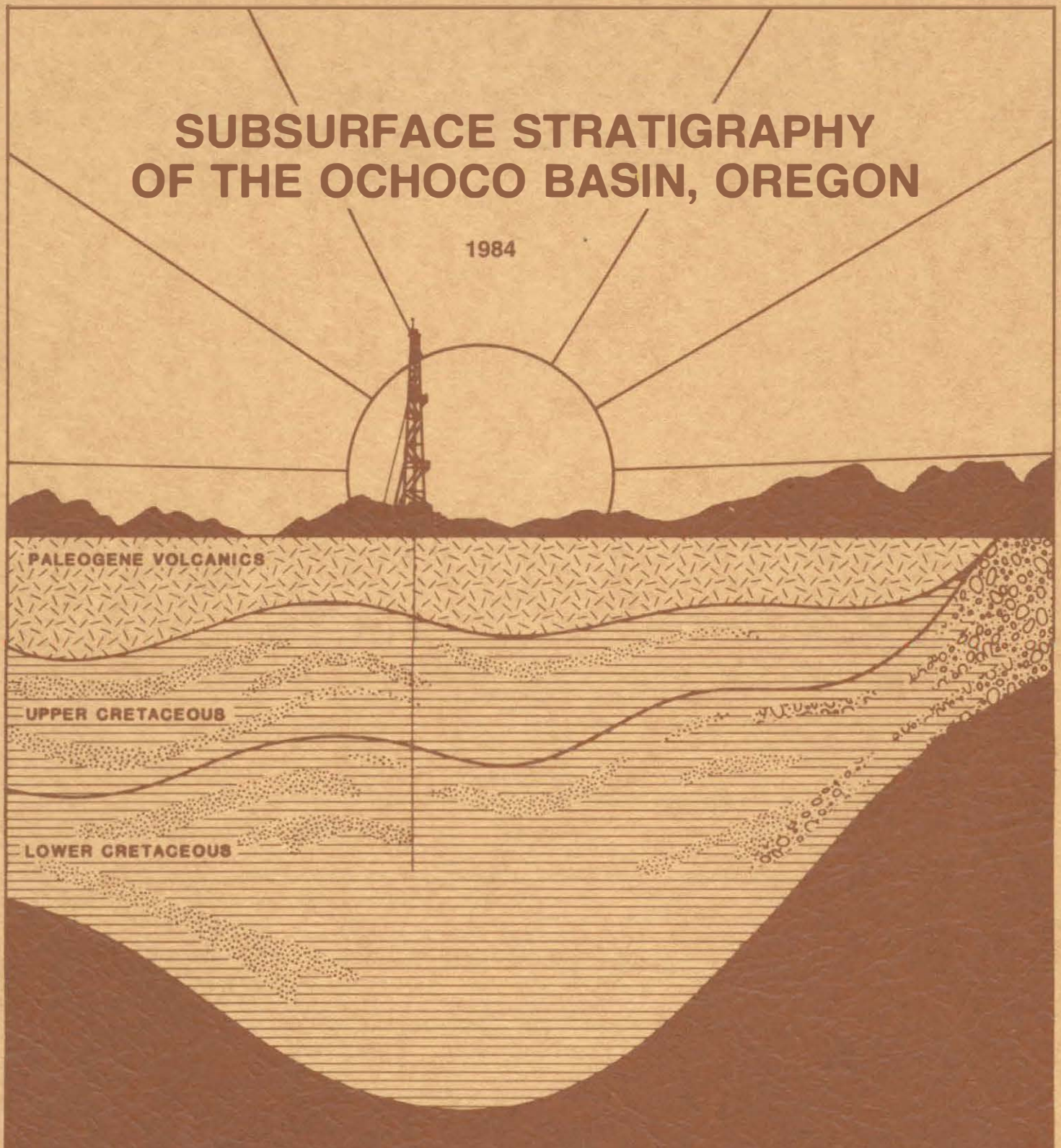
OIL AND GAS INVESTIGATION 8

SUBSURFACE STRATIGRAPHY OF THE OCHOCO BASIN, OREGON

1984



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OIL AND GAS INVESTIGATION 8

SUBSURFACE STRATIGRAPHY OF THE OCHOCO BASIN, OREGON

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Conducted in conformance with ORS 516.030

1984

NOTICE

The Oregon Department of Geology and Mineral Industries is publishing this paper because the subject matter is consistent with the mission of the Department. To facilitate timely distribution of information, camera-ready copy submitted by the authors has not been edited by the staff of the Oregon Department of Geology and Mineral Industries.

CONTENTS

ACKNOWLEDGEMENTS

We would like to express our appreciation to a number of people who have aided us in preparing this report. Mr. H. H. Odiorne of Amerada Hess Corporation initially suggested this project to us and has offered valuable advice throughout its preparation. Dr. John Sloan examined the samples for radiolaria and Dr. Paul Fritts analyzed the samples for calcareous nannoplankton. Dr. Joshua Setiawan examined a number of planktonic foraminifera and Alan Hersey reviewed the benthonic foraminifera. The initial draft of this paper was read by Dan McKeel who made a number of valuable suggestions. We also are greateful to John Beaulieau for his support and patience in guiding this project.

In addition we wish to thank our technical staff, Betil Kunzler, Al Kowalewski, Kevin Green, Robert Witbaard, and Eric Hendrix, for preparation of the samples, typing, and drafting.

ABSTRACT

Selected ditch and core samples from four wildcat wells in central Oregon were analyzed for pollen, spores, microplankton, foraminifera, radiolaria and calcareous nannoplankton. Palynomorphs and foraminifera were present in sufficient numbers to delineate strata of Albian through Campanian age in this area. In addition, an interval of Maastrichtian-Paleogene age overlies much of this area. The Texaco Logan Butte Unit 17-1 well contains sediments which range from Albian or older to Campanian. The foraminiferal assemblages of these sediments suggest deposition at outer neritic to bathyal depths. The presence of a significant sequence of Upper Cretaceous clastic sediments in the Texaco Logan Butte Unit 17-1 and the Standard Pexco No. 1 wells indicate the existence of a Late Cretaceous basin in central Oregon. Strata of this age may be preserved beneath the volcanic cover and may be possible reservoirs for hydrocarbon accumulation.

INTRODUCTION

Little published information exists concerning the subsurface geology of central Oregon (Newton, 1971). Based on surface mapping, this area has been considered to be a potential petroleum producing area. Although no commercial discoveries of hydrocarbons have been made here, major oil and gas leases are presently held over much of the area.

Knowledge of the subsurface in central Oregon is limited to four deep test wells, the last one being completed in 1981 (Figure 1, Table I). These four wildcats have penetrated a substantial section of Cretaceous marine and non-marine clastic sediments beneath the Tertiary volcanic cover, revealing a greater volume of Cretaceous rocks than was known to exist on the basis of surface exposures.

In outcrop, Cretaceous rocks occur in relatively small and scattered areas in central Oregon. They occur as small outliers on the older Mesozoic and Paleozoic rocks of the John Day Uplift or as small inliers in Tertiary volcanics. The largest exposure of Cretaceous rocks in the area is the inlier consisting of about 75 square miles near Mitchell, in Wheeler County (Figure 1). Here the exposed structure is a faulted anticline, within which Wilkinson and Oles (1968) measured over 9000 feet of Albian-Cenomanian sediments. About 1500 feet of Cretaceous (Cenomanian age) strata are recognized in outliers on the western edge of the John Day Uplift in the area of Suplee and Izee (Dickinson and Vigrass, 1965).

In addition, a thin interval of Cretaceous(?) rocks has been recognized in the Standard Kirkpatrick well, a deep test in north-central Oregon (Newton, 1971).

In this report we document the distribution of microfossils in samples from the four deep wells in central Oregon and interpret the age and depositional environments of the rocks that were penetrated in drilling these wells. Of particular interest is the previously unrecorded Upper Cretaceous marine sediments penetrated in the Texaco Logan Butte Unit 17-1 well. Our analyses indicate that Albian through Campanian strata are present in this area and suggest the existence of an extensive Upper Cretaceous basin. This basin has been informally named the Ochoco Basin by H. H. Odiorne of Amerada Hess Corporation. In this paper, we apply the name Ochoco Basin, at the suggestion of Mr. Odiorne, to those Upper Cretaceous deposits in central Oregon below the Clarno Formation in the vicinity of

Table 1. - Deep exploratory test wells in central Oregon

WELL	LOCATION	TOTAL DEPTH	COMPLETION DATE
Texaco Logan Butte 17-1	Sec. 17, T.19S., R 20 E. Crook County	6525'	Feb. 1981
Sunray Bear Creek No. 1	Sec. 30, T.17S., R.19E. Crook County	7920'	Aug. 1958
Texaco Federal No. 1	Sec. 31, T.17S., R.23E. Crook County	7998'	Nov. 1971
Standard Oil Pexco No. 1	Sec. 36, T.20S., R.20E. Crook County	7594'	Dec. 1955

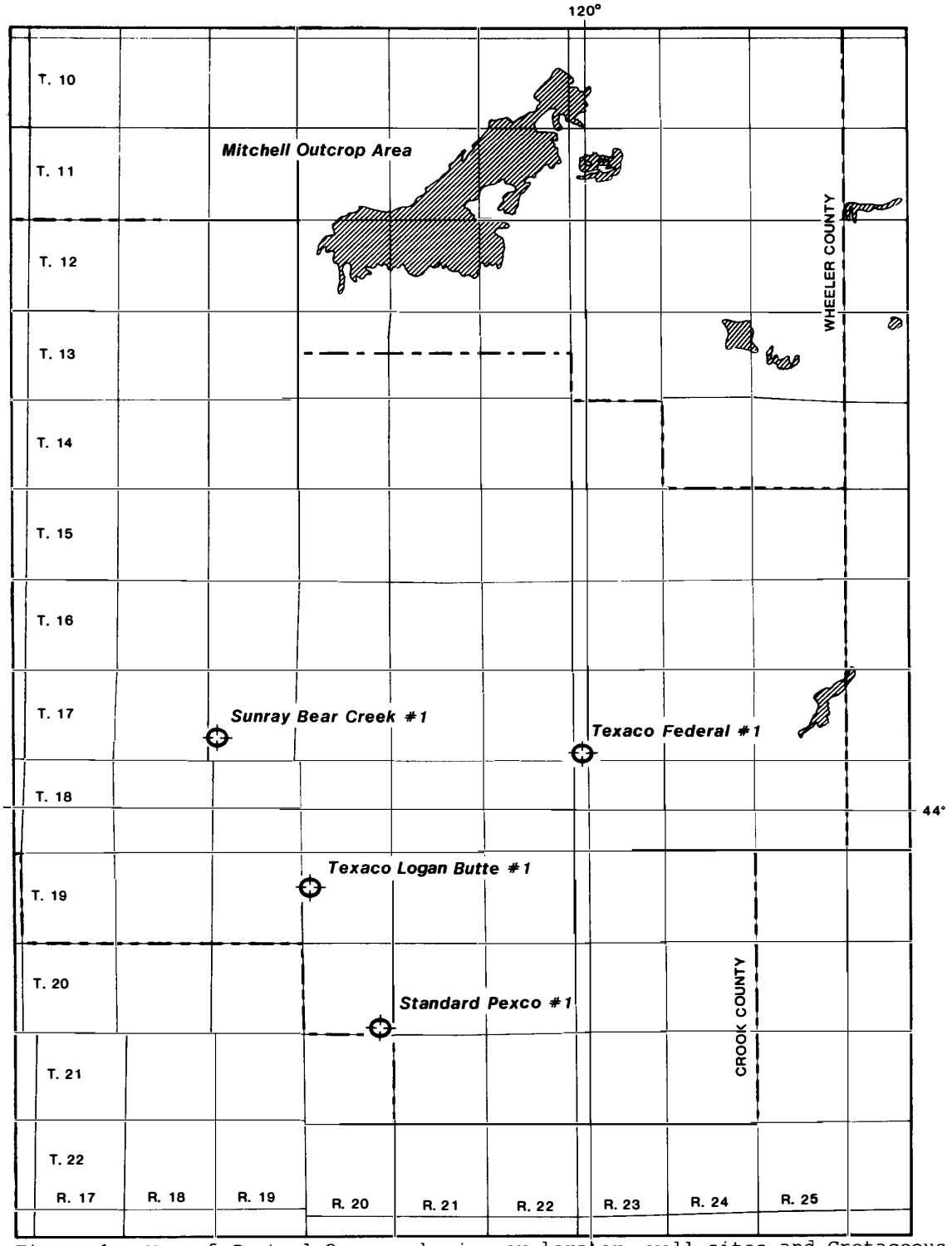

Figure 1 - Map of Central Oregon showing exploratory well sites and Cretaceous outcrops (cross hatching). Contacts from Geologic Map of Oregon East of the 121st Meridian. (G.W.Walker, 1977)

the Ochoco National Forest. This basin extends south to the Brothers Lineament and east and west to the extent of the Upper Cretaceous deposits that were or are now connected to the Upper Cretaceous sediments in central Oregon. The apparent similarity of these sediments to the upper part of the Great Valley Sequence of the Sacramento Basin presents the possibility that both were deposited in the same, or at least a similar, fore-arc basin.

Our analyses are intended to provide a preliminary stratigraphic framework for the subsurface of central Oregon that may prove useful in future exploration efforts.

MATERIALS AND METHODS

Separate cuts of all samples were taken for each of the following: foraminifera, palynomorphs, siliceous microfossils, and calcareous nannoplankton. Each was prepared separately as described below.

Palynology

One hundred and ninety two samples from the four wells were prepared and examined for palynomorphs. Eight of these are core samples, the remainder are ditch samples.

To concentrate palynomorphs about 15 grams of each sample was subjected to a standard procedure. This procedure involved treatment with dilute hydrochloric acid, concentrated hydrofluoric acid, dilute nitric acid, and dilute potassium hydroxide solution, followed by flotation in a zinc bromide solution (2.1 S.G.) and sieving through a 10 micrometer nylon screen. The residues were mounted on 20 mm x 30 mm cover slips using a cellulose acetate solution. The cover slips were then mounted on microscope slides with piccolyte resin. Approximately equal amounts of residue were placed on all microscope slides. The abundance of palynomorphs in each sample is estimated by the number of specimens per microscope slide.

The distributions of palynomorphs in the four wells analyzed are shown in Plates 1, 2, 3, and 4.

Foraminifera

Three hundred and eighty ditch samples were processed and analyzed for foraminifera. Approximately 100 grams of the sample was slowly heated with a mixture of water and Quaternary O and then washed through 20 and 200 mesh sieves. The residue was dried and the foraminifera and other organics picked and identified.

The distributions of species in the two wells which contained foraminifera are shown in Plates 5 and 6.

Nannofossils

A simple gravity settling technique was used in preparation of 56 samples for calcareous nannofossils. This procedure was performed in a buffered solution of sodium carbonate and sodium bicarbonate in order to maintain the pH in a range from 8.5 to 9.3. This was necessary to prevent etching of the nannofossils and achieve complete dispersal of clay material during sample preparation.

Three to five grams of dry, powdered sample was sieved through a 400 mesh screen and then settled in 30 mls of buffered solution with three separate sample fractions taken. The residues were mounted on glass slides by standard mounting techniques with a mounting medium that has a refrac-

tive index below or between that of calcite (1.658 - 1.486).

Radiolarians

Sample preparation for analysis of radiolaria was done on 9 samples in the Sunray Bear Creek No. 1 well and 21 samples in the Texaco Logan Butte Unit 17-1 well. Five to ten grams of washed sample was put into a 400 ml beaker, and the sample was further broken down by adding 50 ml of water, 50 ml of 5% sodium hexametaphosphate (Calgon), and about 50 ml of hydrogen peroxide, which was heated until reaction ceased. The samples were then sieved in a 230 mesh screen and put in about 50 ml of 10% HCl and heated until reaction ceased. The samples were again sieved in a 230 mesh screen.

The residues were then swirled to dissociate the radiolaria from any heavy rock material and then mounted by standard mounting technique on a glass slide (two slides were prepared for each sample).

INTERPRETATIONS

For several obvious reasons, we feel our stratigraphic interpretations must be considered to be a preliminary best-approximation and to be at the reconnaisance level. We are basing our interpretations on: (1) ditch samples, (2) a small number of widely-spaced wells, (3) relatively small numbers of microfossils, (4) generally poorly-preserved microfossils, and (5) somewhat limited knowledge of the true ranges of microfossils in the region.

Ages Interpreted from Palynomorphs

Although there are no published references to palynomorph biostratigraphy of Cretaceous rocks in the area of this study, world-wide ranges for certain dinoflagellates and North American ranges of some pollen and spores are fairly well established. To determine ages based on palynomorphs we have assumed that these ranges can be extended into central Oregon. These stratigraphic ranges have been compiled from published literature (Bebout, 1981; Chlonova, 1971; Drugg, 1967; Griggs, 1970; Millioud, et al., 1975; Newman, 1981; Norris, 1967: Rouse, et al., 1970; Singh, 1971; Srivastava, 1981; Tschudy, 1973).

A Maastrichtian-Paleogene age is indicated by the occurrences of the following palynomorph taxa:

Azolla app.
Bombacacidites naciementoensis
Carya spp.
Cicatricosisporites intersectus
Momipites spp.
Pistillipollenites mcgregorii
Playtycarya spp.
Proteacidites spp.
Triplanisporites sinuosus
Ulmipollenites spp.

Rocks of this age are identified in the Texaco Federal well at depths of 1500 feet to 2040 feet and possibly in the Standard Pexco well at depths of 3560 feet to 4040 feet and 4440 feet to 5040 feet. There is no evidence for rocks of this age among the samples that were examined from the Texaco Logan Butte well or from the Sunray Bear Creek well.

Ages Interpreted from Foraminifera

Due to the lack of exposure of Upper Cretaceous sediments in this area there is little published information regarding the distribution of foraminifera in central Oregon. However, extensive analyses of similar strata in Sacramento Basin by Goudkoff (1945), Trujillo (1960), Marianos and Zingula (1966), Dailey (1973), Berry (1965), and Douglas (1969) and others have established the range of many species in that area. We have attempted to apply these ranges in interpreting the ages of the strata in central Oregon. Goudkoff established his zonation in 1945 and it has been used extensively by industry paleontologists and geologists. A number of industry paleontologists have suggested revisions in Goudkoff's zonation, but a complete revision has not been published. Since such a revision has not been produced, we have used Goudkoff's zonation for the Upper Cretaceous. When possible we have applied Berry's zonation for the Lower Cretaceous sediments.

The following species were encountered in sediments that are interpreted as Campanian:

Globotruncana arca
Globotruncana marginata
Globotruncana churchi
Gavelinella henbesti
Gavelinella cf. G. henbesti
Stensioina pommerana
Gaudryina rudita var. diversa
Marginulina curvisepta
Cribrostomoides cretacea
Bathysiphon vitta
Bathysiphon californica
Silicosigmolina californica
Osangularia corderiana
Spiroplectammina chicoana
Hoeglundina supracretecea

Santonian-Coniacian sediments are characterized by the following species:

Globotruncana coronata
Cribrostomoides cretacea
Gaudryina pyrimidata

The following species were present in Turonian strata:

Hedbergella praehelvetica
Helvetotruncana helvetica
Hedbergella archeocretacea
Valvulineria marianosi

Albian-Cenomanian strata included the following species:

Hedbergella delrioensis
Gyroidinoides infracretacea
Gavelinella andersoni
Favusella washitensis
Gaudryina tailleuri

No definite Cretaceous strata older than Albian were identified in this study, but much of the lower strata in all of the wells was barren and may be Lower Cretaceous or Jurassic.

A Campanian age is indicated by a greater abundance of Proteacidites spp. and the occurrences of the following dinoflagellates:

Areoligera sp.
Cannosphaeropsis cf. C. eleganta
Dinogymnium cf. D. acuminatum
Dinogymnium cf. D. heterocostatum
Dinogymnium sp. A
Dinogymnium sp. B
Dinogymnium sp. C
Palaeotetradinium silicorum
Pterodinium sp.

Campanian rocks occur in the Logan Butte well at depths of 2140 feet to 2980 feet.

Cenomanian-Campanian age was assigned to rocks in the Standard Pexco well at depths of 4120 feet to 4440 feet and 5040 feet to 6740 feet; on the occurrences of Appendicisporites cf. A. tricornatatus, Cicatricosisporites radiatus.

A Cenomanian-Santonian age was assigned to rocks in the Logan Butte well from depths of 2980 feet to 4120 feet based on the occurrences of Alterbia minor, Silicisphaera ferox, and Xenascus ceratioides.

In the Sunray Bear Creek well, rocks from depths of 3158 feet to 4475 feet were assigned an age of Cenomanian-Turonian based on more abundant Taurocusporites reduncus, Distaltriangulisporites spp., and Costatoperferosporites spp.

An Albian-Cenomanian age is indicated by the occurrences of the following palynomorphs:

Spores and pollen

Appendicisporites cf. A. baconicus
Appendicisporites cf. A. cristatus
Appendicisporites cf. A. jansonii
Appendicisporites unicus
Camarozonosporites insignis
Chomotriletes minor
Cicatricosisporites cf. C. exilioides
Cicatricosisporites cf. C. hallei
Cicatricosasporites spp.
Contignisporites cooksoni
Costatoperforosporites cf. C. foveolatus
Costatoperforosporites cf. C. fistulosus
Lileacidites inaequalis
Neoraistrickia truncata
Schizosporites reticulatus

Dinoflagellates

Ovoidinium verrucosum
Protoellipsodinium spinosum
Gonyaulacaceae more abundant

Albian-Cenomanian rocks are identified in the Texaco Federal well at depths of 2040 feet to 3540 feet, in the Sunray Bear Creek well at depths of 4475 feet to 4860 feet, and in the Texaco Logan Butte well at depths of 4120 feet to 4480 feet.

Paleoecologic Interpretations

Paleoecologic interpretations of the Cretaceous benthonic assemblages have been based primarily upon the work of Bandy and Arnal (1960), Sliter (1968, 1972), Sliter and Baker (1980), Almgren (1982), and Douglas (1982). The interpretations of paleobathymetries from ditch samples is complicated by the probability of contamination from strata higher in the well. We have attempted to make the best interpretation based upon the first occurrences of new species and the abrupt changes in species composition of the assemblages.

RESULTS

The distributions of palynomorphs and foraminifera encountered in the four wells are presented on Plates 1 through 6. Foraminifera were not present in the samples from the Standard Pexco No. 1 well and the Texaco Federal No. 1 well. Calcareous nannoplankton and identifiable radiolaria were not found in any of the samples analyzed.

The arrangement of the taxa on the distribution charts was determined by the order in which the taxa were encountered in samples proceeding down the well. In the palynology distribution charts, the "undifferentiated" categories contain specimens that are (1) too poorly preserved to permit more specific identification, (2) unfamiliar, and (3) folded or otherwise obscured. A rough measure of the quality of preservation of the palynomorphs in a sample is the number of "undifferentiated pollen and spores."

Among the taxa on the distribution charts are four dinoflagellates that are named only informally. These are three forms assigned to the genus Dinogymnium and another "smooth proximate dinoflagellate." The three Dinogymnium types, D. sp. A., D. sp. B., and D. sp. C., are large, elongate, smooth types with various shapes and cingulum positions. All specimens of the "smooth proximate dinoflagellate" are poorly preserved, making difficult any identification.

On the foraminifera distribution charts, the categories of "arenaceous indeterminate" and "calcareous indeterminate" are reserved for those specimens in which a generic identification was not made.

The lithologic descriptions of the samples are included as a separate listing.

The following is a summary of our results for each of the wells:

Sunray Midcontinent Bear Creek No. 1
Section 30, T. 17S., R. 19E.
Crook County, Oregon

3158 - 4410 feet

Palynomorphs indicate a Cenomanian-Turonian age for these sediments. Although no foraminifera were found, in this interval, the microfossil flora suggests a shallow marine depositional environment.

4410 - 4680 feet

This interval contains Albian-Cenomanian palynomorphs and questionable Albian-Santonian planktonic foraminifera (Hedbegella delrioensis). The poor foraminiferal assemblages suggest deposition in the outer neritic to upper bathyal depths.

4680 - 4890 feet

This interval contains the planktonic foraminifera Hedbergella praehelvetica and Helvetoglobotruncana helvetica which are good indicators of a Turonian age. The palynomorphs of this interval suggest an Albian-Cenomanian age for these strata. If the Turonian foraminifera are in place then the interval above must indicate either reworking of Albian-Cenomanian microfossils or the presence of a thrust fault. Further work must be done to resolve this point. The foraminiferal assemblages suggest

deposition at upper bathyal depths.

4920 - 5100 feet

Neither palynomorphs or foraminifera suggest a definite age for this interval. Unpublished data indicates an abrupt change in vitrinite reflectance values in this interval. This increase in thermal maturation may indicate either local heating, faulting, or the presence of an unconformity.

5100 - 5220 feet

This interval contains Gyroidina florealis, Planularia tricarinella, Gaudryina tailleuri which suggests a Turonian-Cenomanian age. These genera indicate deposition at outer neritic to upper bathyal depths.

5220 - 5460 feet

The presence of Hedbergella delrioensis (rare), Favusella washitensis (rare), Valvulineria loetterli (rare), Gaudryina tailleuri, Gyrodiniodes infracretacea, and Globigerina hoterivica suggests a probable Albian age for these sediments. The presence of these foraminifera suggest deposition in the upper bathyal depths.

5460 - 7910 feet

This interval contains very few foraminifera and palynomorphs and thus no age determination can be made. The interval from 7400 to 7910 feet does contain arenaceous foraminifera that point toward a Cretaceous age, but a definite age cannot be assigned to this interval. If these foraminifera are in place,then an upper to middle bathyal deposition environment is implied.

Standard Pexco No. 1
Section 36, T. 20S., R. 20E.
Crook County, Oregon

The distribution of palynomorphs in this well is difficult to interpret without the aid of other nearby stratigraphic control. One very tenuous interpretation is listed below and on the distribution chart. The complex distribution of microfossils could result from the effects of folding and/or faulting, redeposition of palynomorphs, and/or sample mixing or contamination. The interpretation given below would reflect complex structure. This well is near the Brothers Fault Zone and this supports an interpretation calling on structural complexity.

3560 - 4040 feet

A Paleogene age is interpreted for these sediments based upon the occurrence of Carya spp., Cicatricosisporites intersectus, and Pistillipollenites mcgregorii.

4040 - 4120 feet

The occurrence of the dinoflagellate Ovoidinium verrucosum suggests marine deposition during the Albian-Cenomanian.

4120 - 5040 feet

The palynomorphs Azolla spp., Bombacacipites nacimientoensis, Cicatricosisporites intersectus, and Platycarya sp. indicate a Paleogene age.

5040 - 5860 feet

The age of these strata was undetermined.

5860 - 7594 feet

The abundance of Proteacidites spp. suggests a Senonian age for these strata.

Texaco Federal No. 1
Section 31, T. 17S., R. 23E.
Crook County, Oregon

The age and depositional environments of the strata of this well are based solely upon data derived from palynological analyses of these sediments. Thirty-four selected ditch samples were analyzed for foraminifera but were found to be barren.

1500 - 2040 feet

These samples contained palynomorphs indicating a Maastrichtian to Paleogene age. The pollen and spores encountered include Alnipollenites spp., Carya spp., Momipites spp., Momipites triradiatus, Pinus spp., Pistillipollenites mcgreggori, Platycarya spp., Ulmipollenites spp., Triplanisporites sinuosus, Bombacacipites nacimientoensis, and Proteacidites spp. The abundance of pollen and the lack of dinoflagellates and foraminifera suggest a nonmarine depositional environment.

2040 - 2220 feet

This interval is interpreted to be Albian-Cenomanian based upon the occurrence of Acanthotriletes varispinosus, Chomotriletes minor, Cirulina spp., Converrucosisporites cf. C. proxigranulatus, Costatoperforosporites foveolatus, Distaltriangulisporites perplexus, Eucommiidites troedssonii, Exesipollenites tumulus, Lycopodiumsporites dentimuratus. The occurrence of the microplankton Baltisphaeridium spp. and ?Michrystridium spp. indicate a marine environment.

2220 - 3540 feet

This interval is also Albian-Cenomanian but probably was deposited in a nonmarine environment. The pollen and spores found in these samples include Antulsporites distaverrucatus, Appendicisporites cf. A. bilaterallis, Chomotriletes minor, Cicatricosisporites augustus, C. cf. C. exilioides, C. subrotundus, Distaltriangulisporites cf. C. costatus, D. cf. D. maximus, D. perplexus, Eucommiidites troedssonii, Impardecisporites apiverrucatus, Lileacidites inaequalis, L. veriegatus, Perinopollenites elatoides, Retitricolpites georgensis.

Texaco Logan Butte Unit 17-1
Section 17, T. 19S., R. 20E.
Crook County, Oregon

2020 - 2140 feet

This interval is Upper Cretaceous based upon the limited occurrence of benthic foraminifera, palynomorphs and Inoceramus prisms. The few foraminifera present suggest deposition at outer neritic to upper bathyal depths.

2140 - 2980 feet

These samples contained abundant palynomorphs, microplankton and foraminifera indicative of Campanian stage. The palynomorphs found include

Anacolosporites sp. A, Appendicisporites tricornatatus, Kuylisporites scutatus, Quadripollis krempii, and Trisolisporites spp.. Microplankton encountered in this interval include Deflandrea cf. D. diebeli, Dinogymnium cf. D. acuminatum, D. cf. D. heterocostatum, Horologinella spp., Odontochitina porifera, Palaeotetradinium silicorum.

The foraminifera present in the interval from 2140 to 2380 feet include Gavelinella henbesti, Silicosigmoilina californica, Hoeglundina supracretacea, Bathysiphon californica, Lenticulina modesta. These assemblages would be assigned to Goudkoff's E zone. The presence of the genera Gavelinella, Hoeglundina, Osangularia, Silicosigmoilina and Bathysiphon point to deposition at upper bathyal depths. The presence of numerous poorly preserved and pyritized radiolaria support this interpretation.

The interval 2380 to 2620 feet contains foraminiferal assemblages similar to those above but also including Stensioina pommerana, Marssonella oxycona, and Globorotalites michelianus. Some paleontologists would separate this interval into an undefined "Lower E zone".

The occurrence of Marginulina curvisepta, Cribrostomoides cretacea, Spiroplectammina chicoana in the interval 2620 to 2980 feet suggest a correlation with Goudkoff's originally defined F zone. Deposition within deeper waters, probably upper to middle bathyal is suggested by the presence of the general Cribrostomoides, Bathysiphon, Ammodiscus, Gaudryina Silicosigmolina, and Marssonella.

2980 - 4120 feet

This interval is assigned an undifferentiated age of Cenomanian through Santonian based upon the occurrence of the following palynomorphs: Ornamentifera echinata, Siberiapollis montanensis, Alterbia minor, Silicisphaera ferox, and Xenascus ceratioides. The foraminifera identified in this interval do not permit the recognition of Goudkoff's G-1, G-2 or H zones, except for a single specimen of Gaudryina pyramidata at 3220 feet which indicates a G-1 or G-2 age. The rare occurrence of Orthokarstenia shastaensis(?) at 3610 to 3640 feet and at 3760 to 3790 feet suggest a questionable Cenomanian (I zone) age for these sediments. Also the rare occurrence of Hedbergella archeocretacea suggests an uppermost Cenomanian through lower Coniacian for the interval 4060 to 4120 feet.

4120 - 4270 feet

The presence of the planktonic foraminifera Favusella washitensis, the palynomorphs Chomotriletes minor, Acanthotriletes varispinosus, and the microplankton Ovoidinium verrrucosum, and Protoellipsodinium spinosum indicate Albian-Cenomanian age for these strata. The presence of Lenticulina (common), Gyridinoides, Trochammina, Gaudryina suggest deposition at upper bathyal to outer neritic depths. An abrupt increase in TAI and vitrinite reflectance values occurs at about 4000 to 4100 feet. This increase in thermal maturation may indicate an unconformity at this level.

4270 - 4600 feet

The occurrence of a few specimens of planktonic foraminifera "Globigerina" hoterivica (sp. A, of Marianos and Zingula) indicate an age of Albian or older for this interval. The presence of Lenticulina, Gavelinella, Gaudryina, Haplophragmoides suggests continued deposition in outer neritic to upper bathyal depths.

4600 - 6490 feet

Neither palynomorphs nor foraminifera were abundant enough to make an

age determination for this interval. The few taxa that are present may not be in place but the result of caving from strata higher in the well. Additional analyses of strata from future wells may permit a later interpretation of the age of these strata.

CORRELATION AND INTERPRETATION

Plate 7 illustrates our interpretation of the biostratigraphic correlations between the Sunray Bear Creek No. 1, Texaco Logan Butte Unit 17-1, and Texaco Federal No. 1 wells. We have not included the Standard Pexco No. 1 due to the apparent structural complexity of this well. The most striking element of these correlations is the presence of a thick sequence of Campanian strata present in the Texaco Logan Butte Unit 17-1 well. The foraminiferal assemblages indicate deposition in the outer neritic to middle (lower?) bathyal depths throughout this time and thus suggests the presence of a significant Upper Cretaceous basin in this area. The similarity of many of the foraminiferal assemblages to coeval assemblages in the Sacramento Basin suggest a similar depositional system in cental Oregon. The remainder of the Upper Cretaceous strata is represented by faunas that are not easily dated but do indicate significant clastic deposition during this time.

Albian-Cenomanian strata are widespread in this area and have been penetrated in all four of the wells analyzed. Apparently in the easternmost well, Texaco Federal No. 1, there are no strata of Turonian through Campanian age preserved. In addition, only Albian to Cenomanian sediments are preserved in the Bernard Ranch outcrop section to the east of the study area. Our unpublished analyses of the foraminifera and megafossils indicate deposition of these sediments in shallow marine to brackish water environments. To the north in the Mitchell anticline, over 9,000 feet of Albian through lower(?) Cenomanian strata are exposed. Our unpublished analyses of the faunas and floras suggest deposition at middle neritic to upper or middle bathyal depths. Although originally interpreted as fluvial to deltaic sediments (Wilkinson and Oles, 1968) these strata have been shown to be a part of a submarine fan complex (Kleinhans, 1984).

There is a great thickness of strata penetrated in all of the wells below the Albian-Cenomanian strata that could not be dated. Some of these strata may possibly be Cretaceous.

The overall distribution of sediments encountered in this study indicates that a significant Albian-Cenomanian basin is present in central Oregon and that the strandlines of this basin were to the east of the wells analyzed with the possible exception of Texaco Federal No. 1 well. The presence of a considerable thickness of Upper Cretaceous strata indicates that a significant basin was developed in central Oregon and that some of these strata may be preserved beneath the volcanic cover. The apparent similarity of these sediments to those of the Sacramento Basin indicates a significant potential for hydrocarbon accumulation.

SUMMARY

1. Albian-Cenomanian sediments are present in the Standard Sunray Bear Creek No. 1, the Texaco Logan Butte No. 1, the Standard Pexco No.1, and the Texaco Federal No. 1 wells.

2. Turonian sediments are present in the Standard Sunray Bear Creek No. 1 and the Texaco Logan Butte No. 1 wells.

3. Cenomanian-Santonian sediments were identified in the Texaco Logan Butte No. 1 well.

4. A widespread Paleogene-Maastrichtian unit unconformably overlies much of the Cretaceous sediments in central Oregon.

5. Only the Texaco Logan Butte No. 1 well contained a section of Campanian sediments. The Standard Pexco No.1 contains Senonian strata. These sediments indicate the presence of a significant Upper Cretaceous basin.

6. The Standard Pexco No. 1 appears to be structurally complex, apparently due to its proximity to the Brothers Lineament.

7. The Cretaceous strandlines were to the east of the Suplee-Izee and Mitchell area during Albian-Cenomanian times.

8. The foraminiferal zonations used for the Upper and Lower Cretaceous sediments of northern California are at least in part applicable in central Oregon. Additional data from future wells will help to establish the ranges of the species more precisely and permit a more detailed zonation.

LITHOLOGIC DESCRIPTIONS OF WELL CUTTINGS

Standard Pexco State No. 1, Crook Co., OR

4000 - 4020 feet

Texture: 95% sand; 5% coarse silt
Composition: 70% intermediate volcanics; 5% monocrystalline quartz; 20% fine siltstone fragments; 5% polycrystalline quartz (quartzite, chert).

4060 - 4080 feet

Texture: 95% sand; 5% coarse silt
Composition: 70% intermediate volcanics; 5% monocrystalline quartz; 20% fine siltstone fragments; 5% polycrystalline quartz (quartzite, chert) with subordinate medium-gray quartzite fragments.

4120 - 4140 feet

Texture: 100% coarse to medium sand
Composition: 25% monocrystalline quartz; 25% fine sandstone fragments; 35% polycrystalline quartz (including gray quartzite, chert, etc.); 15% basic/intermediate volcanics (some oxidized, hematitic brownish-red stain).

4180 - 4200 feet

Texture: 100% coarse to medium sand
Composition: 15% sandstone; 10% monocrystalline quartz; 20% polycrystalline quartz; 55% basic-intermediate volcanics (basalt, andesite, latite).

4240 - 4260 feet

Texture: 100% coarse to medium sand
Composition: 10% sandstone; 70% basic-intermediate volcanics (including latite porphyry fragments); 10% monocrystalline quartz; 10% polycrystalline quartz (medium to dark gray).

4300 - 4320 feet

Texture: 100% coarse to medium sand
Composition: 70% volcanic; 15% sandstone; 10% quartzite; 5% monocrystalline quartz.

4360 - 4380 feet

Texture: 100% coarse to medium sand
Composition: 70% volcanic; 15% sandstone; 10% quartzite; 5% monocrystalline quartz.

4420 - 4440 feet

Texture: 100% coarse to medium sand
Composition: 40% volcanic; 50% polycrystalline quartz (mostly dark gray quartzite); 5% monocrystalline quartz; 5% sandstone.

4480 - 4500 feet

Texture: 100% coarse to medium sand
Composition: 65% volcanics, dark brown to red (oxidized) some fragments vesicular; 30% polycrystalline quartz; 5% monocrystalline quartz. (Note: volcanics include dark brown volcanic glass.)

4540 - 4560 feet

Texture: 100% coarse to medium sand
Composition: 75% volcanics (basic to felsic); 20% quartzite and polycrystalline quartz aggregates (light yellow color); 5% monocrystalline quartz (volcanics are porphyritic).

4600 - 4620 feet

Texture: 100% coarse to medium sand
Composition: 85% volcanics (basic to felsic); 10% quartzite and polycrystalline quartz aggregates; 5% monocrystalline quartz.

4660 - 4680 feet

Texture: 100% coarse to medium sand
Composition: 90% volcanics (basic to felsic) volcanic glass included; 10% quartzite and polycrystalline quartz aggregates.

4720 - 4740 feet

Texture: 100% coarse to fine sand
Composition: 90% volcanic; 9% quartzite and yellow to light brown (probably devitrified felsic volcanics) polycrystalline quartz aggregates; 1% monocrystalline quartz.

4780 - 4800 feet

Texture: 100% sand
Composition: 85% volcanic; 10% polycrystalline quartz; 5% monocrystalline quartz.

4840 - 4860 feet

Texture: 100% coarse to medium sand
Composition: 80% basic-felsic volcanics, some vesicular, some porphyritic; 10% monocrystalline quartz; 10% quartzite, flint and other polycrystalline quartz.

4900 - 4920 feet

Texture: 100% sand
Composition: 75% volcanics; 15% polycrystalline quartz, mostly quartzite; 10% monocrystalline quartz.

4960 - 4980 feet

Texture: 100% sand
Composition: 85% volcanic; 35% basic (basaltic-vesicular, partly with reddish-oxidized stain); 10% intermediate, and 30% porphyritic felsic (rhyolitic) fragments plus minor volcanic glass; 10% quartzite; 5% monocrystalline quartz.

5020 - 5040 feet

Texture: 100% sand
Composition: 90% volcanic: 60% porphyritic felsic fragments, 20% vesicular basaltic, 10% andesite; 5% quartzite (gray to greenish to light yellow) 5% monocrystalline quartz.

5860 - 5880 feet

Texture: 100% sand
Composition: 60% volcanics: 60% porphyritic felsic fragments, 20% vesicular basaltic, 10% andesite; 35% quartzite (brown to gray); 5% monocrystalline quartz.

5920 - 5940 feet

Texture: 100% sand
Composition: 60% volcanics: 60% porphyritic felsic fragments, 20% vesicular basaltic, 10% andesite; 35% quartzite (brown to gray); 5% monocrystalline quartz.

5980 - 6000 feet

Texture: 100% sand
Composition: 75% basic-felsic volcanics; 25% polycrystalline quartz (quartzite, devitrified felsic volcanic aggregates); 5% monocrystalline quartz.

6040 - 6060 feet

Texture: 100% sand
Composition: 70% basic volcanics, vitreous-looking; 20% flint-chert type polycrystalline quartz; 10% monocrystalline quartz, transparent to milky translucent.

6100 - 6120 feet

Texture: 95% sand; 5% coarse silt
Composition: 70% basic volcanics, vitreous-looking; 20% flint-chert type polycrystalline quartz; 10% monocrystalline quartz, transparent to milky translucent.

6160 - 6220 feet

Texture: 100% sand
Composition: 70% volcanics, vitreous-looking; 20% flint-chert type polycrystalline quartz; 10% monocrystalline quartz, transparent to milky translucent.

6220 - 6240 feet

Texture: 100% sand
Composition: 65% volcanics (non-vesicular basalt, predominantly plus minor felsics); 30% quartzite, devitrified felsic volcanics, "flint" (polycrystalline quartz); 5% monocrystalline quartz.

6280 - 6300 feet

Texture: 100% sand
Composition: 65% volcanics (non-vesicular basalt, predominantly plus minor felsics); 30% quartzite, devitrified felsic volcanics, "flint" (polycrystalline quartz); 5% monocrystalline quartz.

6340 - 6360 feet

Texture: 100% sand
Composition: 70% volcanics (non-vesicular basalt predominantly plus minor felsics); 25% polycrystalline quartz; 5% monocrystalline quartz.

6400 - 6420 feet

Texture: 100% sand
Composition: 80% volcanics, mostly basic; 15% polycrystalline quartz, pinkish-red; 5% monocrystalline quartz.

6460 - 6480 feet

Texture: 100% sand
Composition: 85% volcanics, mostly basic; 10% polycrystalline quartz; 5% monocrystalline quartz.

6520 - 6540 feet

Texture: 100% sand
Composition: 15% polycrystalline quartz, light colored; 5% monocrystalline quartz; 85% volcanics, mostly basic.

6580 - 6600 feet

Texture: 100% sand
Composition: 85% volcanics; 15% polycrystalline quartz, light colored; 5% monocrystalline quartz. (Note: polycrystalline quartz contains minor reddish-pink grains.)

6700 - 6720 feet

Texture: 100% sand
Composition: 85% volcanics; 15% polycrystalline quartz, light colored (contains minor reddish-pink grains); 5% monocrystalline quartz.

6800 - 6820 feet

Texture: 100% sand
Composition: 85% volcanics; 15% polycrystalline quartz, light colored (contains minor reddish-pink grains); 5% monocrystalline quartz.

6860 - 6880 feet

Texture: 100% sand
Composition: 85% volcanics, mostly basalt and basaltic andesite; 15% polycrystalline quartz, light colored; 5% monocrystalline quartz.

6920 - 6940 feet

Texture: 100% sand
Composition: 90% basaltic volcanics, several serpentinized fragments; 5% polycrystalline quartz (includes distinct scarlet grains); 5% monocrystalline quartz.

6980 - 7000 feet

Texture: 100% sand
Composition: 95% basaltic volcanics; 5% quartz (polycrystalline and monocrystalline).

7040 - 7060 feet

Texture: 100% sand
Composition: 65% basaltic volcanics; 35% polycrystalline quartz, 75% of which are scarlet grains (quartzite?), (chert?).

7100 - 7120 feet

Texture: 100% sand
Composition: 70% basalt, locally serpentinized; 5% felsic volcanics; 20% polycrystalline; 5% monocrystalline quartz.

7160 - 7180 feet

Texture: 100% sand
Composition: 60% polycrystalline quartz, including white massive milky cryptocrystalline quartz (chert?) plus devitrified felsic volcanics; 40% basalt and basaltic andesites.

7220 - 7240 feet

Texture: 100% sand
Composition: 60% olivine basalt, locally serpentinized; 40% polycrystalline quartz including scarlet grains.

7280 - 7300 feet

Texture: 100% sand
Composition: 75% olivine basalt; 25% polycrystalline quartz, including scarlet grains.

7340 - 7360 feet

Texture: 100% sand
Composition: 75% olivine basalt; 25% polycrystalline quartz including scarlet grains.

7400 - 7420 feet

Texture: 100% sand
Composition: 85% basalt; 15% polycrystalline quartz with scarlet grains.

7460 - 7480 feet

Texture: 100% sand
Composition: 75% basalt; 25% polycrystalline quartz.

7520 - 7540 feet

Texture: 100% sand
Composition: 50% basalt; 50% polycrystalline quartz.

7580 - 7594 T.D.

Texture: 100% sand
Composition: 60% polycrystalline quartz; 40% basalt.

Texaco Logan Butte Unit 17-1, Crook Co., OR

1690 - 1720 feet

Texture: 60% coarse-fine sand; 40% coarse silt
Composition: 30% rhyolite and rhyolite porphyry with andesite, basalt, coarse angular to rounded (coarse to fine) quartz sand, polycrystalline and monocrystalline quartz 40%.

1720 - 1900 feet

Texture: 80% coarse to fine sand; 20% silt
Composition: 50% rounded 50% angular, (coarse to fine rhyolite porphyry 20%), 5% andesite, 10-25% basalt, some oxidized, some vesicular; 50-65% quartz sand, monocrystalline and polycrystalline.

1900 - 2020 feet

Texture: 70% sand; 30% silt
Composition: 50% rounded, 50% angular, coarse to fine (25% rhyolite porphry); 30% andesite, basalt, and 40% quartz sand, 5% minor amounts of tuff.

2020 - 3460 feet

Texture: 90% siltstone; 10% sandstone
Composition: Gray coarse to medium siltstone with minor amounts of coarse to fine quartz sand; 1% muscovite; 1% white ash tuff.

3460 - 3640 feet

Texture: 50% silt; 50% sand
Composition: 50% fine monocrystalline and polycrystalline quartz sand and 50% gray siltstone.

3640 - 4480 feet

Texture: 90% siltstone; 10% sandstone
Composition: 90% gray fine to coarse siltstone with minor amounts of 1-10% quartz sand; 1-10% basaltic and andesitic volcanics, ± minor hornblende.

4480 - 4540 feet

Texture: 80-95% silt; 5-20% sand
Composition: 80-95% gray siltstone with minor amounts of calcite (0-15%), some minor dark gray quartzite; up to 10% basalt.

4540 - 4750 feet

Texture: 90% silt; 10% sand
Composition: 90% gray siltstone with minor amounts of 0-10% quartz sand and 0-10% calcite.

4750 - 4810 feet

Texture: 70% silt; 30% sand
Composition: 70% gray siltstone and 30% fine polycrystalline and monocrystalline quartz sand.

4810 - 5230 feet

Texture: 80% silt; 20% sand
Composition: 70-95% gray siltstone and 5-15% minor quartz sand, also 5-10% prismatic gypsum crystals plus 1-2% olivine grains.

5230 - 5530 feet

Texture: 70% silt; 30% sand
Composition: 20-25% gray siltstone and olivine sand; 1-10% polycrystalline and monocrystalline quartz.

5530 - 6490 feet

Texture: 50% silt; 50% sand
Composition: 15% gray siltstone with olivine and 65% polycrystalline and monocrystalline white quartz sand; 30% silicic volcanics.

Core at T.D.

Texture: 100% sand
Composition: Olivine, white quartz, quartzite?, and chert sand.

Texaco Federal No. 1, Crook Co., OR

1500 - 1530 feet

Texture: 80% medium to fine sand; 20% silt
Composition: 60% white tuff (ash); 20% polycrystalline quartz; 15% volcanics; 5% monocrystalline quartz.

1560 - 1590 feet

Texture: 80% medium to fine sand; 20% silt
Composition: 60% white tuff (ash); 20% polycrystalline quartz; 15% volcanics; 5% monocrystalline quartz.

1620 - 1650 feet

Texture: 80% medium to fine sand; 20% silt
Composition: 30% tuff; 50% monocrystalline and polycrystalline quartz; 20% volcanics.

1680 - 1710 feet

Texture: 80% medium to fine sand; 20% silt
Composition: 80% polycrystalline and monocrystalline quartz (tuff); 10% volcanics (latite, andesite); 10% tuff.

1740 - 1770 feet

Texture: 80% medium to fine sand; 20% silt
Composition: 80% polycrystalline and monocrystalline quartz (tuff); 10% volcanics (latite, andesite); 10% tuff.

1800 - 1830 feet

Texture: 80% medium to fine sand; 20% silt
Composition: 80% polycrystalline and monocrystalline quartz (tuff); 10% volcanics (latite, andesite); 10% tuff.

1860 - 1890 feet

Texture: 80% medium to fine sand; 20% silt
Composition: 80% polycrystalline and monocrystalline quartz (tuff); 10% volcanics (latite, andesite); 10% tuff.

1920 - 1950 feet

Texture: 80% medium to fine sand; 20% silt
Composition: 50% polycrystalline and monocrystalline quartz; 40% volcanics 10% tuff.

1980 - 2010 feet

Texture: 80% medium to fine sand; 20% silt
Composition: 80% polycrystalline and monocyrstalline quartz; 10% tuff; 10% volcanics (latite, andesite).

2040 - 2070 feet

Texture: 80% medium to fine sand; 20% silt
Composition: 50% polycrystalline and monocrystalline quartz; 10% tuff; 40% volcanics (latite, andesite).

2070 - 2100 feet

Texture: 80% sand; 20% silt
Composition: 20% red and black volcanics; 75% polycrystalline and monocyrstalline yellow to white quartz; 5% minor amounts of white tuff with dark rock fragments.

2100 - 2130 feet

Texture: 80% sand; 20% silt
Composition: 75% white to gray to gray-green fine sands and silts; 5% yellow to white quartz (granules); minor amounts of white tuff with dark rock fragments.

2130 - 2160 feet

Texture: 80% sand; 20% silt
Composition: 20% red and black volcanics; 75% white to gray to gray-green fine sands and silts; 5% yellow to white quartz (granules); minor amounts of white tuff with dark rock fragments.

2160 - 2190 feet

Texture: 65% sand; 35% silt
Composition: 35% red and black volcanics; 45% polycrystalline and monocyrstalline quartz; 20% white tuff with dark rock fragments.

2190 - 2220 feet

Texture: 65% sand; 35% silt
Composition: 20% red and black volcanics; 75% white to gray to gray-green fine sands and silts; minor amounts of white tuff with dark rock fragments with small amounts of skarn.

2220 - 2760 feet

Texture: 65% sand; 35% silt
Composition: 40% red (ferric oxidized) and black volcanics, basalt, latite andesite; 40% yellow to white polycrystalline and monocrystalline quartz (granules); 5% white tuff; 20% dark rock fragments.

2760 - 2790 feet

Texture: 65% sand; 35% silt
Composition: 20% red and black volcanics; 70% yellow to white polycrystalline and monocrystalline quartz; 10% minor amounts of white tuff with dark rock fragments including hornblende, metavolcanics.

2790 - 2910 feet

Texture: 65% sand; 35% silt
Composition: 25% red and black volcanics; 70% yellow to white quartz (granules); 5% minor amounts of white tuff with dark rock fragments.

2910 - 2940 feet

Texture: 65% sand; 35% silt
Composition: 25% quartz (medium-coarse, rounded (5%), angular (95%)); 30% obsidian; 35% gray-red sandstone and siltstone; 10% rhyolite and basalt fragments.

2940 - 2970 feet

Texture: 65% sand; 35% silt
Composition: 40% polycrystalline and monocrystalline quartz (95% angular grains, 5% rounded grains); 55% basaltic volcanics? including ferric oxidized fragments; 5% misc. metavolcanics and metasediments.

2970 - 3000 feet

Texture: 65% sand; 35% silt
Composition: 80% gray sands and silts; 5% obsidian; 15% rhyolite? and basalt fragments.

3000 - 3030 feet

Texture: 70% sand; 30% silt
Composition: 65% polycrystalline and monocrystalline quartz; 30% basaltic and andesitic fragments; 5% obsidian.

3030 - 3060 feet

Texture: 70% sand; 30% silt
Composition: 65% polycrystalline and monocrystalline quartz; 30% basaltic and andesitic fragments; 5% obsidian.

3060 - 3090 feet

Texture: 70% sand; 30% silt
Composition: 75% polycrystalline and monocrystalline quartz; 20% basaltic red and black volcanic rock fragments; 2% hornblende; 2-3% obsidian.

3090 - 3120 feet

Texture: 70% sand; 30% silt
Composition: 95% white, gray, red fine sandstone and siltstone (50% rounded); 5% black glass.

3120 - 3150 feet

Texture: 70% sand; 30% silt
Composition: 75% monocrystalline and polycrystalline quartz; 25% volcanics (basalt, obsidian, andesite, latite, etc.).

3150 - 3210 feet

Texture: 70% sand; 30% silt
Composition: 75% monocrystalline and polycrystalline quartz; 25% volcanics (basalt, obsidian, andesite, latite, etc.).

3210 - 3270 feet

Texture: 70% sand; 30% silt
Composition: 75% monocrystalline and polycrystalline quartz; 25% volcanics (basalt, obsidian, andesite, latite, etc.).

3270 - 3300 feet

Texture: 70% sand; 30% silt
Composition: 75% monocrystalline and polycrystalline quartz; 25% volcanics (basalt, andesite, latite, etc.).

3300 - 3330 feet

Texture: 70% sand; 30% silt
Composition: 80% monocrystalline and polycrystalline quartz; 20% miscellaneous volcanics.

3330 - 3510 feet

Texture: 85% sand; 15% silt
Composition: 50% miscellaneous volcanics; 50% polycrystalline and monocrystalline quartz.

3510 - 3540 feet

Texture: 80% sand; 20% silt
Composition: 95% obsidian; 5% light green chert.

3540 - 3570 feet

Texture: 80% sand; 20% silt
Composition: 75% polycrystalline and monocrystalline quartz, including 5% green chert; 25% miscellaneous volcanics (basalt, andesite, obsidian fragments).

3570 - 3600 feet

Texture: 90% sand; 10% silt
Composition: 85% polycrystalline and monocrystalline quartz; 15% basaltic volcanics (no obsidian).

3600 - 3630 feet

Texture: 90% sand; 10% silt
Composition: 85% polycrystalline and monocrystalline quartz; 15% basaltic volcanics (no obsidian).

3630 - 3660 feet

Texture: 80% sand; 20% silt
Composition: 85% polycrystalline and monocrystalline quartz; 15% basaltic volcanics (no obsidian).

3660 - 3690 feet

Texture: 80% sand; 20% silt
Composition: 85% polycrystalline and monocrystalline quartz; 15% basaltic volcanics (no obsidian).

3690 - 3720 feet

Texture: 95% sand; 5% silt
Composition: 60% polycrystalline (gray and green-gray quartzite); 40% basaltic volcanics.

3720 - 3750 feet

Texture: 95% sand; 5% silt
Composition: 60% polycrystalline (gray and green-gray quartzite); 40% basaltic volcanics.

3750 - 3780 feet

Texture: 95% sand; 5% silt
Composition: 60% polycrystalline (gray and green-gray quartzite); 40% basaltic volcanics.

3780 - 3900 feet

Texture: 85% sand; 15% silt
Composition: 60% polycrystalline quartz (gray-green quartzite and milky quartz); 40% basaltic volcanics.

3900 - 3990 feet

Texture: 85% sand; 15% silt
Composition: 60% polycrystalline quartz (gray-green quartzite and milky quartz); 40% basaltic volcanics.

3990 - 4170 feet

Texture: 95% sand; 5% silt
Composition: 60% polycrystalline quartz (gray-green quartzite and milky quartz); 40% basaltic volcanics.

4170 - 4230 feet

Texture: 95% sand; 5% silt
Composition: 35% basalt and andesite; 60% quartzite; 5% monocrystalline quartz.

4230 - 4250 feet

Texture: 95% sand; 5% silt
Composition: 35% basalt and andesite; 60% quartzite; 5% monocrystalline quartz.

4250 - 4410 feet

Texture: 95% sand; 5% silt
Composition: 35% basalt and andesite; 60% quartzite; 5% monocrystalline quartz.

4410 - 4440 feet

Texture: 95% sand; 5% silt
Composition: 35% basalt and andesite; 60% quartzite; 5% monocrystalline quartz.

4440 - 4500 feet

Texture: 100% sand
Composition: 80% polycrystalline quartz, light colored, mostly milky quartz and quartzite but some minor light green chert; 20% basaltic volcanics.

4500 - 4530 feet

Texture: 95% sand; 5% silt
Composition: 95% basaltic volcanics; 5% polycrystalline quartz.

4530 - 5910 feet

Texture: 95% sand; 5% silt
Composition: 60% polycrystalline (gray and green-gray quartzite); 40% basaltic volcanics.

5910 - 5940 feet

Texture: 95% sand; 5% silt
Composition: 60% polycrystalline quartz (dark gray-green quartzite); 35% basalt, some oxidized red; 5% monocrystalline quartz.

5940 - 7680 feet

Texture: 95% sand; 5% silt
Composition: 60% gray, brown and greenish-gray polycrystalline quartz, quartzite mostly; 35-40% basalt and metabasalt and metaandesite and andesite, some oxidized (red); 0-5% monocrystalline quartz.

7680 - T.D.

Texture: 95% sand; 5% silt
Composition: 80% polycrystalline quartz, mostly gray-greenish quartzite; 20% basalt and metabasalt.

3170 - 3200 feet

Texture: 75% medium-fine sand; 25% coarse silt
Composition: 65% fine sandstone fragments; 25% volcanics, oxidized basalt and andesite; 10% polycrystalline and monocrystalline quartz.

3200 - 3230 feet

Texture: 80% coarse to fine sand; 20% coarse silt
Composition: 40% fine sandstone fragments; 10% coarse siltstone fragments; 40% basalt; 10% felsic volcanics and polycrystalline quartz (white "chert")

3230 - 3260 feet

Texture: 95% medium-fine sand; 5% coarse silt
Composition: 40% polycrystalline quartz; 15% monocrystalline quartz; 40% basaltic and intermediate volcanics.

3260 - 3290 feet

Texture: 95% medium to fine sand; 5% coarse silt
Composition: 40% polycrystalline quartz; 15% monocrystalline quartz; 40% basaltic and intermediate volcanics.

3290 - 3320 feet

Texture: 100% medium to fine sand
Composition: 60% olivine, basalt fragments, some with reddish-stained hematite; 20% polycrystalline quartz (quartzite, chert?); 20% monocrystalline quartz.

3320 - 3350 feet

Texture: 100% medium to fine sand
Composition: 50% olivine basalt (with minor detrital olivine grains weathered out of basalts); 40% polycrystalline quartz; 10% monocrystalline quartz.

3350 - 3380 feet

Texture: 100% medium to fine sand
Composition: 70% olivine basalt (includes detrital olivine grains); 25% polycrystalline quartz; 5% monocrystalline quartz.

3380 - 3410 feet

Texture: 100% medium to fine sand
Composition: 60% basalt and olivine basalt; 10% felsic volcanic (some devitrified); 20% polycrystalline quartz; 10% monocrystalline quartz.

3410 - 3440 feet

Texture: 100% medium to fine sand
Composition: 30% basalt; 30% intermediate and felsic volcanics; 30% polycrystalline quartz; 10% monocrystalline quartz.

3440 - 3460 feet

Texture: 100% medium to fine sand
Composition: 30% basalt; 30% intermediate and felsic volcanics; 30% polycrystalline quartz; 10% monocrystalline quartz.

3870 - 3900 feet

Texture: 100% fine sand
Composition: 30% basalt; 30% intermediate and felsic volcanics; 30% polycrystalline quartz; 10% monocrystalline quartz.

3900 - 3930 feet

Texture: 100% fine sand
Composition: 70% basalt and intermediate volcanics; 5% felsic volcanics; 20% polycrystalline quartz; 5% monocrystalline quartz.

3930 - 3960 feet

Texture: 100% fine sand
Composition: 70% basalt and intermediate volcanics; 5% felsic volcanics; 20% polycrystalline quartz; 5% monocrystalline quartz.

3960 - 3990 feet

Texture: 100% fine sand
Composition: 70% basalt and intermediate volcanics; 5% felsic volcanics; 20% polycrystalline quartz; 5% monocrystalline quartz.

3990 - 4020 feet

Texture: 100% fine sand
Composition: 70% basalt and intermediate volcanics (some basalt is vesicular); 5% felsic volcanics; 20% polycrystalline quartz; 5% monocrystalline quartz.

4020 -4050 feet

Texture: 100% fine sand
Composition: 70% basalt and intermediate volcanics (olivine detrital grains more conspicuous); 5% felsic volcanics; 20% polycrystalline quartz; 5% monocrystalline quartz.

4050 - 4080 feet

Texture: 90% medium to fine sand; 10% silt
Composition: 70% basalt and intermediate volcanics; 5% felsic volcanics; 20% polycrystalline quartz; 5% monocrystalline quartz.

4080 - 4110 feet

Texture: 60% fine to medium sand; 40% silt
Composition: 70% basalt and intermediate volcanics; 5% felsic volcanics; 20% polycrystalline quartz; 5% monocrystalline quartz. Some siltstone may be classified as siltstone fragments of sand textural size. It is impossible to tell whether the siltstone is epiclastic or whether the silt particles are cemented authigenically.

4110 - 4140 feet

Texture: 50% medium to fine sand; 50% silt
Composition: 60% basalt; 20% polycrystalline and monocrystalline quartz; 20% olivine.

4140 - 4170 feet

Texture: 50% medium to fine sand; 50% silt
Composition: 60% basalt; 20% polycrystalline and monocrystalline quartz; 20% olivine.

4170 - 4200 feet

Texture: 50% medium to fine sand; 50% silt
Composition: 60% basalt; 30% polycrystalline and monocrystalline quartz; 10% olivine.

4200 - 4230 feet

Texture: 70% sand; 30% silt
Composition: 60% basalt; 30% polycrystalline and monocrystalline quartz; 10% olivine.

4230 - 4260 feet

Texture: 70% sand; 30% silt
Composition: 80% basalt; 10% polycrystalline quartz; 10% olivine.

4260 - 4290 feet

Texture: 70% sand; 30% silt
Composition: 70% basalt; 20% polycrystalline and monocrystalline quartz; 10% olivine.

4290 - 4320 feet

Texture: 70% sand; 30% silt
Composition: 70% basalt; 20% polycrystalline and monocrystalline quartz; 10% olivine.

4320 - 4350 feet

Texture: 70% sand; 30% silt
Composition: 70% basalt; 20% polycrystalline and monocrystalline quartz; 10% olivine.

4350 - 4380 feet

Texture: 70% sand; 30% silt
Composition: 70% basalt; 20% polycrystalline and monocrystalline quartz; 10% olivine.

4380 - 4410 feet

Texture: 70% sand; 30% silt
Composition: 80% basalt; 15% polycrystalline and monocrystalline quartz; 5% olivine.

4410 - 4440 feet

Texture: 70% sand; 30% silt
Composition: 80% basalt; 15% polycrystalline and monocrystalline quartz; 5% olivine.

4440 - 4470 feet

Texture: 70% sand; 30% silt
Composition: 80% basalt; 15% polycrystalline and monocrystalline quartz; 5% olivine.

4470 - 4500 feet

Texture: 70% sand; 30% silt
Composition: 80% basalt; 15% polycrystalline and monocrystalline quartz; 5% olivine.

4500 - 4530 feet

Texture: 70% sand; 30% silt
Composition: 80% basalt; 15% polycrystalline and monocrystalline quartz; 5% olivine.

4530 - 4560 feet

Texture: 60% medium to fine sand; 40% micaceous silt
Composition: 80% basalt; 15% polycrystalline and monocrystalline quartz; 5% olivine.

4560 - 4590 feet

Texture: 60% mostly fine sand; 40% micaceous silt
Composition: 80% basalt; 15% polycrystalline and monocrystalline quartz; 5% olivine.

4590 - 4620 feet

Texture: 70% sand; 30% silt
Composition: 80% basalt; 15% polycrystalline and monocrystalline quartz; 5% olivine.

4620 - 4650 feet

Texture: 70% fine sand; 30% micaceous silt
Composition: 70% basaltic; 20% polycrystalline and monocrystalline quartz; 10% olivine.

4650 - 4680 feet

Texture: 70% medium to fine sand; 30% micaceous silt
Composition: 70% basaltic; 20% polycrystalline and monocrystalline quartz; 10% olivine.

4680 - 4710 feet

Texture: 70% medium to fine sand; 30% micaceous silt
Composition: 70% basaltic; 20% polycrystalline and monocrystalline quartz; 10% olivine.

4710 - 4740 feet

Texture: 70% medium to fine sand; 30% micaceous silt
Composition: 70% basaltic; 20% polycrystalline and monocrystalline quartz; 10% olivine.

4740 - 4770 feet

Texture: 70% medium to fine sand; 30% micaceous silt
Composition: 70% basaltic; 20% polycrystalline and monocrystalline quartz; 10% olivine.

4770 - 4810 feet

Texture: 70% medium to fine sand; 30% micaceous silt
Composition: 70% basaltic; 20% polycrystalline and monocrystalline quartz; 10% olivine.

4810 - 4830 feet

Texture: 70% medium to fine sand; 30% micaceous silt
Composition: 70% basaltic; 20% polycrystalline and monocrystalline quartz; 10% olivine.

4830 - 4860 feet

Texture: 70% medium to fine sand; 30% micaceous silt
Composition: 70% basaltic; 20% polycrystalline and monocrystalline quartz; 10% olivine.

4860 - 4890 feet

Texture: 60% sand; 40% silt
Composition: 70% basaltic; 20% polycrystalline and monocrystalline quartz; 10% olivine.

4890 - 4920 feet

Texture: 60% sand; 40% silt
Composition: 70% basaltic; 20% polycrystalline and monocrystalline quartz; 10% olivine.

4920 - 4950 feet

Texture: 75% medium to fine sand; 25% silt
Composition: 50% basalt; 45% polycrystalline and monocrystalline quartz; 5% olivine.

4950 - 4980 feet

Texture: 75% medium to fine sand; 25% silt
Composition: 40% basalt; 50% polycrystalline and monocrystalline quartz; 10% olivine.

5010 - 5040 feet

Texture: 50% medium to fine sand; 50% silt
Composition: 45% basalt; 45% quartz; 10% olivine.

5040 - 5070 feet

Texture: 50% medium to fine sand; 50% silt
Composition: 45% basalt; 45% quartz; 10% olivine.

5070 - 5100 feet

Texture: 50% medium to fine sand; 50% silt
Composition: 45% basalt; 45% quartz; 20% olivine.

5100 - 5130 feet

Texture: 50% medium to fine sand; 50% silt
Composition: 45% basalt; 45% quartz; 10% olivine.

5130 - 5160 feet

Texture: 50% medium to fine sand; 50% silt
Composition: 85% basalt; 10% quartz; 5% olivine.

5160 - 5190 feet

Texture: 60% sand; 40% silt
Composition: 85% basalt; 10% quartz; 5% olivine.

5190 - 5220 feet

Texture: 60% sand; 40% silt
Composition: 85% basalt; 10% quartz; 5% olivine.

5220 - 5250 feet

Texture: 60% sand; 40% silt
Composition: 85% basalt; 10% quartz; 5% olivine.

5250 - 5280 feet

Texture: 70% sand; 30% silt
Composition: 85% basalt; 10% quartz; 5% olivine.

5280 - 5310 feet

Texture: 70% sand; 30% silt
Composition: 85% basalt; 10% quartz; 5% olivine.

5310 - 5340 feet

Texture: 70% sand; 30% silt
Composition: 85% basalt; 10% quartz; 5% olivine.

5340 - 5370 feet

Texture: 70% sand; 30% silt
Composition: 85% basalt; 10% quartz; 5% olivine.

5370 - 5400 feet

Texture: 70% sand; 30% silt
Composition: 90% basalt; 5% polycrystalline quartz; 5% olivine.

5400 - 5430 feet

Texture: 70% sand; 30% silt
Composition: 90% basalt; 5% polycrystalline quartz; 5% olivine.

5430 - 5460 feet

Texture: 60% medium sand; 40% silt
Composition: 80% basalt; 15% polycrystalline quartz; 5% olivine.

5460 - 5490 feet

Texture: 60% medium sand; 40% silt
Composition: 80% basalt; 15% polycrystalline quartz; 5% olivine.

5490 - 5520 feet

Texture: 40% sand; 60% silt
Composition: 70% basalt; 25% polycrystalline and monocrystalline quartz; 5% olivine.

5520 - 5550 feet

Texture: 40% sand; 60% silt
Composition: 70% basalt; 25% polycrystalline and monocrystalline quartz; 5% olivine.

5550 - 5580 feet

Texture: 40% sand; 60% silt
Composition: 70% basalt; 25% polycrystalline and monocrystalline quartz; 5% olivine.

5580 - 5610 feet

Texture: 40% sand; 60% silt
Composition: 70% basalt; 25% polycrystalline and monocrystalline quartz; 5% olivine.

5610 - 5640 feet

Texture: 40% sand; 60% silt
Composition: 70% basalt; 25% polycrystalline and monocrystalline quartz; 5% olivine.

5640 - 5670 feet

Texture: 40% sand; 60% silt
Composition: 60% basalt; 35% polycrystalline and monocrystalline quartz; 5% olivine.

5670 - 5700 feet

Texture: 40% sand; 60% silt
Composition: 60% basalt; 35% polycrystalline and monocrystalline quartz; 5% olivine.

5700 - 5730 feet

Texture: 40% sand; 60% silt
Composition: 60% basalt; 35% polycrystalline and monocrystalline quartz; 5% olivine.

5730 - 5760 feet

Texture: 40% sand; 60% silt
Composition: 60% basalt; 35% polycrystalline and monocrystalline quartz; 5% olivine.

5760 - 5790 feet

Texture: 40% sand; 60% silt
Composition: 60% basalt; 35% polycrystalline and monocrystalline quartz; 5% olivine.

5790 - 5820 feet

Texture: 40% sand; 60% silt
Composition: 60% basalt; 35% polycrystalline and monocrystalline quartz; 5% olivine.

5820 - 5850 feet

Texture: 40% sand; 60% silt
Composition: 80% basalt; 15% polycrystalline and monocrystalline quartz; 5% olivine.

5850 - 5880 feet

Texture: 40% sand; 60% silt
Composition: 80% basalt; 15% polycrystalline quartz; 5% olivine.

5880 - 5910 feet

Texture: 40% sand; 60% silt
Composition: 80% basalt; 15% polycrystalline quartz; 5% olivine.

5910 - 5940 feet

Texture: 90% sand; 10% silt
Composition: 50% basalt; 45% polycrystalline quartz; 5% olivine.

5940 - 5970 feet

Texture: 40% sand; 60% silt
Composition: 80% basalt; 15% polycrystalline quartz; 5% olivine.

5970 - 6000 feet

Texture: 40% sand; 60% silt
Composition: 80% basalt; 15% polycrystalline quartz; 5% olivine.

6000 - 6030 feet

Texture: 40% sand; 60% silt
Composition: 80% basalt; 15% polycrystalline quartz; 5% olivine.

6030 - 6060 feet

Texture: 40% sand; 60% silt
Composition: 80% basalt; 15% polycrystalline quartz; 5% olivine.

6060 - 6090 feet

Texture: 40% sand; 60% silt
Composition: 80% basalt; 15% polycrystalline quartz; 5% olivine.

6090 - 6120 feet

Texture: 85% silt; 15% sand
Composition: 80% basalt; 15% polycrystalline quartz; 5% olivine.

6120 - 6150 feet

Texture: 85% silt; 15% sand
Composition: 80% basalt; 15% polycrystalline quartz; 5% olivine.

6150 - 6180 feet

Texture: 85% silt; 15% sand
Composition: 80% basalt; 15% polycrystalline quartz; 5% olivine.

6180 - 6210 feet

Texture: 85% silt; 15% sand
Composition: 80% basalt; 15% polycrystalline quartz; 5% olivine.

6210 - 6240 feet

Texture: 50% sand; 50% silt
Composition: 55% polycrystalline and monocrystalline quartz; 40% basalt; 5% olivine.

6240 - 6270 feet

Texture: 50% sand; 50% silt
Composition: 55% polycrystalline and monocrystalline quartz; 40% basalt; 5% olivine.

6270 - 6300 feet

Texture: 50% sand; 50% silt
Composition: 55% polycrystalline and monocrystalline quartz; 40% basalt; 5% olivine.

6300 - 6330 feet

Texture: 50% sand; 50% silt
Composition: 55% polycrystalline and monocrystalline quartz; 40% basalt; 5% olivine.

6330 - 6360 feet

Texture: 50% sand; 50% silt
Composition: 80% basalt; 15% polycrystalline quartz; 5% olivine.

6360 - 6390 feet

Texture: 50% sand; 50% silt
Composition: 80% basalt; 15% polycrystalline quartz; 5% olivine.

6390 - 6420 feet

Texture: 50% sand; 50% silt
Composition: 80% basalt; 15% polycrystalline quartz; 5% olivine.

6420 - 6450 feet

Texture: 50% coarser sand; 50% silt
Composition: 80% basalt; 15% polycrystalline quartz; 5% olivine.

6710 - 6740 feet

Texture: 60% silt; 40% sand
Composition: 90% basalt; 10% polycrystalline quartz.

6740 - 6770 feet

Texture: 60% silt; 40% sand
Composition: 90% basalt; 10% polycrystalline quartz.

6770 - 6800 feet

Texture: 60% silt; 40% sand
Composition: 90% basalt; 10% polycrystalline quartz.

6800 - 6830 feet

Texture: 60% silt; 40% sand
Composition: 90% basalt; 10% polycrystalline quartz.

6830 - 6860 feet

Texture: 60% silt; 40% sand
Composition: 90% basalt; 10% polycrystalline quartz.

6860 - 6890 feet

Texture: 60% silt; 40% sand
Composition: 90% basalt; 10% polycrystalline quartz.

6890 - 6920 feet

Texture: 60% silt; 40% sand
Composition: 90% basalt; 10% polycrystalline quartz.

6920 - 6950 feet

Texture: 60% silt; 40% sand
Composition: 90% basalt; 10% polycrystalline quartz.

6950 - 6980 feet

Texture: 60% silt; 40% sand
Composition: 90% basalt; 10% polycrystalline quartz.

6980 - 7010 feet

Texture: 60% silt; 40% sand
Composition: 60% basalt; 35% polycrystalline and monocrystalline quartz; 5% olivine.

7010 - 7040 feet

Texture: 60% silt; 40% sand
Composition: 60% basalt; 35% polycrystalline and monocrystalline quartz; 5% olivine.

7040 - 7070 feet

Texture: 60% silt; 40% sand
Composition: 60% basalt; 35% polycrystalline and monocrystalline quartz; 5% olivine.

7070 - 7100 feet

Texture: 60% silt; 40% sand
Composition: 50% basalt; 45% quartz; 5% olivine.

7100 - 7130 feet

Texture: 60% silt; 40% sand
Composition: 50% basalt; 45% quartz; 5% olivine.

7130 - 7160 feet

Texture: 80% medium sand; 20% silt
Composition: 70% polycrystalline quartz; 20% basalt; 10% monocrystalline quartz.

7160 - 7190 feet

Texture: 80% medium sand; 20% silt
Composition: 70% polycrystalline quartz; 20% basalt; 10% monocrystalline quartz.

7190 - 7220 feet

Texture: 80% medium sand; 20% silt
Composition: 70% polycrystalline quartz; 20% basalt; 10% monocrystalline quartz.

7220 - 7250 feet

Texture: 80% medium sand; 20% silt
Composition: 70% polycrystalline quartz; 20% basalt; 10% monocrystalline quartz.

7250 - 7280 feet

Texture: 80% medium sand; 20% silt
Composition: 70% polycrystalline quartz; 20% basalt; 10% monocrystalline quartz.

7280 - 7310 feet

Texture: 80% medium sand; 20% silt
Composition: 70% polycrystalline quartz; 20% basalt; 10% monocrystalline quartz.

7310 - 7340 feet

Texture: 80% medium sand; 20% silt
Composition: 70% polycrystalline quartz; 20% basalt; 10% monocrystalline quartz.

7340 - 7370 feet

Texture: 80% medium sand; 20% silt
Composition: 70% polycrystalline quartz; 20% basalt; 10% monocrystalline quartz.

7370 - 7400 feet

Texture: 80% medium sand; 20% silt
Composition: 70% polycrystalline quartz; 20% basalt; 10% monocrystalline quartz.

7400 - 7430 feet

Texture: 80% medium sand; 20% silt
Composition: 70% polycrystalline quartz; 20% basalt; 10% monocrystalline quartz.

7430 - 7460 feet

Texture: 80% medium sand; 20% silt
Composition: 70% polycrystalline quartz; 20% basalt; 10% monocrystalline quartz.

7460 - 7490 feet

Texture: 80% medium sand; 20% silt
Composition: 70% polycrystalline quartz; 20% basalt; 10% monocrystalline quartz.

7490 - 7520 feet

Texture: 80% medium sand; 20% silt
Composition: 70% polycrystalline quartz; 20% basalt; 10% monocrystalline quartz.

7520 - 7550 feet

Texture: 80% medium sand; 20% silt
Composition: 70% polycrystalline quartz; 20% basalt; 10% monocrystalline quartz.

7550 - 7580 feet

Texture: 80% medium sand; 20% silt
Composition: 75% polycrystalline quartz; 15% basalt; 10% monocrystalline quartz.

7580 - 7610 feet

Texture: 80% medium sand; 20% silt
Composition: 75% polycrystalline quartz; 15% basalt; 10% monocrystalline quartz.

7610 - 7640 feet

Texture: 80% medium sand; 20% silt
Composition: 40% polycrystalline quartz; 40% basalt; 17% monocrystalline quartz; 3% olivine.

7640 - 7670 feet

Texture: 80% medium sand; 20% silt
Composition: 40% polycrystalline quartz; 40% basalt; 17% monocrystalline quartz; 3% olivine.

7670 - 7700 feet

Texture: 80% medium sand; 20% silt
Composition: 40% polycrystalline quartz; 40% basalt; 17% monocrystalline quartz; 3% olivine.

7700 - 7730 feet

Texture: 80% medium sand; 20% silt
Composition: 40% polycrystalline quartz; 40% basalt; 17% monocrystalline quartz; 3% olivine.

7730 - 7760 feet

Texture: 80% medium sand; 20% silt
Composition: 40% polycrystalline quartz; 40% basalt; 17% monocrystalline quartz; 3% olivine.

7760 - 7790 feet

Texture: 80% medium sand; 20% silt
Composition: 40% polycrystalline quartz; 40% basalt; 17% monocrystalline quartz; 3% olivine.

7790 - 7820 feet

Texture: 80% medium sand; 20% silt
Composition: 40% polycrystalline quartz; 40% basalt; 17% monocrystalline quartz; 3% olivine.

7820 - 7850 feet

Texture: 80% medium sand; 20% silt
Composition: 65% basalt; 30% polycrystalline quartz; 4% monocrystalline quartz; 1% olivine.

7850 - 7880 feet

Texture: 80% medium sand; 20% silt
Composition: 65% basalt; 30% polycrystalline quartz; 4% monocrystalline quartz; 1% olivine.

7880 - 7910 feet

Texture: 80% medium sand; 20% silt
Composition: 65% basalt; 30% polycrystalline quartz; 4% monocrystalline quartz; 1% olivine.

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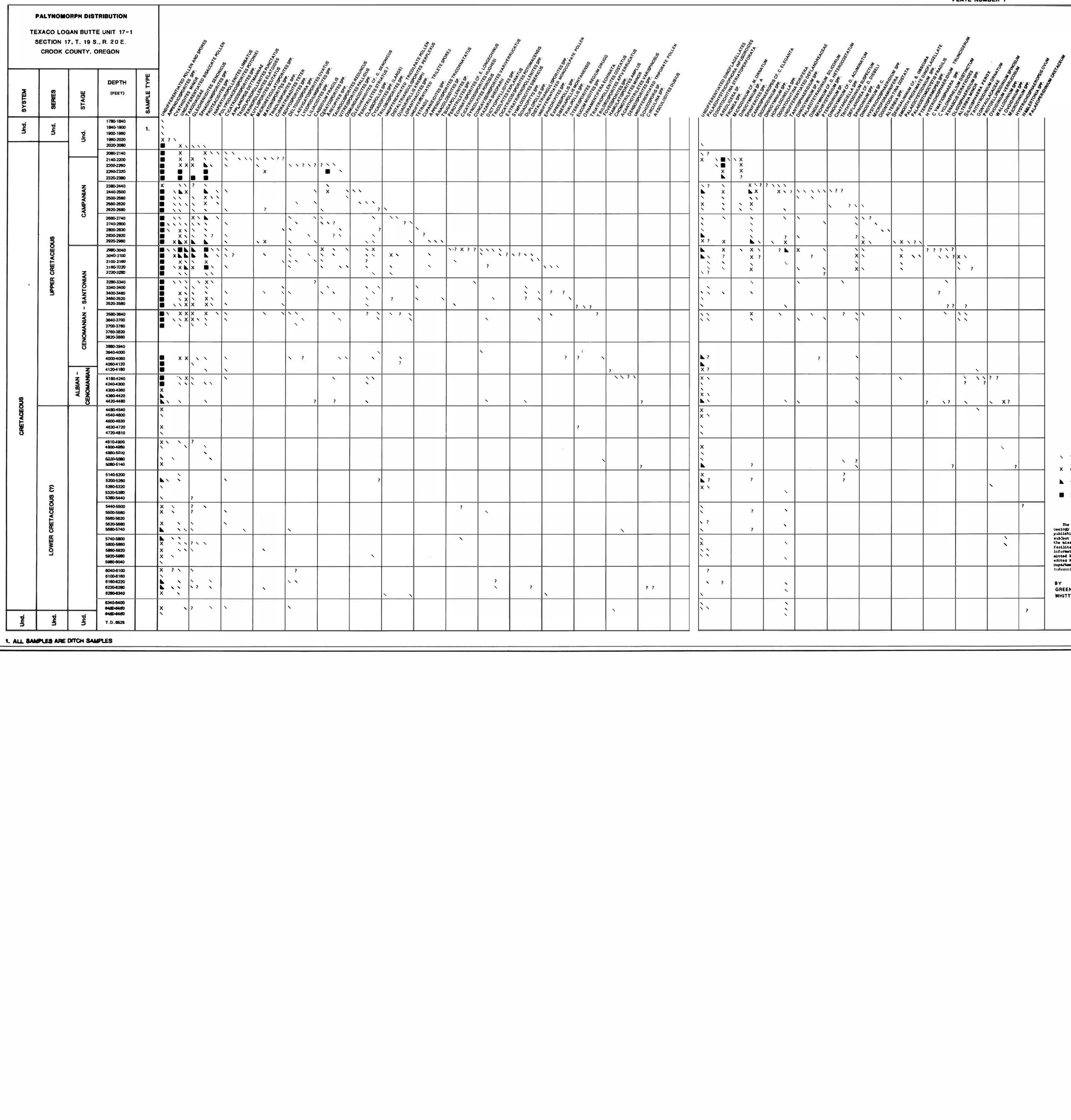
STATE OF OREGON
DEPARTMENT OF GEOLOGY AND MINERAL INDUSTRIES
DONALD A. HULL, STATE GEOLOGIST

Oil and Gas Investigation 8

SUBSURFACE STRATIGRAPHY OF THE OCHOCO BASIN, OREGON.
G.G. THOMPSON et al.
PLATE NUMBER 1

PALYNOMORPH DISTRIBUTION

TEXACO LOGAN BUTTE UNIT 17-1
SECTION 17, T. 19 S., R. 20 E.
CROOK COUNTY, OREGON



LEGEND

\ 1 TO 5 SPECIMENS
X 6 TO 14 SPECIMENS
◣ 15 TO 29 SPECIMENS
■ 30 OR MORE SPECIMENS

BY
GREEN & ASSOCIATES
WHITTIER, CALIFORNIA

1. ALL SAMPLES ARE DITCH SAMPLES

STATE OF OREGON
DEPARTMENT OF GEOLOGY AND MINERAL INDUSTRIES
DONALD A. HULL, STATE GEOLOGIST

Oil and Gas Investigation 8

SUBSURFACE STRATIGRAPHY OF THE OCHOCO BASIN, OREGON.
G.G. THOMPSON et al.
PLATE NUMBER 2

PALYNOMORPH DISTRIBUTION
SUNRAY MID-CONTINENT STANDARD
LLOYD MCCULLOCH BEAR CREEK UNIT # 1
Section 30, T. 17 S., R. 19 E.
Crook County, Oregon

SYSTEM	SERIES	STAGE	DEPTH (FEET)	Sample type
CRETACEOUS	UPPER CRETACEOUS	CENOMANIAN - TURONIAN	3158-3165	c
			3170-3260	d
			3260-3350	d
			3350-3440	d
			3489-3496	c
			3600	d
			3700	d
			3800	d
			3870-3960	d
			3960-4050	d
			4050-4140	d
			4140-4230	d
			4230-4320	d
			4463-4475	c
			4410-4500	d
		ALBIAN - CENOMANIAN	4500-4590	d
			4590-4660	d
			4660-4770	d
			4770-4860	d
			4860-4950	d
			4950-5040	d
			5040-5130	d
			5130-5220	d
			5220-5310	d
			5311-5320	c
			5310-5400	d
			5400-5490	d
			5490-5580	d
			5580-5670	d
			5670-5760	d
CRETACEOUS (?)			5828-5841	c
			5760-5850	d
			5850-5940	d
			5940-6030	d
			6030-6090	d
			6090-6160	d
			6160-6270	d
			6304-6309	c
			6270-6360	d
			6360-6450	d
			6560	d
			6600	d
			6711-6722	c
			6710-6600	d
			6600-6690	d
			6990-6980	d
			6980-7070	d
			7070-7160	d
			7161-7167	c
			7160-7250	d
			7250-7340	d
			7340-7430	d
			7430-7520	d
			7520-7610	d
			7610-7700	d
			7700-7790	d
			7790-7880	d

UNDIFFERENTIATED POLLEN AND SPORES
INAPERTUROPOLLENITES HIATUS
UNDIFFERENTIATED BISACCATE POLLEN
PLURICELLAESPORITES SPP.
UNDIFFERENTIATED TRIPORATE POLLEN
CYATHIDITES SPP.
LARICOIDITES SPP.
ECHINATISPORIS SPP.
SPHAGNUMSPORITES SPP.
LAEVIGATOSPORITES OVATUS
SCHIZOSPORIS SPP.
GLEICHENIIDITES SENONICUS
EUCOMMIIDITES SPP.
CICATRICOSISPORITES OVATUS
DISTALTRIANGULISPORITES SPP.
CICATRICOSISPORITES SPP.
APPENDICISPORITES LIMBATUS
INAPERTUROPOLLENITES HUGHESI
CONCAVISSIMISPORITES CF. A. MATEROVAE
APPENDICISPORITES CF. A. VARIVERRUCATUS
KLUKISPORITES FOVEOLATUS
POLYPODIACEOISPORITES SPP.
CYATHIDITES MINOR
POLYCINGULATISPORITES SPP.
APPENDICISPORITES SPP.
VITREISPORITES PALLIDUS SPP.
ACANTHOTRILETES SPP.
FOVEOTRILETES SPP.
TSUGAPOLLENITES VARISPINOSUS
TAUROCUSPORITES SPP.
DELTOIDOSPORA SPP.
TRILOBOSPORA SPP.
ANTULSPORITES SPP.
UNDIFFERENTIATED TRILETE SPORES
CLASSOPOLLIS SPP.
EXESIPOLLENITES SPP.
COSTATOPERFOROSPORITES SPP.
APPENDICISPORITES SPP.
CICATRICOSISPORITES CF. A. TRICORNATATUS
LEPTOLEPIDITES SPP.
CERATOSPORITES SPP.
MATONISPORITES SPP.
TAUROCUSPORITES VERRUCATUS
DISTALTRIANGULISPORITES REDUNCUS
CHOMOTRILETES SPP.
LYCOPODIUMSPORITES PERPLEXUS
BACULATISPORITES SPP.
OSMUNDACIDITES SPP.
TRIGISPORITES SPP.
TRIGULISSPORITES SPP.
TRILOBOSPORITES SPP.
CICATRICOSISPORITES RADIATUS
POLYCINGULATISPORITES CF. C. VENUSTUS
CYCADOPITES SPP.
VERRUCOSISPORITES RADIATUS
AEQUITRIRADITES SPINULOSUS
ROUSEISPORITES RETICULATUS
CICATRICOSISPORITES ROTUNDUS
CICATRICOSISPORITES SPP.
ORNAMENTIFERA ECHINATA
NEORAISTRICKIA TRUNCATA
DICTYOPHYLLIDITES SPP.
CLASSOPOLLIS MINOR
INTERULOBITES SPP.
APPENDICISPORITES SPP.
CAMAREOZONOSPORITES CF. A. JANSONII
ARECIPITES SSP. RETICULATUS
SCHIZOSPORIS INSIGNIS
QUADRIPOLLIS KREMPII
TETRADS
TAUROCUSPORITES SEGMENTATUS
COSTATOPERFOROSPORITES FOVEOLATUS
DENSOSPORITES SPP.
TAPPANISPORA RETICULATUS
CLASSOPOLLIS ECHINATA
NEORAISTRICKIA SPP.
POLYAD (?)
PALAEOHYSTRICHOPHORA INFUSOROIDES
ARAEOLIGERA SP.
TRYTHYRODINIUM SUSPECTUM
ODONTOCHITINA SPP.
LEIOSPHERE 36-A
SPHAERITES SPP.
UNDIFFERENTIATED DINOFLAGELLATES
CANNOSPHAEROPSIS SPP. COMPLEX
OLIGOSPHAERIDIUM COMPLEX
TANYOSPHAERIDIUM VARIEGALAMUM

Compiled by
GREEN AND ASSOCIATES
Whittier, Ca.

KEY

\ = 1 - 5 specimens
X = 6 - 14 spec.
◣ = 15 - 29 spec.
■ = 30 or more spec.
d = Ditch sample
c = Core sample

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STATE OF OREGON
DEPARTMENT OF GEOLOGY AND MINERAL INDUSTRIES
DONALD A. HULL, STATE GEOLOGIST

Oil and Gas Investigation 8

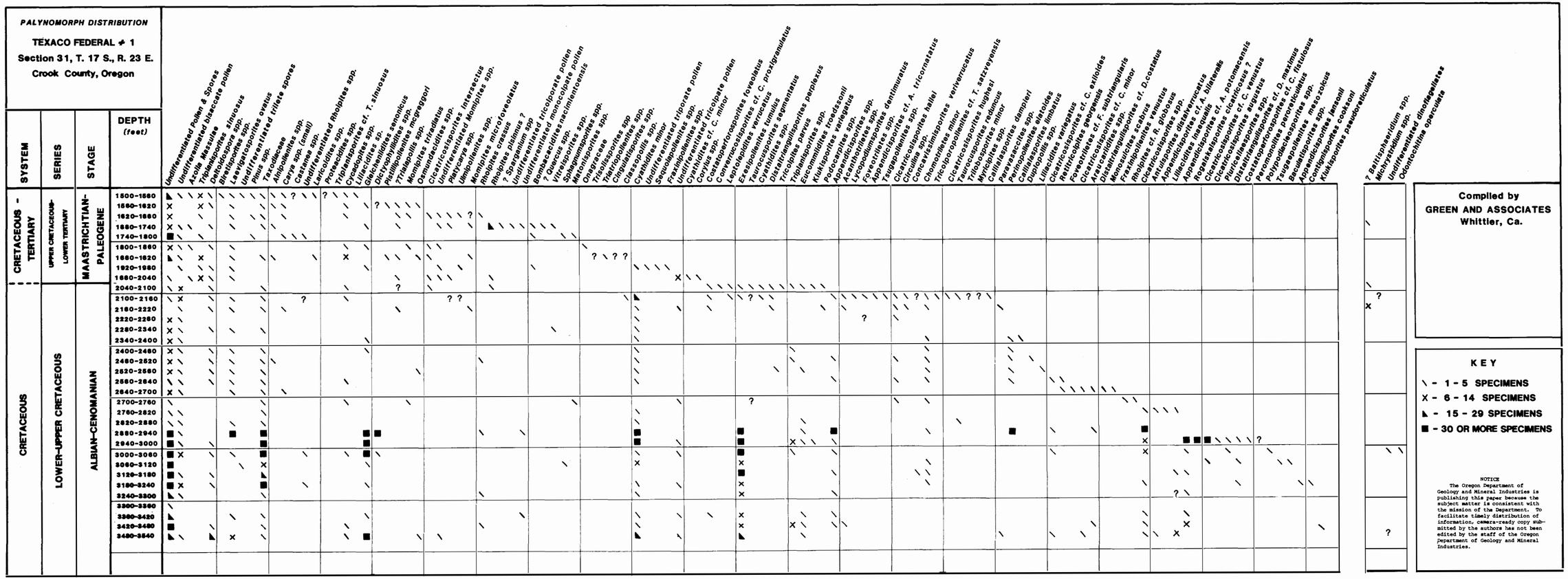
SUBSURFACE STRATIGRAPHY OF THE OCHOCO BASIN, OREGON.

G.G. THOMPSON et al.

PLATE NUMBER 3

PALYNOMORPH DISTRIBUTION

TEXACO FEDERAL # 1
Section 31, T. 17 S., R. 23 E.
Crook County, Oregon



Complied by
GREEN AND ASSOCIATES
Whittier, Ca.

KEY

\ - 1 - 5 SPECIMENS
X - 6 - 14 SPECIMENS
◣ - 15 - 29 SPECIMENS
■ - 30 OR MORE SPECIMENS

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DEPARTMENT OF GEOLOGY AND MINERAL INDUSTRIES
DONALD A. HULL, STATE GEOLOGIST

Oil and Gas Investigation 8

SUBSURFACE STRATIGRAPHY OF THE OCHOCO BASIN, OREGON.
G.G. THOMPSON et al.
PLATE NUMBER 4

PALYNOMORPH DISTRIBUTION

STANDARD OIL PEXCO STATE NO. 1
Section 17, T. 19 S., R. 20 E.
Crook County, Oregon

AGE				DEPTH (FEET)	SAMPLE TYPE
TERTIARY	LOWER TERTIARY	PALEOGENE		3560-3640	d
				3640-3720	d
				3720-3600	d
				3600-3660	d
				3660-3960	d
		3.		3960-4040	d
				4040-4120	d
				4120-4200	d
				4200-4260	d
				4260-4360	d
				4360-4440	d
				4440-4520	d
				4520-4600	d
				4600-4660	d
				4660-4760	d
		4.		4760-4640	d
				4640-4920	d
				4920-5000	d
				5000-5040	d
				5398-5404	c
CRETACEOUS	UPPER CRETACEOUS	SENONIAN		5660-5940	d
				5940-6020	d
				6045-6051	c
				6020-6100	d
				6100-6160	d
				6160-6260	d
				6260-6340	d
				6340-6420	d
				6420-6500	d
				6500-6560	d
				6560-6660	d
				6660-6740	d
				6740-6820	d
				6820-6900	d
				6900-6960	d
				6960-7060	d
				7060-7140	d
				7140-7220	d
				7220-7300	d
				7300-7360	d
				7360-7460	d
				7460-7540	d
				7540-7594	d

UNDIFFERENTIATED POLLEN AND SPORES
PINUS SPP.
ALNIPOLLENITES SPP.
TETRADS
ARAUCARIACITES SPP.
DELTOIDOSPORA SPP.
? COMPOSITAE
UNDIFFERENTIATED TRICOPORATE POLLEN
TAXODIACEAE
ARTEMISIA SPP.
CICATRICOSISPORITES INTERSECTUS
UNDIFFERENTIATED TRILETE SPORES
LAEVIGATOSPORITES DISCORDATUS
CICATRICOSISPORITES SPP.
TRIPLANISPORITES SPP.
OSMUNDACIDITES SPP.
MOMIPITES TRIRADIATUS
CYCADOPITES SPP.
UNDIFFERENTIATED TRICOLPATE POLLEN
TSUGAPOLLENITES SPP.
LAEVIGATOSPORITES SPP.
PROTEACIDITES SPP.
GLEICHENIDITES SPP.
PISTILLIPOLLENITES SENOMICUS
THIN LEIOSPHERE (Ø)
CAPRIFOLIIPITES MACGREGORII
MOMIPITES SPP.
PESAVIS SPP.
MOMIPITES TENUAPOLLIS
PARAALNIPOLLENITES CONFUSUS
SPHAGNUMSPORITES SPP.
MAGNOSPORITES SPP.
SYMPLOCITES SSP.
CARYA SPP. (SMALL)
ULMIPOLLENITES STAPLINI
UNDIFFERENTIATED POLLEN
BOMBACACIDITES BISACCATE POLLEN
NYSSAPOLLENITES NACIMIENTOENSIS
APPENDICISPORITES SPP.
SCHIZOSPORIS SPP.
CORYLUS SPP.
CICATRICOSISPORITES SPP.
TODISPORITES SPP.
PLURICELLAESPORITES SPP.
TRILOBOSPORITES SPP.
DISTALTRIANGULISPORITES PERPLEXUS
BETULA SPP.
PLATYCARYA SPP.
CICATRICOSISPORITES CF. C. VENUSTUS
AZOLLA MASSULAE
AZOLLA MICROSPORES (?)
LILEACIDITES SPP.
CYATHIDITES MINOR
EUCOMMIIDITES ? SPP.
MOMIPITES MICROPOVEOLATUS
DICTYOPHYLLIDITES SPP.
TRIPORITES RHAMNOIDES
EPHEDRAPITES SPP.
DENSOISPORITES SPP.
SCIADOPITYS SPP.
KLUKISPORITES FOVEOLATUS
CERATOSPORITES SPP.
APPENDICISPORITES SPP.
ORNAMENTIFERA ECHINATA
MATONISPORITES TRICORNATATUS
VERRUCOSISPORITES SPP.
LYCOPODIUMSPORITES SPP.
CAMAROZONOSPORITES INSIGNIS
COSTATOPERFOROSPORITES FOVEOLATUS
OVOIDINIUM VERRUCOSUM
ODONTOCHITINA PORIFERA
UNDIFFERENTIATED DINOFLAGELLATES
DINOGYMNIUM SPP.
?S PINIDINIUM SPP.
TRITHYRODINIUM SPP. SUSPECTUM
MICHRYSTRIDIUM SPP.
CORONIFERA OCEANICA
?CORODSPHAERIDIUM SPP.
AREOLIGERA SPP.

Compiled by
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Whittier, Ca.

KEY

\ 1 TO 5 SPECIMENS
x 6 TO 14 SPECIMENS
◣ 15 TO 29 SPECIMENS
■ 30 OR MORE SPECIMENS
d DITCH SAMPLE
c CORE SAMPLE

1. ALBIAN - CENOMANIAN
2. LOWER CRETACEOUS
3. CRETACEOUS
4. UNDETERMINED

STATE OF OREGON
DEPARTMENT OF GEOLOGY AND MINERAL INDUSTRIES
DONALD A. HULL, STATE GEOLOGIST

FORAMINIFERAL DISTRIBUTION

Oil and Gas Investigation 8

SUBSURFACE STRATIGRAPHY OF THE OCHOCO BASIN, OREGON.
G.G. THOMPSON
PLATE 5

SUNRAY MID-CONTINENT STANDARD
LLOYD MCCULLOCH BEAR CREEK UNIT # 1
Section 30, T. 17 S., R. 19 E.
Crook County, Oregon

AGE: SYSTEM | SERIES | STAGE | ZONE

DEPTH | SAMPLE TYPE

ARENACEOUS AND CALCAREOUS FORAMINIFERA

Hedbergella sp.
Nodosaria sp.
Hedbergella archaecretacea
Haplophragmoides deliriosensis
Gyroidinoides cf. H. glabra
Hedbergella infracretacea
Gyroidinoides praehelvetica
Haplophragmoides nitida
Helvetoglobotruncana helvetica
Valvulineria sp.
Haplophragmoides fraseri
Rugoglobigerina rugosa
Silicosigmoilina pilula
Gyroidina floreallis
Haplophragmoides sp.
Trochammina sp.
Ammodiscus obesus
Haplophragmoides cf. T. goudkoffi
Bathysiphon sp.
Ammodiscus glabratus
Gaudryina vitta
Ceratobulimina taulleri
Lenticulina sp.
Lenticulina cretacea
Bathysiphon brossei
Trochammina sp.
Ammobaculites trifolia
Epistominella sp.
Gyrodinoides cf. E. caracolla
Planularia globosa
Marginulinopsis sp.
Anomalina tricarinella
Reinholdella complanata
Lenticulina ultima
Haplophragmoides turgidula
Praebulimina spp.
Haplophragmoides nanning
Valvulineria loatterli
Planulina sp.
Dentalina sp.
Gavelinella sp.
Gavelinella andersoni
Stilostomella sp.
Reophax sp.
Haplophragmoides formosus
Globigerina hoterivica
Favuseila washitensis
Lenticulina modesta
Bathysiphon sp.
Haplophragmoides sp.
Saccammina sp.
Trochammina cf. H. spissum
Trochammina sp.
Calcareous indeterminate
Arenaceous indeterminate

ORGANICS
RADIOLARIA
GASTROPODS
PELECYPODS
ECHINOID REMAINS
OSTRACOD
DIATOMS
INOCERAMUS PRISMS
PLANT REMAINS

ENVIRONMENT
MARINE
NERITIC | BATHYAL
NONMARINE | INNER | MIDDLE | OUTER | UPPER | MIDDLE | LOWER | ABYSSAL

SYSTEM	SERIES	STAGE	ZONE	DEPTH	SAMPLE TYPE
UNDETERMINED	UNDETERMINED	UNDETERMINED	UNDETERMINED	3170-3200 3200-3230 3230 3260 3260-3290 3290-3320	1.
				3320-3350 3350-3380 3380-3410 3410-3440 3440-3460	
				3670-3900 3900-3930 3930-3960 3960-3990 3990-4020	
				4020-4050 4050-4080 4080-4110 4110-4140 4140-4170	
				4170-4200 4200-4230 4230-4260 4260-4290 4290-4320	
				4320-4350 4350-4380 4380-4410 4410-4440 4440-4470	
CRETACEOUS	UPPER CRETACEOUS	UND.	UND.	4470-4500 4500-4530 4530-4560 4560-4590 4590-4620	
		CENOMANIAN-TURONIAN	PROB. H	4620-4650 4650-4680 4680-4710 4710-4740 4740-4770	
		TURONIAN	H	4770-4800 4800-4830 4830-4860 4860-4890 4890-4920	
		UND.	UND.	4920-4950 4950-4980 4980-5010 5010-5040 5040-5070	
		CENOMANIAN-TURONIAN	H-I	5070-5100 5100-5130 5130-5160 5160-5190 5190-5220	
		ALBIAN-CENOMANIAN	J-I	5220-5250 5250-5280 5280-5310 5310-5340 5340-5370	
				5370-5400 5400-5430 5430-5460 5460-5490 5490-5520	
				5520-5550 5550-5580 5580-5610 5610-5640 5640-5670	
				5670-5700 5700-5730 5730-5760 5760-5790 5790-5820	
				5820-5850 5850-5880 5880-5910 5910-5940 5940-5970	
				5970-6000 6000-6030 6030-6060 6060-6090 6090-6120	
				6120-6150 6150-6180 6180-6210 6210-6240 6240-6270	
				6270-6300 6300-6330 6330-6360 6360-6390 6390-6420	
				6420-6450 6450-6480 6710-6740 6740-6770 6770-6800	
				6600-6630 6630-6660 6660-6690 6690-6920 6920-6950	
				6950-6980 6980-7010 7010-7040 7040-7070 7070-7100	
				7100-7130 7130-7160 7160-7190 7190-7220 7220-7250	
				7250-7280 7280-7310 7310-7340 7340-7370 7370-7400	
				7400-7430 7430-7460 7460-7490 7490-7520 7520-7550	
				7550-7580 7580-7610 7610-7640 7640-7670 7670-7700	
				7700-7730 7730-7760 7760-7790 7790-7820 7820-7850	
				7820-7850 7850-7880 7880-7910	

1. ALL DITCH SAMPLES

Compiled by
GREEN AND ASSOCIATES
Whittier, Ca.

KEY

- B - BARREN
- I - VERY RARE 1 INDIVIDUAL
- / - RARE 2-3 IND.
- X - RATHER RARE 4-10 IND.
- U - RATHER COMMON, 11-20 IND.
- C - COMMON, 21-50 IND.

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DONALD A. HULL, STATE GEOLOGIST

Oil and Gas Investigation 8
SUBSURFACE STRATIGRAPHY OF THE OCHOCO BASIN, OREGON.
G.G. THOMPSON
PLATE 6

TEXACO, INC.
LOGAN BUTTE UNIT 17-1
Section 17., T. 19 S., R. 20 E.
Crook County, Oregon

FORAMINIFERAL DISTRIBUTION

KEY

B – Barren, no specimens
I – Very rare, 1 specimen
/ – Rare, 2 – 3 specimens
X – Rather rare, 4 – 10 specimens
⊔ – Rather common, 11 – 20 specimens
C – Common, 20 – 50 specimens

Compiled by
GREEN AND
ASSOCIATES

AGE: SYSTEM | SERIES | STAGE | ZONE
DEPTH
FORAMINIFERA
ORGANICS
INORGANICS
ENVIRONMENT: NON-MARINE; MARINE: NERITIC (INNER, MIDDLE, OUTER), BATHYAL (UPPER, MIDDLE, LOWER), ABYSSAL

Gyroidinoides trulliiel
Marginulina texasensis
Marginulina bullata
Hoeglundina supracretacea
Gavelinella henbesti
Gavelinella cf. G. henbesti
Haplophragmoides cf. H. fraseri
Gaudryina sp.
Haplophragmoides sp.
Nodosaria sp.
Lenticulina modesta
Gaudryina rudita var. diversa
Bathysiphon californica
Haplophragmoides incognatus
Trochammina sp.
Silicosigmoilina californica
Gaudryina sp.
Heterohelix pulchra
Bathysiphon varans
Marssonella oxycona
Osangularia corderiana
Ammobaculites alexanderi
Haplophragmoides eggeri
Gyroidinoides nitida
Trochammina boehmi
Cribrostomoides cf. C. cretacea
Gavelinella eriksdalensis
Globorotalites michellanus
Stensioina pommerana
Globotruncana marginata
Dorothia sp.
Bathysiphon brosgei
Lenticulina davisi
Haplophragmoides kirki
Reophax prolatus
Dorothia retusa
Trochammina pilea
Haplophragmoides excavata
Textularia sp.
Marginulina sp.
Eggerella scabra
Vermulina muensteri
Trochammina texana
Spiroplectammina chicoana
Bulliminella colonensis
Dentalina stephensoni
Nodosaria spinifera
Nodosaria septemcostata
Marginulina curvisepta
Heterohelix rumseyensis
Rzehkina epigona
Lenticulina spissocostata
Globotruncana churchi
Bathysiphon vitta
Lenticulina sp.
Dorothia bulleta
Pullenia jarvisi
Stilostomella sp.
Saracenaria sp.
Gaudryina cf. G. tailleri
Pseudonodosaria manifesta
Globotruncana imbricata
Trochammina trifolia
Nodosaria cf. N. velascoensis
Rotalia bandyi
Dorothia sp.
Gyroidina sp.
Globotruncana arca
Heterohelix striata
Gaudryina pyramidata
Haplophragmoides obesus
Dentalina alternata
Globotruncana coronata
Heterohelix reussi
Haplophragmoides famosus
Globotruncana schneegansi
Orthokarstenia shasteensis
Epistomina sp.
Citharina sp.
Trochammina ribotonensis
Spiroplectammina sp.
Nodosaria probiscidea
Ammodiscus glabratus
Hedbergella archaocretacea
Furcisella washitensis
Gyroidinoides cretacea
Lenticulina pseudosecans
Hedbergella delrioensis
Gyroidina floralis
Trochammina wetteri
Gavelinella stephensoni
Arenobulimina cf. A. jarvisi
Gaudryina laevigata
Ammodiscus glabratus
Gyroidinoides infracretacea
Eponides foetterli
Saccammina sp.
Lenticulina cf. L. russiensis
Globotruncana sp.
Osangularia occidentalis
Globigerina hoterivica
Trochammina/Ioides cf. T. velascoensis
Asterorotalites cf. A. potandensis
Astacolus sp.
Vaginulina sp.
Spiroplectammina cretosa
Gavelinella andersoni
Gavelinella cf. G. dryceokensis
Praeglobotruncana sp.
Valvulineria sp.
Pseudonodosaria sp.
Gavelinella sp.
Lagenicella sp.
Bathysiphon sp.

ORGANICS: SHELL FRAGMENTS; INOCERAMUS PRISMS; ECHINOID SPINES; ARENACEOUS INDETERMINATE; RADIOLARIANS (PYRITIZED); FISH REMAINS; DIATOMS (PYRITIZED); RADIOLARIANS; OSTRACOD; ECHINOID REMAINS; GASTROPOD; PELECYPOA; DIATOMS

INORGANICS: VOLCANIC GLASS; PYRITE; MAGNETITE; CHERT; CALCAREOUS SPHERES; PYRITIZED RODS; DOUBLY TERMINATED QUARTZ

SYSTEM	SERIES	STAGE	ZONE	DEPTH
UNDETERMINED	UNDETERMINED	UNDETERMINED	UNDETERMINED	1690-1720, 1720-1750, 1750-1780, 1780-1810, 1810-1840
				1840-1870, 1870-1900, 1900-1930, 1930-1960, 1960-1990
				1990-2020, 2020-2050
			E ZONE ?	2050-2080, 2080-2110, 2110-2140
				2140-2170, 2170-2200, 2200-2230, 2230-2260, 2260-2290
			E ZONE	2290-2320, 2320-2350, 2350-2380, 2380-2410, 2410-2440
				2440-2470, 2470-2500, 2500-2530, 2530-2560, 2560-2590
		CAMPANIAN		2590-2620, 2620-2650, 2650-2680, 2680-2710, 2710-2740
			F ZONE	2740-2770, 2770-2800, 2800-2830, 2830-2860, 2860-2890
				2890-2920, 2920-2950, 2950-2980, 2980-3010, 3010-3040
				3040-3070, 3070-3100, 3100-3130, 3130-3160, 3160-3190
		TURONIAN - SANTONIAN	H - G1 (?)	3190-3220, 3220-3250, 3250-3280, 3280-3310, 3310-3340
				3340-3370, 3370-3400, 3400-3430, 3430-3460, 3460-3490
				3490-3520, 3520-3550, 3550-3580, 3580-3610, 3610-3640
		CENOMANIAN ?	I ZONE (?)	3640-3670, 3670-3700, 3700-3730, 3730-3760, 3760-3790
				3790-3820, 3820-3850, 3850-3880, 3880-3910, 3910-3940
				3940-3970, 3970-4000, 4000-4030, 4030-4060, 4060-4090
		ALBIAN - CENOMANIAN	J1 - I	4090-4120, 4120-4150, 4150-4180, 4180-4210, 4210-4240
		ALBIAN OR OLDER	J1 OR OLDER	4240-4270, 4270-4300, 4300-4330, 4330-4360, 4360-4390
				4390-4420, 4420-4450, 4450-4480, 4480-4510, 4510-4540
				4540-4570, 4570-4600, 4600-4630, 4630-4660, 4660-4690 B
				4690-4720 B, 4720-4750, 4750-4780 B, 4780-4810 B, 4810-4840 B
				4840-4870, 4870-4900, 4900-4930, 4930-4960, 4960-4990
				4990-5020, 5020-5050, 5050-5080 B, 5080-5110, 5110-5140
				5140-5170, 5170-5200, 5200-5230, 5230-5260 B, 5260-5290
				5290-5320 B, 5320-5350, 5350-5380 B, 5380-5410 B, 5410-5440
				5440-5470, 5470-5500, 5500-5530, 5530-5560, 5560-5590 B
				5590-5620, 5620-5650, 5650-5680, 5680-5710 B, 5710-5740 B
				5740-5770, 5770-5800 B, 5800-5830, 5830-5860 B, 5860-5890
				5890-5920 B, 5920-5950, 5950-5980, 5980-6010, 6010-6040 B
				6040-6070, 6070-6100 B, 6100-6130 B, 6130-6160 B, 6160-6190
				6190-6220 B, 6220-6250, 6250-6280, 6280-6310, 6310-6340
				6340-6370 B, 6370-6400, 6400-6430 B, 6430-6460 B, 6460-6490

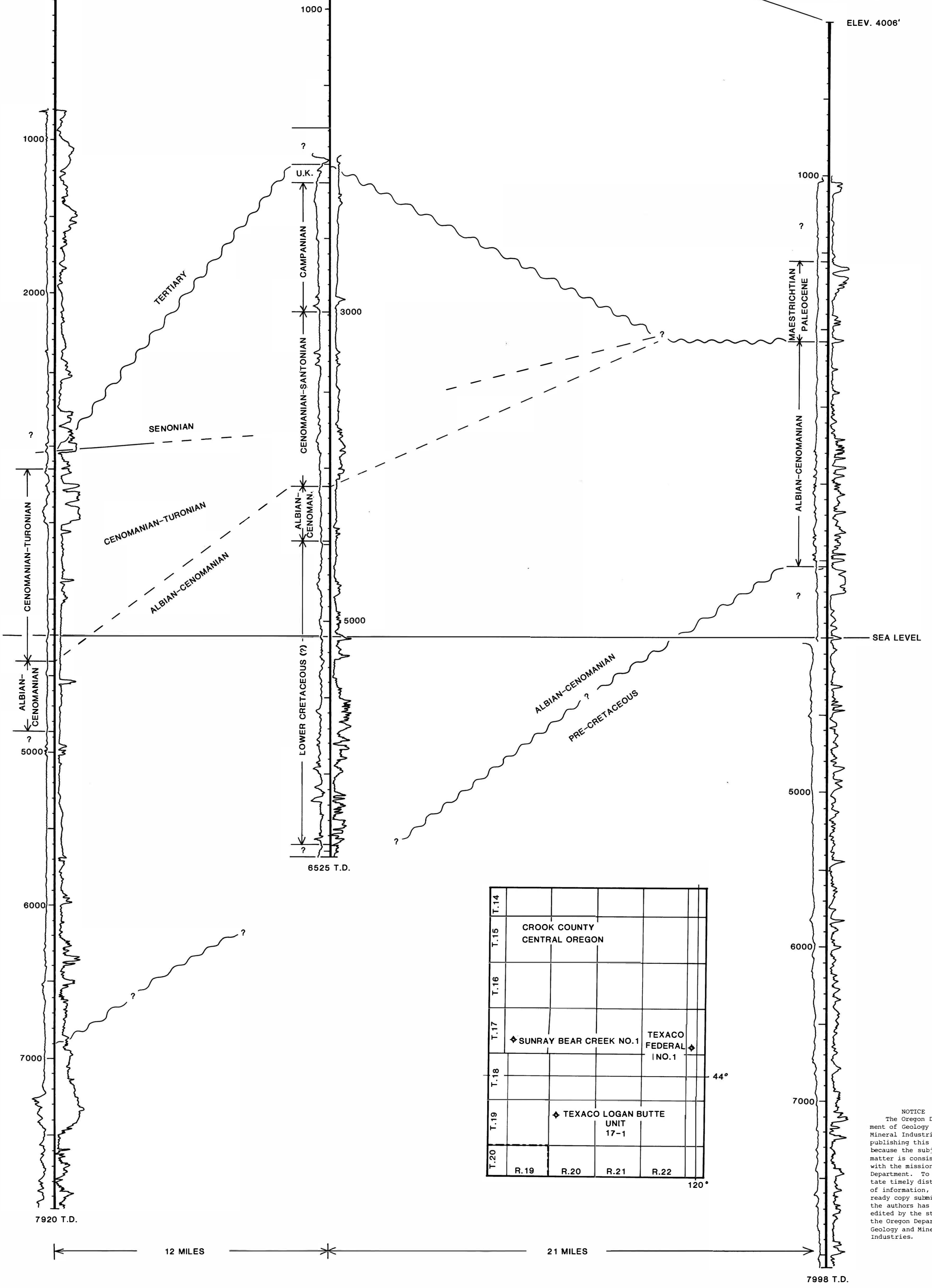
ENVIRONMENT: NON-MARINE 0 | MARINE: NERITIC — INNER 150' | MIDDLE 300' | OUTER 600' | BATHYAL — UPPER 2000' | MIDDLE 4000' | LOWER 8000' | ABYSSAL

Compiled by GREEN AND ASSOCIATES

STATE OF OREGON
DEPARTMENT OF GEOLOGY AND MINERAL INDUSTRIES
DONALD A. HULL, STATE GEOLOGIST

PALYNOLOGY CORRELATIONS, CRETACEOUS OF CENTRAL OREGON

Oil and Gas Investigation 8
SUBSURFACE STRATIGRAPHY OF THE OCHOCO BASIN, OREGON.
G.G. THOMPSON
PLATE 7



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