

MICROPALEO
CONSULTANTS, INC.

CHEVRON, USA

DIAMOND NO. 1 (OCS-Y-0996)

API #55-322-00001

QUAD NR04-01 BLOCK 620

CHUKCHI SEA, ALASKA

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BIOSTRATIGRAPHY REPORT

Job No. 22-113

July, 2003

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INTEGRATED SUMMARY

450-1320'

Early Cretaceous
Aptian to Albian

1320-4230'

Early Cretaceous
Probable Aptian

4230-4280'

Early Cretaceous
Barremian
KE_B

4280-4640'

Early Cretaceous
Hauterivian
KE_H

4640-4725'

Early Cretaceous
Valanginian
KE_v

Discussion. Paly finds no evidence for Valanginian age strata.

4725-5359'SW

Early Triassic
Undifferentiated

Discussion. Sadlerochit Group. Ivishak tops at 4725 feet and Kavik Fm. tops at 5311 feet.

Well site geologist reports a single *Monotis*? shell fragment in the sample from 4710-4740 feet, suggesting the possibility for 30' or less of Shublik Fm. just above this interval. No Shublik Fm. evidence was found in the paleo samples, however.

5359SW-5990'

Late Permian
Undifferentiated

Discussion. Echooka Fm. Trolld Fiord Fm. equivalent from the Sverdrup Basin. Probably equivalent to 16,890-17,100' interval in the Tunalik No. 1 well, but thicker.

5990-6750'T.D.

Probable Early Permian
Undifferentiated

Discussion. Uppermost Lisburne Limestone ("Wahoo" Fm.). "Unnamed A" Fm. or Belcher Channel Fm. equivalent from the Sverdrup Basin. Probably equivalent to 18,300-18,960' interval (in part) in the Tunalik No. 1 well.

FORAMINIFERA REPORT

Interpreted by
Michael B. Mickey

FORAMINIFERA SUMMARY

450-1320'

<u>Age.</u>	Early Cretaceous Aptian to Albian
<u>Zone.</u>	F-9
<u>Environment.</u>	Nonmarine to Inner Neritic (Alluvial Plain to Inner Shelf)

1320-4230'

<u>Age.</u>	Early Cretaceous Probable Aptian
<u>Zones.</u>	F-9 to F-11
<u>Environment.</u>	1320-2040': Inner to Middle Neritic (Inner to Middle Shelf) 2040-4230': Outer Neritic to Middle Bathyal (Outer Shelf to Middle Slope)

4230-4290'

<u>Age.</u>	Early Cretaceous Barremian
<u>Zone.</u>	F-12
<u>Environment.</u>	Distal (Starved Basin)

4290-4620'

<u>Age.</u>	Early Cretaceous Hauterivian
<u>Zone.</u>	F-13a
<u>Environment.</u>	Middle Neritic to Upper Bathyal (Middle Shelf to Upper Slope)

4620-4739.1'SW

<u>Age.</u>	Early Cretaceous Valanginian
<u>Zone.</u>	F-13b
<u>Environment.</u>	Middle to Outer Neritic (Middle to Outer Shelf)

4739.1SW-5350'

<u>Age.</u>	Probable Early Triassic Undifferentiated
<u>Zone.</u>	Probable F-20a
<u>Environment.</u>	Nonmarine to Marginal Marine (Alluvial Plain to Transitional)

<u>Discussion.</u>	Sadlerochit Group. Ivishak Fm. tops at 4740 feet and Kavik Fm. tops at 5320 feet. Well site geologist reports <i>Monotis?</i> shell fragment from sample at 4710-4740 feet, suggesting the possibility for 30' or less of Shublik Fm. just above this interval. No Shublik Fm. evidence was found in the paleo samples, however.
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5350-5990'

<u>Age.</u>	Late Permian Undifferentiated
<u>Zone.</u>	F-20b
<u>Environment.</u>	Marginal Marine (Transitional)
<u>Discussion.</u>	Echooka Fm. Troid Fiord Fm. equivalent from the Sverdrup Basin. Probably equivalent to 16,890-17,100' interval in the Tunalik No. 1 well, but thicker.

5990-6750'T.D.

<u>Age.</u>	Probable Early Permian Undifferentiated
<u>Zone.</u>	Probable F-21
<u>Environment.</u>	Shoaling Shelf (Lagoonal to Inner Bank)
<u>Discussion.</u>	Uppermost Lisburne Limestone ("Wahoo" Fm.). "Unnamed A" Fm. or Belcher Channel Fm. equivalent from the Sverdrup Basin. Probably equivalent to 18,300-18,960' interval (in part) in the Tunalik No. 1 well.

INTRODUCTION

Scope

Data from 225 Foraminifera samples from the Chevron, USA Diamond No. 1 (OCS-Y-0996) well were incorporated into this report. These consisted of 204 ditch and 21 sidewall core samples covering the interval 450 to 6750 feet total depth. This work was done as part of M.C.I. Job Number 22-113.

Procedures

Standard techniques were used to process the material. All samples were boiled in Quaternary-O and washed over 20 and 200 mesh screens. Frequency symbols correspond to the following numerical values: very rare (1), rare (2 - 4), frequent (5 -25), common (26 - 100), abundant (101 - 999) and prolific (1000+). The picked foram slides and residues are repositied at the State of Alaska Geological Materials Center in Eagle River, Alaska.

Certain factors such as shelf widths, basin configuration and overall basin depths associated with Arctic Mesozoic basins are not completely understood at present. The paleoenvironments presented in this report reflect relative basinal position only and should not be tied to specific water depths. Generally, neritic corresponds to shelf or deltaic environments, while bathyal corresponds to slope or prodelta environments and bathyal (starved basin) corresponds to distal (far from the source) deposition. As an example, prodelta deposits could represent deposition as shallow as middle neritic or as deep as bathyal (slope) depending on the delta type and shelf width. With a narrow shelf, a river-dominated deltaic system could build across the shelf and the prodelta deposits would be in a bathyal (slope) depth. A tide-dominated deltaic system associated with a wide shelf could result in middle neritic prodelta deposition.

Format

A listing of the age, environment, fauna and occasional lithology comments for each biostratigraphic interval follows. A generalized summary of the well is presented in the Conclusions section at the end of the Foraminifera Report. A Foraminifera Distribution Chart (Figures F-1) and a High Resolution Biostratigraphy Plot (Figure B-1) containing foram diversity/abundance plots, a cumulative faunal plot and paleoenvironmental plot(s) are in pockets at the back of this report.

RESULTS

450-1320'

Age.

Early Cretaceous
Aptian to Albian

Zone.

F-9

Environment.

Nonmarine to Inner Neritic
(Alluvial Plain to Inner Shelf)

Fauna.

Haplophragmoides linki, *H. topagorukensis*, *H. gigas*, *H. excavatus*, *Trochammina rainwateri*, *Saracenaria projectura*, *Saccamina lathrami*, *Miliammina manitobensis*, *Uvigerinammina athabascensis*, *Ammobaculites wenonahae*, megaspores, pyrite, coal, and frequent tar above 690 feet.

1320-4230'

<u>Age.</u>	Early Cretaceous Probable Aptian
<u>Zones.</u>	F-9 to F-11
<u>Environment.</u>	1320-2040': Inner to Middle Neritic (Inner to Middle Shelf) 2040-4230': Outer Neritic to Middle Bathyal (Outer Shelf to Middle Slope)
<u>Fauna.</u>	<i>Verneuilinoides borealis</i> , <i>Haplophragmoides kirki</i> , <i>H. linki</i> , <i>H. topagorukensis</i> , <i>H. excavatus</i> , <i>H. gigas</i> , <i>Lenticulina macrodisca</i> , <i>Hippocrepina</i> cf. <i>barksdalei</i> , <i>Ammodiscus</i> sp. (very small, very thin), <i>Bathysiphon vitta</i> , <i>Conorboides umiatensis</i> , <i>Gaudryina nanushukensis</i> , <i>G. barrowensis</i> , <i>Ammobaculites wenonahae</i> , <i>Saccamina lathrami</i> , <i>Glomospira corona</i> , <i>Ditrupa cornu</i> , megaspores, coal, pyrite, tar, rare to frequent pyritized radiolaria below 3660 feet, rare scattered paper shale below 3720 feet, and rare oil? staining below 3900 feet.

4230-4290'

<u>Age.</u>	Early Cretaceous Barremian
<u>Zone.</u>	F-12
<u>Environment.</u>	Distal (Starved Basin)
<u>Fauna.</u>	Very rare <i>Haplophragmoides duoflatis</i> , <i>H. excavatus</i> and <i>Bathysiphon vitta</i> . Frequent to common pyritized radiolaria. Rare to frequent pyrite, frequent to common paper shale and frequent rounded frosted quartz floating sand grains.

4290-4620'

<u>Age.</u>	Early Cretaceous Hauterivian
<u>Zone.</u>	F-13a
<u>Environment.</u>	Middle Neritic to Upper Bathyal (Middle Shelf to Upper Slope)
<u>Fauna.</u>	<i>Haplophragmoides duoflatis</i> , <i>H. coronis</i> , <i>Ammobaculites erectus</i> , <i>A. reophacoides</i> , <i>Bathysiphon scintillata</i> , arenaceous spp. (large, coarse), <i>Thuramminoides</i> sp., <i>Trochamminoides</i> sp. (small, thin), <i>Gaudryina tailleuri</i> , <i>Marginulinopsis collinsi</i> , <i>Pseudobolivina rayi</i> , <i>Gavelinella barremiana</i> , <i>Lenticulina muensteri</i> , <i>Glomospirella arctica</i> , <i>Glomospira subarctica</i> , megaspores, <i>Inoceramus</i> prisms, pyrite, frequent to common pyritized radiolaria including rare <i>Lithocampe</i> sp. N in the top sample, and frequent to abundant rounded frosted quartz floating sand grains.

4620-4739.1'SW

<u>Age.</u>	Early Cretaceous Valanginian
<u>Zone.</u>	F-13b
<u>Environment.</u>	Middle to Outer Neritic (Middle to Outer Shelf)
<u>Fauna.</u>	<i>Globulina prisca</i> , <i>Quinqueloculina</i> sp. 2, <i>Ammobaculites erectus</i> , <i>Haplophragmoides goodenoughensis</i> , <i>H. coronis</i> , <i>H. inflatigrandis</i> , <i>H. duoflatis</i> , arenaceous spp. (large, coarse), <i>Lenticulina muensteri</i> , <i>L.</i> sp. (raised sutures), <i>Praebulimina</i> sp. 2, <i>Glomospirella</i> sp. S, <i>Gaudryina milleri</i> , <i>G. tailleuri</i> , <i>Trochammina conicomina</i> , <i>T. squamata</i> , <i>Glomospira subarctica</i> , pyrite and frequent to common rounded frosted quartz floating sand grains.

4739.1SW-5350'

<u>Age.</u>	Probable Early Triassic Undifferentiated
<u>Zone.</u>	Probable F-20a
<u>Environment.</u>	Nonmarine to Marginal Marine (Alluvial Plain to Transitional)
<u>Fauna.</u>	Cornuspirids, <i>Ammodiscus</i> sp. P, spines, ostracods, pelmatozoan fragments, pyrite, coal, tar, rare to frequent? pyritized radiolaria, and very rare to rare glauconite in and below the sidewall core at 5293.1 feet.
<u>Discussion.</u>	Sadlerochit Group. Ivishak Fm. tops at 4740 feet and Kavik Fm. tops at 5320 feet. Well site geologist reports <i>Monotis?</i> shell fragment from sample at 4710-4740 feet, suggesting the possibility for 30' or less of Shublik Fm. just above this interval. No Shublik Fm. evidence was found in the paleo samples, however.

5350-5990'

<u>Age.</u>	Late Permian Undifferentiated
<u>Zone.</u>	F-20b
<u>Environment.</u>	Marginal Marine (Transitional)
<u>Fauna.</u>	Cornuspirids, archaediscids, <i>Paleoaplysina</i> sp., <i>Gaudryina</i> sp., prismatic shell fragments, productid spines, ostracods, spicules, coral wall debris and rare to common glauconite.
<u>Discussion.</u>	Echooka Fm. Trolld Fiord Fm. equivalent from the Sverdrup Basin. Probably equivalent to 16,890-17,100' interval in the Tunalik No. 1 well, but thicker.

5990-6750'T.D.

<u>Age.</u>	Probable Early Permian Undifferentiated
<u>Zone.</u>	Probable F-21
<u>Environment.</u>	Shoaling Shelf (Lagoonal to Inner Bank)
<u>Fauna.</u>	<i>Pseudoglomospira</i> sp., <i>Trepeilopsis</i> sp., <i>Globivalvulina</i> sp., <i>G. bulloides</i> , <i>Volvotextularia mississippiana</i> , <i>Monotaxinoides multivolutus</i> , <i>Earlandia elegans</i> , <i>Biseriella parva</i> , cornuspirids, <i>Priscella prisca</i> , <i>Profusulinella</i> sp., <i>Zellerina</i> sp., <i>Millerella pressa</i> , <i>Tetrataxis</i> sp., glomospirids (large, thick walled), <i>Protonodosaria</i> sp., <i>Paleoaplysina</i> sp., <i>Asphaltina</i> sp., coral wall debris, ostracods, pelmatozoan fragments, spines and rare glauconite.
<u>Discussion.</u>	Uppermost Lisburne Limestone ("Wahoo" Fm.). "Unnamed A" Fm. or Belcher Channel Fm. equivalent from the Sverdrup Basin. Probably equivalent to 18,300-18,960' interval (in part) in the Tunalik No. 1 well.

CONCLUSIONS

The Chevron, USA Diamond No. 1 (OCS-Y-0996) well penetrated the following biostratigraphic sequence based on foraminiferal analysis:

- 4170+ feet (450-4620') of Hauterivian to Aptian and/or Albian age (Early Brookian & Beaufortian - Rift Sequence) alluvial plain to middle? or outer? shelf topsets.
- 1370 feet (4620-5990') of Late Permian to Early Triassic age (Late Ellesmerian) alluvial plain to transitional clastics.
- 760+ feet (5990-6750'T.D.) of Early Permian age (Early Ellesmerian) shoaling shelf (lagoonal) calcilutites interbedded with (inner bank) packstones and wackestones.

REFERENCES

Beauchamp, B., Harrison, J.C. and Henderson, C. M., 1989. Upper Paleozoic stratigraphy and basin analysis of the Sverdrup Basin, Canadian Arctic Archipelago: Part 1, time frame and tectonic evolution. *In*: Current Research, Part G, Geological Survey of Canada, Paper 89-1 G, pp. 105-113.

_____, 1989. Upper Paleozoic stratigraphy and basin analysis of the Sverdrup Basin, Canadian Arctic Archipelago: Part 2, transgressive-regressive sequences. *In*: Current Research, Part G, Geological Survey of Canada, Paper 89-1 G, pp. 115-124.

PALYNOLOGY REPORT

Interpreted by:

Hideyo Haga

PALYNOLOGY SUMMARY

450-4200'

<u>Age.</u>	Early Cretaceous Aptian - Early Albian
<u>Zone.</u>	P-M18
<u>Environment.</u>	Marginal Marine

4200-4560'

<u>Age.</u>	Early Cretaceous Barremian - Aptian
<u>Zone.</u>	P-M18a
<u>Environment.</u>	Marine

4560-4739.1'SW

<u>Age.</u>	Early Cretaceous Hauterivian
<u>Zone.</u>	P-M19
<u>Environment.</u>	Marine

4739.1SW-5359'SW

<u>Age.</u>	Early Triassic Undifferentiated
<u>Zones.</u>	P-T17 to P-T16
<u>Environment.</u>	Marine
<u>Remarks.</u>	Palynomorph evidence indicates Kavik Fm. tops at about 5320 feet.

5359SW-5990'

<u>Age.</u>	Permian Undifferentiated
<u>Zone.</u>	P-T18
<u>Environment.</u>	Marginal Marine? - Nonmarine

5990-6750'T.D.

<u>Age.</u>	Pennsylvanian - Early Permian Undifferentiated
<u>Zones.</u>	P-T19 to P-T18
<u>Environment.</u>	Nonmarine - Marginal Marine?
<u>Remarks.</u>	Essentially barren of marine palynomorphs.

INTRODUCTION

Purpose and Scope

Micropaleo Consultants, Inc. (M.C.I.) conducted palynological analyses on a total of 144 samples from the Chevron, USA Diamond No. 1 (OCS-Y-0996) well. This total consisted of 123 ditch-cutting composites and 21 sidewall core samples taken between 450 feet and the total depth of 6750 feet.

In this report, data from 38 ditch samples that were prepared for a later study have been included.

Kerogen maturation analyses were also conducted on selected samples. These analyses included Thermal Alteration Index (T.A.I.) estimates on 19 samples and Vitrinite Reflectance (V.R.) measurements on 10 samples.

This report provides an updated format for these data.

Procedures

The samples were processed with standard palynologic techniques using hydrochloric, hydrofluoric and nitric acid treatments. Sonification, a heavy liquid separation and a sieving/panning technique further concentrated the resultant kerogen residues. Permanent palynology slide mounts were made for each sample.

The kerogen maturation samples were processed without the nitric acid treatment. Permanent slide mounts were made for the T.A.I. samples. Some of the dried kerogen was formed into polyester resin "plugs" that were then polished for V.R. measurements.

As each palynology slide was examined, an estimate of abundance for each palynomorph taxon was recorded in a microcomputer. These data form the basic elements of the species distribution chart.

Based on the palynomorph assemblages observed, an age and environment of deposition are interpreted for the palynostratigraphic subdivision. The environments, as interpreted from the palynological preparations, are merely categorized as nonmarine, marginal marine or marine. These categories are based on the absence or presence and diversity of microplankton cysts.

Report Format

The following Results section gives the age, environment of deposition and significant palynomorphs. This is an expansion of the brief Summary at the beginning of this report. Following the Results are general comments in the Conclusion section. The last section of the report is the Kerogen Maturation Analyses.

The Palynomorph Distribution Chart (Figure P-1) lists the occurrence and abundance of recorded taxa in each sample. Included on this chart are the diversity and abundance curves for the spore-pollen and the microplankton cysts.

High Resolution Biostratigraphy Plots - Foraminifera/Palynomorphs (Figure B-1) are also provided. This chart includes additional palynology parameters in the form of a cumulative plot that illustrates the relative abundance of the nonmarine, marine and miscellaneous palynomorph components.

RESULTS

450-4200'

<u>Age.</u>	Early Cretaceous Aptian to Early Albian
<u>Zone.</u>	P-M18
<u>Environment.</u>	Marginal Marine
<u>Palynomorphs.</u>	<p>The Aptian - Early Albian interval is characterized by a generalized Early Cretaceous palynomorph assemblage. The nonmarine forms include <i>Cicatricosisporites</i>, bisaccate pollen, <i>Lycopodiumsporites</i> and <i>Osmundacidites</i>. Consistent occurrences of reworked Paleozoic spores and some Triassic pollen were also noted.</p> <p>The dinocyst assemblage includes <i>Cyclonephelium distinctum</i>, <i>Odontochitina operculata</i> and <i>Oligosphaeridium complex</i>. Scattered, single specimens of reworked Jurassic and Neocomian species were recorded.</p>
<u>Discussion.</u>	The abundance of reworked palynomorphs in these Early Cretaceous strata is typical of the Nanushuk/Torok units.

4200-4560'

<u>Age.</u>	Early Cretaceous Barremian to Aptian
<u>Zone.</u>	P-M18a
<u>Environment.</u>	Marine
<u>Palynomorphs.</u>	The Barremian - Aptian section is marked by the increase in abundance of dinocysts. The dominant forms include <i>Cyclonephelium distinctum</i> , <i>Gardodinium trabeculosum</i> , <i>Odontochitina operculata</i> and <i>Oligosphaeridium complex</i> . Also consistent in this section is the acritarch <i>Micrhystridium</i> sp. A.
<u>Discussion.</u>	This interval is associated with relatively abundant amorphous organics.

4560-4739.1'SW

<u>Age.</u>	Early Cretaceous Hauterivian
<u>Zone.</u>	P-M19
<u>Environment.</u>	Marine
<u>Palynomorphs.</u>	The Hauterivian interval is marked by the common occurrence of <i>Oligosphaeridium complex</i> (thick-wall), and the appearance of <i>Florentinia cooksoniae</i> , <i>Imbatodinium micropodum</i> , <i>Protoellipsodinium spinigerum</i> and <i>Pseudoceratium nudum</i> . Other marker species that were recorded as sloughed specimens below this interval were <i>Herendeenia alaskaensis</i> , <i>Imbatodinium longicornutum</i> and <i>Tubotuberella uncinata</i> .
<u>Discussion.</u>	There was no palynomorph evidence to support the presence of Valanginian age strata.

4739.1SW-5359'SW

<u>Age.</u>	Early Triassic Undifferentiated
<u>Zones.</u>	P-T17 to P-T16
<u>Environment.</u>	Marine
<u>Palynomorphs.</u>	<p>The Early Triassic interval is characterized by consistent occurrences of the striated bisaccate forms <i>Striatites richteri</i> and <i>Taeniaesporites</i> spp. Other significant forms include <i>Aratrisporites</i> sp., <i>Dulhuntyispora minuta</i>, <i>Kraeuselisporites</i> spp., <i>Lueckisporites</i> sp., <i>Lundbladispora</i> sp. and <i>Punctatisporites</i> spp.</p> <p>Common to this interval are the marine acritarch forms <i>Micrhystridium</i> and <i>Veryhachium</i>.</p>
<u>Discussion.</u>	<p>The section below 5311 feet is equated to the Kavik Fm. The associated spore-pollen assemblage is, as seen here, typically more diverse than the overlying Ivishak Fm. assemblage.</p>

5359SW-5990'

<u>Age.</u>	Permian Undifferentiated
<u>Zone.</u>	P-T18
<u>Environment.</u>	Marginal Marine? to Nonmarine
<u>Palynomorphs.</u>	<p>The Permian interval is separated by the appearance of <i>Vittatina</i>. Other accompanying forms are <i>Cycadopites</i>, <i>Crustaesporites</i> and many striated bisaccate forms.</p> <p>The acritarch species show a decline in occurrence. This suggests a decrease in marine influences through the interval.</p>
<u>Discussion.</u>	<p>This interval probably includes all or part of the <i>Limitisporites monstruosus</i> - <i>Vittatina costabilis</i> and <i>Weylandites striatus</i> - <i>Protohaploxypinus perfectus</i> assemblage zones reported by Utting (1989). These zones range from the Asselian to Artinskian (Early Permian) stages.</p>

5990-6750'T.D.

<u>Age.</u>	Pennsylvanian to Early Permian Undifferentiated
<u>Zones.</u>	P-T19 to P-T18
<u>Environment.</u>	Nonmarine to Marginal Marine?
<u>Palynomorphs.</u>	<p>The occurrences of <i>Cordaitina</i> sp., <i>Potonieisporites</i> cf. <i>P. novicus</i> and <i>Vittatina</i> spp. mark this interval. Other accompanying forms are <i>Cycadopites</i>, <i>Crustaesporites</i> and many striated bisaccate forms.</p> <p>The sidewall cores recovered rare acritarchs and, thus, indicate that these strata were deposited in essentially nonmarine to possibly marginal marine conditions.</p>
<u>Discussion.</u>	This assemblage is equated to the <i>Potonieisporites</i> - <i>Vittatina</i> assemblage zone of Utting (1989) which encompasses the Gzhelian to Asselian (Late Pennsylvanian - Early Permian) stages.

CONCLUSIONS

Palynological analysis of the Chevron, USA Diamond No. 1 (OCS-Y-0996) well provides the following palynostratigraphic subdivisions:

- Marginal marine strata of Aptian - Early Albian age occur between 450 feet and 4200 feet.
- Marine strata of Barremian - Aptian age occur between 4200 feet and 4560 feet.
- Marine strata of Hauterivian age are present from 4560 feet to 4739.1SW feet.
- No palynomorph evidence was recovered to support the presence of Valanginian age strata.
- Marine Early Triassic strata are recognized between 4739.1SW feet and 5359SW feet.
- Marginal marine? and nonmarine Permian age strata are seen from 5359SW feet to 5990 feet. The assemblage probably correlates, at least in part, to the Early Permian assemblage zones reported by Utting (1989).
- Nonmarine and marginal marine? strata of Pennsylvanian and Early Permian age are present from 5990 feet to the total depth of 6750 feet. The assemblage here is equated to the Late Pennsylvanian - Early Permian assemblage zone of Utting (1989).

REFERENCE

- Utting, J., 1989. Preliminary palynological zonation of surface and subsurface sections of Carboniferous, Permian and lowest Triassic rocks, Sverdrup Basin, Canadian Arctic Archipelago: Geol. Survey Canada, Paper 89-1G, pp. 233-240.

KEROGEN MATURATION REPORT

Interpreted by:

Hideyo Haga

KEROGEN MATURATION **(T.A.I. - VITRINITE REFLECTANCE)**

Maturation levels of the kerogen residues from the Chevron, USA Diamond No. 1 (OCS-Y-0996) well were determined by visual methods, Thermal Alteration Index (T.A.I.) estimates and by Vitrinite Reflectance (V.R.) measurements. A chart correlating the scales of the two methods with hydrocarbon generation is given in Figure 1.

Thermal Alteration Index

Nineteen (19) T.A.I. samples were prepared and analyzed. The sample composites were selected at intervals of about 270 feet.

The T.A.I. and percentage estimates for the major organic constituents are presented in Table I. A generalized organic classification scheme is used here, but the terminology employed may be equated to the following categories:

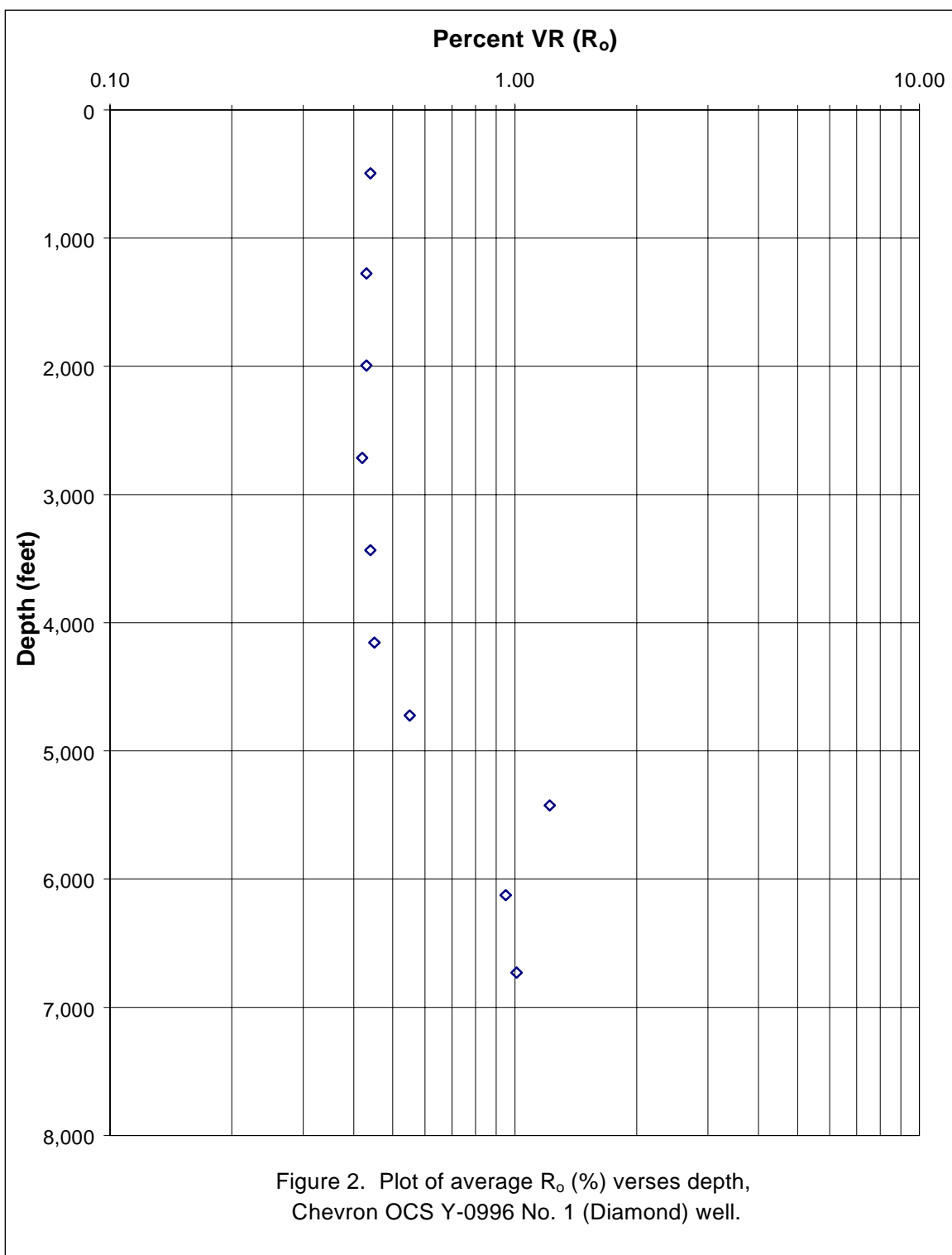
■	Amorphous	=	Alginite	=	Type I
■	Herbaceous	=	Exinite	=	Type II
■	Woody	=	Vitrinite	=	Type III
■	Fusinitic	=	Inertnite	=	Type IV

The T.A.I. estimates suggest that mature levels of thermal maturation were encountered below 4400 feet. This places the uppermost part of the mature strata in the Neocomian section.

The organic constituents are rich in oil prone material between about 4400 feet and 4700 feet. The sample at 5700 feet consists largely of amorphous organics deemed to be sloughed.

COALIFICATION (ASTM)	HYDROCARBON GENERATION		TRANSMITTED LIGHT		REFLECTED LIGHT VR (% Ro)
			SPORE-POLLEN COLORATION	TAI	
PEAT	IMMATURE	BIOGENIC GAS	GREENISH-YELLOW	1.4	0.2
LIGNITE SOFT BROWN COAL		EARLY DRY GAS			
LIGNITE HARD	TRANSITION	WET GAS	PALE YELLOW	2.0	0.3
SUBBITUMINOUS					0.4
BITUMINOUS HIGH	MATURE	OIL WINDOW	AMBER YELLOW	2.5	0.5
				2.6	0.6
					0.8
	TRANSITION	CONDENSATE	RED BROWN - BROWN	2.8	
				3.0	1.3
BITUMINOUS LOW	SUPRAMATURE	GAS ↓ DRY	DARK BROWN	3.5	1.5
			BROWN BLACK- BLACK	3.7	2.0
				4.0	2.5
					3.0
					4.0
				5.0	5.0
SEMIGRAPHITE					

Figure 1. Correlation of Thermal Alteration Index (TAI) and Vitrinite Reflectance (VR) values to hydrocarbon generation. Modified from Heroux, Y., Chagnou, A. and Bertrand, R., (1979).



Vitrinite Reflectance

A Leitz MPV-II photometer system and Leitz Orthoplan microscope were used to make the V.R. measurements. This equipment was integrated with a desktop computer for data recording and manipulation.

Ten samples were used for V.R. (R_o) measurements. Two samples provided sparse vitrinite and the average R_o values are questionable.

The individual V.R. measurements, histogram plots and calculated averages are given in the Appendix. The average V.R. values of the measured samples are also included in Table I. Figure 2 is a graphic display of the average V.R. for each sample in a semi-log plot.

The V.R. averages are in general agreement with the T.A.I. estimates in the Cretaceous strata.

An abrupt shift to higher V.R. averages across the Cretaceous/Permian contact is obvious. The two unquestioned V.R. averages in the Pennsylvanian - Early Permian strata are higher than the T.A.I. estimates. The V.R. measurements indicate that the Paleozoic section is nearing overmature levels.

Chevron OCS Y-0996 #1 (Diamond)

	SAMPLE (Feet)	TAI	KEROGEN TYPES (%)			VR (Avg Ro)	REMARKS	
			A	H	W-F			
1	450-540	2.3	-	30	70	0.44		
2	810-960	2.3	-	20	80			
3	1230-1320	2.3	-	10	90	0.43		
4	1590-1880	2.3	-	10	90			
5	1950-2040	2.3	-	20	80	0.43		
6	2310-2400	2.3	-	30	70	0.42		
7	2370-2760	2.3	-	50	50			
8	3030-3120	2.3	10	40	50	0.44		
9	3390-3480	2.3	T	40	60			
10	3750-3840	2.3	30	20	50			
11	4110-4200	2.3	10	40	50	0.45	Sparse vitrinite	
12	4410-4440	2.3-2.5	40	20	40	0.55?		
13	4710-4740	2.3-2.5	40	10	50			
14	5110-5140	2.5	T	50	50	1.22?		
15	5410-5440	2.5+	10	10	80			Very large deviation
16	5700-5740	2.5+	60	10	30	0.95	Large deviation	
17	6110-6140	2.5+	-	10	90			
18	6410-6440	2.5+	-	10	90			
19	6710-6750TD	2.5+	-	10	90	1.01		

A = amorphous, H = herbaceous (includes palynomorphs), W-F = woody-fusinitic, T = trace

TABLE 1 Thermal Alteration Index (TAI), percent of kerogen types, and Vitrinite Reflectance (VR).

REFERENCE

Heroux, Y., Chagnou, A. and Bertrand, R., 1979. Compilation and correlation of major thermal maturation indicators: Bull. Am. Assoc. Petr. Geol., 63: pp. 2128-2144.

APPENDIX

VITRINITE REFLECTANCE DATA

Chevron OCS Y-0996 #1 (Diamond)

Sample Depth: 450-540'

VR Measurements:

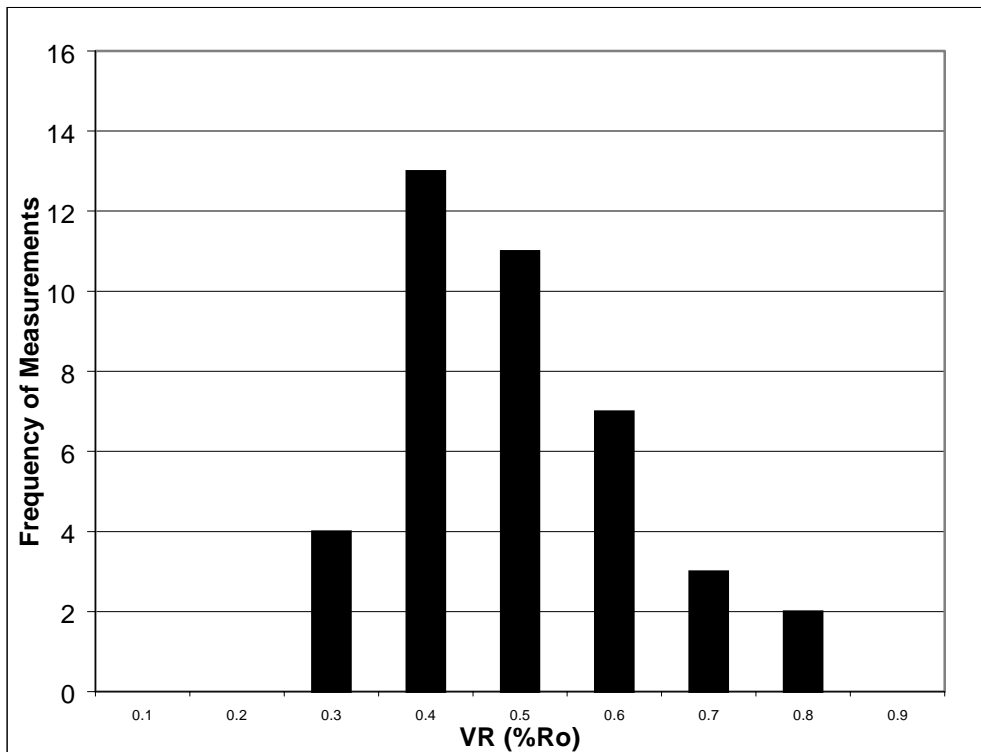
0.23	0.34	0.43	0.53
0.25	0.35	0.43	0.54
0.28	0.35	0.45	0.55
0.29	0.36	0.46	0.56
0.33	0.36	0.46	0.57
0.33	0.36	0.46	0.60
0.33	0.37	0.46	0.62
0.33	0.40	0.47	0.68
0.34	0.40	0.50	0.70
0.34	0.42	0.51	0.73

Number of meas: 40

Median: 0.43

Average: 0.44

Stand. Dev: 0.12



Chevron OCS Y-0996 #1 (Diamond)

Sample Depth: 1230-1320'

VR Measurements:

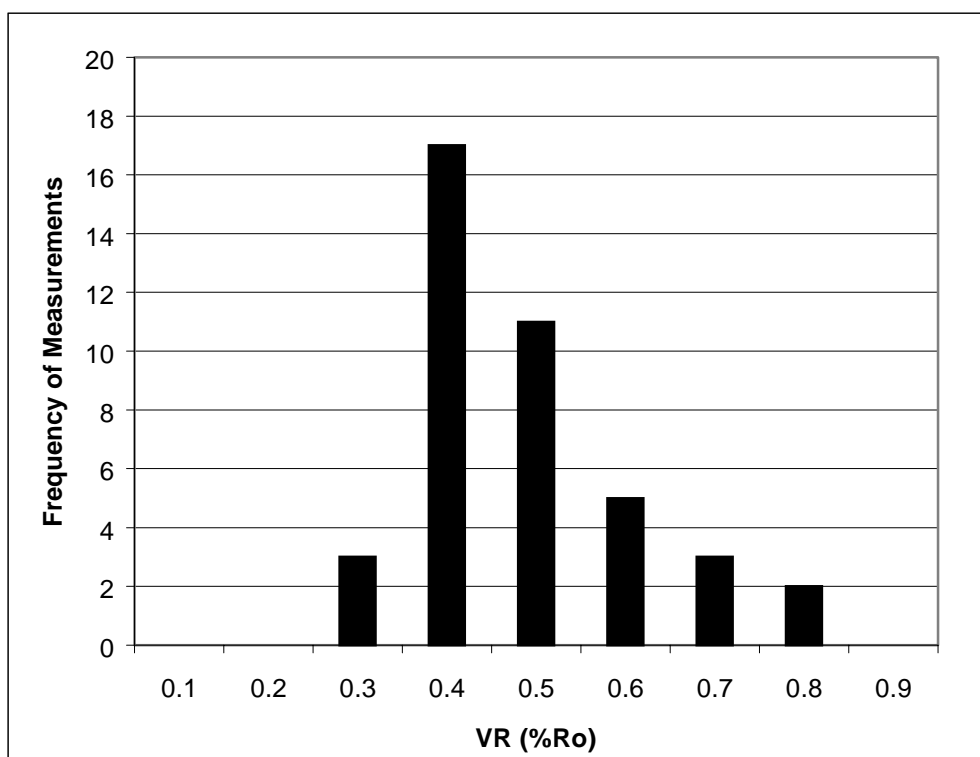
0.26	0.35	0.40	0.48	0.72
0.28	0.35	0.40	0.50	
0.28	0.35	0.40	0.50	
0.31	0.36	0.41	0.52	
0.31	0.37	0.41	0.56	
0.32	0.37	0.42	0.58	
0.32	0.38	0.42	0.62	
0.33	0.38	0.43	0.66	
0.33	0.39	0.43	0.69	
0.34	0.39	0.44	0.71	

Number of meas: 41

Median: 0.40

Average: 0.43

Stand. Dev: 0.12



Chevron OCS Y-0996 #1 (Diamond)

Sample Depth: 1950-2040'

VR Measurements:

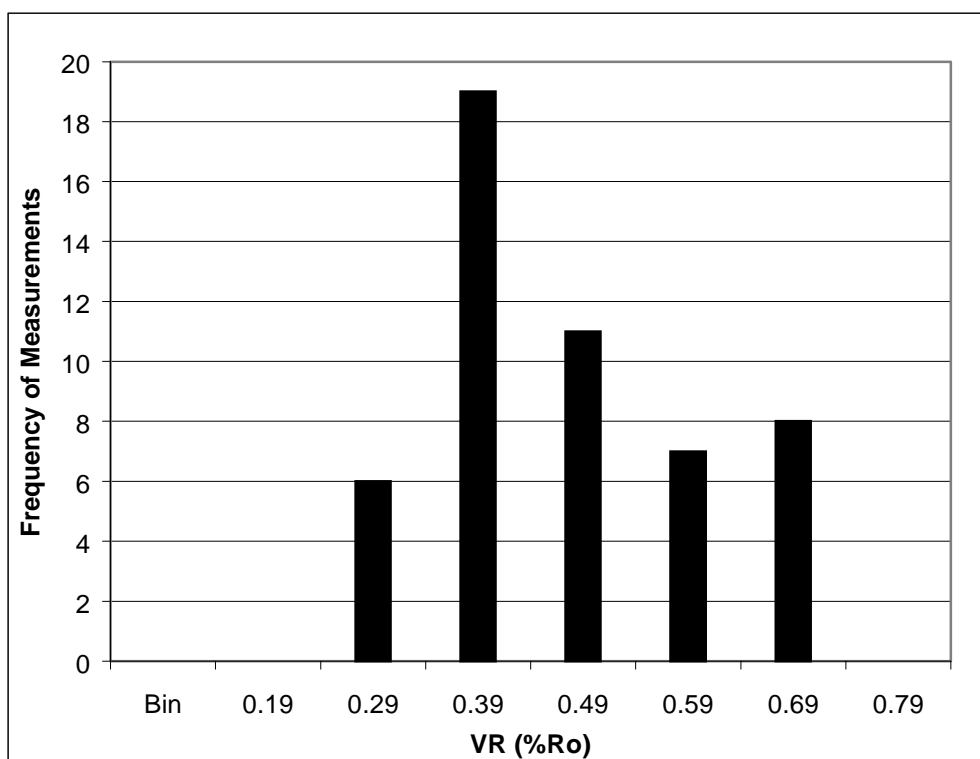
0.23	0.32	0.36	0.45	0.54	0.69
0.24	0.32	0.37	0.45	0.56	
0.24	0.32	0.37	0.47	0.59	
0.26	0.33	0.38	0.47	0.60	
0.29	0.33	0.39	0.48	0.64	
0.29	0.34	0.40	0.49	0.65	
0.30	0.34	0.40	0.50	0.65	
0.30	0.35	0.42	0.50	0.66	
0.30	0.35	0.43	0.51	0.68	
0.32	0.36	0.45	0.51	0.69	

Number of meas: 51

Median: 0.40

Average: 0.43

Stand. Dev: 0.13



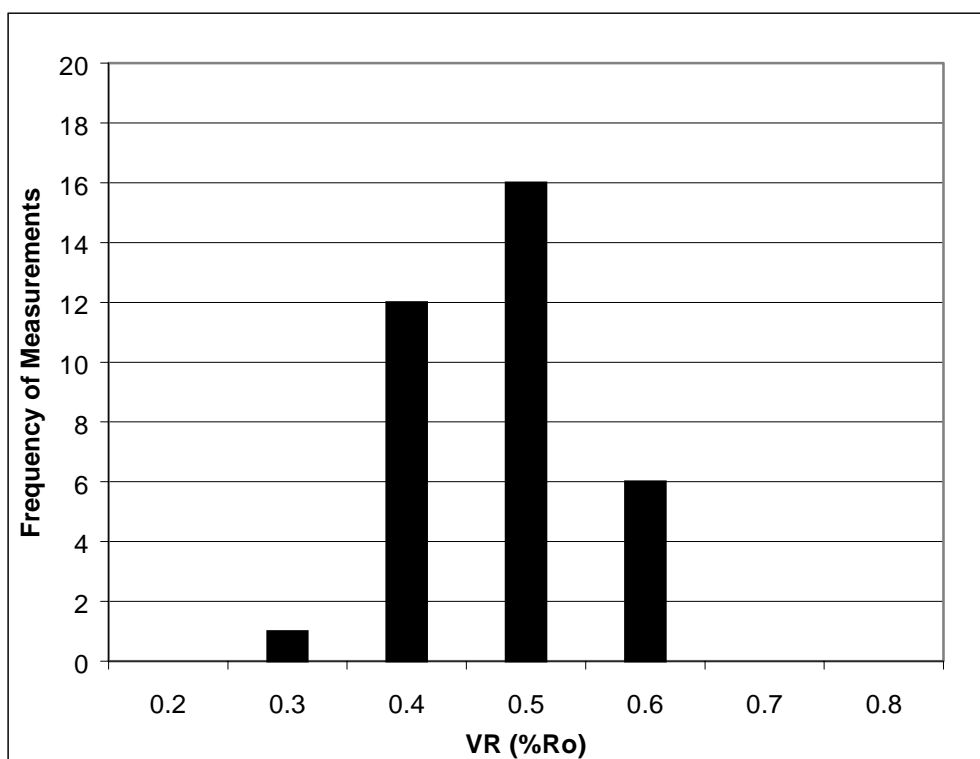
Chevron OCS Y-0996 #1 (Diamond)

Sample Depth: 2670-2760'

VR Measurements:

0.28	0.38	0.44	0.50	
0.33	0.38	0.45	0.51	
0.34	0.38	0.45	0.52	
0.34	0.40	0.46	0.53	
0.35	0.40	0.47	0.58	
0.35	0.40	0.48		
0.36	0.41	0.48		
0.36	0.43	0.48		
0.37	0.44	0.49		
0.37	0.44	0.50		

Number of meas: 35 **Median:** 0.43
Average: 0.42 **Stand. Dev:** 0.07



Chevron OCS Y-0996 #1 (Diamond)

Sample Depth: 3390-3480'

VR Measurements:

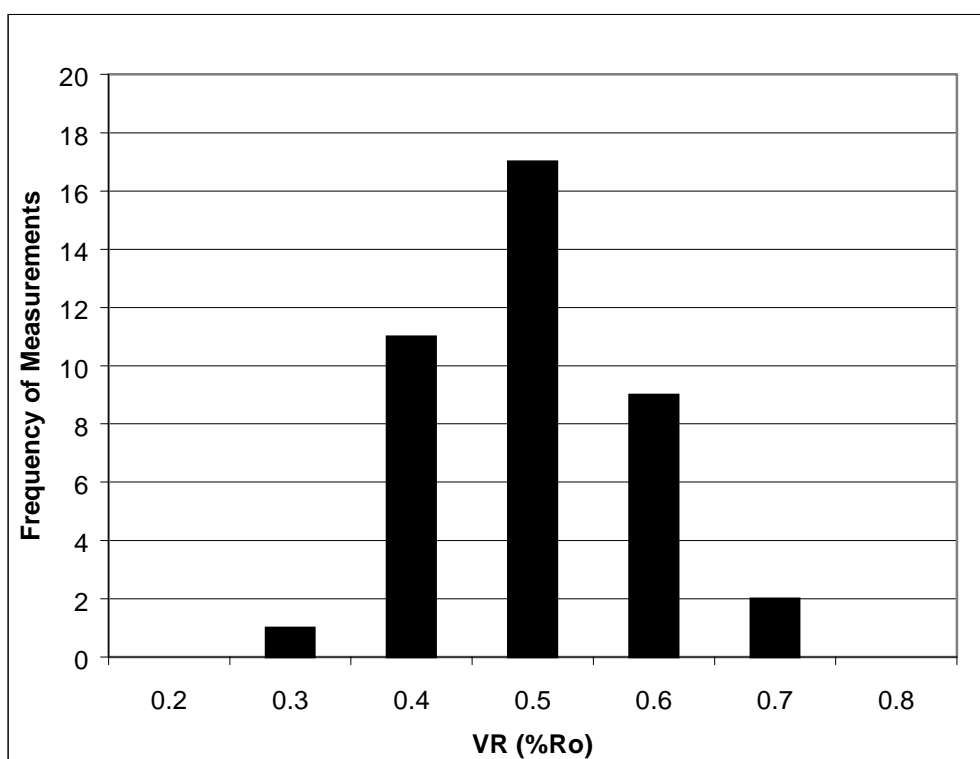
0.27	0.37	0.44	0.50	
0.30	0.38	0.45	0.51	
0.31	0.41	0.45	0.53	
0.31	0.42	0.46	0.54	
0.32	0.42	0.47	0.54	
0.33	0.43	0.48	0.54	
0.34	0.43	0.48	0.56	
0.35	0.44	0.48	0.58	
0.36	0.44	0.49	0.60	
0.37	0.44	0.50	0.62	

Number of meas: 40

Median: 0.44

Average: 0.44

Stand. Dev: 0.09



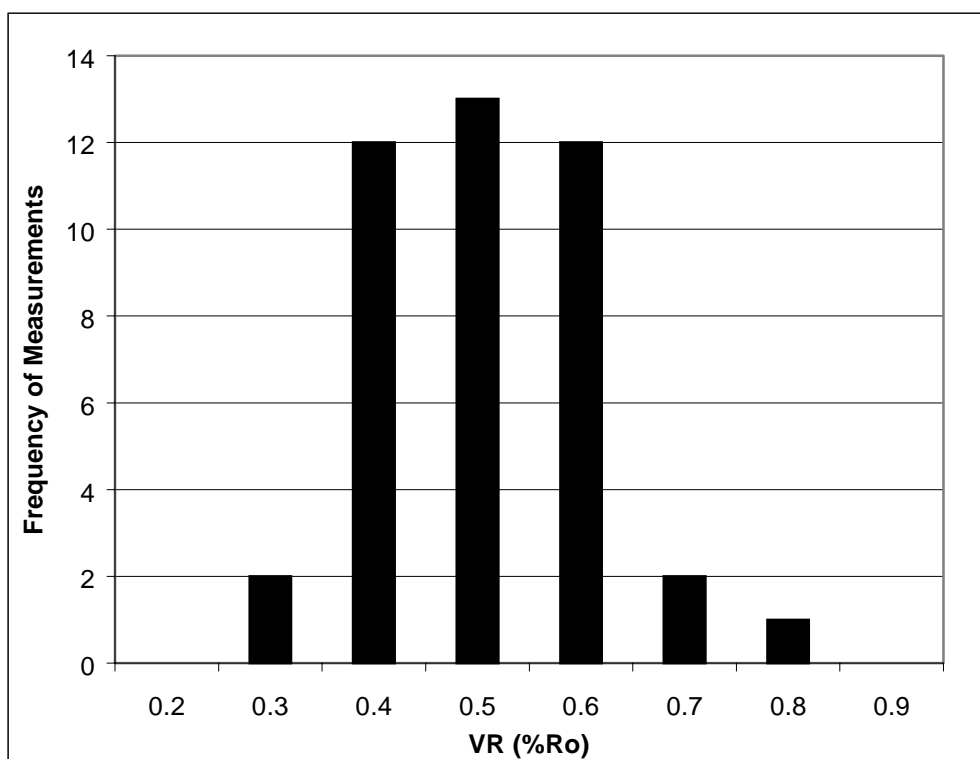
Chevron OCS Y-0996 #1 (Diamond)

Sample Depth: 4110-4200'

VR Measurements:

0.26	0.37	0.43	0.51	0.63
0.29	0.38	0.44	0.52	0.78
0.30	0.39	0.45	0.52	
0.30	0.39	0.46	0.52	
0.33	0.40	0.46	0.58	
0.35	0.40	0.46	0.58	
0.36	0.42	0.46	0.59	
0.36	0.43	0.50	0.59	
0.36	0.43	0.51	0.59	
0.36	0.43	0.51	0.61	

Number of meas:	42	Median:	0.44
Average:	0.45	Stand. Dev:	0.11



Chevron OCS Y-0996 #1 (Diamond)

Sample Depth: 4710-4740'

VR Measurements:

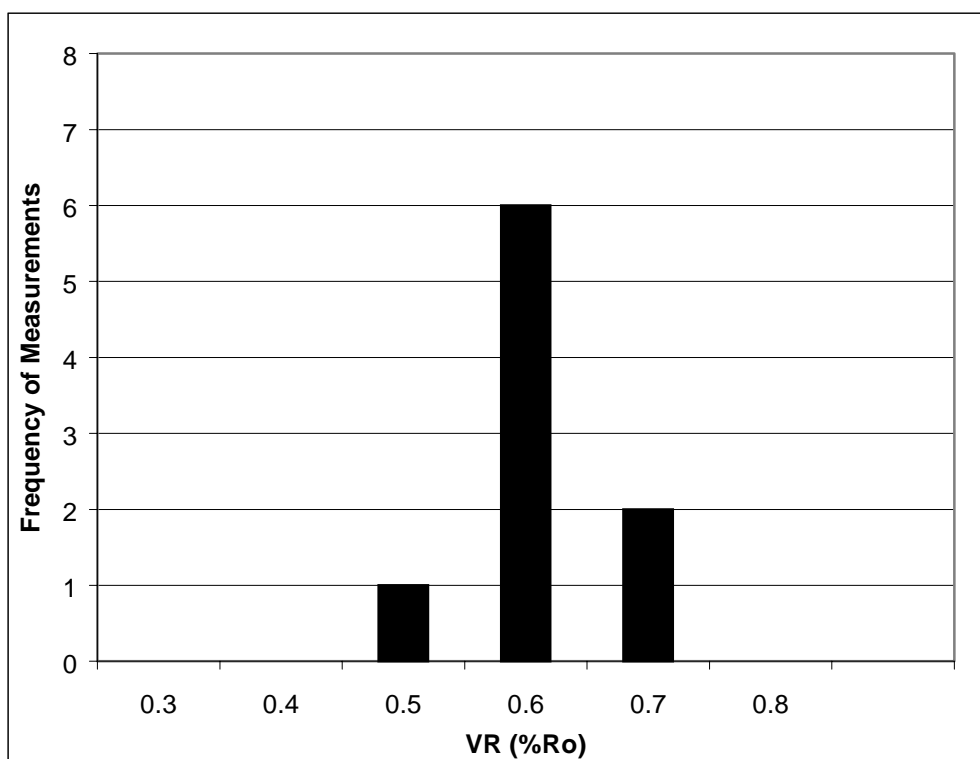
0.46	
0.50	
0.50	
0.50	
0.51	
0.55	
0.59	
0.67	
0.69	

Number of meas: 9

Median: 0.51

Average: 0.55

Stand. Dev: 0.08



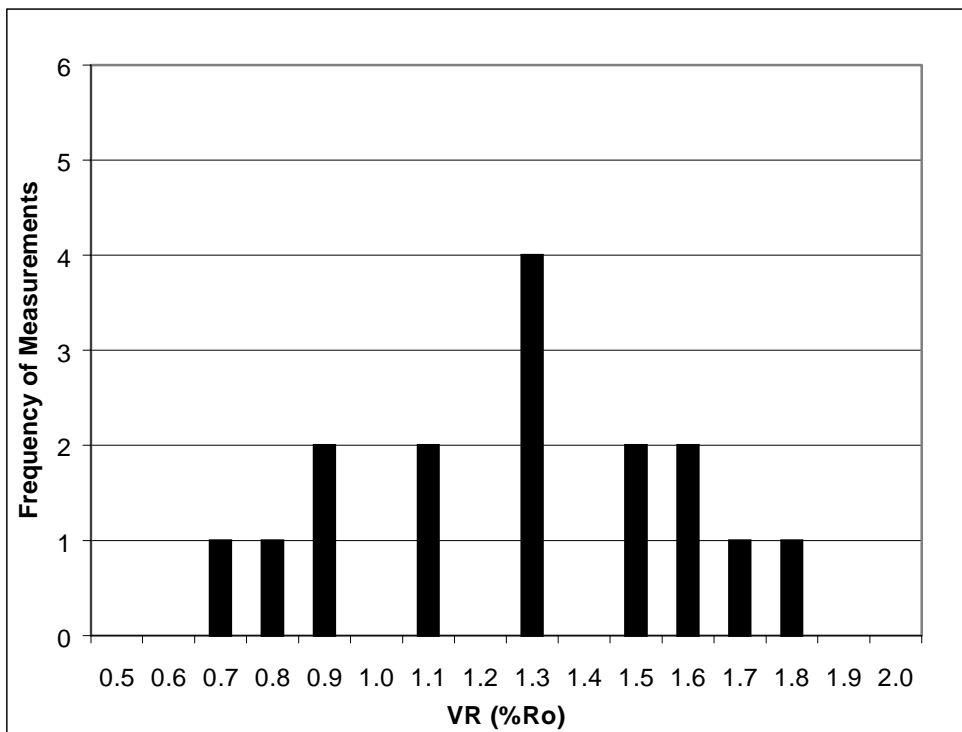
Chevron OCS Y-0996 #1 (Diamond)

Sample Depth: 5410-5440'

VR Measurements:

0.65	1.41	
0.79	1.49	
0.82	1.50	
0.86	1.51	
1.00	1.67	
1.01	1.75	
1.20		
1.24		
1.28		
1.28		

Number of meas: 16 **Median:** 1.26
Average: 1.22 **Stand. Dev:** 0.33



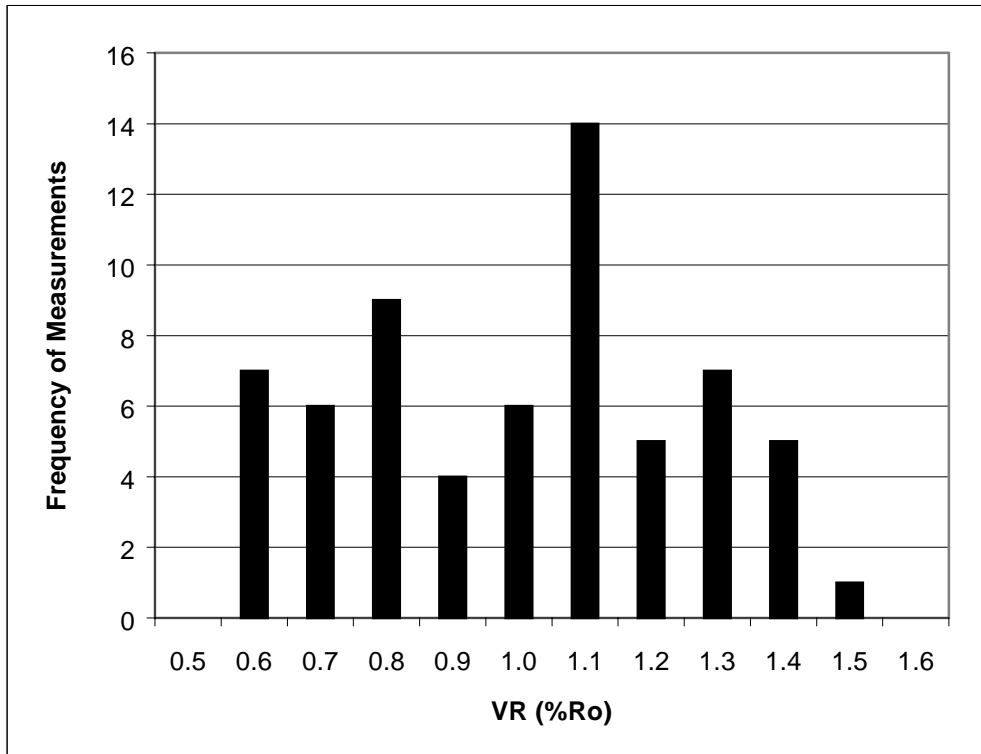
Chevron OCS Y-0996 #1 (Diamond)

Sample Depth: 6110-6140'

VR Measurements:

0.51	0.65	0.79	0.97	1.04	1.18	1.36
0.54	0.66	0.79	0.97	1.05	1.20	1.37
0.56	0.67	0.80	1.00	1.05	1.21	1.39
0.57	0.74	0.82	1.00	1.06	1.21	1.46
0.58	0.74	0.84	1.01	1.06	1.24	
0.59	0.74	0.88	1.01	1.09	1.24	
0.59	0.76	0.91	1.02	1.10	1.26	
0.61	0.76	0.93	1.02	1.13	1.28	
0.63	0.77	0.95	1.03	1.14	1.30	
0.64	0.77	0.95	1.03	1.15	1.35	

Number of meas:	64	Median:	0.99
Average:	0.95	Stand. Dev:	0.25



Chevron OCS Y-0996 #1 (Diamond)

Sample Depth: 6710-6750'TD

VR Measurements:

0.63	0.85	0.97	1.03	1.13	1.27
0.65	0.87	0.97	1.05	1.14	1.34
0.69	0.87	0.98	1.05	1.14	1.34
0.71	0.89	0.98	1.06	1.16	1.39
0.74	0.91	0.98	1.06	1.17	1.56
0.75	0.91	1.00	1.07	1.18	
0.77	0.93	1.00	1.09	1.19	
0.78	0.93	1.01	1.09	1.23	
0.79	0.94	1.01	1.09	1.23	
0.84	0.97	1.03	1.09	1.23	

Number of meas: 55

Median: 1.01

Average: 1.01

Stand. Dev: 0.19

