations of age (benthic foraminiferal Stage) and paleobathymetry for each distinctive well interval. Four of the well reports contain correlation sections which tie the well to another in the study.

Concluding this report (back cover) is a subsurface illustration which contains a surface location map and key correlations for all the wells in the form of three separate north-south cross sections.

### SAMPLE COVERAGE AND PROCESSING

Interpretations in this study are based on analyses by the writer of 1478 samples (1020 wet ditch, 358 dry ditch and 100 cores). Essentially one ditch sample was analyzed for each 30 feet of section in 12 of the 15 wells. The remaining three, the Clark & Wilson, Benson Clatskanie and Crown Zellerbach No. 4 were sampled sparsely and are herein interpreted tentatively. Overall coverage, however, is sufficient for generally complete faunal representation and hence reliable correlations.

Raw material from each sample was boiled for 20 minutes in a 32 to 1 water to Quaternary "0" (Zingula, 1968) solution. Fossils were not concentrated by flotation, thereby eliminating the possibility of losing replaced, infilled, pyritized or arenaceous specimens in the tailings.

### FOSSIL CORRELATIONS

California benthic foraminiferal Stages of Kleinpell (1938), Schenck and Kleinpell (1936) and Mallory (1959) are used in this study. The Pacific Northwest framework of Rau (1981) and insights by McDougall (1980) also influenced the interpretations.

The only Stage boundary recognized in this study is that between the Refugian and underlying Narizian. This boundary appears to be a major unconformity throughout the Nehalem Basin. The Zemorrian-Refugian boundary may exist in two well sections (American Quasar Nos. 15-14 and 34-21) but it cannot be identified because of shallow neritic facies.

Highest occurrences of species at six different horizons were selected for correlation on a subsurface chart (back cover). Because all wells discussed herein were drilled in the same basin, distribution of certain benthic as well as planktic forms were found to be time-stratigraphic.

Planktic Foraminifera are rare and of low diversity in Narizian and younger sediments of the Pacific Northwest. However, a few species are useful stratigraphically in the Nehalem Basin. The most important one is the Refugian Turborotalia insolita. Although small in size it occurs consistently for a few hundred feet of section in sufficient numbers for repeated recognition. T. insolita became extinct within the "Middle" Refugian as it is here interpreted in the Nehalem Basin. Regionally, this point in time occurred slightly before the end of the Eocene in New Zealand (Jenkins, 1971) and most probably in other late Eocene seas with similar watermass conditions, including off the northwest coast of North America.

Besides Turborotalia insolita, other rare but somewhat useful planktic species are Globigerina-theka index and Pseudohastigerina micra. Highest occurrences of G. index and P. micra appear to be essentially at and slightly below the top of the Narizian, respectively, in the Nehalem Basin.

Certain benthic species provide the best Narizian markers in the Nehalem Basin. Highest Narizian sediments are marked by highest occurrences of Cibicides natlandi in neritic to upper bathyal facies and Bulimina microcostata in the upper middle bathyal. A deep bathyal "maximum transgression" within the upper Narizian above the top of the upper Cowlitz sand is herein defined by maximum numbers of hispid Uvigerina and the highest occurrence of U. churchi, s.l.

Narizian (undifferentiated) sediments below the upper Cowlitz sand contain nondescript faunas which are difficult to correlate. Only a few species below the thick Narizian volcanics appear to have stratigraphic significance.



## LITHOLOGIC CORRELATIONS

Lithologies noted throughout this study are from biased sample residues after boiling in Quaternary "0" and washing through a 200 mesh screen. Although quantitatively incorrect, they are qualitatively useful, especially for correlation.

Most correlative lithologies in the Nehalem Basin are related to volcanic events. Refugian sediments generally contain a much greater abundance of glass shards than strata of Narizian age. More specifically, there is a distinctive lower Refugian horizon of rounded coarse-grained volcanic sand (see subsurface correlation chart, back cover). This event (hiatus?) is excellent for correlation in cross section no. 2. It involves probably less than 30 ft of section.

Thick Narizian volcanics (below the upper Cowlitz sand) occur in most of the wells except those which were drilled in or immediately around Township 5 North, Range 4 West. The beginning and end of this major volcanic event are generally useful for correlation in the Nehalem Basin.

A Narizian sand equivalent to Mist Field's producer (upper Cowlitz sand) is correlative in most all Nehalem Basin wells. The sand is typically fine-grained at the top, coarsening to medium-grained a short distance below. In this study, occasional inner to middle neritic foraminiferal species were found within the sandy interval with sandstone stuck to the specimens. These very rare occurrences are considered indigenous, whereas more abundant bathyal forms are thought to be from finer-grained cavings.

In the three wells drilled farthest east in the study area, the upper Cowlitz sand is not immediately recognizable. The Texaco Clatskanie No. 1 may have spudded in pre-upper Cowlitz sand sediments. In the Reichhold Crown Zellerbach Nos. 2 and 4, the upper Cowlitz sand appears to be missing along with the entire upper Narizian section which normally occurs above thick volcanics.

## PALEOENVIRONMENTAL TRENDS

A generalized paleobathymetric curve for the study area is illustrated in Figure 1. Interpretations of water depth throughout this study are based primarily on southern California data presented by Ingle (1980). Maximum depths for his Paleogene biofacies are: inner neritic 150 ft; outer neritic 470 ft; upper bathyal 1560 ft; upper middle bathyal 4700 ft; lower middle bathyal 6250 ft. It is quite possible that southern California species migrated into shallower water in the Pacific Northwest due to cooler water temperatures. But this factor does not affect paleobathymetric correlations based on transgressive-regressive cycles.

Essentially all strata penetrated by the wells of this study were deposited close to shore. None of the wells reached Ulatisian or older sediments which in the Oregon Coast Range typically contain abundant fossil plankton indicating offshore deposition.

Before upper bathyal depths prevailed in the lower Refugian a "maximum transgression" to deep bathyal occurred momentarily in the upper Narizian. This event (often represented by only one 30 ft sample) generally is recognizable slightly below midway between highest Narizian and top of the sand.

As such, recognition of this event while a well is drilling provides a useful means of estimating where the top of the sand will be. Complicating this procedure however is the presence of a younger Narizian sand (which is glauconitic, and therefore marine) in certain wells (e.g., Texaco Clark & Wilson and American Quasar Nos. 20-21 and 23-33). In most Nehalem Basin wells this sand along with other uppermost Narizian sediments has been eroded away at the Narizian-Refugian boundary hiatus.

Narizian sediments between the upper Cowlitz sand and the underlying thick volcanics generally contain relatively poorly developed faunas of mixed paleobathymetric origins. Few species are present here that are not found above the sand. However, there are greater numbers of neritic species immediately below the sand than above it.

In Narizian sediments below the volcanics, faunas are of much lower diversity than those above the upper Cowlitz sand, but both represent middle bathyal or deeper conditions. A glaring exception is the Reichhold Crown Zellerbach No. 2 section, where only shallow neritic (Narizian?) faunas occur below the volcanics.

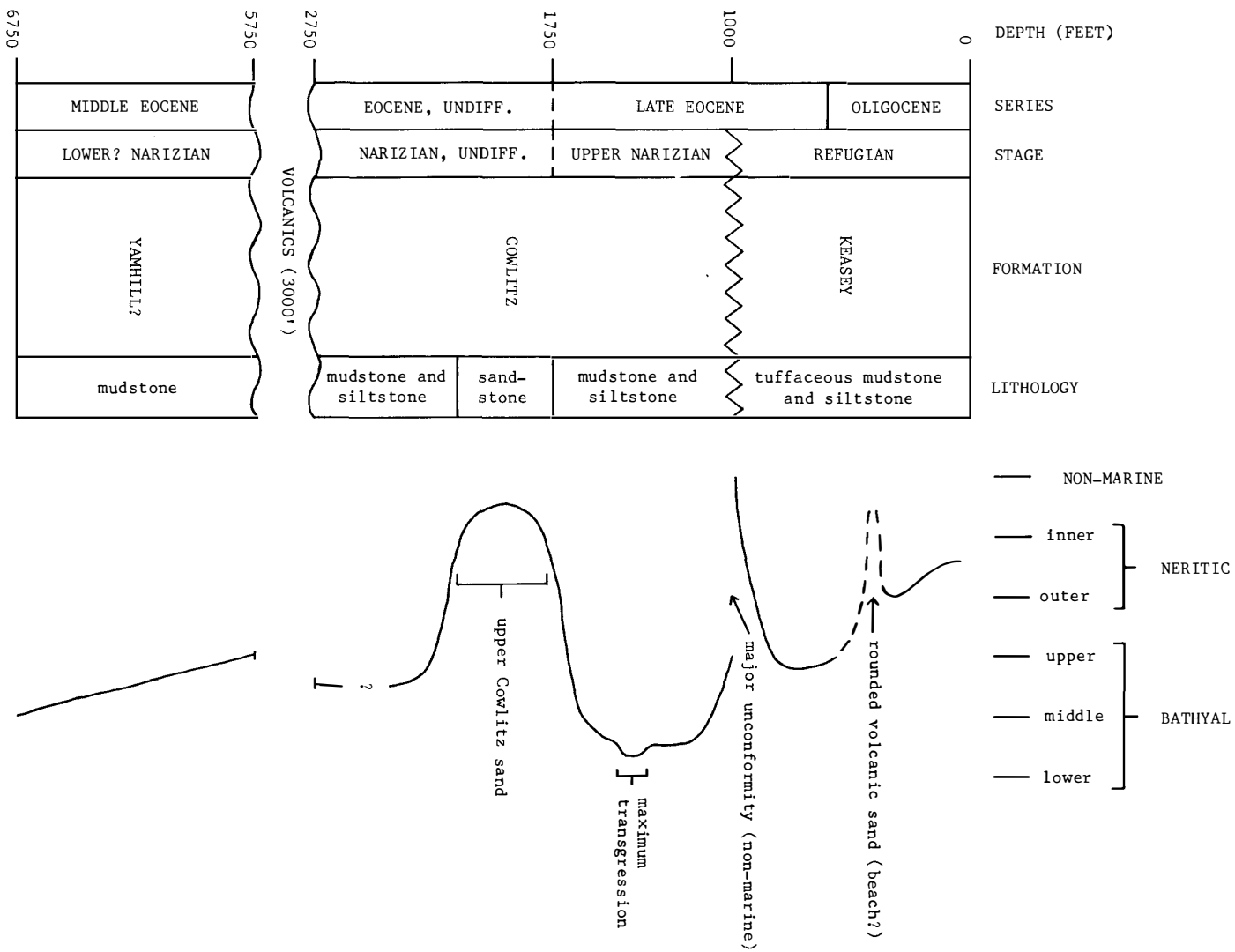


Figure 1. Generalized paleobathymetric curve for typical well section, east Nehalem Basin.

## SECTION II. FORAMINIFERAL REPORTS

REICHHOLD ENERGY CORPORATION  
COLUMBIA COUNTY NO. 1, OH  
NW¼ SEC. 11, T6N, R5W

### Summary

Foraminifera characteristic of the Refugian Stage occur from 360 to 1620 ft. Species from 1620 to 3120 ft are indicative of the Narizian.

Water depth was generally outer neritic or deeper; it was deepest (maximum transgression) at 2190 to 2220 ft. Shallowest marine conditions (inner neritic to middle neritic) occurred during deposition of the upper Cowlitz sand from 2430 to 3000 ft.

Relatively low percentages of fossil plankton indicate deposition was open marine but relatively close to shore throughout the well section. Maximum numbers of plankton (spumelline Radiolaria) occur from 1680 to 1740 ft, just below the highest occurrence of Cibicides natlandi (top of the Narizian).

Two hiatuses are here postulated. One is between 1200 and 1230 ft where there is a sudden faunal increase and a sudden disappearance of volcanic glass, the latter being abundant above this depth. The other is between 1860 and 1890 ft where there is a significant increase in paleo-depth accompanied by a great abundance of Bulimina microcostata, the latter being conspicuously absent above this depth.

### BIOSTRATIGRAPHIC RESULTS

The following data were derived from previously unprocessed dry ditch samples borrowed from the Oregon Department of Geology and Mineral Industries (DOGAMI) collection. All single depths noted below represent bottoms of 30 ft intervals.

- 60' Lignitic siltstone. Barren of marine fossils.
- 90' Glauconite and glass shards both very abundant. Barren of marine fossils.
- 90-210' Light brown mudstone. Barren of fossils.
- 210-360' No samples available.
- 390' Globobulimina spp., Quinqueloculina spp., Cassidulina cf. galvinensis, Guttulina irregularis, Caucasina schencki, Plectofrondicularia multilinea, Arenaceous indeterminate, Cibicides sp.
- 420' Uvigerina atwilli/cocoaensis (intermediate form), Cibicides evolutus, Plectofrondicularia spp., P. vokesi, Spumellaria (spheres), Dentalina/Nodosaria spp. (fragments), Cassidulina galvinensis/globosa (intermediate form).

- 450' Nodosaria longiscata, Uvigerina cf. atwilli, Cassidulina cf. globosa, Gyroidina? condoni? (worn), Anomalina sp. (juvenile), Diatoms (pyritized, centrate).
- 480' Shell fragments, Quinqueloculina imperialis? (fragments), Sterrasters.
- 480-540' No new species or lithologies.
- 570' Uvigerina yazooensis?, Gyroidina planata, Plectofrondicularia packardi, Spongodiscidae (discs).
- 600' No new species or lithologies.
- 630' Ceratobulimina washburnei.
- 660' Subbotina sp., Echinoid spines.
- 690' Uvigerina sp. var. (costate, juvenile).
- 690-750' No new species or lithologies.
- 780' Spongurus sp.
- 810' No new species or lithologies.
- 840' Diatoms (centrate, not pyritized).
- 870' No new species or lithologies.
- 900' Alabamina kernensis.
- 930' Light brown diatomaceous mudstone. No new species.
- 960' No new species or lithologies.
- 990' Cassidulina globosa.
- 1020' No new species or lithologies.
- 1050' Prunopyle? cf. titan?.
- 1080' Karreriella? sp.
- 1110' Barren of fossils.
- 1110-1170' No new species or lithologies.
- 1200' Pyrite common. Barren of fossils.
- 1230' Cassidulina cf. globosa var. (uncoiling), Pseudoglandulina inflata, Siphonina? sp. (crushed), Gyroidina cf. condoni. Volcanic glass disappears here. Possible hiatus.
- 1260' Lenticulina sp. var. (large), Cassidulina globosa var. (uncoiling), Ostracod, Gyroidina? (Eponides?) sp. (convex spiral side), Cibicides sp. var. (coarsely perforate, spiral side only), Bolivina basiscurta, Plectofrondicularia minuta, Turborotalia insolita, Sponge spicules, Bolivina klein-pelli.
- 1260-1350' No samples available.
- 1380' Volcanic? fragments. Pullenia sp., Cibicides cf. mcmastersi, Gastropod, Eponides mexicana, Subbotina minima?, Florilus applini.



- 1410' Globigerinatheka? (crushed), Plectofrondicularia robusta, Cibicides mcmastersi, Chiloguembelina cubensis, Globobulimina sp. var. (very large).
- 1440' Uvigerina atwilli, s.s., Cibicides aff. lobatulus, C. aff. natlandi (smooth involute side).
- 1470' Lagena striata, Nonion planatum.
- 1500' No sample available.
- 1530' Uvigerina sp. var. (lightly costate), Cibicides lobatulus/fletcheri (intermediate form).
- 1560' Uvigerina cocoaensis, Boldia hodgei, Plectofrondicularia aff. californica.
- 1590' Cyclammina? sp. (crushed), Lagena hexagona, Cibicides haydoni, Lenticulina chirana, "Angulogerina" cooperensis, Buliminella elegantissima?.
- 1620' Bolivina cf. oregonensis.
- 1650' Alabamina scitula, Cibicides natlandi.
- 1680' Light tan sucrosic siltstone. No new species.
- 1710' No new species or lithologies. Increase in Spumellaria to abundant.
- 1740' Pseudohastigerina micra, Trochammina sp. var. (small, thin, concavo-convex).
- 1770' Lenticulina welchi, L. cf. terryi, Nonion inflatum.
- 1800' Bulimina sculptilis.
- 1830' Bulimina sp. var. (small, spinose lower third of test).
- 1860' Bulimina laciniata, Bathysiphon eocenica.
- 1890' Bulimina microcostata (very abundant), Uvigerina nudorobusta, Valvulineria tumeyensis, Bulimina sp. var. (small, thin, pointed initial end). Possible hiatus.
- 1920' Brown mudstone. No new species.
- 1950' Cibicides cf. laurissae, Sigmoilina tenuis.
- 1980' Plectofrondicularia vaughani, Valvulineria cf. churchi.
- 2010' Eggerella sp. var. (large, crushed).
- 2040' Plectofrondicularia oregonensis.
- 2070' Valvulineria welcomensis, Gyroidina aff. scalata.
- 2100' Valvulineria churchi, Gyroidina condoni, s.s., Cassidulina margareta?, Fish teeth, Bulimina sp. var. (small, costate except for last chamber).
- 2130' Cassidulina globosa, s.s., Boldia hodgei/cushmani (intermediate form).
- 2160' Bolivina oregonensis, Loxostomum? sp. var. (very small, very thin).
- 2190' Valvulineria churchi var. (large), Uvigerina nudorobusta var. (large), U. elongata, U. churchi, Dentalina? sp. var. (large fragment).
- 2220' Valvulineria tumeyensis/churchi (intermediate form), V. tumeyensis/churchi var. (high trochospiral), U. cf. yazoensis (large),
- 2220', Cibicides granulatus?, C. laurissae, s.s., cont. Cassidulina globosa var. (large), Truncorotaloides aspensis, Bolivina "raui" (new species - short, wide test). Remark: Hispid Uvigerina reach maximum numbers in this sample, indicating a "maximum transgression" (maximum water depth).
- 2250' Eponides mexicana var. (highly convex involute side), Cyclammina pacifica, Vaginulinopsis saundersi, Anomalina cf. garzaensis?, Gyroidina soldanii/condoni (intermediate form), Textularia sp., Subbotina minima, Karreriella contorta.
- 2280' Globigerinatheka index, Saracenaria sp., Quadrimorphina sp.
- 2310' Subbotina sp. var. (large), Pseudoglandulina nallpeensis, Cibicides? sp. var. (small, thin, many chambers).
- 2340' Plectofrondicularia searsii. Brown mudstone lithology increasingly resistant to Quaternary "0".
- 2370' Pseudohastigerina lillisi, Virgulina? sp. var. (very thin, small, rounded cross section, finely costate), V.? sp. var. (very thin, small, smooth), Bolivina striatella, increase in echinoid spines to abundant. Coal very abundant.
- 2400' Subbotina prasaepis. Increase in Florilus aplini and Globobulimina spp. to very abundant.
- 2430' Cibicides olequaensis.
- 2460' Clean fine-grained sandstone. Cibicides natlandi/haydoni (intermediate form).
- 2490' Pyrite-quartz sandstone clusters. Barren of indigenous fossils.
- 2520' Truncorotaloides pentacamerata, Caucasina schencki var. (large).
- 2550' Subbotina linaperta.
- 2580' Bulimina sp. var. (large, smooth, elongate).
- 2610' Subbotina cf. wilsoni.
- 2640' Medium-grained sandstone. No new species.
- 2640-2760' No new species or lithologies.
- 2790' Lenticulina cowlitzensis, coal/lignite (intermediate) very abundant.
- 2820' Valvulineria involuta.
- 2850' Probably barren if indigenous Foraminifera.
- 2880' Increase in sand. Barren of indigenous fossils.
- 2910' Light gray to white tuffaceous? siltstone?. Barren of indigenous fossils.
- 2910-2970' No new species or lithologies.
- 3000' Ostracod var. (deep median sulcus). Probably barren of indigenous Foraminifera.
- 3030' Cyclammina sp. var. (large), Bifarina nuttalli, Spumellaria var. ("spiny spheres"), Eponides aff. rosaformis.
- 3060' Anomalina crassisepta, Spongodiscidae var. (large).
- 3090' No new species or lithologies.

3120' Volcanic rock fragments abundant. Siphonina cowlitzensis, Alabamina californica, Uvigerina sp. var. (hispido-costate), Bolivina kleinPELLI var. (increased elongation), "Angulogerina" sp. var. (obese).

#### CONCLUSIONS

DEPTH (FEET)	STAGE	PALEOENVIRONMENT
30-60	Indeterminate	Indeterminate
360-1080	Refugian	Upper Bathyal
1080-1200	Indeterminate	Indeterminate
1200-1620	Refugian	Upper Bathyal
1620-1740	Upper Narizian	Outer Neritic to Upper Bathyal
1740-1770	Upper Narizian	Upper Bathyal
1770-1860	Upper Narizian	Upper Middle Bathyal
1860-2070	Upper Narizian	Lower Middle Bathyal
2070-2160	Upper Narizian	Upper Middle Bathyal
2160-2190	Upper Narizian	Lower Middle Bathyal
2190-2220	Upper Narizian	Lower Middle to Lower Bathyal
2220-2340	Upper Narizian	Lower Middle Bathyal
2340-2370	Upper Narizian	Middle Bathyal undifferentiated
2370-2430	Upper Narizian	Outer Neritic to Upper Bathyal
2430-2640	Indeterminate	Probably Middle Neritic
2640-2760	Indeterminate	Indeterminate
2760-2820	Indeterminate	Probably Middle Neritic
2820-2970	Indeterminate	Indeterminate
2970-3000	Narizian undifferentiated	Inner Neritic?
3000-3111	Narizian undifferentiated	Lower Middle Bathyal

AMERICAN QUASAR PETROLEUM COMPANY  
LARKINS NO. 23-33  
NW¼ SEC. 23, T6N, R5W

#### Summary

A distinctive feature of this well section is the unusually thick fossiliferous Narizian section above the upper Cowlitz sand. Highest Narizian fossils occur at 870 to 900 ft. The section from 870 to 1260 ft appears to be missing in many of the other wells of this study. This aberrant interval consists of a middle bathyal uppermost (?) Narizian fauna from 870 to 1050 ft underlain by glauconitic sandstone from 1080 to 1200 ft. This sand is here considered distinctive from (younger than) the producing non-glauconitic upper Cowlitz sand at Mist Field.

The sediments penetrated by this well were deposited quite close to shore with one exception; the interval from 960 to 990 ft contains abundant

nasselline Radiolaria, indicating somewhat greater distances from shore. Fossiliferous portions of the section suggest open marine conditions in the upper Narizian and intermittent open marine in the Refugian.

A maximum transgression just above the upper Cowlitz sand is defined by maximum numbers of hispid Uvigerina from 1650 to 1680 ft.

Two coal/lignite layers suggest non-marine or marginal marine conditions at 1860 to 1890 ft and 2070 to 2100 ft.

The well bottomed in volcanics at 2130 ft.

#### BIOSTRATIGRAPHIC RESULTS

The following data were derived from previously unprocessed wet ditch samples. All single depths noted below represent bottoms of 30 ft intervals.

- 30' Quinqueloculina sp.
- 60-150' Barren of fossils. Pyrite very abundant at 60-90'.
- 180' Shell fragments, Guttulina irregularis.
- 210' Caucasina schenckii.
- 240' Gastropod.
- 270' Globobulimina sp.
- 300, 330' Barren of fossils. Glauconite.
- 360' Spumellaria (spheres), Spongodiscidae (discs), Spongurus sp. Barren of Foraminifera.
- 390' Cassidulina globosa, Melonis cf. pompilioides, Uvigerina atwilli/cocoaensis (intermediate form), Pullenia sp.
- 420' Uvigerina atwilli, Cibicides evolutus, Cassidulina cf. galvinensis.
- 450' Eponides cf. kleinPELLI, Lenticulina spp., Plectofrondicularia packardii.
- 480' Diatom (pyritized, centrate), Sterrasters. Barren of Foraminifera.
- 510' Light tan glauconitic mudstone. Sponge spicules. Barren of Foraminifera.
- 540, 570' No new species or lithologies. Barren of Foraminifera.
- 570-720' No new species or lithologies. Barren of Foraminifera. Volcanic rock fragments.
- 750' Uvigerina sp. var. (lightly costate).
- 780' Barren of Foraminifera.
- 810' Cibicides haydoni, C. aff. mcMastersi, Plectofrondicularia gracilis, Florilus applini.
- 840' Turborotalia insolita, Bolivina striatella, Chiloguembelina cubensis.
- 870' Quinqueloculina imperialis, Lenticulina texanus, Boldia hodgei, Cibicides cf. mcMastersi, Bolivina oregonensis, B. basiscurta.
- 900' Bulimina microcostata, "Angulogerina" cooperensis, Loxostomum? sp., Nodosaria longiscata.
- 930' Elphidiella sp., Uvigerina nudorobusta, Pseudohastigerina micra, Nassellaria.
- 960' Lenticulina welchi, Gyroidina sp.
- 990' Plectofrondicularia vaughani, Nassellaria abundant (maximum).

1020' Gyroidina condoni.

1050' Cibicides natlandi. Significant shoaling from samples above.

1080' Sucrosic lithology. Increase in sand through 100 mesh sieve.

1110' Fine-grained glauconitic sandstone, pyrite-quartz sandstone clusters, Elphidium sp., Eponides mexicana.

1140' Alabamina kernensis, "Eponides" sp. (of Tipton, et. al., 1973), Nonion inflatum.

1170' Vaginulinopsos lewisensis?, Valvulineria menloensis (worn).

1200' Epistomina sp., Lenticulina chirana.

1230' Vaginulinopsis saundersi. Sharp decrease in sample size after processing.

1260' Tan to brownish-gray mudstone. No new species.

1290' Ceratobulimina washburnei, Plectofrondicularia aff. californica?, Echinoid spines.

1320' Tan silty mudstone. Bulimina laciniata.

1350' Gyroidina cf. scalata?

1380' Cibicides cf. cushmani?

1410' Cibicides cf. cushmani.

1440' Cibicides mcmastersi, Cassidulina globosa var. (inflated chambers).

1470' Haplophragmoides sp., Arenaceous indeterminate.

1500' Eggerella sp. var. (crushed), Bulimina sculptilis, Lenticulina cf. terryi, Bolivina kleinpellii.

1530' Brown calcareous? mudstone. Haplophragmoides trullissata.

1560' No new species or lithologies.

1590' Valvulineria churchi, Textularia? sp. var. (large), Uvigerina cf. churchi, Eponides mexicana var. (involute side highly convex), Bulimina corrugata, Truncorotaloides sp. var. (four chambers outer whorl).

1620' Diatom var. (triangular outline, pyritized), Subbotina spp.

1650' Pseudoglandulina nallpeensis, Quinqueloculina goodspeedi, Uvigerina elongata?, Subbotina senni?, Gyroidina condoni/octocamerata (intermediate form), Bulimina cf. corrugata.

1680' Uvigerina cf. yazooensis var. (large), U. nudorobusta common (maximum).

1710' Cibicides sp. var. (thin in edge view), Saracenaria sp. Uvigerina nudorobusta var. (large), Bulimina sp. var. (thin wall, spinose lower half).

1740, 1770' No new species or lithologies.

1800' Highest medium-grained sandstone. Cibicides mcmastersi, Eponides aff. duprei?. Top of upper Cowlitz sand.

1830' Ammodiscus? (fragment).

1860' "Globulina" landesi (of Beck, 1943), Sigmolina tenuis. Top of second (lower) interval

1860', of sandstone-pyrite clusters. cont.

1890' Coal/lignite very abundant. Valvulineria welcomensis.

1920, 1950' No new species or lithologies.

1980' Cyclammina sp. var. (large).

2010, 2040, 2070' No new species or lithologies. Barren of indigenous Foraminifera.

2100' Barren of indigenous Foraminifera. Coal/lignite flood.

2130' Barren of indigenous Foraminifera. Volcanic rock fragments very very abundant.

#### CONCLUSIONS

DEPTH (FEET)	STAGE	PALEOENVIRONMENT
0-150	Indeterminate	Indeterminate
150-270	Refugian	Neritic undifferentiated
270-330	Indeterminate	Marine undifferentiated
330-450	Refugian	Upper Bathyal
450-780	Indeterminate	Marine undifferentiated
780-870	Refugian	Upper Bathyal
870-900	Upper Narizian	Upper Middle Bathyal
900-990	Upper Narizian	Middle Bathyal undifferentiated
990-1050	Upper Narizian	Upper Middle Bathyal
1050-1260	Upper Narizian	Inner to Outer Neritic
1260-1530	Upper Narizian	Mixed Neritic to Upper Middle Bathyal
1530-1650	Upper Narizian	Lower Middle Bathyal
1650-1680	Upper Narizian	Lower Middle Bathyal to Lower Bathyal
1680-1710	Upper Narizian	Lower Middle Bathyal
1710-1860	Indeterminate	Mixed Neritic to Middle Bathyal
1860-1980	Indeterminate	Mixed Marginal Marine to Middle Neritic
1980-2130	Indeterminate	Possibly Non-Marine

AMERICAN QUASAR PETROLEUM COMPANY  
 LONGVIEW FIBRE NO. 25-33  
 SE½ SEC. 25, T6N, R5W

#### Summary

The well penetrated two main sedimentary intervals separated by a thick volcanic sequence. The higher sedimentary interval contains the Refugian-upper Narizian boundary in a siltstone at 590 to 620 ft. A large benthic faunal change occurs here. Also, differing watermass conditions across this contact are indicated by a large increase in radiolarian abundance in the Narizian. Therefore a hiatus at 590 to 620 ft exists based

on microfossils.

The entire well section below 620 ft is Narizian in age. Volcanics extend from 3600 to 5830 ft, followed by a sandy interval from 6070 to 6700 ft. The bottom 300 ft (to 7000 ft, T.D.) is lower Narizian in age, based on the presence of *Baggina teninoensis* and *Gaudryina coalingsensis*.

Paleobathymetry is somewhat monotonous in fossiliferous sedimentary intervals of the well, which could be due in part to considerable cavings in the ditch samples. Most of the fossiliferous sediments were deposited in open marine nearshore waters at upper to middle bathyal depths. An exception is a possibly marginal marine interval from 3480 to 3600 ft. Two relatively deep (lower middle bathyal) intervals occur at 740 to 1100 ft and 6400 to 6430 ft.

Concluding this well report is a correlation with the Reichhold Columbia County No. 1, OH.

#### BIOSTRATIGRAPHIC RESULTS

The following data were derived from previously unprocessed wet ditch samples. All single depths noted below represent bottoms of 30 ft intervals.

- 0-180' Very fine-grained sandstone and siltstone. Lignite very abundant (0-120'). Glass shards very abundant (120-150'). Barren of marine fossils.
- 210' *Uvigerina* cf. *cocoaensis*, *Melonis pompilioides*, *Cibicides* cf. *evolutus* var. (very thick sutures and peripheral rim), *Eponides gaviotaensis*? (worn), Shell fragments.
- 240' Highest brown sucrosic mudstone. *Lenticulina* sp., *Uvigerina* *gallowayi/atwilli* (intermediate form), *Plectofrondicularia packardi*, *Cibicides evolutus*, *Bolivina kleinpelli*, Diatom (pyritized, centrate).
- 270' *Guttulina irregularis*, *Uvigerina* cf. *gallowayi*?
- 300' No new species or lithologies.
- 330' *Uvigerina* aff. *mexicana*, *U. atwilli*, *Cassidulina globosa*.
- 360' *Uvigerina* cf. *atwilli*, *Spumellaria* (spheres).
- 390' No new species or lithologies.
- 420' *Cassidulina globosa/galvinensis* (intermediate form), *Caucasina schencki*.
- 450, 480' No new species or lithologies.
- 480-500' No sample available.
- 530' *Cibicides haydoni*, *Boldia hodgei*, *Gyroidina condoni*.
- 560' "Salt and pepper" siltstone. *Planularia markleyana* (of Rau, 1948).
- 590' *Quinqueloculina imperialis*, *Cibicides olequaensis*, Echinoid spines, *Eponides yeguaensis*.
- 620' *Vaginulinopsis saundersi*, *V. lewisensis*, *Cibicides natlandi*, *C. mcmastersi*, *Bulimina laciniata*, *Lenticulina* cf. *terryi*, *L. cf. welchi*, *Alabamina scitula*, *Siphonina cowlitzensis*, Ostracod, *Subbotina yeguaensis*, *S. spp.*, *Florilus applini*, *Nonion planatum*, *Bathysiphon eocenica*, *Plectofrondicularia*

- 620' (cont.) *multilineata*, *Uvigerina gardnerae*?, *Spongodiscidae* (discs), *Pseudohastigerina micra*, *Ceratobulimina washburnei*. Possible hiatus.
- 650' *Gyroidina rotundiformis*, *Gaudryina* sp. var. (small), *Plectofrondicularia* aff. *californica*?, Diatom var. (triangular outline).
- 680' *Cyclammina pacifica*.
- 710' *Plectofrondicularia searsi*, *Lenticulina chirana*, *Haplophragmoides* sp. var. (small), *Bolivina oregonensis*, *B. striatella*.
- 740' *Cibicides cushmani*, "*Angulogerina*" *cooperensis*.
- 770' *Uvigerina nudorobusta*, *Bulimina microcostata*, Pyrite "sticks".
- 800' *Bulimina corrugata*?
- 830' *Sterrasters*, *Truncorotaloides*? sp. (juvenile), *Plectofrondicularia vaughani*.
- 860' *Epistomina* sp., *Nassellaria*.
- 890' *Bolivina basiscurta*, Fish remains.
- 920' *Uvigerina* aff. *churchi*?, *Alabamina kernensis*, *Spiroloculina*? sp.
- 950' *Virgulina* cf. *bramlettei*.
- 980' *Karreriella contorta*, *Cibicides felix*?, *Subbotina linaperta*, *Truncorotaloides aspensis*.
- 1010' No new species or lithologies.
- 1040' *Plectofrondicularia gracilis*.
- 1070' No new species or lithologies.
- 1100' *Valvulineria churchi*, s.l., *V. involuta*.
- 1130' No new species or lithologies.
- 1160' Highest medium-grained sandstone. *Valvulineria churchi*, *Saracenaria* sp.
- 1190' *Virgulina* sp. var. (inflated chambers).
- 1220' *Anomalina garzaensis*? (umbilical plug on evolute side).
- 1250' *Valvulineria* cf. *tumeyensis*, *Truncorotaloides pentacamerata*? (juvenile), *Amphimorphina*? *californica*? (juvenile).
- 1280' *Eggerella* sp. var. (large), *Uvigerina* cf. *elongata*.
- 1310' *Allomorphina* cf. *macrostomata*. Bentonite very rare.
- 1330' *Gyroidina* cf. *scalata*.
- 1350' *Amphimorphina californica*. Increase in sand.
- 1390' *Anomalina costiana* (of Beck, 1943). Lignite/gilsonite very very abundant.
- 1430' No new species or lithologies.
- 1470' *Bulimina* cf. *macilenta* var. (large).
- 1470-1910' Barren of indigenous Foraminifera.
- 1950' No new species or lithologies.
- 1970' *Saracenaria hantkeni* (of Beck, 1943).
- 1990, 2020' No new species or lithologies.
- 2050' *Quinqueloculina goodspeedi*, *Eponides*

2050' (cont.) mexicana var. (involute side highly convex).

2080' Cassidulina cf. globosa var. (uncoiling).

2110' No new species or lithologies.

2140' Volcanic? sandstone. Cassidulina globosa var. (uncoiling), Uvigerina yazooensis?, Valvulineria menloensis.

2140-2260' No new species. Possibly barren of indigenous Foraminifera. Highest translucent green grains at 2170-2200'.

2290, 2320' No new species or lithologies.

2350' Sigmomorphina schencki (possibly caved).

2380' No new species or lithologies.

2410' Pseudoglandulina conica, Reophax? sp. var. (large), Cibicides sp. var. (umbilical plug, both sides), Nodosaria delicata? (fragment), Cyclamina sp. var. (large).

2440' Ostracod var. (deep median sulcus), Trochammina cf. globigerinaformis.

2470' Ammodiscus cf. incertus, Eggerella aff. elongata (coarse wall).

2470-2560' No new species or lithologies.

2590' Pseudoglandulina nallpeensis.

2620, 2650' No new species or lithologies.

2680' Marginulina sp. B? (of Beck, 1943).

2710' No new species or lithologies.

2740' Eggerella cf. elongata.

2770' Marginulina sp. c (of Beck, 1943).

2770-2930' No new species or lithologies.

2960' Volcanic rock fragments. No new species or lithologies.

2960-3480' Probably barren of indigenous Foraminifera.

3480-3600' Calcareous indeterminate (poorly preserved).

3600-5830' Basalt. Barren of indigenous fossils.

5830-5860' No sample available.

5860-6100' No new species or lithologies.

6100-6120' No samples available.

6120-6320' Barren of indigenous Foraminifera. Serpentine/talc? common at 6160-6190'.

6320-6400' No new species or lithologies.

6400-6430' Uvigerina nudorobusta (not a "top") rare to common (possibly indigenous).

6430-6460' Barren of indigenous Foraminifera.

6460-6490' Nodosaria? (chambers) common.

6490-6640' No new species or lithologies.

6640-6670' Bifarina? sp. (very worn).

6670-6700' No new species or lithologies.

6700-6730' Baggina teninoensis.

6760' Gaudryina cf. coalingensis, Subbotina praesaepis, Uvigerina? demicostata (poorly preserved), Globigerinathea spp. (poorly preserved), Chilostomella sp. var. (slender

6760' (cont.) test.

6760-6770' No samples available.

6770-6800' No new species or lithologies.

6830' Sponge spicules (large), Gaudryina coalingensis, Truncorotaloides bullbrooki.

6860' Globigerinathea index, Uvigerina garzaensis.

6890' Quadrimorphina sp.

6890-6940' No samples available.

6970' No new species or lithologies

6970-6990' No sample available

6990-7000' No new species or lithologies.

#### CONCLUSIONS

DEPTH (FEET)	STAGE	PALEOENVIRONMENT
0-180	Indeterminate	Indeterminate
180-480	Refugian	Upper Bathyal
500-590	Refugian	Upper to Upper Middle Bathyal
590-740	Upper Narizian	Upper Middle Bathyal
740-830	Upper Narizian	Lower Middle Bathyal
830-890	Upper Narizian	Middle Bathyal undifferentiated
890-920	Upper Narizian	Lower Middle to Lower Bathyal
920-1100	Upper Narizian	Lower Middle Bathyal
1100-1160	Upper Narizian	Upper Middle Bathyal
1160-1350	Upper Narizian	Mixed Middle Neritic to Lower Middle Bathyal
1350-1590	Indeterminate	Non-marine to Marginal Marine?
1590-1910	Indeterminate	Indeterminate
1910-2020	Narizian	Upper Middle Bathyal
2020-2050	Narizian	Lower Middle Bathyal
2050-2110	Narizian	Upper Middle Bathyal
2110-2260	Indeterminate	Indeterminate
2260-2930	Narizian	Probably Upper Bathyal
2930-3450	Indeterminate	Indeterminate
3450-3600	Indeterminate	Non-marine to Marginal Marine?
3600-5830	Indeterminate	Indeterminate
5860-6100	Narizian	Outer Neritic or deeper
6120-6320	Indeterminate	Indeterminate
6320-6400	Narizian	Bathyal undifferentiated
6400-6430	Narizian	Lower Middle Bathyal?
6430-6460	Indeterminate	Indeterminate
6460-6700	Narizian	Upper to Middle Bathyal undifferentiated
6700-7000	Lower Narizian	Probably Middle Bathyal

CORRELATION WITH THE REICHHOLD  
COLUMBIA COUNTY NO. 1, OH

There is a good foraminiferal correlation for the following intervals: 500 to 980 ft in the Longview Fibre No. 25-33 correlates with 1530 to 2220 ft in the Columbia County No. 1, OH. The wells do not correlate paleontologically outside the above mentioned intervals due to faunal dilution by sand below and volcanic glass shards (in the 25-33) above.

L.F. 25-33	HIGHEST OCCURRENCE	C.C. 1, OH
- - - -	<u>Uvigerina cf. atwilli</u>	450'
- - - -	<u>Plectofrondicularia packardii</u>	570'
- - - -	<u>Alabamina kernensis</u>	900'
- - - -	<u>Turborotalia insolita</u> , <u>Plectofrondicularia minuta</u>	1260'
- - - -	<u>T. insolita</u> , maximum numbers	1380'
530'	<u>Cibicides haydoni</u>	1590'
620'	<u>C. natlandi</u>	1650'
620'	<u>Pseudohastigerina micra</u>	1740'
620' (cf.)	<u>Lenticulina welchi</u>	1770'
770'	<u>Uvigerina nudorobusta</u>	1890'
800'	<u>Bulimina microcostata</u>	1890'
830'	<u>Plectofrondicularia vaughani</u>	1980'
920'	<u>Uvigerina nudorobusta</u> , maximum numbers	2220'
980'	<u>Truncorotaloides aspensis</u>	2220'
980'	<u>Karreriella contorta</u>	2250'
1130'	Increase in sand	2430'
1280'	<u>Eggerella sp. var.</u> (large, crushed)	2490'
2440'	<u>Trochammina cf. globigerinaformis</u>	- - - -

AMERICAN QUASAR PETROLEUM COMPANY  
CROWN ZELLERBACH NO. 14-21  
NW¼ SEC. 14, T5N, R5W

Summary

The fossiliferous portion of this well section (30 to 1240 ft) was deposited near shore, and for the most part under open marine conditions. There was a distinctive transgressive-regressive cycle in the upper Narizian from 510 to 1240 ft. A maximum transgression occurred from 900 to 960 ft.

Comparison of the 14-21 well with the nearby 25-33 indicates that the two well sections are very similar between the top of the Narizian and the upper Cowlitz sand. However, it appears that the upper Narizian section penetrated by the 14-21 was deposited shoreward of equivalent 25-33 sediments. This is indicated by the offshore radiolarian group Nassellaria being present in the 25-33, but absent in the 14-21 during their upper Narizian maximum transgressions.

BIOSTRATIGRAPHIC RESULTS

The following data were derived from previously unprocessed wet ditch samples. All single depths noted below represent bottoms of 30 ft intervals.

- 30' Cassidulina globosa, Sterrasters, Sponge spicules.
- 60' Light brownish-gray mudstone. Spumellaria.
- 90' Uvigerina cf. atwilli, U. atwilli, U. spp. (finely costate), Lenticulina spp., Cassidulina cf. galvinensis, C. cf. globosa, Cibicides aff. evolutus (thickened sutures and peripheral rim), C. evolutus, Guttulina irregularis, Eponides kleinpelli (immature), Turborotalia insolita, Nonion planatum, Lagenella sp., Plectofrondicularia packardii, Gaudryina sp. (poorly preserved), Florilus applini.
- 120' Cyclammina pacifica, Globobulimina spp., Lenticulina "cf. welchi" (of Rau, 1948), Karreriella washingtonensis, Gyroidina planata, Pullenia spp., Uvigerina cf. cocoaensis, Gaudryina alazanensis, Nodosaria longiscata, Uvigerina garzaensis (contamination?).
- 150' Bolivina striatella, Alabamina kernensis, Cibicides haydoni, Glass shards very abundant.
- 180' Globigerinathea index, Cibicides olequaensis, "Angulogerina" cooperensis, Nonion halkyardi.
- 210' Light gray siltstone. Shell fragments, Guttulina frankei.
- 240' Pseudoglandulina inflata, Quinqueloculina spp., Melonis pompilioides, Anomalina sp.
- 270' Quinqueloculina imperialis, Spongodiscidae var. (discs), Bolivina kleinpelli.
- 300, 330' Samples not examined.
- 360' Ceratobulimina washburnei, Boldia cf. hodgei.
- 390, 420' Samples not examined.
- 450' Plectofrondicularia multilineata.
- 480' Sample not examined.
- 510' Boldia hodgei, Lenticulina sp. var. (large), Bulimina laciniata, Gyroidina condoni? (distorted test), Echinoid spines.
- 540' Elphidiella sp., Virgulina sp. var. (chambers very loosely arranged), Cibicides cf. natlandi, C. cf. mcmaistersi.
- 570' Globobulimina oregonensis, Elphidium sp. var., Cibicides natlandi, "Robulus" ?sp. d (of Beck, 1943).
- 600' Bentonite common. Bathysiphon eocenica, Vaginulinopsis saundersi, Ostracod, Caucasina schencki.
- 630' Siltstone to very fine-grained sandstone. No new species.
- 660' Lignite common. Very fine-grained sand very very abundant. No new species. Possibly barren of indigenous Foraminifera.
- 690' Guttulina hantkeni. Possibly barren of indigenous Foraminifera.
- 720' Arenaceous indeterminate, Cibicides sp. var. (attached? form).
- 750' Light gray micaceous mudstone. Karreriella

750' (cont.) contorta? (obese).  
 780' Haplophragmoides trullissata, Eponides cf. gaviotaensis, Bolivina oregonensis.  
 810' Cibicides cushmani, Quadrimorphina sp., Gaudryina? (Eggerella?) sp. (large fragments), Haplophragmoides sp. var. (small, smooth), Eggerella? elongata? (poorly preserved), Lenticulina chirana, Bulimina sp. var. (small, lightly spinose, pointed initial end), Plectofrondicularia searsi, Gyroidina condoni.  
 840' Eponides gaviotaensis, Pseudohastigerina micra, Alabamina scitula, Sigmoilina? sp. (small).  
 870' Plectofrondicularia robusta? (fragment), Bulimina sculptilis, Plectofrondicularia vaughani.  
 900' Diatom (pyritized, centrate), Subbotina spp., Uvigerina garzaensis.  
 930' Epistomina eocenica, Uvigerina churchi, U. garzaensis (maximum numbers), Cassidulina globosa var. (uncoiling), Lenticulina cf. terryi.  
 960' Uvigerina elongata?, Marginulina sp., Spiroloculina? sp., Lagenella costata, Valvulinaria churchi (poorly preserved), Uvigerina nudorobusta, Cibicides laurissae, Gastropod.  
 990' Subbotina prasaepis, Eponides sp. (of Tipton, et. al., 1973), Gyroidina octocamerata, Robertina washingtonensis, Spumellaria very abundant.  
 1020' Eggerella? sp. (large), Pseudohastigerina micra/lillisi (intermediate form), Valvulinaria churchi.  
 1050' Reduced fauna. No new species or lithologies.  
 1080, 1110' No new species or lithologies.  
 1140' Nodosaria deliciae.  
 1170' Major increase in sand. Bulimina sp. var. (large, smooth), Cibicides evolutus var. (plug on spiral side), Cibicides mcmaistersi, Discorbis coalingensis (of Mallory, 1959).  
 1200' Valvulinaria involuta. Very micaceous siltstone.  
 1220, 1240' No new species or lithologies.  
 1260' No new species. Increase in sand.  
 1280' No new species. Lignite abundant.  
 1300' Cibicides sp. var. (thin, smooth).  
 1320' No new species or lithologies.  
 1340' Ammodiscus? sp. (large fragment).  
 1360' Lithology primarily fine-grained sandstone. Lignite very very abundant. Possibly barren of indigenous Foraminifera.  
 1380' Gilsonite abundant. No new species.  
 1400' No new species. Quartz-pyrite spherical clusters abundant.  
 1400-1540' Barren of indigenous Foraminifera. Cement at 1460'. Pyrite abundant at 1540'.  
 1560' Sandstone coarsens to fine to medium-grained. Barren of indigenous Foraminifera.

1560-1640' No new lithologies. Barren of indigenous Foraminifera.  
 1660' Subbotina cf. wilsoni. Probably barren of indigenous Foraminifera.  
 1680, 1700' No new lithologies. Barren of indigenous Foraminifera.

#### CONCLUSIONS

DEPTH (FEET)	STAGE	PALEOENVIRONMENT
0-450	Refugian	Upper Bathyal
480-510	Refugian	Upper to Upper Middle Bathyal
510-660	Upper Narizian	Mixed Inner Neritic to Upper Bathyal
660-780	Upper Narizian	Middle to Outer Neritic
780-870	Upper Narizian	Upper Middle Bathyal
870-900	Upper Narizian	Lower Middle Bathyal
900-960	Upper Narizian	Lower Middle to Lower Bathyal
960-990	Upper Narizian	Lower Middle Bathyal
990-1140	Upper Narizian	Upper to Upper Middle Bathyal
1140-1240	Upper Narizian	Middle to Outer Neritic
1240-1340	Upper Narizian	Marginal Marine to Middle Neritic
1340-1700	Indeterminate	Indeterminate

#### AMERICAN QUASAR PETROLEUM COMPANY

WILNA et al NO. 5-23

SW $\frac{1}{2}$  SEC. 5, T6N, R4W

#### Summary

In this well section both lower Refugian and uppermost Narizian faunas were not seen perhaps due to low sampling density between 1170 and 1570 ft. Also of interest is a Narizian fauna from 3840 to 3900 ft, which is interbedded in volcanics.

The main sand body (upper Cowlitz sand) above the volcanics contains a mixed fauna with species representing depths ranging from middle neritic to middle bathyal. It is the opinion of this writer that the shallowest species in the sand are indigenous. Furthermore, a typical shoaling is evident from the maximum upper Narizian transgression at 1600 ft down to the top of the upper Cowlitz sand at approximately 1950 ft.

Generally rare spumelline Radiolaria and planktic Foraminifera indicate nearshore open marine conditions throughout the fossiliferous sections of the well.

Rounded coarse sand above the highest fossils at 540 to 600 ft is suggestive of a beach environment.

#### BIOSTRATIGRAPHIC RESULTS

The following data were derived from previously unprocessed wet ditch samples. Single depths noted below represent bottoms of 30 ft intervals.

0-270' No samples available.



- 300' Very fine-grained micaceous sandstone. Barren of fossils.
- 300-390' No samples available.
- 420' *Bolivina* cf. *kleinpellii*.
- 450, 480' No samples available.
- 510' Light brown siltstone. Volcanic glass shards very abundant. Barren of fossils.
- 540' No samples available.
- 570' Rounded coarse-grained sand abundant. Barren of fossils. Possible beach.
- 570-660' No new lithologies. Barren of fossils.
- 690' Shell fragments (very abundant), *Elphidium*/*Elphidiella* group. Volcanic? lithology.
- 690-750' No new lithologies. Barren of Foraminifera.
- 780' Light tan silty lignitic mudstone. Barren of Foraminifera.
- 810' Increase in lignite. Barren of Foraminifera.
- 840' *Gyroidina* cf. *planata* (small).
- 870' *Cassidulina crassipunctata*, *Cibicides* spp., Diatom (pyritized, centrate).
- 900' *Guttulina irregularis*, *Subbotina senilis*, *Elphidium* aff. *frigidum*, *Quinqueloculina* spp.
- 930' *Cibicides* aff. *fletcheri*?, *Globigerina* sp.
- 960' No samples available.
- 990' Tan sucrosic mudstone. *Quinqueloculina* cf. *imperialis*, *Spumellaria* (spheres).
- 1020' No new species or lithologies.
- 1050' *Lenticulina* sp.
- 1050-1170' No new species or lithologies.
- 1170-1260' No samples available.
- 1300' Light tan coarsely tuffaceous? mudstone. Glass shards brown. *Gyroidina planata*.
- 1330-1370?' No samples available.
- 1400' *Valvulineria willapaensis*? (fragment), *Bulimina laciniata*, *Cassidulina globosa*, *Bolivina kleinpellii*. Pyrite common.
- 1400-1470?' No samples available.
- 1500' *Plectofrondicularia vaughani*, *Cibicides natlandi*, *Truncorotaloides aspensis* (small).
- 1500-1570?' No samples available.
- 1600' "*Hopkinsina*" *garzaensis*, *Uvigerina churchi*, *Valvulineria churchi*, *Boldia hodgei*, *Plectofrondicularia packardi*, *Epistomina* sp.
- 1630' No sample available.
- 1660' *Eponides mexicana*, *Quinqueloculina imperialis*, *Oridorsalis umbonatus*, *Siphonina cowlitzensis*, *Globulina landesi*, *Ceratobulimina washburnei*, *Cibicides* cf. *mcmastersi*, *Uvigerina garzaensis*/*nudorobusta* (intermediate form), *Nonion planatum*, *Alabama kernensis*, *Gyroidina condoni*, Echinoid spines.
- 1700' *Eponides* sp. (of Tipton, et. al., 1973), *Vaginulinopsis saundersi*, *Karrerella contorta*? (juvenile), *Valvulineria involuta*, *Spongodiscidae* (discs).
- 1700-1770' No samples available.
- 1800' *Saracenaria* sp. (small), *Plectofrondicularia* cf. *searsi*, *Globigerina wilsoni*?, *Caucasina schencki*.
- 1830, 1860' No samples available.
- 1890' *Florilus applini*, *Cibicides* sp. var. (wide keel), *Gyroidina* cf. *octocamerata*.
- 1920' *Lenticulina chirana*, *Bulimina corrugata*, *Bolivina striatella*.
- 1950' Fine-grained sandstone rare. Quartz-pyrite clusters abundant. *Eponides* cf. *gaviotaensis*.
- 1980' *Eponides gaviotaensis*, s.s., *Elphidium* cf. *californicum*, *Nonion halkyardi*.
- 2010' Arenaceous indeterminate. Probably barren of indigenous Foraminifera.
- 2040' Increase in fine-grained sandstone to very abundant. Probably barren of indigenous Foraminifera.
- 2070' No sample available.
- 2070-2220' No new lithologies. Barren of indigenous Foraminifera.
- 2250, 2280' Increase in pyrite and lignite to very abundant. Barren of indigenous Foraminifera.
- 2310' *Lenticulina* cf. *terryi*.
- 2340, 2370' No new lithologies. Barren of indigenous Foraminifera.
- 2400' Coal/lignite flood. Barren of indigenous Foraminifera.
- 2430' Bentonitic mudstone. Barren of indigenous Foraminifera.
- 2460' Medium-grained sandstone. Barren of indigenous Foraminifera.
- 2490' Bentonitic mudstone flood. Barren of fossils.
- 2520' No new lithologies. Barren of fossils.
- 2550' Arenaceous (crushed) var. "brown".
- 2580' Volcanic rock fragments. No new species.
- 2610' *Eponides mexicana* var. (involute side highly convex).
- 2640, 2670' Volcanics. Barren of indigenous Foraminifera.
- 2700' Basalt flood. *Cibicides haydoni*, s.l., *Alabama* aff. *scitula*, *Subbotina linaperta*.
- 2730' Major increase in processed sample size. *Stilostomella*? sp.
- 2760' Red volcanic rock fragments with green inclusions. Barren of indigenous Foraminifera. Possible hiatus with subaerial erosional surface.
- 2790' Ostracod var. (deeply incised median sulcus).
- 2820' No new species or lithologies.
- 2850' Lost circulation material very very abundant. Barren of Foraminifera.
- 2880' Greenish-black basalt with rare pyrite and coal layers. Barren of indigenous Foraminifera.

		CONCLUSIONS		
		DEPTH (FEET)	STAGE	PALEOENVIRONMENT
2910'	Basalt flood. Barren of indigenous Foraminifera.			
2940'	Cibicides malloryi? Barren of indigenous Foraminifera.	270-300	Indeterminate	Indeterminate
2970, 3000'	No new species or lithologies.	390-540	Indeterminate	Indeterminate
3030'	Plectofrondicularia gracilis. Barren of indigenous Foraminifera.	540-600	Indeterminate	Beach?
3060'	Gray mudstone abundant. Nonion florinense, Bulimina microcostata (replaced?).	600-660	Indeterminate	Indeterminate
3090'	Cibicides felix, Uvigerina churchi, s.s.	660-690	Indeterminate	Inner Neritic
3120'	Opaque green volcanics? abundant. Cassidulina globosa var. (large), Sponge spicules, Nodosaria longiscata, Cibicides cf. laurissae, Spumellaria var. ("spiny").	690-810	Indeterminate	Indeterminate
		810-1080	Probably Refugian	Upper Bathyal
		1080-1170	Probably Refugian	Mixed Inner Neritic and Upper Bathyal
3150, 3180'	No new species or lithologies.	1300	Probably Refugian	Indeterminate
3210'	Marginulina sp. c (of Beck, 1943).	1400	Probably Lower Refugian	Upper to Upper Middle Bathyal
3240'	No new species or lithologies.	1500	Upper Narizian	Upper to Upper Middle Bathyal
3270, 3300'	Volcanic rock fragments very very abundant. Barren of Foraminifera.	1600	Upper Narizian	Lower Middle to Lower Bathyal
3330'	Translucent green grains very abundant. Barren of indigenous Foraminifera.	1660	Upper Narizian	Upper Middle Bathyal
3360'	Volcanic sand in mudstone matrix. Barren of indigenous Foraminifera.	1700	Upper Narizian	Outer Neritic
3360-3450'	Barren of indigenous Foraminifera. Volcanic lithology.	1800	Upper Narizian	Outer Neritic to Upper Bathyal
3480'	Lenticulina washingtonensis, Cibicides nantlandi var. (thickened peripheral rim), Pullenia sp., Sterrasters.	1860-2400	Upper Narizian	Mixed Middle Neritic to Middle Bathyal
3510'	Gastropod var. (ornate), Darbyella sp.	2400-2580	Narizian	Non-marine to Marginal Marine
3540'	Diatom var. (pyritized, pennate).	2580-2730	Narizian	Probably Outer Neritic
3570'	Chilostomella sp. var. (pyritized, obese), Gastropod var. (smooth). Coal very very abundant.	2730-2760	Narizian	Possibly Non-marine
3600'	Probably barren of indigenous Foraminifera.	2760-2790	Narizian	Estuarine to Inner Neritic
3630'	Allomorphina sp. (pyritized).	2790-3030	Probably Narizian	Indeterminate
3660'	Barren of indigenous Foraminifera.	3030-3240	Narizian	Middle Bathyal?
3690, 3720'	Coal very very abundant. Barren of indigenous Foraminifera.	3240-3450	Indeterminate	Indeterminate
3750, 3780'	Probably barren of indigenous Foraminifera.	3450-3510	Narizian	Middle to Outer Neritic
3810'	Dentalina communis, Bathysiphon eocenica.	3510-3540	Indeterminate	Indeterminate
3840'	Cyclammina sp. var. (large), Pseudoglandulina nallpeensis, Dentalina sp. var. (large), Valvulineria churchi var. (very limbate sutures), Quinqueloculina goodspeedi, Globobulimina sp. var. (small, thin), Lagena costata.	3540-3810	Narizian	Probably Middle Bathyal
		3810-3900	Narizian	Probably Middle Bathyal
		3900-4500	Indeterminate	Indeterminate
3870'	Dentalina dusenburyi, Lenticulina chirana/welchi (intermediate form), Marginulina sp. B (of Beck, 1943), Anomalina garzaensis? (small).	AMERICAN QUASAR PETROLEUM COMPANY RAU NO. 18 - 14, OH SW 1/4 SEC. 18, T6N, R4W		
3900'	Arenaceous indeterminate (large).	<u>Summary</u>		
3900-4500'	Basalt very abundant to flood. Probably barren of indigenous Foraminifera. Species not seen above include Cibicides pachyderma (3960') and Virgulina sp. (pyritized) (4410'). Rare elongate conical crystal clusters occur at 4080'.	The fossil sequence in this well is similar to that in American Quasar's Larkins 23-33 to the west. However, the uppermost Narizian deep water faunas are less well developed in the 18-14. The upper Narizian maximum transgression appears to be missing because of a hiatus (fault?) at 1560 to 1590 ft.		

Another perhaps significant difference between the two wells is that the uppermost Narizian fauna in the 18-14 appears to have been deposited closer to shore than that in the 23-33. The former contains only rare offshore nasselline Radiolaria.

Nearshore, intermittent open marine conditions occurred throughout deposition of the section penetrated. Possibly intermittent non-marine conditions are indicated from 1680 ft to TD based on fluctuating abundances of coal/lignite, with a maximum occurring at 2070 to 2100 ft. The Larkins 23-33 also contains a maximum of coal/lignite at precisely the same depth interval.

There were two redrills of this well by American Quasar because of the hiatus in the original hole at 1560 to 1590 ft.

#### BIOSTRATIGRAPHIC RESULTS

The following data were derived from previously unprocessed wet ditch samples. Single depths noted below represent bottoms of 30-ft intervals.

- 0-30' Light brown mudstone. Barren of fossils.
- 60' Glauconitic mudstone. Barren of fossils.
- 90' Shell fragments, Gastropod var. (ornate), Anomalina californiensis, Cassidulina cf. globosa, C. cf. galvinensis, "Angulogerina" cooperensis, Globobulimina spp., Cibicides mcmaistersi, C. aff. lobatulus, Spumellaria (spheres), "Valvulineria" menloensis, Nonion planatum?, Melonis pompilioides, Lagenas sp., Ostracod.
- 120' Quinqueloculina imperialis, Plectofrondicularia multilinea, Guttulina irregularis, Cassidulina galvinensis, s.l., Diatom (pyritized, centrate), Florilus applini, Caucasina schencki, Sterrasters.
- 150' Volcanic? rock fragments and sub-angular to rounded coarse sand. Barren of fossils. Possible beach.
- 180' Lithology as in sample above. Barren of indigenous fossils.
- 210' Tuffaceous? silty mudstone. Glass shards. Barren of indigenous fossils.
- 240' Mudstone as above, but lignitic. Barren of Foraminifera
- 270' Silty mudstone. Barren of fossils.
- 300' Siltstone to medium-grained sandstone. Many rounded grains on 50 mesh screen. Barren of fossils.
- 330' Bolivina striatella.
- 360' Sponge spicules, Uvigerina sp. (costate, locked in lithology).
- 390, 420' No new species or lithologies.
- 420-540' No new lithologies. Essentially barren of fossils.
- 570' Coal/lignite abundant, Plectofrondicularia gracilis, Cibicides sp. var. (thin test, granular surface), Spongodiscidae (discs).
- 600' Lenticulina spp., Boldia hodgei, Triloculina gilboei?, Pseudohastigerina micra.
- 630' Gyroidina condoni, Lenticulina welchi/chirana (intermediate form), Cassidulina globosa,
- 630' (cont.) Bolivina kleinpelli, Nassellaria.
- 660' Vaginulinopsis saundersi?, Sigmomorphina schencki?, Bulimina microcostata, Cibicides olequaensis, Bolivina basiscorta.
- 690' Cornuspira lewisensis, Cibicides sp. var. (concavo-convex).
- 720' Cibicides natlandi, Lenticulina cf. welchi, Ceratobulimina washburnei.
- 750' Lenticulina welchi, s.l., Elphidium sp., Ostracod var. (deeply incised median sulcus).
- 780, 810' No new species or lithologies.
- 840' Darbyella? sp. var. (large).
- 870' Guttulina cf. hantkeni.
- 900' Plectofrondicularia packardii.
- 930' Subbotina prasaepis, Robertina washingtonensis, Gyroidina scalata?.
- 960' Karreriella contorta.
- 990' No new species or lithologies. Bulimina microcostata common.
- 1020' Eponides mexicana.
- 1050' Eponides mexicana var. (involute side highly convex).
- 1080' Plectofrondicularia vaughani.
- 1110' Bentonite very abundant, Cassidulina globosa var. (inflated chambers), increase in sand through 100 mesh screen.
- 1140' No new species. Increase in sand on 100 mesh screen.
- 1170' No new lithologies. Barren of indigenous fossils.
- 1200' Fine-grained sandstone abundant. Barren of indigenous fossils.
- 1230' Quartz-pyrite clusters. No new species. "Valvulineria" menloensis (one specimen) with sandstone stuck to it.
- 1260' Ostracod var. (deeply incised median sulcus).
- 1290, 1320' No new species or lithologies.
- 1350' Sand-sized crystals in mudstone matrix; lithology has distinctive greenish-gray color. Karreriella washingtonensis?. Probably barren of indigenous fossils.
- 1350-1560' No new species or lithologies. Intermittent occurrences of shallow shelf species, including "Valvulineria" (=Hanzawia) menloensis, Ostracod var. (deep median sulcus), Elphidiella sp. Medium-grained sandstone rare at 1440'.
- 1590' Valvulineria churchi. Significant decrease in processed sample size. Possible hiatus in this sample interval.
- 1620' Bulimina laciniata, Subbotina angiporoides? (juvenile).
- 1650' No new species or lithologies.
- 1680' Eggerella? sp. (large, crushed).
- 1710' No new species or lithologies. Major increase in processed sample size (sand).
- 1740' Pyritized lignite rare, lignite/coal common.

1740' (cont.) Probably barren of indigenous Foraminifera.

1770' No new lithologies. Barren of indigenous Foraminifera.

1800' Valvulineria involuta. Probably barren of indigenous Foraminifera.

1800-1890' Barren of indigenous Foraminifera.

1920' Coal/lignite very abundant. No new species.

1920-2100' No new species or lithologies.

2130' Tan limey mudstone common. Barren of indigenous Foraminifera.

2160' No sample available.

2160-2280' No new lithologies. Barren of indigenous Foraminifera.

2280-2400' Coal/lignite abundant to very abundant. Barren of indigenous Foraminifera.

2430' No new species or lithologies. Tan limey mudstone abundant. Barren of indigenous Foraminifera.

#### CONCLUSIONS

DEPTH(FEET)	STAGE	PALEOENVIRONMENT
0-60	Indeterminate	Marine
60-120	Refugian	Outer Neritic to Upper Bathyal
120-300	Indeterminate	Intermittent Beach or Non-marine
300-420	Indeterminate	Upper Bathyal?
420-540	Indeterminate	Indeterminate
540-630	Lower Refugian	Upper to Upper Middle Bathyal
630-750	Upper Narizian	Upper to Upper Middle Bathyal
750-960	Upper Narizian	Outer Neritic to Upper Bathyal
960-990	Upper Narizian	Upper Middle Bathyal
990-1050	Upper Narizian	Outer Neritic to Upper Bathyal
1050-1560	Upper Narizian	Inner to Middle Neritic
1560-1680	Upper Narizian	Upper Middle Bathyal
1680-2430	Narizian	Possibly Non-marine

THE TEXAS COMPANY  
CLARK & WILSON NO. 6 - 1  
NE½ SEC. 19, T6N, R4W

#### Summary

Nearly the entire well section is of Narizian age. The presence of Bolivina basiscurta and Eggerella elongata in cores at 8021 and 8308 ft, respectively, indicate an age no older than Narizian. The presence of Bolivina basiscurta without Cibicides natlandi above 700 feet suggests a basal Refugian age above this depth.

Due to widely spaced sample coverage, the upper Narizian maximum transgression was not found. It occurred somewhere between 2052 and 2992 ft. Sandy

ditch samples from 3435 to 3585 ft contain numerous deep bathyal species which are here considered to be caved from the maximum transgression interval above. Previously McKeel (1979) incorrectly interpreted these ditch samples to contain indigenous bathyal faunas.

The distribution of Radiolaria and planktic Foraminifera indicate generally open marine near-shore conditions down to 8204 ft. A significant increase in plankton (Radiolaria) from 8274 ft to TD suggest an increased distance from shore.

#### BIOSTRATIGRAPHIC RESULTS

The following data were derived from cores and dry ditch samples (previously unprocessed) and faunal slides borrowed from DOGAMI. Single ditch sample depths noted below probably represent bottoms of sample intervals.

- 30' Light gray glauconitic silty mudstone. Barren of fossils.
- 215' Light brown sandy mudstone. Elphidium? sp., Nonion inflatum, Sponge spicules, Ostracod.
- 395' Nonion halkyardi, Cassidulina globosa, Bulimina spp. (smooth), Spongodiscidae (discs), "Angulogerina" sp. var. (smooth, obese), Diatom (pyritized, centrate), Bolivina kleinpellii?.
- 575' Lenticulina spp., Spumellaria (spheres), Cibicides cf. evolutus, Globobulimina spp., Subbotina sp., Quinqueloculina spp., Nonion planatum, Bolivina marginata?, B. basiscurta, Nassellaria, Bolivina kleinpellii, Sterrasters.
- 700-710' (core)\* Caucasina schencki, Anomalina garzaensis, Alabamina kernensis, "Angulogerina" cooperensis, Plectofrondicularia vokesi, Ceratobulimina washburnei, Cibicides natlandi, Lagenella sp., Gyroidina condoni? (juvenile).
- 915-925' (core)\* Plectofrondicularia vaughani, Cibicides olequaensis, Plectofrondicularia packardii, Pseudohastigerina micra, Florilus applini, Reophax sp., Nodosaria longiscata, Pseudoglandulina conica, Quinqueloculina imperialis, Guttulina irregularis, Robertina washingtonensis, Sigmomorphina schencki, Marginulina sp. c (of Beck, 1943), Vaginulinopsis lewisensis, Dentalina spp. Anomalina sp. A (of Beck, 1943).
- 1103-1113' (core)\* Dentalina dusenburyi, Gyroidina planata? (small), Haplophragmoides sp., Boldia hodgei, Dentalina cf. colei, Bulimina sp. var. (small, spinose lower half).
- 1325-1335' (core)\* Gaudryina sp. var. (small), Vaginulinopsis saundersi, Plectofrondicularia robusta? (fragment), Lenticulina alato-limbata, L. washingtonensis, Pullenia cf. salisburyi, Karreriella? sp. (coarse wall texture).
- 1548-1558'; 1568-1574' (cores)\* Cyclammina pacifica, Elphidiella sp.
- 1814-1818' (core)\* Lenticulina chirana, Bulimina microcostata, Haplophragmoides obliquicameratus.
- \* Data from picked faunal slides only.

- 2040-2052' (cores)\* *Bolivina striatella*, *Bathysiphon eocenica*, *Bulimina laciniata*, *Cibicides mcmaistersi*, *Eggerella elongata*, *Eponides yeguaensis*, *E. gaviotaensis*, *Karrerella contorta*, *Martinotiella?* sp., *Gyroidina* cf. *condoni*.
- 2992-3002' (core)\* No new species.
- 3282-3292' (core)\* *Bulimina sculptilis*, *Silicosigmolina californica* (small).
- 3435-3510'\* *Valvulineria chirana*, *Gyroidina condoni*, *Uvigerina garzaensis*. Probably barren of indigenous Foraminifera.
- 3585' Shell fragments, *Alabamina kernensis*, *Truncorotaloides pentacamerata*. Probably barren of indigenous Foraminifera.
- 3800' *Siphonina cowlitzensis*, *Catapsydrax* sp., *Trochammina* cf. *globigerinaformis?*, *Lenticulina* cf. *terryi*, *Subbotina* cf. *senilis*, *Globorotaloides* cf. *suteri*.
- 3870' *Lenticulina* sp. var. (robust test, raised, limbate sutures), *Arenaceous* sp. (large, crushed), *Valvulineria churchi* var. (high-trochospiral), *Subbotina* cf. *eocaena*, *Truncorotaloides* cf. *aspensis*, *Pseudohastigerina lillisi*.
- 4015' *Cibicides felix* (of Mallory, 1959, pl. 31), *Epistomina* sp., *Spongodiscidae* var. (large disc with central raised spine).
- 4100' *Trochammina* cf. *globigerinaformis*, *Gyroidina* cf. *scalata*.
- 4325' *Cibicides* cf. *laurisae* (thin test), *Valvulineria tumeyensis* var. (high-trochospiral), *Diatom* var. (pyritized, pennate), *Cibicides* sp. var. (planconvex-concavoconvex), *Planulina?* sp., *Gyroidina simiensis??*, *Gaudryina coalingsensis* (small). Also *Bulimina microcostata* abundant.
- 4545' Dark gray volcanic? sand. No new species. Probably barren of indigenous Foraminifera.
- 4740' Yellowish-brown (Fe-stained?) volcanic? very fine-grained sandstone. Barren of indigenous Foraminifera.
- 4970' Light gray volcanic? siltstone. Barren of indigenous Foraminifera.
- 5575' Volcanic? siltstone to very fine-grained sandstone. Barren of indigenous Foraminifera.
- 6115' No new species or lithologies. Barren of indigenous fossils.
- 6730' Translucent green grains. Probably barren of indigenous fossils.
- 7400' No new species or lithologies. Barren of indigenous fossils.
- 7545' No new species or lithologies. Barren of indigenous fossils.
- 7620' No new species or lithologies. Barren of indigenous fossils.
- 7723' (core) No new species or lithologies.
- 7733' (core) No new species or lithologies.

\* Data from picked faunal slides only.

\*\* Two samples accidentally combined in processing.

- 7733' (core, cont.) *Lenticulina* spp., *Gaudryina coalingsensis* (small).
- 7780' No new species or lithologies. *Lenticulina* spp.
- 8021' (core) No new species or lithologies. *Florilus applini*, *Trochammina* cf. *globigerinaformis*, *Nonion planatum*, *Haplophragmoides* spp., *Lenticulina* spp., *Caucasina schencki*, *Bolivina basiscurta*, *B. kleinpellii*, *Spumellaria*.
- 8042' (core) Gray micaceous siltstone. No new species. *Lenticulina* spp., *Haplophragmoides* spp., *Cassidulina globosa*, *Spumellaria*.
- 8064' (core) Olive gray micaceous siltstone. Barren of Foraminifera.
- 8163' (core) White very fine-grained angular to subangular sandstone. Barren of Foraminifera.
- 8204' (core) Olive gray micaceous siltstone. Barren of Foraminifera.
- 8274' (core) Gray radiolarian (pyritized) mudstone. *Spongurus* sp. Also *Eggerella elongata*, *Arenaceous* sp. (indeterminate), *Spumellaria* (spheres, some pyritized), *Spumellaria* var. ("spiny" spheres), *Spongodiscidae* (large, pyritized discs), *Sponge spicules*, *Diatom* (pyritized, centrate).
- 8308' (core) Gray radiolarian mudstone, as above. *Nassellaria*. Also *Eggerella elongata*, s.s., *Haplophragmoides* sp., *Arenaceous* indeterminate common, *Spongodiscidae* common, *Spumellaria* (spheres) abundant, *Spumellaria* var. ("spiny" spheres).
- 8318' (core) Gray radiolarian mudstone as above. No new species or lithologies. *Arenaceous* indeterminate common, *Haplophragmoides* spp., *Bulimina* spp., *Spongodiscidae* common, *Spumellaria* (spheres) abundant, *Bolivina?* sp. (striate).
- 8325' (core) Gray silty mudstone. *Nodogenerina* cf. *bradyi* (of Mallory, 1959). Also *Arenaceous* indeterminate very abundant, *Spumellaria* rare to common, *Spongodiscidae* common, *Sponge spicules*.
- 8365' (core) Gray mudstone. *Bathysiphon* sp. var. (small, thin). Also *Arenaceous* indeterminate common, *Eggerella?* (*Gaudryina?*) sp. (crushed), *Spongodiscidae* very rare.
- 8451' (core) Gray radiolarian-rich mudstone. No new species. *Spongodiscidae* rare, *Spumellaria* (spheres) very abundant, *Arenaceous* indeterminate rare.

#### CONCLUSIONS

DEPTH (FEET)	STAGE	PALEOENVIRONMENT
0-30	Indeterminate	Marine
215	Indeterminate	Neritic
395	Probably Refugian	Upper Bathyal
575	Probably Refugian	Upper Bathyal
700-1574	Upper Narizian	Upper Bathyal
1814-2052	Upper Narizian	Upper Middle Bathyal
2992-3002	Indeterminate	Marine

## CONCLUSIONS (CONT.)

DEPTH (FEET)	STAGE	PALEOENVIRONMENT
3282-3292	Upper Narizian	Upper Middle Bathyal
3435-3585	Indeterminate	Marginal Marine?
3800	Narizian	Mixed Neritic to Lower Bathyal
3870-4325	Lower Narizian?	Mixed Neritic to Lower Bathyal
4545-7620	Indeterminate	Indeterminate
7723-7780	Lower Narizian	Outer Neritic to Upper Bathyal
8021-8042	Lower Narizian	Outer Neritic to Upper Bathyal
8064-8204	Indeterminate	Indeterminate
8274-8308	Lower Narizian	Probably Bathyal
8318-8451	Probably Lower Narizian	Probably Bathyal

AMERICAN QUASAR PETROLEUM COMPANY  
INVESTMENT MANAGEMENT NO. 20 - 21  
NW¼ SEC. 20, T6N, R4W

Summary

This well section contains thick upper Narizian section (1020 ft) above the upper Cowlitz sand. Also, much of the interval between 270 and 630 ft is of unusually shallow water (neritic) origin. Below 630 ft, however, paleobathymetry is typical for Columbia County. The upper Narizian maximum transgression is well-developed at 1110 to 1140 ft, followed by a slight shoaling down the hole just above the top of the upper Cowlitz sand. The sand is here interpreted to be of non-marine to inner neritic origin.

Deposition was nearshore throughout the section penetrated. Open marine conditions existed intermittently during the Narizian. The Refugian portion of the well section was deposited in waters restricted from open ocean circulation. The possible beach at 150 to 180 ft is based on lithology only. Intermittent non-marine? environments between 1290 and 1950 ft are based on large quantities of lignite accompanied by an absence of indigenous marine fossils.

## BIOSTRATIGRAPHIC RESULTS

The following data were derived from previously unprocessed wet ditch samples. Single depths noted below represent bottoms of 30 ft intervals.

- 30-60' Gray mudstone. Glass shards abundant. Barren of fossils.
- 90' *Cassidulina galvinensis*, s.l., *Lenticulina* sp., *Uvigerina* cf. *atwilli* (juvenile), *Caucasina schencki*, *Cassidulina galvinensis/globosa* (intermediate form), *Cibicides* aff. *haydoni*? (immature).
- 120' *Cibicides elmaensis*? (of McDougall, 1980), *Plectofrondicularia packardii*.
- 150' *Quinqueloculina* sp. var. (small, thin).

- 180' Well-rounded volcanic coarse-grained sand very abundant. Barren of fossils. Possible beach.
- 210' Light brownish gray siltstone. *Globobulimina* spp.
- 240' Shell fragments, *Quinqueloculina imperialis*, *Boldia hodgei*, *Elphidiella* sp., *Cibicides olequaensis*. Glass shards flood.
- 270' *Ceratobulimina washburnei*.
- 300' *Cibicides natlandi*, *Dentalina* sp., Diatom (pyritized, centrate). Glass shards disappear.
- 330' *Spongodiscidae* (discs), *Nonion inflatum*, *N. planatum*, *Pullenia* sp., *Spumellaria* (spheres), *Guttulina irregularis*, *Lagena hexagona*, *Cassidulina globosa*.
- 360' *Florilus applini*, *Bulimina microcostata*, "*Angulogerina*" *cooperensis*, *Bolivina basis-curta*, *B. oregonensis*, *B. kleinpellii*, *Gyroldina condoni*.
- 390' *Plectofrondicularia vaughani*.
- 420' *Lenticulina* sp. var. (large), *Cassidulina globosa* var. (large), *Elphidiella* sp. var. (large), *Diocibicides perforata*, *Sterrasters*.
- 450' *Vaginulinopsis saundersi*, *Eponides mexicana*, *Cibicides* aff. *mcmastersi*.
- 480' Sandy (glauconitic) calcareous? mudstone and fine-grained sandstone. No new species.
- 510' Pyrite very abundant, bentonite very abundant. *Valvulineria involuta*?
- 540' Drilling cement. "*Valvulineria*" *menloensis*.
- 570' *Eponides gaviotaensis*, *Cornuspira lewisensis*.
- 600' Lignitic mudstone. *Valvulineria churchi* (poorly preserved, reworked).
- 630' *Cibicides mcmastersi*.
- 660' *Vaginulinopsis saundersi* var. (test doubled), *Cibicides cushmani*?, *Bulimina laciniata*.
- 690' *Lenticulina welchi*, s.l.
- 720' Echinoid spines. No new foraminiferal species.
- 750' No new species or lithologies.
- 780' *Sigmoilina tenuis*.
- 810, 840' No new species or lithologies.
- 870' *Lenticulina* cf. *terryi*?, *Quadriformina* sp. Also shell fragments abundant.
- 900, 930' No new species or lithologies.
- 960' Medium-grained sandstone. Probably barren of indigenous Foraminifera.
- 990' No new species or lithologies. Probably barren of indigenous Foraminifera.
- 1020' *Epistomina* sp.
- 1050' *Subbotina* sp.
- 1080' No sample available.
- 1110' Brown fossiliferous mudstone. *Uvigerina garzaensis*, *U.* cf. *churchi*, *Valvulineria churchi*, *Cibicides* cf. *laurisae*, *Cassidulina globosa* cf. var. (uncoiling).

- 1140' *Uvigerina churchi*, s.l., *Subbotina wilsoni*, *Alabamina kernensis*, *Uvigerina churchi*, s.s., *Cibicides haydoni/natlandi* (intermediate form), *Pseudohastigerina micra*. Also *Uvigerina garzaensis* common (maximum upper Narizian transgression).
- 1170' *Karrerella washingtonensis*, *Siphonina* sp., *Eponides* sp. (of Tipton, et. al., 1973), *E. mexicana* var. (involute side highly convex), *Truncorotaloides*? sp. (diminutive).
- 1200' No new species or lithologies.
- 1230' *Saracenaria* sp., *Bulimina sculptilis*, *Cibicides granulatus*, *Subbotina linaperta*, *Bulimina corrugata*.
- 1260' *Quinqueloculina goodspeedi*?
- 1290' *Bathysiphon eocenica*?, *Lenticulina chirana*, *Subbotina prasaepis*, s.s.
- 1320' *Quinqueloculina goodspeedi*, Lignite very abundant.
- 1350' No new species or lithologies.
- 1380' No new species or lithologies. *Cibicides natlandi* abundant.
- 1410' No sample available.
- 1440' *Vaginulinopsis lewisensis*.
- 1470' Significant increase in sand through 50 mesh screen. *Eggerella*? sp. (large, crushed).
- 1500' Fine to medium-grained micaceous sandstone. Barren of indigenous Foraminifera. Shell fragments common.
- 1530' Barren of indigenous Foraminifera.
- 1560' Barren of indigenous Foraminifera. Lignite very very abundant.
- 1590' Increase in sample size (sand). Quartz-pyrite clusters. Barren of indigenous Foraminifera.
- 1620' Coarse-grained volcanic sand. Gastropod var. (ornate). Barren of indigenous Foraminifera.
- 1650' Pyritized lignite rare. Lignite very very abundant. Barren of indigenous Foraminifera.
- 1680' Medium-grained sandstone. Lignite very very abundant. Quartz-pyrite clusters very abundant.
- 1710' No new species or lithologies. *Quinqueloculina* spp., Gastropod.
- 1740' No new species or lithologies. Lignite very very abundant, well-rounded coarse-grained sand common. Barren of indigenous Foraminifera.
- 1770' No new species or lithologies. Lignite very abundant. Barren of indigenous Foraminifera.
- 1800' Sample size (sand) decreases. No new species or lithologies. Lignite very very abundant. *Cibicides natlandi* rare to common, *Siphonina* sp. rare.
- 1830' No new species or lithologies. Lignite very very abundant. *Globigerina* sp. var. (five chambers outer whorl).
- 1860' No new species or lithologies. Lignite very very abundant.
- 1890' No new species or lithologies. Lignite very abundant.
- 1920' No new lithologies. Lignite very abundant. *Nonion halkyardi*, *Uvigerina beccarii* (caved from Refugian strata), *Gyroidina* cf. *octocamerata*.
- 1950' No new species or lithologies. Lignite very abundant.
- 1980' No new lithologies. Lignite abundant. *Robertina washingtonensis*, *Valvulinaria involuta*.
- 2010' No new species or lithologies. Lignite abundant.
- 2040' *Uvigerina* sp. var. (lightly costate). Decrease in sample (sand) size.
- 2070' *Bulimina* sp. var. (small, pointed initial end, spinose lower half of test).
- 2100' Brown sucrosic (calcareous?) mudstone. No new species.
- 2130' No new species or lithologies.
- 2160' No new species or lithologies.
- 2190' *Bathysiphon eocenica*, *Gyroidina* cf. *scalata*. Also *Spumellaria* common, *Spongodiscidae* rare, *Globobulimina* sp. (crushed) rare to common.
- 2220' Volcanic? rock fragments abundant. *Eponides*? sp. Also *Spumellaria* common.
- 2250' No new species or lithologies.

#### CONCLUSIONS

DEPTH (FEET)	STAGE	PALEOENVIRONMENT
30-60	Indeterminate	Indeterminate
60-150	Refugian	Outer Neritic to Upper Bathyal
150-180	Indeterminate	Possible Beach
180-240	Refugian	Inner to Middle Neritic
240-270	Refugian	Middle to Outer Neritic
270-330	Upper Narizian	Middle to Outer Neritic
330-360	Upper Narizian	Upper Middle Bathyal
360-450	Upper Narizian	Outer Neritic to Upper Bathyal
450-630	Upper Narizian	Inner to Middle Neritic
630-930	Upper Narizian	Upper to Upper Middle Bathyal
930-990	Indeterminate	Indeterminate
990-1050	Upper Narizian	Upper Middle Bathyal
1080-1110	Upper Narizian	Lower Middle Bathyal
1110-1140	Upper Narizian	Lower Middle to Lower Bathyal
1140-1290	Upper Narizian	Lower Middle Bathyal
1290-1950	Indeterminate	Non-marine to Inner Neritic
1950-2010	Narizian	Neritic?



# CONCLUSIONS (CONT.)

DEPTH (FEET)	STAGE	PALEOENVIRONMENT
2010-2070	Narizian	Upper to Middle Bathyal?
2070-2160	Indeterminate	Indeterminate
2160-2190	Narizian	Upper to Upper Middle Bathyal
2190-2250	Indeterminate	Indeterminate

AMERICAN QUASAR PETROLEUM COMPANY  
CROWN ZELLERBACH NO. 30 - 33  
SE½ SEC. 30, T6N, R4W

## Summary

This well section is similar to the nearby American Quasar Investment Management No. 20-21. One exception however is the thinner upper Narizian section above the upper Cowlitz sand in the 30-33.

Deposition was nearshore throughout most of the section penetrated, with sediments from 810 to 870 ft being deposited slightly farther from shore. Open marine conditions existed during the upper Narizian section from 690 to 1710 ft. During deposition of Refugian sediments and the sandy interval from 1710 ft to TD, there was restriction from open ocean circulation. The possible beach at 630 to 690 ft is based on lithology only. Possible intermittent non-marine environments from 1710 ft to TD are based on large quantities of coal and/or lignite accompanied by an absence of indigenous marine fossils.

## BIOSTRATIGRAPHIC RESULTS

The following data were derived from previously unprocessed wet ditch samples. Single depths noted below represent bottoms of 30 ft intervals.

- 0-30' Iron-stained mudstone? Barren of fossils.
- 60' Light gray mudstone with glass shards in matrix. Barren of fossils.
- 90' *Cibicides elmaensis* (of McDougall, 1980, pl. 24, figs. 1-3).
- 120' *Uvigerina atwilli*, U. cf. *atwilli*, *Guttulina irregularis*, *Plectofrondicularia packardi*.
- 150' *Eponides mexicana*, *Uvigerina* cf. *cocoaensis*, *Cassidulina* cf. *galvinensis*, *C. galvinensis/globosa* (intermediate form).
- 180' *Caucasina schencki*.
- 210' *Nonion inflatum*?
- 240' No new species or lithologies.
- 270' *Lenticulina* spp., *Plectofrondicularia multilineata*.
- 300' No new species or lithologies.
- 330' Tan sucrosic mudstone. *Globobulimina* spp., *Spumellaria* (spheres), Diatom (pyritized, centrate), *Sterrasters*.
- 360' *Lenticulina* sp. var. (large).
- 390' Shell fragments, Gastropod (ornate), Arenaceous indeterminate, *Cibicides* cf. *olequensis*, *C. cf. evolutus*.

- 420' Light gray muddy siltstone. Pyrite abundant, *Cibicides haydoni*, *Cassidulina globosa*, *Quinqueloculina imperialis*, Sponge spicules.
- 450' No new species or lithologies.
- 480' Highest volcanics. *Boldia hodgei*, *Pseudoglandulina inflata*, *Eponides kleinpellii*, s.l., *Melonis* cf. *pompilioides*.
- 510' *Subbotina praeturritilina*.
- 540' No new species or lithologies.
- 570' Very large processed sample. *Eponides gaviot-aensis*.
- 600, 630' No new species or lithologies.
- 660' Sub-rounded coarse sand abundant. Also volcanic? rock fragments. Barren of Foraminifera. Possible beach.
- 690' No new species or lithologies.
- 720' Fossiliferous silty mudstone. *Ceratobulimina washburnei*, *Lenticulina inornata*, *Florilus applini*, *Nonion inflatum*, *Pullenia* sp., *Cibicides mcmastersi* (abundant), *Alabama kernensis*, *Eponides* sp. (of Tipton, et. al., 1973), *Guttulina* cf. *hantkeni*, "*Angulogerina*" *cooperensis*, *Valvulineria involuta*.
- 750' No new species or lithologies.
- 780' *Gyroidina condoni*? (cf. *octocamerata*?), *Cibicides laurissae*? (small), *Bolivina* cf. *striatella*.
- 810' *Robertina washingtonensis*, *Chilostomella* sp., *Dyocibicides*? *perforata*?
- 840' *Spongodiscidae* (discs), *Bolivina basiscurta*.
- 870' *Nonion halkyardi*, s.s., *Plectofrondicularia vaughani*, *Nassellaria*.
- 900' *Alabama scitula*?, Ostracod, *Globigerina-theka* index (juvenile), *Elphidium* sp.
- 930, 960' Mudstone still contains glass shards. No new species.
- 990' *Vaginulinopsis saundersi*, *Bulimina* sp. var. (small, costate lower half of test).
- 1020' Bentonite rare. *Plectofrondicularia searsii*.
- 1050' No new species or lithologies.
- 1080' Last sample with glass shard laden mudstone. Also tan calcareous? mudstone. *Cibicides natlandi*, *Spumellaria* var. ("spiny"). Major increase in sand through 80 mesh screen.
- 1110' *Bathysiphon eocenica*, *Bulimina laciniata*, *B. sculptilis*, s.l.
- 1140' *Chilostomella* sp. var. (robust), *Gyroidina* cf. *scalata*.
- 1170' Dark tan calcareous? (cherty?) mudstone. No new species.
- 1200' *Cyclamina* sp. var. (large).
- 1230' *Haplophragmoides* sp. var. (evolute).
- 1260, 1290' No new species or lithologies.
- 1320' No new species or lithologies. Bentonite very very abundant.
- 1350' Ostracod var. (deep median sulcus), *Haplophragmoides* sp. var. (thin, small).

1380' Lost circulation material abundant. *Cibicides cushmani*.

1410' *Bulimina* sp. var. (pointed proloculus, smooth test), *Sigmoilina tenuis*.

1440' No new species or lithologies. Bentonite very very abundant.

1470' *Cassidulina galvinensis/globosa* var. (very inflated chambers), *Allomorphina* sp. var. (large, pyritized).

1500' *Nodosaria latejugata* (worn, reworked).

1530' *Valvulineria churchi* (common), *Cassidulina globosa* var. (uncoiling), *Uvigerina garzaensis*. Bentonite very very abundant.

1560' *Epistomina* sp., *Uvigerina churchi*, s.l. Also maximum numbers of *Uvigerina garzaensis* (rare). This sample represents the upper Narizian maximum transgression above the upper Cowlitz sand. Also bentonite very abundant.

1590' *Cibicidoides* aff. *venezuelanus*, *Spiroplectammina?* sp. (wedge-shaped test), *Anomalina* cf. *crassiseptus?*, *Truncorotaloides?* sp. (small), *Bolivina kleinpellii*. Also highest occurrence of consistent *Eponides* sp. (of Tipton, et. al., 1973).

1620' *Saracenaria* sp., *Eponides mexicana* var. (on 80 mesh screen, highly convex involute side), *Truncorotaloides aspensis*, *Pseudohastigerina lillisi*, *Gyroidina* sp. var. (slightly concave spiral side).

1650' *Gyroidina* aff. *octocamerata*, *Subbotina linaperta*, *Karrerella contorta*.

1680' *Gyroidina* cf. *octocamerata*.

1710' Very large increase in sand through 100 mesh screen. No new species.

1740' Lignite very very abundant. Barren of indigenous Foraminifera. Shell fragments common.

1770' Fine-grained sandstone. No new species. Arenaceous spp. (crushed) rare.

1800' Barren of indigenous calcareous Foraminifera.

1830' Medium-grained sandstone. Coal/lignite very abundant. Barren of indigenous calcareous Foraminifera.

1860, 1890' No new species or lithologies. Barren of indigenous Foraminifera.

1920' Lignite/coal very very abundant. No new species. *Epistomina* sp. rare (possibly indigenous).

1950' No new species or lithologies. Barren of indigenous Foraminifera.

1980' No new species or lithologies. Shell fragments abundant (indigenous). Barren of indigenous Foraminifera.

2010' Garnet-looking lithology. Barren of indigenous calcareous Foraminifera. Arenaceous sp. (crushed) rare (possibly indigenous).

2040' Small sample after processing. Barren of indigenous Foraminifera.

2070' Quartz-pyrite clusters common. Barren of indigenous Foraminifera.

2100' Fine to medium-grained micaceous sandstone very abundant. Coal very abundant. Barren of indigenous Foraminifera.

2130' No new species or lithologies. Coal very abundant. Barren of Foraminifera.

2160-2250' No new species or lithologies. Coal very abundant. Barren of indigenous Foraminifera.

2280, 2310' No new species or lithologies. Coal common. Barren of indigenous Foraminifera.

2340' No new species or lithologies. Barren of indigenous Foraminifera.

#### CONCLUSIONS

DEPTH (FEET)	STAGE	PALEOENVIRONMENT
0-60	Indeterminate	Indeterminate
60-510	Refugian	Upper Bathyal
510-570	Refugian	Outer Neritic
570-630	Refugian	Middle to Outer Neritic
630-690	Indeterminate	Possible Beach
690-810	Upper Narizian to Lower Refugian undiff.	Middle to Outer Neritic
810-1050	Upper Narizian to Lower Refugian undiff.	Upper Bathyal
1050-1500	Upper Narizian	Upper Middle Bathyal
1500-1590	Upper Narizian	Lower Middle Bathyal
1590-1710	Upper Narizian	Upper Middle Bathyal
1710-1860	Indeterminate	Marginal Marine to Non-marine
1860-1950	Indeterminate	Indeterminate
1950-2010	Indeterminate	Probable Marginal Marine to Non-marine
2010-2340	Indeterminate	Probably Non-marine

AMERICAN QUASAR PETROLEUM COMPANY  
CROWN ZELLERBACH NO. 29 - 14  
SW $\frac{1}{4}$  SEC. 29, T6N, R4W

#### Summary

Two fossiliferous Narizian sections in this well are typically separated by the upper Cowlitz sand. The top of the Narizian, as in most other wells of this study, is defined by the highest occurrence of *Cibicides natlandi*. The Narizian section below the sand is less definitive, but in this well it is recognizable by the presence of *Trochammina* cf. *globigerinaformis*.

All sediments penetrated by this well were deposited close to shore. Plankton distribution indicates that intermittent open marine conditions existed during the Narizian below the sand and during the Refugian, but that open marine waters persisted throughout the upper Narizian (above the sand).

Paleobathymetry ranges from marginal marine to

as deep as lower bathyal. Common specimens of the inner neritic *Elphidiella* at 1110 to 1140 ft correlate with a widespread hiatus at the Refugian-Narizian boundary. The interval of deepest deposition in the upper Narizian at 1740 to 1770 ft (represented by maximum numbers of hispid *Uvigerina*) correlates with similar "maximum transgressions" in nearby wells (see correlation with the Reichhold Columbia County No. 1, OH at the end of this well report).

#### BIOSTRATIGRAPHIC RESULTS

The following data were derived from previously unprocessed wet ditch samples. Single depths noted below represent bottoms of 30-ft intervals.

- 18-50' Light gray tuffaceous (glass shards) siltstone. Plectofrondicularia packardii, Guttulina frankei, Shell fragments.
- 80' Lenticulina texana?, Cibicides evolutus, Uvigerina cf. atwilli.
- 110' Uvigerina atwilli, Guttulina irregularis, Plectofrondicularia multilineata.
- 140' Cassidulina globosa, C. cf. galvinensis, Globobulimina sp.
- 170' Eponides kleinpelli, Cassidulina galvinensis.
- 200, 230' Brown silty mudstone. No new species.
- 260' Uvigerina cf. cocoaensis, Lenticulina sp.
- 290' Quinqueloculina sp., Cibicides cf. elmaensis.
- 320' Gastropod, Ostracod, Uvigerina sp. var. (costate), Bathysiphon sp. var. (coarse wall, slender test), Spumellaria (spheres), Diatom (pyritized, centrate).
- 350' Melonis pompilioides, Caucasina schencki, Cibicides haydoni, Nonion planatum?.
- 380' Highest glauconitic sandstone. Globobulimina sp. var. (large), Gastropod var. (ornate) Cassidulina galvinensis/globosa (intermediate form-very inflated chambers), Robertina washingtonensis, Gaudryina alazanensis (of Rau, 1948), Turborotalia insolita, "Angulogerina" cooperensis, Spongodiscidae (discs). Glass shards flood.
- 410' Sigmomorphina? sp. (fragment).
- 440' No new species or lithologies. Siltstone resistant to Quaternary "O".
- 470' Plectofrondicularia robusta.
- 500' Quinqueloculina imperialis, Biloculina sp., Boldia hodgei, Ceratobulimina washburnei.
- 510' Pullenia sp., Sponge spicules.
- 540' Cibicides natlandi (one specimen-reworked).
- 570' Volcanic rock fragments. No new species.
- 600-660' No new species or lithologies.
- 690' Guttulina hantkeni.
- 720' No new species or lithologies.
- 750' Gray silty mudstone. Pseudoglandulina inflata, "Valvulinaria" willapaensis, Nonion halkyardi, Lagenaria striata.
- 780' Cibicides mcmaistersi, C. olequaensis, Subbotina sp., S. cf. angiporoides, S. senilis?
- 780' (cont.) (juvenile), Alabamina kernensis, Caucasina schencki var. (very elongate), Bolivina striatella.
- 810' Allomorphina cf. macrostoma (of Rau, 1948), Textularia cf. adalta (of Rau, 1948), Gyroidina planata, Florilus applini, Bolivina oregonensis.
- 840' Fish remains. No new species or lithologies.
- 870, 900' No new species or lithologies.
- 930' Globigerinathea index? (low-arched primary aperture).
- 960' Sigmomorphina schencki, Globigerinathea index.
- 990' Decrease in glass shards. Vaginulinopsis lewisensis.
- 1020' Lenticulina chirana, L. "cf. welchi" (of Rau, 1948).
- 1050' No new species or lithologies.
- 1080' Vaginulinopsis saundersi, Plectofrondicularia searsii.
- 1110' No new species or lithologies.
- 1140' Elphidiella sp. (common), Elphidium sp. (rare), Spumellaria var. ("spiny" sphere). Possible hiatus in this sample interval.
- 1170' Cibicides natlandi.
- 1200' Pseudohastigerina micra.
- 1200-1320' No new species or lithologies.
- 1350' Gaudryina sp. var. (small).
- 1380' Haplophragmoides sp. (crushed), Bathysiphon eocenica, Cyclamina sp. var. (large), Arenaceous indeterminate (crushed).
- 1410' "Angulogerina" cf. cooperensis (obese), Bulimina laciniata.
- 1440' Eggerella? sp. (large, crushed), Karreriella washingtonensis? (crushed).
- 1470' Gyroidina octocamerata, Cibicides cushmani, Eponides mexicana group.
- 1500' Eponides gaviotaensis?
- 1530' Diatom var. (pyritized, triangular), Lenticulina welchi, s.s., Gyroidina scalata/condoni (intermediate form).
- 1560' Lenticulina cf. terryi, Spiroloculina sp., Plectofrondicularia vaughani, Eponides gaviotaensis.
- 1590' Brown micaceous fossiliferous mudstone. No new species.
- 1620' Epistomina sp.
- 1650' No new species or lithologies.
- 1680' "Sucrosic" lithology. Ammodiscus sp. (large, fragment), Bulimina sculptilis, Uvigerina nudorobusta.
- 1710' No new species or lithologies. Uvigerina nudorobusta var. (obese) rare.
- 1740' Valvulinaria churchi. Also Uvigerina nudorobusta rare.
- 1770' Uvigerina churchi, Quadrimorphina sp., Subbotina wilsoni, Alabamina scitula. Also

1770' (cont.) *Uvigerina nudorobusta* rare and *U. garzaensis* rare to common. This sample represents the upper Narizian maximum transgression.

1800' *Uvigerina elongata*. Also *U. garzaensis* rare and *Cassidulina globosa* abundant.

1830' *Cibicides laurissae*.

1860' *Cibicidoides venezuelanus*, *Virgulina* sp. (pyritized). Also *Spumellaria* (spheres) abundant.

1890' *Subbotina minima*?, *Karreriella*? contorta? (fragment), *Uvigerina* cf. *yazooensis*?, *Truncorotaloides* cf. *aspensis*.

1920' *Eponides* sp. (of Tipton, et. al., 1973), *Gyroidina condoni*.

1950, 1980' No new species or lithologies.

2010' *Valvulineria involuta*, *Subbotina* sp. var. (large).

2040' No sample available.

2070' No new species or lithologies. *Elphidium* sp. very rare, *Elphidium/Elphidiella* sp. very rare.

2100' Increase in sand. No new species or lithologies.

2130' Very micaceous fine-grained sandstone. No new species. *Elphidium/Elphidiella* sp. rare.

2160' Highest medium-grained sandstone. No new species.

2160-2250' No new species or lithologies.

2280' Gilsonite flood. Barren of indigenous Foraminifera.

2310' Bentonite very rare. Barren of indigenous Foraminifera. Gilsonite/coal common.

2340' No new species or lithologies. *Globobulimina* sp. (pyritized) rare-possibly indigenous.

2370' No new species or lithologies. Echinoid spines rare-probably indigenous.

2400' *Chilostomella* sp. var. (thin).

2430' *Trochammina* cf. *globigerinaformis*. Probably barren of indigenous calcareous Foraminifera.

2460-2610' Barren of indigenous Foraminifera.

2640' Barren of indigenous calcareous Foraminifera. *Trochammina* cf. *globigerinaformis*.

2670' *Plectofrondicularia*? (*Amphimorphina*?) (fragment, double-keeled), probably reworked. Probably barren of indigenous Foraminifera.

2700' *Valvulineria tumeyensis*, possibly caved. Probably barren of indigenous Foraminifera.

2730' *Gyroidina*? aff. *florealis*?-probably reworked. Probably barren of indigenous Foraminifera.

2760' Barren of indigenous calcareous Foraminifera. *Trochammina* cf. *globigerinaformis*.

2790' No new species. Barren of indigenous Foraminifera.

2820' No sample available.

2850' *Uvigerina* sp. var. (small, thin test, costate), probably caved. Probably barren of indigenous Foraminifera.

2880' Barren of indigenous Foraminifera.

#### CONCLUSIONS

DEPTH (FEET)	STAGE	PALEOENVIRONMENT
18-630	Refugian	Upper Bathyal
630-720	Refugian	Marine undifferentiated
720-1110	Refugian	Outer Neritic to Upper Bathyal
1110-1140	Refugian	Mixed Inner Neritic and Upper Bathyal
1140-1350	Upper Narizian	Middle to Outer Neritic
1350-1380	Upper Narizian	Outer Neritic to Upper Bathyal
1380-1500	Upper Narizian	Upper Bathyal
1500-1650	Upper Narizian	Upper Middle Bathyal
1650-1740	Upper Narizian	Lower Middle Bathyal
1740-1770	Upper Narizian	Lower Middle Bathyal to Lower Bathyal
1770-1920	Upper Narizian	Lower Middle Bathyal
1920-2010	Upper Narizian	Upper Middle Bathyal
2040-2130	Indeterminate	Probably Inner to Middle Neritic
2130-2220	Indeterminate	Indeterminate
2220-2310	Indeterminate	Probably Non-marine to Marginal Marine
2310-2400	Narizian	Probably Neritic
2400-2580	Indeterminate	Probably Non-marine to Marginal Marine
2580-2880	Indeterminate	Indeterminate

#### CORRELATION WITH THE REICHOLD COLUMBIA COUNTY NO. 1, OH

The following correlation indicates a considerably greater hiatus at the Refugian-Narizian boundary in the Columbia County No. 1, OH than in the Crown Zellerbach 29-14. The Columbia County is missing approximately 700 ft of Refugian section relative to the Crown Zellerbach. However, the upper Narizian sections above the upper Cowlitz sand in the two wells are similar in thickness.

CROWN Z. 29-14 (DEPTH IN FEET)	SPECIES TOPS	COL. CO. 1, OH (DEPTH IN FEET)
? *	<u><i>Turborotalia insolita</i></u>	1230
350	<u><i>Cibicides haydoni</i></u>	1590
Hiatus		Hiatus
1170	<u><i>Cibicides natlandi</i></u>	1650
1200	<u><i>Pseudohastigerina micra</i></u>	1740
1560	<u><i>Plectofrondicularia vughani</i></u>	1980
1740	<u><i>Valvulineria churchi</i></u>	2100
1770	<u><i>Uvigerina churchi</i></u>	2190
1800	<u><i>Uvigerina elongata</i></u>	2190
1830	<u><i>Cibicides laurissae</i></u>	2220

\* Sparse faunas mask highest occurrence of species.

## CORRELATION (CONT.)

CROWN Z. 29-14 (DEPTH IN FEET)	SPECIES TOPS	COL. CO. 1, OH (DEPTH IN FEET)
1890	<u>Truncorotaloides cf. aspensis</u> , <u>Uvigerina cf. yazoensis?</u>	2220
1890	<u>Subbotina minima</u> , <u>Karrerella contorta</u>	2250
2100	Upper Cowlitz sand	2460

THE TEXAS COMPANY  
BENSON CLATSKANIE NO. 1  
NE½ SEC. 36, T7N, R4W

Summary

The entire well section is in sediments and volcanics of Narizian age. It is possible that the samples from 628 to 643 ft represent the base of poorly developed upper Cowlitz sand. A few species occurring from 1259 to 1370 ft generally have not been seen above the upper Cowlitz sand in Columbia County by this writer. They are: Trochammina cf. globigerinaformis, Ostracod variety (deep median sulcus), and Spumellaria variety ("spiny" spheres).

Deposition was nearshore throughout the well section. Only one interval, 1250 to 1422 ft, represents intermittent open ocean circulation. The rest of the sediments in the well essentially lack fossil plankton, indicating either restricted ocean circulation or exclusion of plankton by upwelling and/or fresh water runoff.

Relatively shallow water depths throughout the section indicate that the drill site was a topographic high. As a result, all the upper Narizian and younger sediments were eroded away.

## BIOSTRATIGRAPHIC RESULTS

The following data were derived from previously unprocessed core samples borrowed from the DOGAMI collection.

628-638'	Muscovite and angular quartz sand. Barren of fossils.
643'	Same as above.
658'	Gilsonite common. Barren of fossils.
750-760'	Pyritic volcanic? rock fragments. Barren of fossils.
1143-1154'	Volcanic? rock fragments. Barren of fossils.
1227-1237'	Light brown tuffaceous silty mudstone. Cyclammina sp., Lenticulina sp., Ammodiscus sp. (fragment), Cibicides nalandi, C. mcmastersi, Arenaceous indeterminate, Plectofrondicularia oregonensis, Cassidulina globosa, Haplophragmoides? sp. (very small), Bolivina kleinpelli, Dentalina sp.
1250'	Light brown sucrosic silty mudstone. Spumellaria (spheres).
1259'	Trochammina cf. globigerinaformis, Diatom (pyritized, centrate), Lenticulina sp. var. (large).

1270'	Eponides mexicana, Spongodiscidae (discs), Eponides gaviotaensis, Globobulimina/Bulimina sp. (poorly preserved), Stilostomella sp. (fragment), Cibicides spp.
1280'	Shell fragments, Nonion halkyardi? (small), Nodosaria longiscata.
1301'	No new species or lithologies. Shell fragments common, Diatoms abundant.
1307-1317'	Lenticulina cf. terryi?, Pseudoglandulina? sp.
1325'	Eponides mexicana var. (involute side highly convex).
1334'	Pullenia sp.
1346'	Caucasina schenckii.
1358'	Poorly sorted very fine-grained sandstone. No new species.
1370'	Ostracod var. (deep median sulcus), Florilus applini, Spumellaria var. ("spiny" spheres).
1381-1391'	No new species or lithologies.
1394'	No new species or lithologies.
1422'	Sterrasters, Sponge spicules. No new species.
1427-1438'	Light brown siltstone. No new species.
1448'	Poorly sorted very fine to medium-grained volcanic? sandstone. Translucent green grains. Barren of fossils.
1540'	No new species or lithologies.
1550'	Ceratobulimina washburnei.
1562'	No new species or lithologies.
1571'	No new species or lithologies.
1573-1584'	Pseudoglandulina inflata.
1684'	Cibicides cushmani
1693'	Nonion planatum.
1705'	Brown mudstone. Barren of fossils.
1708-1720'	No new species or lithologies.
1820-1830'	Volcanics. Barren of fossils.
1830-1840'	Volcanics. Barren of fossils.
1879-1889'	Volcanics. Barren of fossils.
1977'	Volcanics. Barren of fossils.
1987'	Volcanics. Barren of fossils.
1989-2001'	Volcanics. Barren of fossils.
2001-2013'	Volcanics. Barren of fossils.
2024'	Volcanics. Barren of fossils.
2025-2037'	Volcanics. Barren of fossils.
2037-2061'	Volcanics. Barren of fossils.
2135'	Micaceous fine to medium-grained sandstone. Barren of fossils.
2159-2170'	Barren of Foraminifera. Shell fragments common.
2340-2352'	Clean white angular to subangular sand. Barren of fossils.
2460'	Volcanic? sandstone. Barren of fossils.
2472'	Volcanic sand. Barren of fossils.

2510' Volcanic? sandstone. Barren of fossils.  
 2622' Clean white angular to subangular sand. Barren of fossils.  
 2632' Same as sample above.  
 2645' Same as sample above.  
 2665' Rounded volcanic? fragments and brown silty mudstone. Gilsonite very very abundant. Barren of Foraminifera.  
 2700' Rock fragments and light gray siltstone? Barren of fossils.  
 2709' Clean white angular to subangular sand. Barren of fossils.  
 2820' Sand and brown silty mudstone. Barren of fossils.  
 2830' Very fine-grained sand. Barren of fossils.  
 2960' Fine-grained sand. Barren of fossils.  
 2966-2978' "Succrosic" very fine-grained sandstone to siltstone. Barren of fossils.  
 3133' Volcanic very fine-grained sandstone. Barren of fossils.  
 3150' Volcanic very fine-grained sandstone. Barren of fossils.  
 3395' Cribronion? cf. roemerii?, Rotalia aff. becki?.  
 3401' Volcanics. Barren of fossils.  
 3806' Volcanics. Barren of fossils.  
 4336' Poorly sorted very fine to coarse-grained volcanic sandstone. Barren of fossils.  
 4540' Volcanics. Barren of fossils.  
 4550' Volcanics. Barren of fossils.  
 4858' Volcanic sandstone? Barren of fossils.  
 4868' Volcanics. Barren of fossils.  
 4899' Volcanics. Barren of fossils.  
 5114-5126' Volcanics and sand flood. Barren of fossils.  
 5145' Volcanic? siltstone. Barren of fossils.  
 5155' Light brownish-gray sandy mudstone. Barren of fossils.  
 5294' Volcanic? sandy siltstone? Barren of fossils.  
 5445' Gray mudstone. Barren of fossils.  
 5564-5576' Plectofrondicularia packardii, Gyroidina cf. scalata? (broken), Eponides minimus? (worn).  
 5615-5621' No new species. Caucasina schencki, Arenaceous indeterminate, Cyclamina sp.  
 5630' Lenticulina cf. welchi, L. inornata, "Ellipsonodosaria" sp.  
 5644-5650' Pseudoglandulina conica, Gyroidina cf. scalata.

#### CONCLUSIONS

DEPTH (FEET)	STAGE	PALEOENVIRONMENT
628-1154	Indeterminate	Indeterminate

#### CONCLUSIONS (CONT.)

DEPTH (FEET)	STAGE	PALEOENVIRONMENT
1227-1720	Narizian	Outer Neritic to Upper Bathyal
1820-2135	Indeterminate	Indeterminate
2159-2170	Indeterminate	Probably Marginal Marine to Inner Neritic
2340-2645	Indeterminate	Indeterminate
2665	Indeterminate	Possibly Non-marine to Marginal Marine
2700-3150	Indeterminate	Indeterminate
3395	Probably Narizian	Neritic?
3401-5445	Indeterminate	Indeterminate
5564-5650	Narizian	Probably Upper Middle Bathyal

AMERICAN QUASAR PETROLEUM COMPANY  
 CROWN ZELLERBACH NO. 15 - 14  
 SW¼ SEC. 15, T6N, R4W

#### Summary

This is one of two wells in this study which penetrated sediments possibly as young as Zemorrian in age (see also American Quasar Investment Management No. 34-21), but shallow neritic facies mask the Zemorrian-Refugian boundary.

Two distinct fossiliferous Narizian intervals in the 15-14 bracket the upper Cowlitz sand. Comparison of these intervals with Quasar's 25-33 drilled four miles southwest indicates the latter has a thicker section through these intervals relative to the 15-14. Highest Narizian faunas dominated by *Bulimina microcostata*, "*Angulogerina*" *cooperensis* and *Nassellaria* are distinctly absent in the 15-14.

Intermittent open marine conditions existed during the Narizian, but post-Narizian faunas indicate restriction from open ocean circulation (no fossil plankton).

The upper Narizian maximum transgression occurred somewhere between 1530 and 1740 ft - probably in the 1530 to 1560 ft sample.

#### BIOSTRATIGRAPHIC RESULTS

The following data were derived from previously unprocessed wet ditch samples. Single depths mentioned below represent bottoms of 30 ft intervals.

0-30'	Light gray siltstone. Glass shards very abundant. Barren of fossils.
60'	Light gray silty mudstone. Barren of fossils.
90'	Light gray mudstone. Glass shards very abundant. Barren of fossils.
120'	No new lithologies. Barren of fossils.
150'	Glauconite very very abundant. Barren of fossils.
180, 210'	No new lithologies. Barren of fossils.
240'	<i>Buccella</i> sp., Diatom (pyritized, ctntrate), <i>Anomalina californiensis</i> , <i>Cassidulina</i>

- 240' (cont.) *crassipunctata*, *Cibicides evolutus*, *Gyroidina planata*, *Epistominella* sp. var. (small), *Cibicides* sp.
- 270' Shell fragments, *Anomalina* cf. *patella*?, *Nonionella turgida*?, *Buliminella* cf. *subfusiformis*, *Cibicides* aff. *evolutus* (highly convex involute side).
- 300' *Alabamina*? sp., *Lenticulina* sp., *Buccella oregonensis*, *Globobulimina* sp. var. (small, thin test, pyritized).
- 330' No new lithologies. Barren of Foraminifera.
- 360' Siltstone to very fine-grained sandstone. Barren of Foraminifera.
- 390, 420' No new lithologies. Barren of Foraminifera.
- 420-518' No samples available.
- 518-600' No new lithologies. Barren of Foraminifera.
- 630' Pyrite abundant. Barren of Foraminifera.
- 660' *Bolivina kleinpellii*.
- 690' *Elphidium* sp.
- 720-900' No new species or lithologies.
- 930' *Elphidiella*? sp. (large).
- 930-1050' No new lithologies. Barren of Foraminifera.
- 1080' No new species or lithologies. *Elphidiella* sp. rare to common, *Gyroidina planata* rare to common, *Cibicides haydoni*?
- 1110' No new lithologies. *Uvigerina cocoaensis*, s.s., *U. cocoaensis* group, *U. gallowayi/cocoaensis* (intermediate form), *Epistomina* sp., *Plectofrondicularia multilinea*, *Caucasina schencki*, *Cibicides* cf. *evolutus*, *C. aff. haydoni*?
- 1140' No sample available.
- 1170' *Lagena striata*, *Cibicides* aff. *natlandi* (no pustules on involute side), *Quinqueloculina* sp.
- 1200' No new species or lithologies.
- 1230' *Quinqueloculina imperialis*, *Eponides mexicana*.
- 1260' No sample available.
- 1290' No new species or lithologies.
- 1310' *Melonis pompilioides*. Decrease in glass shards.
- 1330' Brown limestone flood. Barren of fossils.
- 1350' No new species or lithologies.
- 1380' *Uvigerina atwilli*, s.s., *Dentalina* sp.
- 1410' No new lithologies. Barren of indigenous Foraminifera.
- 1440' Volcanics. Barren of indigenous Foraminifera.
- 1470' Light gray mudstone and very fine-grained sandstone. *Cibicides natlandi*, *Bulimina laciniata*, Echinoid spines, *Boldia hodgei*, *Eponides mexicana* var. (bi-convex test), *Bolivina striatella*.
- 1500' *Lenticulina chirana*, *Globigerina officinalis*?
- 1530' *Cassidulina globosa*, *Lenticulina welchi*, s.l., *Alabamina kernensis*.
- 1560' *Plectofrondicularia vauhanii*, *Valvulineria churchi*, *Uvigerina garzaensis* (rare), *Bulimina sculptilis*, *Gyroidina* cf. *scalata*?, *Truncorotaloides* cf. *aspensis*, *Valvulineria chirana*, *Bolivina oregonensis*, *Globorotaloides* sp. (of McKeel and Lipps, 1975), Diatom var. (pyritized, triangle-shaped test). This sample probably represents the upper Narizian maximum transgression.
- 1590' No new species or lithologies.
- 1620' *Lenticulina* cf. *terryi*, *Cibicides cushmani*, *Spiroloculina* sp. Also *Cassidulina globosa* abundant.
- 1650' "*Angulogerina*" *cooperensis*, *Cibicoides venezuelanus*, *Globigerina wilsoni*, *Valvulineria involuta*.
- 1680' *Uvigerina yazooensis*, *Vaginulinopsis saundersi*, *Eponides gaviotaensis*, *Eponides* sp. (of Tipton, et. al., 1973), *Ceratobulimina washburnei*, *Cibicides natlandi/haydoni* (intermediate forms), *Gyroidina octocamerata*, *Saracenaria* sp., *Spumellaria* (spheres).
- 1710' Ostracod var. (deep median sulcus, poorly preserved, probably reworked).
- 1740' Very fine-grained micaceous sandstone. *Plectofrondicularia oregonensis*.
- 1740-1830' No new species or lithologies. Possibly barren of indigenous Foraminifera.
- 1860' *Florilus applini* (abundant). Also *Cibicides natlandi* abundant, *Lenticulina* spp. (large) common.
- 1890, 1920' No new species or lithologies.
- 1950' Very fine-grained sandstone. Barren of indigenous Foraminifera. Top of upper Cowlitz sand (main body) in this sample.
- 1980' Pyrite-quartz clusters. Barren of indigenous Foraminifera.
- 2010' No sample available.
- 2040, 2070' Barren of indigenous Foraminifera.
- 2100' Fine to medium-grained sandstone. Barren of indigenous Foraminifera.
- 2100-2190' No new lithologies. Barren of indigenous Foraminifera.
- 2220' Medium-grained sandstone. Barren of indigenous Foraminifera.
- 2220-2270' No samples available.
- 2270-2280' Lignitic? shale? Arenaceous sp. indeterminate (crushed).
- 2310' Lignitic mudstone. No new species.
- 2340' *Trochammina* cf. *globigerinaformis*.
- 2340-2430' No new lithologies. Barren of indigenous Foraminifera.
- 2460' Very pyritic sandstone. Barren of indigenous Foraminifera.



2460-2590' No new lithologies. Barren of indigenous Foraminifera.

2620' White (opaline or hydrated?) quartz abundant. Barren of indigenous Foraminifera.

2650' Lignite/coal very abundant. Barren of Foraminifera.

2650-2710' No samples available.

2740' No new lithologies. Barren of indigenous Foraminifera.

2740-2760' No sample available.

2790' Well-consolidated very fine-grained sandstone. Barren of Foraminifera.

2820' Micaceous siltstone. *Cibicides natlandi* var. (wide keel).

2850' *Cyclammina* sp. (large), *Haplophragmoides* sp. (crushed).

2880' *Eggerella*? sp. var. (large, crushed), *Lenticulina* sp. var. (very curved sutures), *Eponides mexicana* var. (involute side highly convex), *Ostracod* var. (deep median sulcus).

2910' No new species or lithologies.

2940' *Spumellaria* var. ("spiny" spheres), *Pseudoglandulina nallpeensis*, *Marginulina*? sp.

2970' Top of volcanic interbeds. No new species.

3000' Volcanics. Inorganic spheres. Barren of indigenous Foraminifera.

3030' *Bathysiphon eocenica*, *Pseudoglandulina conica*.

3060, 3090' No new species or lithologies.

3120' No new species or lithologies. *Cibicides natlandi* common.

3150' No new species or lithologies. *Bathysiphon eocenica* and *Cibicides natlandi* both common.

3180' Brownish-gray mudstone. *Cassidulina globosa* var. (uncoiling), *Parrella*? sp. Also *Cibicides natlandi* abundant.

#### CONCLUSIONS

DEPTH (FEET)	STAGE	PALEOENVIRONMENT
0-210	Indeterminate	Indeterminate
210-300	Uppermost Refugian to Zemorrian undiff.	Upper Bathyal
300-630	Indeterminate	Indeterminate
630-1080	Uppermost Refugian to Zemorrian undiff.	Mixed Inner Neritic to Upper Bathyal
1080-1410	Refugian	Upper Bathyal
1410-1440	Indeterminate	Indeterminate
1440-1530	Upper Narizian	Upper Middle Bathyal
1530-1740	Upper Narizian	Lower Middle Bathyal
1740-1830	Indeterminate	Indeterminate
1830-1890	Upper Narizian	Probably Outer Neritic to Upper Bathyal

#### CONCLUSIONS (CONT.)

DEPTH (FEET)	STAGE	PALEOENVIRONMENT
1890-1920	Upper Narizian	Probably Middle to Outer Neritic
1920-2220	Indeterminate	Indeterminate
2270-2340	Narizian	Probably Middle to Outer Neritic
2340-2620	Indeterminate	Indeterminate
2620-2650	Indeterminate	Non-marine to Marginal Marine
2710-2790	Indeterminate	Indeterminate
2790-3180	Narizian	Neritic undifferentiated

AMERICAN QUASAR PETROLEUM COMPANY  
INVESTMENT MANAGEMENT NO. 34 - 21  
NW¼ SEC. 34, T6N, R4W

#### Summary

This well apparently penetrated a Narizian topographic high. Volcanics are conspicuously absent. Also, non-marine or very shallow marine paleodepths extend from 1620 ft to TD.

An interval between Refugian and Narizian faunas contains well-rounded coarse-grained sand (1110 to 1170 ft), indicating a high energy (beach?) environment, and probably an erosional unconformity.

Maximum paleobathymetry within the upper Narizian above the upper Cowlitz sand occurs at 1350 to 1380 ft. This point is a time equivalent to upper Narizian maximum transgressions in other Columbia County wells as reported by this writer.

Fossiliferous Narizian section below the upper Cowlitz sand in this well is probably similar in thickness to that found in the American Quasar No. 25-33 drilled four miles to the west.

All sediments penetrated were deposited close to shore. During Refugian time open sea circulation was restricted at this location. In contrast, the fossiliferous Narizian intervals are open marine deposits. Relatively large amounts of coal and/or lignite indicating non-marine? conditions occur in two general intervals; one is between the Narizian (undifferentiated) and upper Narizian fossiliferous intervals and the other is below the Narizian faunas close to the bottom of the well (see next section, this well report).

#### BIOSTRATIGRAPHIC RESULTS

The following data were derived from previously unprocessed wet ditch samples. Single depths noted below represent bottoms of 30 ft intervals.

- 20?-40' Glauconitic mudstone. Glass shards very very abundant. Barren of fossils.
- 60' Shell fragments. Barren of indigenous Foraminifera.
- 90' *Gyroidina planata*.
- 120' Light gray glauconitic muddy siltstone. Barren of fossils.
- 150' Very fine-grained glauconitic sandstone. *Quinqueloculina* sp., *Cibicides evolutus*?

- 150' (cont.) (large). Also *Gyroidina* cf. *soldanii*, *Cibicides cushmani* (both poorly preserved, probably reworked).
- 180' *Cassidulina crassipunctata*, *Cibicides evolutus*.
- 210' Diatom (pyritized, centrate), *Sterrasters*, *Anomalina* cf. *californiensis* (small).
- 240' *Nonion halkyardi*, *Cassidulina galvinensis*, s.s., *Alabamina kernensis*, *Cibicides* sp. var. (granular wall, central plug), *Guttulina irregularis*, *Plectofrondicularia multilinea*, *Spumellaria* (spheres).
- 270' *Uvigerina atwilli*, U. cf. *atwilli*, *Cassidulina galvinensis/globosa* (intermediate form), *Eponides mexicana*?
- 300' No sample available.
- 330' *Eponides* cf. *kleinPELLI*, *Caucasina schencki*.
- 360' *Dentalina dusenburyi*, *Cassidulina* cf. *globosa*, *Melonis* cf. *pompilioides*.
- 390' *Quinqueloculina imperialis*, *Epistomina* sp., *Ceratobulimina washburnei*, *Plectofrondicularia packardii*, *Nodosaria longiscata*.
- 420' Volcanic? rock fragments common. *Uvigerina cocoaensis* group.
- 450' Tan limey mudstone. No new species. *Uvigerina cocoaensis* group rare to common.
- 480, 510' No new species or lithologies.
- 540' *Subbotina* sp.
- 540-630' No new species or lithologies.
- 660' No new species. Increase in glauconite.
- 690, 720' No new species or lithologies.
- 750' *Plectofrondicularia robusta*. Tan very limey mudstone (as in 450 ft sample).
- 780, 810' No new species or lithologies.
- 840' *Elphidium/Elphidiella* sp.
- 840-930' No new species or lithologies.
- 960' No new species. Volcanic rock fragments abundant.
- 990' Barren of Foraminifera. Volcanic rock fragments abundant.
- 1020' *Globobulimina* sp., *Pullenia* sp., *Florilus applini*, *Pseudoglandulina conica* (internal mold, reworked).
- 1050' Very fine-grained bentonitic sandstone. Barren of Foraminifera.
- 1080, 1110' Fine to medium-grained bentonitic sandstone. Barren of Foraminifera.
- 1140, 1170' Rounded very coarse-grained sand. Barren of Foraminifera. Possible beach.
- 1200' Light tan silty mudstone. *Elphidiella* sp., *Boldia hodgei*, *Globulina* cf. *landesi*, *Vaginulina* cf. *wrighti* (of Beck, 1943), *Discorbis? coalingsensis?* (of Mallory, 1959). Hiatus in this sample.
- 1230' Ostracod, *Cibicides mcMastersi*, *C. natlandi*, *C. olequaensis*, "*Angulogerina*" *cooperensis*, *Cassidulina globosa*.
- 1260' *Valvulineria churchi*, *Bulimina laciniata*, *Uvigerina nudorobusta*, *Pseudohastigerina micra*, *Spongodiscidae* (discs), *Pullenia salisburyi*, *Bolivina oregonensis*, *Arenaceus* sp. (crushed), *Plectofrondicularia searsi*, *Nonion planatum*, Echinoid spines. Also *Spumellaria* (spheres) very abundant.
- 1290' *Vaginulinopsis saundersi*, *Allomorphina* sp.
- 1320' *Uvigerina* cf. *churchi*. Also *Cassidulina globosa* abundant.
- 1350' *Eponides mexicana* var. (involute side highly convex), *Sigmoilina tenuis*, *Siphonina* sp., *Bolivina striatella*.
- 1380' *Eponides* sp. (of Tipton, et. al., 1973), *Uvigerina* aff. *yazooensis*, *Karrerella contorta*, *Plectofrondicularia vaughani*. Also *Uvigerina nudorobusta* rare (maximum numbers). This sample represents the upper Narizian maximum transgression.
- 1410' *Guttulina frankei/hantkeni*, *Quinqueloculina goodspeedi*, *Gyroidina scalata/condoni* (intermediate form). Also bentonite abundant.
- 1440' *Haplophragmoides* sp., *Truncorotaloides* sp. (four chambers outer whorl).
- 1470' No new species or lithologies.
- 1500' *Bathysiphon eocenica*.
- 1530, 1560' No new species or lithologies.
- 1590' *Bulimina* cf. *jacksonensis?*.
- 1620' *Sigmomorphina schencki?*.
- 1650' No new species. Shell fragments very abundant. Increase in very fine-grained sand.
- 1680' Rock fragments rare. Lignite abundant. Barren of indigenous Foraminifera.
- 1710' Lignite flood. Barren of indigenous Foraminifera.
- 1740' Fine-grained micaceous sandstone. No new species. Shell fragments very abundant, *Quinqueloculina imperialis* rare.
- 1770' Tan limestone very abundant. Rounded rock fragments rare. No new species. *Elphidium/Elphidiella* sp. very rare.
- 1800' Quartz-pyrite clusters abundant, rounded coarse-grained sand rare to common. Barren of indigenous Foraminifera.
- 1830' Barren of indigenous Foraminifera. Rounded coarse-grained sand rare. Lignite very very abundant.
- 1860' *Robertina washingtonensis*. Rounded coarse-grained sand common, lignite very abundant. Barren of indigenous Foraminifera.
- 1890' Barren of indigenous Foraminifera. Lignite very abundant.
- 1920' Barren of indigenous Foraminifera. Lignite flood. Rounded coarse-grained sand common.
- 1950' Barren of indigenous Foraminifera. Fine-grained micaceous sandstone flood, lignite very abundant.
- 1980' Barren of indigenous Foraminifera. Rounded coarse-grained sand common, lignite very

1980'	(cont.) abundant.	2820'	No new species or lithologies. <i>Cibicides natlandi</i> abundant.
2010'	Barren of indigenous Foraminifera. Lignite very abundant.	2850-3030'	No new species or lithologies.
2040'	Barren of indigenous Foraminifera. Shell fragments abundant.	3060'	<i>Valvulineria involuta</i> .
2070'	No new species or lithologies. <i>Elphidiella</i> sp., Shell fragments common.	3090-3240'	No new species or lithologies.
2100'	Brown lignitic mudstone (probably caved). Lignite very very abundant. Sparse lower middle bathyal fauna, no new species, probably caved. Shell fragments abundant, <i>Elphidiella</i> sp., rounded coarse-grained sand common.	3270'	No new species. Increase in sand. <i>Elphidiella</i> sp.
2130'	No new species or lithologies. <i>Elphidiella</i> sp.	3300'	No new species or lithologies.
2160'	Coal very very abundant. Rounded coarse-grained sand common. Probably barren of indigenous Foraminifera.	3330'	Dark gray mudstone. No new species.
2190'	No new species or lithologies. Lignite/coal very abundant.	3360'	No new species or lithologies.
2220'	No new species or lithologies. <i>Elphidiella</i> sp.	3390'	" <i>Angulogerina</i> " sp. var. (obese). Faunal increase.
2250'	Rock fragments (mostly calcareous or limestone?) abundant (probably caved). Sparse bathyal fauna (no new species), probably caved.	3420'	No new species or lithologies.
2280-2370'	No new species or lithologies. Barren of indigenous Foraminifera.	3450'	No new species or lithologies.
2400'	No new species or lithologies. Very fine-grained sandstone very abundant. Lignite/coal very abundant. Barren of indigenous Foraminifera.	3480'	<i>Bulimina</i> sp. var. (spinose lower half of test), possibly caved.
2430'	No new species or lithologies. Very fine-grained sandstone flood.	3510'	No new species or lithologies. Coal very abundant, Shell fragments abundant.
2460'	No new species or lithologies. Lignite/coal very very abundant.	3540'	" <i>Valvulineria</i> " <i>menloensis</i> ?. Very fine-grained sandstone common. Coal/lignite abundant. Probably barren of indigenous Foraminifera.
2490'	<i>Pseudoglandulina nallpeensis</i> , <i>Gyroidina</i> cf. <i>scalata</i> . Also <i>Spumellaria</i> abundant, <i>Spongodiscidae</i> (discs) rare to common. Lignite/coal very very abundant.	3570'	No new species or lithologies. Coal/lignite very very abundant. Abundant mudstone and <i>Cibicides natlandi</i> rare to common, both probably caved.
2520'	<i>Siphonina cowlitzensis</i> . Decrease in lignite/coal to abundant.	3600'	No new species or lithologies. Fine-grained sandstone common. Barren of indigenous Foraminifera.
2550'	<i>Bathysiphon eocenica</i> var. (large), <i>Trochammina</i> cf. <i>globigerinaformis</i> , <i>Eponides</i> ? sp. var. (small test, planoconvex, ventral plug, 11 chambers outer whorl), <i>Lenticulina</i> aff. <i>welchi</i> , <i>Gyroidina condoni</i> .	3630'	Barren of indigenous Foraminifera. Very fine-grained sandstone abundant.
2580'	<i>Cyclammina</i> sp. var. (large), <i>Ostracod</i> var. (deep median sulcus). Also <i>Siphonina cowlitzensis</i> common, <i>Spumellaria</i> very abundant.	3660'	Major increase in sand. Major decrease in coal/lignite. Barren of Foraminifera.
2610'	<i>Ammodiscus</i> sp. var. (large).	3690'	Fine to medium-grained sandstone. Barren of Foraminifera.
2640'	<i>Cassidulina globosa</i> var. (large). Also <i>Cyclammina</i> sp. var. (large) rare to common.	3720'	Coaly mudstone flood. Barren of marine fossils.
2670'	<i>Eggerella</i> ? sp. (large).	3750'	Fine-grained sandstone and coal. Barren of marine fossils.
2700'	<i>Haplophragmoides</i> sp. var. (evolute - <i>trullissata</i> ?).	3780'	Fine-grained sandstone with increase in coal. Barren of indigenous Foraminifera.
2730'	No new species or lithologies.	3810'	Coal and very fine to fine-grained sandstone. Arenaceous sp. var. ("shiny brown" surface, crushed) common.
2760'	No new species. Mudstone becoming more resistant to Quaternary "0".	3840'	Clean sand with some coal. Barren of indigenous Foraminifera.
2790'	<i>Lenticulina</i> cf. <i>terryi</i> .	3870-3960'	Clean sand. Barren of indigenous Foraminifera.
		3990'	Clean sand with rare bentonite. Barren of Foraminifera.
		3990-4080'	Clean sand. Barren of Foraminifera.
CONCLUSIONS			
	<u>DEPTH (FEET)</u>	<u>STAGE</u>	<u>PALEOENVIRONMENT</u>
	20-150	Indeterminate	Marine undifferentiated

## CONCLUSIONS (CONT.)

DEPTH (FEET)	STAGE	PALEOENVIRONMENT
150-210	Lower Zemorrian to Upper Refugian, undiff.	Outer Neritic to Bathyal, undiff.
210-240	Upper Refugian	Upper Bathyal
240-960	Refugian	Upper Bathyal
960-990	Indeterminate	Indeterminate
990-1020	Probably Refugian	Neritic
1020-1110	Indeterminate	Indeterminate
1110-1170	Indeterminate	Possible beach
1170-1200	Probably Upper Narizian	Mixed Inner Neritic and Middle Neritic
1200-1230	Upper Narizian	Outer Neritic to Upper Bathyal
1230-1320	Upper Narizian	Middle Bathyal undiff.
1320-1350	Upper Narizian	Lower Middle Bathyal
1350-1410	Upper Narizian	Upper Middle Bathyal
1410-1620	Upper Narizian	Outer Neritic to Upper Bathyal
1620-1650	Upper Narizian	Mixed Inner Neritic and Middle Neritic
1650-2460	Indeterminate	Non-marine to Inner Neritic
2460-3450	Narizian	Probably Outer Neritic
3450-3480	Narizian	Probably Upper Bathyal
3480-4080	Indeterminate	Non-marine to Marginal Marine

REICHHOLD ENERGY CORPORATION  
CROWN ZELLERBACH NO. 4  
NW½ SEC. 36, T5N, R4W

Summary

Due to sparse sample coverage the interpretations herein are tentative.

In this well section the entire upper Narizian (including the upper Cowlitz sand) appears to be missing above the volcanics. Therefore the sandy interval between 4920 and 5480 ft is older than the producing (upper Cowlitz) sand at Mist Field.

Distribution of benthic microfossils indicates relatively shallow ocean depths (neritic to upper bathyal) in most all of the section penetrated. Between 4520 and 4890 ft water depths reached middle bathyal.

Sparse plankton suggest nearshore deposition throughout, with general restriction from open sea circulation. Two exceptions to the latter are in the Refugian from 830 to 1190 ft and in the Narizian, where rare radiolarians were found. The only planktic foraminiferal species noted in the well is Turborotalia insolita at 950 to 980 ft. The highest occurrence of T. insolita serves as an excellent timeline slightly before the top of the Eocene in the Pacific Northwest and New Zealand.

A correlation is provided with the nearby Reichhold Crown Zellerbach No. 2 in this report.

## BIOSTRATIGRAPHIC RESULTS

The following data were derived from previously unprocessed dry ditch samples borrowed from DOGAMI.

110-140'	Barren of fossils.
230-260'	Elphidium spp.
350-380'	Guttulina irregularis, Quinqueloculina spp., Caucasina schencki, Eponides mexicana var. (immature).
470-500'	Light brown slightly silty mudstone. Uvigerina atwilli, U. sp. var. (small, costate), Cibicides aff. evolutus. Glass shards very very abundant.
590-620'	Uvigerina aff. cocoaensis (costae closely spaced), Diatom (pyritized, centrate), Gyroidina planata, Sponge spicules, Cassidulina cf. galvinensis (small).
710-740'	Epistomina sp.
830-860'	Eponides kleinPELLI, Plectofrondicularia spp., Globobulimina sp., Spongodiscidae (discs), Pullenia sp., Spumellaria (spheres), Sterrasters, Bolivina kleinPELLI.
950-980'	Melonis pompilioides, Cassidulina margar-eta?, C. cf. globosa, Cibicides cf. evolutus, Florilus applini, Turborotalia insolita.
1070-1100'	Lenticulina spp. (large), Cassidulina galvinensis, s.l., Cyclamina sp. Uvigerina cocoaensis, Gaudryina alazanensis.
1160-1190'	Brown sucrosic mudstone. Cassidulina globosa.
1310-1340'	Cibicides haydoni, Anomalina sp.
1430-1460'	Bentonite? rare. Nonion halkyardi, "Valvulineria" menloensis.
1550-1580'	No new species or lithologies.
1670-1700'	Volcanic? sandstone?. Probably barren of indigenous Foraminifera.
1790-1820'	Probably barren of indigenous Foraminifera.
1940-1970'	Oxidized fine-grained sandstone. Barren of indigenous Foraminifera.
2060-2090'	No new species or lithologies. Florilus applini very rare, Globobulimina sp. rare.
2190-2210'	Barren of indigenous Foraminifera.
2300-2330'	Anomalina cf. glabrata. Probably barren or indigenous Foraminifera.
2420-2450'	Fine to medium-grained sandstone. Elphidiella sp.
2540-2570'	Barren of fossils.
2660-2690'	Barren of fossils.
2780-2810'	Rock fragments abundant. Probably barren of indigenous Foraminifera.
2900-2930'	Barren of fossils.
3020-3050'	Barren of fossils.
3080-3110'	No new species or lithologies. Eponides mexicana group rare.

3140-3170' No new species or lithologies. Sparse calcareous fauna, poorly preserved and unidentifiable.

3200-3230' "Valvulineria" willapaensis? (poorly preserved).

3260-3290' Bulimina sp. var. (elongate, smooth, megalospheric).

3380-3410' No new species or lithologies.

3500-3530' Brown siltstone. Cibicides aff. natlandi.

3620-3650' Quinqueloculina imperialis.

3740-3770' Alabamina kernensis, Gastropod, Cibicides haydoni/natlandi (intermediate form).

3860-3890' No new species or lithologies.

3980-4010' No new species or lithologies.

4100-4130' Vaginulinopsis sp. (fragment). Also Cibicides natlandi? (juvenile).

4220-4250' Valvulineria involuta. Also Cibicides aff. natlandi (no extraneous shell material on involute side).

4340-4370' Volcanics?. Dentalina sp., Nodosaria sp.

4460-4490' No new species or lithologies.

4520-4550' Cibicides natlandi, Bulimina laciniata, Boldia hodgei.

4590-4620' Arenaceous indeterminate, Eggerella? sp. (large, crushed), Pseudohastigerina micra.

4740-4770' Barren of fossils.

4860-4890' Lignite/coal very very abundant. Vaginulinopsis saundersi, Lenticulina chirana, Virgulina sp. var. (very thin test, pyritized).

4970-5000' Volcanics common. Barren of fossils.

5120-5150' Barren of indigenous Foraminifera.

5300-5330' Barren of fossils.

5480-5510' Pseudoglandulina nallpeensis, P. inflata.

5660-5690' No new species or lithologies.

5840-5870' Haplophragmoides sp. var. (evolute, large - trullissata?), Bathysiphon eocenica, Ostracod var. (deep median sulcus).

5990-6020' Barren of indigenous Foraminifera. Sand very very abundant.

#### CONCLUSIONS

DEPTH (FEET)	STAGE	PALEOENVIRONMENT
110-140	Indeterminate	Indeterminate
230-260	Indeterminate	Inner Neritic or deeper
350-1460	Refugian	Upper Bathyal
1550-4490	Indeterminate	Indeterminate
4520-4890	Narizian	Upper to Upper Middle Bathyal

#### CONCLUSIONS (CONT.)

DEPTH (FEET)	STAGE	PALEOENVIRONMENT
4970-5330	Indeterminate	Indeterminate
5480-5690	Narizian	Outer Neritic to Upper Bathyal
5840-5870	Narizian	Inner to Middle Neritic
5990-6020	Indeterminate	Indeterminate

#### CORRELATION WITH THE REICHHOLD CROWN ZELLERBACH NO. 2

The data below show a good Refugian correlation above the volcanics? with the Crown Zellerbach No. 4 being 200 to 300 ft high to the Crown Zellerbach No. 2. However, the lower fossiliferous intervals in the two wells cannot be correlated due to the shallow neritic facies of the Crown Zellerbach No. 2 from 4960 to 5805 ft.

CROWN Z. NO. 4 (DEPTH IN FEET)	HIGHEST OCCURRENCE	CROWN Z. NO. 2 (DEPTH IN FEET)
380-500	<u>Uvigerina atwilli</u>	610-640
860-980	<u>Turborotalia insolita</u>	1120-1150
? *	Glauconitic mudstone	1480-1510
1190-1310	<u>Cibicides haydoni</u>	1540-1570
1340-1460	<u>Nonion halkyardi</u>	1630-1660
1580-1670	Volcanics?	1900-1930
4130-4220	<u>Valvulineria involuta</u>	?
4490-4550	<u>Cibicides natlandi</u>	?
5690-5840	Ostracod var. (deep median sulcus)	?

\* Not seen due to sparse sample coverage.

REICHHOLD ENERGY CORPORATION  
CROWN ZELLERBACH NO. 2  
NW¼ SEC. 8, T4N, R3W

#### Summary

Upper bathyal Refugian Foraminifera occur in ditch samples throughout this well section, even in the thick volcanic sequence from 1960 to 4960 ft. It is the opinion of this writer that indigenous Refugian faunas occur only above the volcanics. Extensive cavings resulted probably in part because of the large amounts of sand penetrated.

Underlying the volcanics to total depth are fossiliferous marine sediments of very shallow water (primarily inner neritic) origin which are indeterminate in age.

Sparse fossil plankton indicate nearshore deposition throughout the fossiliferous portions of the well section. Refugian faunas from 43 to 1960 ft reflect a slight regression from open marine, upper middle bathyal depths at the bottom to upper bathyal depths restricted from open sea circulation at the top.

A correlation is provided with the Reichhold Columbia County No. 1, OH at the end of this well report.

# BIOSTRATIGRAPHIC RESULTS

The following data were derived from previously unprocessed dry ditch samples borrowed from DOGAMI. Single depths noted below represent bottoms of 30 ft intervals.

- 43-70' Shell fragments, *Florilus incisum?*, *Pseudoglandulina?* sp.
- 100' Diatom (pyritized, centrate), *Bolivina kleinpellii*.
- 130' *Gyroidina planata*, *Elphidiella* sp. var. (subacute periphery), Gastropod, *Cassidulina crassipunctata*, *Guttulina* sp. var. (small, thin test), *Anomalina* cf. *californiensis* (thin test), Fish remains, *Elphidium* aff. *frigidum*. Also shell fragments very abundant.
- 160' No new species or lithologies. Glass shards very very abundant (not highest occurrence).
- 190' Barren of fossils.
- 220' Sponge spicules. Barren of Foraminifera.
- 250' *Guttulina irregularis*, *Elphidium* sp. var. (lobulate, subacute periphery).
- 280' Barren of fossils.
- 310' *Spumellaria* (spheres). Barren of Foraminifera.
- 340' Barren of fossils.
- 370' Lignite/coal very very abundant. Barren of marine fossils.
- 400' Barren of fossils.
- 430' Pyrite abundant. Barren of Foraminifera.
- 460, 490' Barren of Foraminifera.
- 520' *Quinqueloculina* cf. *weaveri*, *Caucasina schencki*.
- 550' *Globobulimina* sp., *Quinqueloculina imperialis*.
- 580' *Uvigerina* sp. (costate, fragment).
- 610' *Uvigerina* cf. *cocoaensis*, *Quinqueloculina* sp. var. (small, elongate, thin test).
- 640' *Eponides* cf. *kleinpelli*, *E.* cf. *gaviotaensis*, *Uvigerina beccarii*, *U.* *atwilli*, *Cyclamina pacifica*, *Cibicides* sp. var. (large clear umbo on spiral side), *C.* *evolutus*, Echinoid spines, *Plectofrondicularia multilineata*, *Cibicides felix* (of Mallory, 1959, pl. 25).
- 670' *Uvigerina* cf. *gallowayi*, *U.* sp. var. (worn, finely costate), *Cassidulina galvinensis*, *C.* *globosa*.
- 700' *Melonis pompilioides*, *Uvigerina* aff. *mexicana*.
- 730' No new species or lithologies.
- 760' *Lenticulina inornata*, *Gyroidina* cf. *soldanii*.
- 790' *Ceratobulimina washburnei*.
- 820' *Stilostomella* sp. (fragments), *Plectofrondicularia packardii*.
- 850' *Epistomina* sp.
- 880' *Pseudoglandulina inflata*, pyrite "sticks".
- 910' *Eponides gaviotaensis*.
- 940' No new species or lithologies.
- 970' Volcanic? siltstone?. *Cassidulina globosa* var. (uncoiling).
- 1000' *Eponides yeguaensis*.
- 1030' *Uvigerina vicksburgensis?* (not highest occurrence), *Subbotina* cf. *senilis*, *Gaudryina* sp. (fragment), *Nonionella* sp. var. (small), *Cibicides* cf. *evolutus* (of Tipton, et. al., 1973 - not quite highest occurrence).
- 1060' *Lagena hexagona*, *Alabamina kernensis*, *Uvigerina* cf. *yazooensis?* (large) (of Mallory, 1959).
- 1090' *Pullenia* sp. var. (small test, five chambers outer whorl, subacute periphery).
- 1120' No new species or lithologies.
- 1150' *Turborotalia insolita*.
- 1180' *Globigerinatheka tropicalis*, *Gaudryina alazensis?* (juvenile), *Florilus applini*.
- 1210' No new species or lithologies.
- 1240' *Cibicides* aff. *natlandi* (no extraneous shell material on involute side).
- 1270, 1300' No new species or lithologies.
- 1330' *Plectofrondicularia robusta?* (fragment), *Spongodiscidae* (discs).
- 1360' No new species or lithologies.
- 1390' *Dentalina dusenburyi*, *Spumellaria* var. ("large" spheres - on 80 mesh screen).
- 1420' *Plectofrondicularia searsii*.
- 1450' *Eponides kleinpelli*, *Lenticulina* aff. *washingtonensis*.
- 1480' *Spongodiscidae* var. ("large" discs - on 80 mesh screen), *Gyroidina scalata?*.
- 1510' Major lithology change. Glauconitic mudstone and rock fragments. No new species.
- 1540' No new species or lithologies. Glauconite flood.
- 1570' *Lenticulina* cf. *washingtonensis*, *Cibicides haydoni*, *Caucasina schencki* var. ("large" - on 100 mesh screen).
- 1600' No new species or lithologies.
- 1630' *Gaudryina alazanensis* (probably not highest occurrence).
- 1660' *Nonion halkyardi*.
- 1690' *Nonion* cf. *pacificum*.
- 1720' No new species or lithologies. Faunal decrease. Glass shards very very abundant.
- 1750, 1780' No new species or lithologies.
- 1810' No new species or lithologies. Glass shards very abundant.
- 1840' *Bolivina striatella*.
- 1870' No new species or lithologies.
- 1900' Lithology change to light brown sucrosic mudstone. No new species.
- 1930' Volcanic? rock fragments. No new species. Rare translucent green grains.
- 1960' Rock fragments and sand. "*Valvulineria*" *willapaensis*.

- 1990' Increase in translucent green grains. Barren of indigenous Foraminifera.
- 1990-2200' Barren of indigenous Foraminifera. Primarily volcanic rock fragments.
- 2230' Buff siltstone? and sand. No new species. Probably barren of indigenous Foraminifera (only cavings).
- 2260' Very fine-grained sandstone. Barren of indigenous Foraminifera.
- 2290, 2320' Sparse fauna. No new species. Probably barren of indigenous Foraminifera (only cavings).
- 2350' Barren of indigenous Foraminifera. Rock fragments. Pyrite very abundant.
- 2350-2770' Rock fragments and caved sediments. Barren of indigenous Foraminifera.
- 2800' Highest "reddish" volcanic? sand. Barren of indigenous Foraminifera.
- 2800-3040' Barren of fossils. Volcanics.
- 3070' Highest blue-green opaque to slightly translucent grains. Barren of fossils.
- 3070-4090' Barren of indigenous Foraminifera. Volcanics.
- 4120, 4150' Barren of fossils. Volcanics and lost circulation material.
- 4150-4240' Barren of indigenous Foraminifera. Very fine-grained sandstone and volcanics.
- 4240-4960' Barren of indigenous Foraminifera. Volcanics and caved sediments.
- 4990' No new species or lithologies. Very fine-grained sandstone rare, and Elphidiella? sp. very rare, probably indigenous.
- 5020, 5050' No new species or lithologies. Elphidium? sp., very rare, indigenous.
- 5080' Barren of Foraminifera. Echinoid spines.
- 5110' No new species. Elphidiella? sp. (encrusted with sandstone).
- 5140' No new species. Elphidiella sp. rare.
- 5170' No new species. Elphidium? sp. (encrusted with sandstone).
- 5200' No new species. Elphidiella? sp., Elphidium? sp., and Ostracods, all very rare.
- 5230' No new species. Elphidiella sp. (large) rare to common, Elphidiella sp. rare, Ostracods and Gastropods very rare.
- 5260' No new species. Elphidiella sp. (large, encrusted with sandstone) rare, Elphidiella sp. rare, Lenticulina sp. (large) very rare.
- 5290' No new species. Elphidiella sp. (large) rare, Elphidiella sp. very rare.
- 5320' No new species. Elphidiella sp. rare to common, Eponides kleinpelli rare.
- 5350' "Valvulineria" menloensis. Also Elphidiella sp. common, Elphidium sp. rare.
- 5380' No new species. Elphidiella sp. rare.
- 5410' No new species. Elphidiella sp. common, Elphidium? sp. and "Valvulineria" menloensis very rare.
- 5440' No new species. Elphidiella sp. rare to common, Elphidium? sp. rare, Gaudryina alazanensis.
- 5470' No new species. Elphidiella sp. rare, Ostracod (large) very rare.
- 5500' (5560'?) No new species. Elphidiella? sp., Elphidium? sp., "Valvulineria" menloensis, Florilus applini, all rare. Also Uvigerina garzaensis? very rare.
- 5530' No new species. Elphidiella sp. common.
- 5560' (5500'?) No new species. Elphidiella sp. common, Elphidium sp. very rare, Eponides spp. rare.
- 5590' No new species. Elphidiella sp. common, Florilus applini rare.
- 5620' No new species. Elphidiella sp. rare.
- 5650' No new species. Elphidiella sp. rare to common, "Valvulineria" menloensis very rare, Eponides gaviotaensis? rare.
- 5680' Valvulineria tumeyensis (pyritized), Bulimina? sculptilis? (small test, worn). Also Elphidiella sp. common, Lenticulina spp. (large) rare, plus rare caved species.
- 5710' No new species. Elphidiella sp. rare, Elphidium sp. rare. Also Uvigerina atwilli rare, U. cocoaensis rare, caved?.
- 5740' No new species. Elphidiella sp. rare, Guttulina irregularis. Also sparse upper bathyal Refugian fauna, probably caved.
- 5770' No new species. Elphidiella sp. rare, Eponides gaviotaensis?. Also pyritized (re-worked?) species including Globobulimina sp., Quadrimorphina? sp., Gyroidina cf. scalata, all very rare.
- 5800' No new species. "Valvulineria" menloensis (small), Eponides sp., Lenticulina sp., all very rare.
- 5805' No new species. Elphidiella sp. rare.

#### CONCLUSIONS

DEPTH (FEET)	STAGE	PALEOENVIRONMENT
43-130	Probably Upper Refugian	Upper Bathyal
130-490	Indeterminate	Marginal Marine to Inner Neritic
490-1120	Refugian	Upper Bathyal
1120-1960	Refugian	Upper to Upper Middle Bathyal
1960-4960	Indeterminate	Indeterminate
4960-5290	Indeterminate	Inner Neritic
5290-5805	Indeterminate	Inner to Middle Neritic

#### CORRELATION WITH THE REICHOLD COLUMBIA COUNTY NO. 1, OH

The data below indicate a strong correlation for approximately 1000 ft of Refugian section in the two wells. However, the upper Narizian bathyal

## CORRELATION (CONT.)

faunas from 1620 to 2430 ft in the Columbia County No. 1 are not present in the Crown Zellerbach No. 2. Shallow water Foraminifera from 4960 to 5805 ft (total depth) in the latter well cannot be correlated to any horizons in the Columbia County No. 1.

<u>CROWN Z. NO. 2</u> <u>(DEPTH IN FEET)</u>	<u>HIGHEST</u> <u>OCCURRENCE</u>	<u>COL. CO. NO. 1</u> <u>(DEPTH IN FEET)</u>
580-610	<u>Uvigerina cf.</u> <u>cocoaensis</u>	390-420
760-790	<u>Ceratobulimina</u> <u>washburnei</u>	600-630
1030-1060	<u>Alabamina kernensis</u>	870-900
Possible hiatus		
1120-1150	<u>Turborotalia</u> <u>insolita</u>	1230-1260
1480-1510	Glauconitic mudstone *	1350-1380
1540-1570	<u>Cibicides haydoni</u>	1560-1590
Not present	<u>Cibicides natlandi</u>	1620-1650
Not present	Sucrosic siltstone	1650-1680
Not present	<u>Pseudohastigerina</u> <u>micra</u>	1710-1740
Not present	<u>Lenticulina welchi</u>	1740-1770
Not present	<u>Bulimina micro-</u> <u>costata</u>	1860-1890
Not present	<u>Plectofrondicularia</u> <u>vaughani</u>	1950-1980

\* This lithology may extend as high as 1260 ft in the Columbia County No. 1; samples are missing from 1260 to 1350 ft.



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SUBSURFACE BIOSTRATATIGRAPHY OF THE EAST NEHALEM BASIN, COLUMBIA COUNTY, OREGON

1983

