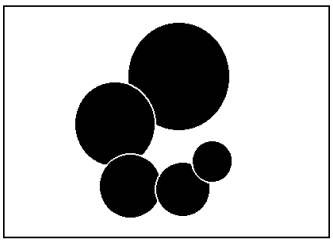

MICROPALEO CONSULTANTS, INC.

PHILLIPS ALASKA (ARCO)

FIREWEED NO. 1 (OCS-Y-0267)

API #55-232-00003

BLOCK NR5-2-883

BEAUFORT SEA, ALASKA

Prepared by:

Michael B. Mickey - Foraminifera

Hideyo Haga - Palynomorphs

BIOSTRATIGRAPHY REPORT

Job No. 21-106 **April, 2002**

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TE

Discussion. Sadlerochit Group. Ivishak Fm.

9480-9650'T.D.

Indeterminate Age

Discussion. Dark gray wavy-banded? argillite, dark red hematitic? shale, and rare white fine to medium grained quartzite or quartzitic sandstone.

FORAMINIFERA REPORT

Interpreted by

Michael B. Mickey

FORAMINIFERA SUMMARY

300-660'

Age.	Tertiary Early Pliocene
Zone.	F-2A(2)
Environment.	Inner to Middle Neritic (Inner to Middle Shelf)

660-840'

Age.	Tertiary Early to Middle Miocene
Zone.	F-2B(1)
Environment.	Inner to Middle Neritic (Inner to Middle Shelf)

840-1210'?

Age.	Tertiary Possible Late Oligocene to Early Miocene
Zone.	F-2B(2)?
Environment.	Middle to Outer? Neritic (Middle to Outer? Shelf)

1210?-1570'?

Age.	Indeterminate
Environment.	Probable Nonmarine (Probable Alluvial Plain)
Discussion.	May contain some Eocene? age strata between 1300 and 1480 feet.

1570?-2560'?

Age.	Late Cretaceous to Tertiary Maestrichtian to Paleocene
Zones.	F-5 to F-4(2)
Environment.	Nonmarine to Marginal Marine (Alluvial Plain to Transitional)
Discussion.	Top based on lithology change to gray medium to coarse grained sandstone.

2560?-3450'

Age.	Late Cretaceous Campanian to Maestrichtian
Zone.	F-5
Environment.	Middle Neritic to Upper Bathyal (Middle Shelf to Upper Slope)

3450-4530'

Age.	Late Cretaceous Turonian to Santonian
Zone.	F-6
Environment.	Probable Bathyal (Probable Slope)

4530-4800'

Age.	Late Cretaceous Probable Cenomanian
Zone.	Probable F-8
Environment.	Marginal Marine to Middle Neritic (Transitional to Middle Shelf)

4800-7530'

Age.	Early Cretaceous Middle to Late Albian
Zones.	Probable F-9 to F-11
Environment.	4800-5430': Marginal Marine to Middle Neritic (Transitional to Middle Shelf) 5430-6930': Outer Neritic to Upper Bathyal (Outer Shelf to Upper Slope) 6930-7530': Middle to Lower Bathyal (Middle to Lower Slope)

7530-7560'

Age.	Early Cretaceous Aptian to Early Albian
Zone.	F-11
Environment.	Distal (Base of Slope - Starved Basin)

7560-7620'

Age.	Early Cretaceous Barremian
Zone.	F-12
Environment.	Inner to Middle Neritic - Some Distal (Inner to Middle Shelf - Some Starved Basin)

7620-7650'

Age.	Early Cretaceous Hauterivian
Zone.	F-13a
Environment.	Inner to Middle Neritic (Inner to Middle Shelf)

7650-7800'

Age.	Early Jurassic Toarcian
Zone.	F-18a
Environment.	Inner Neritic (Inner Shelf)

7800-8520'

Age.	Early Jurassic Pliensbachian
Zone.	F-18b
Environment.	Middle Neritic (Middle Shelf)

8520-8700'

Age.	Late Triassic Possible Rhaetian
Zone.	F-19a?
Environment.	Middle Neritic (Middle Shelf)

8700-9150'?

Age. Late Triassic
Norian

Zone. F-19b

Environment. Marginal Marine to Inner Neritic
(Transitional to Inner Shelf)

9150?-9300'

Age. Late Triassic
Carnian

Zone. F-19c

Environment. Nonmarine to Marginal Marine
(Alluvial Plain to Transitional)

9300-9480'

Age. Early Triassic

Zone. F-20a

Environment. Nonmarine to Marginal Marine
(Alluvial Plain to Transitional)

Discussion. Sadlerochit Group. Ivishak Fm. This interval is separated on the basis of a lithologic change to very fine grained quartzitic sandstone coupled with the paly data.

9480-9650'T.D.

Age.	Indeterminate
Environment.	Indeterminate
Discussion.	Dark gray wavy-banded? argillite, dark red hematitic? shale, and rare white fine to medium grained quartzite or quartzitic sandstone.

INTRODUCTION

Scope

Micropaleo Consultants, Inc. processed, picked and analyzed for Foraminifera 124 ditch samples from the Phillips Alaska (ARCO) Fireweed No. 1 (OCS-Y-0267) well. These samples covered the interval 300 to 9650 feet total depth. This work was done as part of M.C.I. Job Number 21-106.

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 reposited 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 (Figure 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

300-660'

Age.	Tertiary Early Pliocene
Zone.	F-2A(2)
Environment.	Inner to Middle Neritic (Inner to Middle Shelf)
Fauna.	*Cassidulina quadrata, C. reflexa, C. reniforme, C. teretis, Cibicides grossus, Cornuspira involvens, Dentalina soluta, Elphidiella acutum, Elphidium clavatum, E. frigidum, Polymorphina* sp., *Quinqueloculina akneriana, Fissurina semimarginata, Guttulina* sp., *Nonion erucopsis, Cribroelphidium katanglensis, Angulogerina angulosa, Pullenia* cf. *quinqueloba,* ostracods, pelmatozoan fragments, shell fragments, pyrite, rare to frequent glauconite and rare to frequent tar.

660-840'

Age. Tertiary
Early to Middle Miocene

Zone. F-2B(1)

Environment. Inner to Middle Neritic
(Inner to Middle Shelf)

Fauna. *Angulogerina fluens, Asterigerina staeschei, Cibicides perlucidus, C. tenellus, Elphidiella brunnescens, E. acutum, Lenticulina nikobarensis, Pyrgo* sp., *Quinqueloculina akneriana, Q. seminulum, Valvulineria petrolei*, ostracods, pelmatozoan fragments, pyrite and pyrite sticks.

840-1210'?

Age. Tertiary
Possible Late Oligocene to Early Miocene

Zone. F-2B(2)?

Environment. Middle to Outer? Neritic
(Middle to Outer? Shelf)

Fauna. *Cibicides dutemplei, C. perlucidus, C. tenellus, Elphidiella acutum, E. brunnescens, Elphidium clavatum, E. ustulatum, Globobulimina* sp.?, *G. auriculata, Oolina laevigata, Quinqueloculina akneriana, Q. seminulum, Sphaeroidina bulloides, Globulina inaequalis, Lenticulina nikobarensis*, shell fragments, pyrite, pyrite sticks and aragonite.

1210?-1570'?

Age.	Indeterminate
Environment.	Probable Nonmarine (Probable Alluvial Plain)
Fauna.	Probably barren of indigenous Foraminifera. Pyrite, pyrite sticks, coal, pyrite oblates and tar.
Discussion.	May contain some Eocene? age strata between 1300 and 1480 feet.

1570?-2560'?

Age.	Late Cretaceous to Tertiary Maestrichtian to Paleocene
Zones.	F-5 to F-4(2)
Environment.	Nonmarine to Marginal Marine (Alluvial Plain to Transitional)
Fauna.	Essentially a barren sandy interval with a single specimen of *Reticulophragmium borealis* at 1840-1930 feet. Calcispheres, shell fragments, coal, pyrite and scattered tar.
Discussion.	Top based on lithology change to gray medium to coarse grained sandstone.

2560?-3450'

Age.	Late Cretaceous Campanian to Maestrichtian
Zone.	F-5
Environment.	Middle Neritic to Upper Bathyal (Middle Shelf to Upper Slope)
Fauna.	*Eoeponidella strombodes, E. linki, Haplophragmoides bonanzaensis, H. excavata, H. rota, Reticulophragmium borealis, R. amplectens, Saccammina lathrami, S.* sp. (large, coarse), *Anomalinoides pinguis, Bathysiphon* sp. (large, coarse), *B. varans, Pullenia* cf. *jarvisi, Quinqueloculina sphaera, Textularia gravenori, Trochammina albertensis, T. whittingtoni, T. ribstonensis, Verneuilinoides fischeri, Gavelinella ammonoides, G. tumida, Verneuilina* sp. (large), *Neobulimina canadensis, Caucasina vitrea*, shell fragments, megaspores, fish debris, pyrite, tar, volcanic glass shards and oil? staining between 3000 and 3390 feet.

3450-4530'

Age.	Late Cretaceous Turonian to Santonian
Zone.	F-6
Environment.	Probable Bathyal (Probable Slope)
Fauna.	*Saccammina lathrami, Haplophragmoides excavata, H. bonanzaensis, H. rota, Spiroplectammina webberi, Trochammina diagonis, Zonodiscus* sp. A, fish debris, megaspores, *Inoceramus* prisms, coal, pyrite, siderite globules and tar.

4530-4800'

Age.	Late Cretaceous Probable Cenomanian
Zone.	Probable F-8
Environment.	Marginal Marine to Middle Neritic (Transitional to Middle Shelf)
Fauna.	*Haplophragmoides bonanzaensis, H. excavata, H. rota, Praebulimina seabeensis, Saccammina lathrami, Bathysiphon vitta, Trochammina diagonis*, fish debris, megaspores, shell fragments, coal and rare to frequent pyrite.

4800-7530'

Age. Early Cretaceous
Middle to Late Albian

Zones. Probable F-9 to F-11

Environment.
4800-5430': Marginal Marine to Middle Neritic (Transitional to Middle Shelf)
5430-6930': Outer Neritic to Upper Bathyal (Outer Shelf to Upper Slope)
6930-7530': Middle to Lower Bathyal (Middle to Lower Slope)

Fauna. *Saccammina lathrami, Quadrimorphina ruckerae?, Haplophragmoides topagorukensis, H. kirki, H. linki, Trochammina albertensis, Praebulimina nannina, Conorboides umiatensis, Lenticulina macrodisca,* fish debris, megaspores, *Inoceramus* prisms, coal, pyrite and rare to frequent tar.

7530-7560'

Age. Early Cretaceous
Aptian to Early Albian

Zone. F-11

Environment. Distal
(Base of Slope - Starved Basin)

Fauna. Barren of Foraminifera. Pyritized radiolaria, megaspores and pyrite.

7560-7620'

Age.	Early Cretaceous Barremian
Zone.	F-12
Environment.	Inner to Middle Neritic - Some Distal (Inner to Middle Shelf - Some Starved Basin)
Fauna.	*Haplophragmoides duoflatis, Lenticulina prima, Saracenaria* sp. (raised sutures), megaspores, pyrite and frequent to common rounded frosted quartz floating sand grains.

7620-7650'

Age.	Early Cretaceous Hauterivian
Zone.	F-13a
Environment.	Inner to Middle Neritic (Inner to Middle Shelf)
Fauna.	*Bathysiphon scintillata, Haplophragmoides* sp., *Trochammina* sp. (small), megaspores and frequent rounded frosted quartz floating sand grains.

7650-7800'

Age. Early Jurassic
Toarcian

Zone. F-18a

Environment. Inner Neritic
(Inner Shelf)

Fauna. *Haplophragmoides canui, H.* sp., *Thuramminoides* sp., *Recurvoides turbinatus, Gaudryina dyscrita, Lenticulina audax, L. varians, Lituotuba irregularis, Ammobaculites alaskensis,* tar, pyrite, and rare to frequent gray and brown phosphatic? sand-size pebbles.

7800-8520'

Age. Early Jurassic
Pliensbachian

Zone. F-18b

Environment. Middle Neritic
(Middle Shelf)

Fauna. *Ammobaculites barrowensis, A. alaskensis, A.* cf. *sthenarus, Astacolus dubius, Triplasia kingakensis, Nodosaria detruncata, N. radiata, Ammodiscus siliceous, Vaginulinopsis matutina,* ostracods, fish debris, pyrite, frequent to common tar above 8160 feet, and common paper shale below 8340 feet.

8520-8700'

Age.	Late Triassic Possible Rhaetian
Zone.	F-19a?
Environment.	Middle Neritic (Middle Shelf)
Fauna.	*Gaudryina adoxa, Frondicularia acmaea, Discorbis pristina, Astacolus connudatus, Ammobaculites sthenarus, Nodosaria larina, N. shublikensis, N. liratella,* echinoid spines, shell fragments, pyrite and medium size smooth ("*Healdia*" type) ostracods.

8700-9150'?

Age.	Late Triassic Norian
Zone.	F-19b
Environment.	Marginal Marine to Inner Neritic (Transitional to Inner Shelf)
Fauna.	*Nodosaria larina, Vaginulinopsis acrulus, Astacolus connudatus,* ostracods (medium, smooth), echinoid spines, tar, very rare to frequent *Monotis/Halobia* shell fragments below 8940 feet, and rare dark gray to black phosphatic? sand-size pebbles below 8970 feet.

9150?-9300'

Age.	Late Triassic Carnian
Zone.	F-19c
Environment.	Nonmarine to Marginal Marine (Alluvial Plain to Transitional)
Fauna.	Echinoid spines, ostracods (medium, smooth), pelmatozoan fragments, pyrite, rare to common *Monotis/ Halobia* shell fragments and rare to common dark gray to black phosphatic? sand-size pebbles.

9300-9480'

Age.	Early Triassic
Zone.	F-20a
Environment.	Nonmarine to Marginal Marine (Alluvial Plain to Transitional)
Fauna.	Barren of Foraminifera. Frequent to common angular chert fragments below 9360 feet.
Discussion.	Sadlerochit Group. Ivishak Fm. This interval is separated on the basis of a lithologic change to very fine grained quartzitic sandstone coupled with the paly data.

9480-9650'T.D.

Age.	Indeterminate
Environment.	Indeterminate
Fauna.	Barren of Foraminifera. Rare to abundant argillite, frequent red beds at the top and rare to frequent clear angular quartz below 9510 feet.
Discussion.	Dark gray wavy-banded? argillite, dark red hematitic? shale, and rare white fine to medium grained quartzite or quartzitic sandstone.

CONCLUSIONS

The Phillips Alaska (ARCO) Fireweed No. 1 (OCS-Y-0267) well penetrated the following biostratigraphic sequence based on foraminiferal analysis:

- 540+ feet (300-840') of Early Miocene to Early Pliocene age (Late Brookian) inner to middle shelf clastics.

- 730 feet (840-1570'?) of possible Late Eocene to Early Miocene age (Middle Brookian) nonmarine to outer? shelf deposits.

- 2960 feet (1570?-4530') of Turonian to Paleocene age (Early Brookian) upward shallowing slope foresets and shelf topsets shallowing to inner delta plain and alluvial plain at the top.

- 3120 feet (4530-7650') of Hauterivian to Cenomanian age (Early Brookian & Beaufortian - Rift Sequence) marginal marine to outer shelf topsets, slope foresets and base of slope bottomsets with some distal - starved basin paper shales between 7530 and 7590 feet.

- 870 feet (7650-8520') of Pliensbachian to Toarcian age (Beaufortian - Incipient Rift Sequence) inner to middle shelf clastics.

- 960 feet (8520-9480') of Early Triassic and Late Triassic (Rhaetian?) age (Late Ellesmerian) nonmarine to middle shelf clastics.

- 170+ feet (9480-9650'T.D.) of indeterminate age (Franklinian) argillite, red shale and quartzite.

PALYNOLOGY REPORT

Interpreted by:

Hideyo Haga

PALYNOLOGY SUMMARY

300-660'

Age.	Tertiary - Quaternary Pliocene - Pleistocene
Environment.	No evidence of marine.

660-1210'

Age.	Tertiary Oligocene - Miocene
Environment.	Marginal Marine

1210-1390'

Age.	Tertiary Possible Late Eocene
Zone.	P-M11a?
Environment.	Marginal Marine
Remarks.	Eocene evidence is sparse.

1390-2200'

Age.	Tertiary Paleocene
Zone.	P-T10
Environment.	Nonmarine - Marginal Marine?

2200-2740'

Age.	Late Cretaceous Maestrichtian
Zone.	P-T11 and marginal marine equivalent
Environment.	Nonmarine - Marginal Marine

2740-3360'

Age.	Late Cretaceous Campanian
Zone.	P-T12 and marine equivalent
Environment.	Marginal Marine

3360-3540'

Age.	Late Cretaceous Possible Santonian - Campanian
Zone.	P-M14?
Environment.	Marine

3540-4800'

Age.	Late Cretaceous Turonian - Coniacian
Zone.	P-M15
Environment.	Marine

4800-7530'

Age.	Early Cretaceous Middle - Late Albian
Zone.	P-M17
Environment.	Marine

7530-7620'

Age.	Early Cretaceous Barremian - Early Albian
Zone.	P-M18a
Environment.	Marine

7620-7650'

Age.	Early Cretaceous Probable Hauterivian
Zone.	Probable P-M19
Environment.	Marine

7650-8340'

Age.	Early - Middle Jurassic Undifferentiated
Zones.	P-M24 to P-M23
Environment.	Marine - Marginal Marine
Remarks.	P-M24 zonule tops at about 7890 feet.

8340-9000'

Age.	Late Triassic Probable Rhaetian
Zone.	Probable P-M25
Environment.	Marginal Marine

9000-9240'

Age.	Late Triassic Norian
Zone.	P-M26
Environment.	Marginal Marine

9240-9420'

Age.	Permian? - Early Triassic Undifferentiated
Zones.	P-T18? to P-T16
Environment.	Marginal Marine

9420-9650'T.D.

Age.	Indeterminate
Environment.	Indeterminate
Remarks.	This interval begins the recovery of very dark brown to black organics.

INTRODUCTION

Purpose and Scope

Micropaleo Consultants, Inc. (M.C.I.) conducted palynological analyses on a total of 124 ditch samples from the Phillips Alaska (ARCO) Fireweed No. 1 (OCS-Y-0267) well. The samples were taken between 300 feet and the total depth of 9650 feet.

The thermal maturation of selected samples was also analyzed. These analyses included 34 thermal alteration index (T.A.I.) samples and 12 vitrinite reflectance (V.R.) samples.

The samples were cut from material made available by the State of Alaska Department of Natural Resources, Geologic Materials Center in Eagle River, Alaska. All processed material is on reposit at that facility.

Procedures

The samples were processed by M.C.I. in San Diego, California. The preparation method employed standard palynological techniques using hydrochloric, hydrofluoric and nitric acid treatments. The resultant kerogen residues were concentrated with heavy liquid separation, sonification and a sieving/panning procedure. Permanent slide mounts were made for each sample.

During the processing steps a fraction of the kerogen material was not treated with nitric acid and separated for the maturation analyses. These non-oxidized slurries were used to make T.A.I. slides and polished V.R. plugs.

As each sample was examined, an estimate of abundance was recorded for each taxon. These data were entered into a desktop PC which produced the basic elements for a palynomorph species distribution chart (Figure P-1).

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

RESULTS

The species distribution chart (Figure P-1) is located in the pocket. This chart provides the palynostratigraphic subdivisions and the occurrences and estimated frequencies of observed taxa. Additionally, curves displaying the diversity and abundance of the spore-pollen and microplankton cyst assemblages in each sample are included. These curves comprise a quick reference showing intervals where an influx of marine or nonmarine assemblages may be significant.

300-660'

Age. Tertiary to Quaternary
Pliocene to Pleistocene

Environment. No evidence of marine.

Palynomorphs. This uppermost interval is characterized by a nondescript spore-pollen assemblage. The recorded forms include *Alnipollenites*, Betulaceae, *Osmundacidites*, *Sphagnumsporites* and undifferentiated bisaccate pollen.

No indigenous marine forms were recorded. Only reworked Cretaceous dinocysts were observed.

660-1210'

Age. Tertiary
Oligocene to Miocene

Environment. Marginal Marine

Palynomorphs. An increase in palynomorph abundance and diversity marks this interval.

The nonmarine assemblage includes forms such as *Alnipollenites*, Betulaceae, Ericaceae, *Laevigatosporites*, *Tsugaepollenites* and *Ulmipollenites*.

The microplankton assemblage consists of forms such as *Micrhystridium* spp., *Operculodinium centrocarpum* and *Palaeocystodinium golzowense*. The species *Dioxya*? *pignerata* may be reworked into this interval.

1210-1390'

Age. Tertiary
Possible Late Eocene

Zone. P-M11a?

Environment. Marginal Marine

Palynomorphs. The Late Eocene section is separated on a tentative basis by the appearance of the dinocyst *Deflandrea wetzelii*.

Discussion. The age assignment is questionable due to the sparse Eocene evidence found within this narrow interval.

1390-2200'

Age. Tertiary
Paleocene

Zone. P-T10

Environment. Nonmarine to Marginal Marine?

Palynomorphs. The Paleocene section is marked by the presence of the pollen *Paraalnipollenites confusus*.

This interval is essentially nonmarine. However, very sparse evidence was recorded in some samples to suggest possible marginal marine influences.

Reworked Late Cretaceous pollen are scattered through the interval.

2200-2740'

Age. Late Cretaceous
Maestrichtian

Zone. P-T11 and marginal marine equivalent

Environment. Nonmarine to Marginal Marine

Palynomorphs. The Maestrichtian interval is marked by the occurrences of the pollen *Aquilapollenites magnus* and *Wodehouseia spinata,* along with a specimen of *Azonia pulchella*.

The microplankton assemblage includes the forms *Adnatosphaeridium* sp. and *Chatangiella biapertura*.

2740-3360'

Age. Late Cretaceous
Campanian

Zone. P-T12 and marine equivalent

Environment. Marginal Marine

Palynomorphs. The Campanian section is separated by the presence of *Aquilapollenites fusiformis* and *Aquilapollenites trialatus*.

The dinocyst assemblage reflects an increase in diversity. More species of *Chatangiella* appear, as well as species of *Isabelidinium* and the species *Laciniadinium biconiculum*.

3360-3540'

Age. Late Cretaceous
Possible Santonian to Campanian

Zone. P-M14?

Environment. Marine

Palynomorphs. This relatively thin interval is tentatively separated based on the occurrence of *Chatangiella ditissima* and an increase in abundance of other *Chatangiella* species.

3540-4800'

Age. Late Cretaceous
Turonian to Coniacian

Zone. P-M15

Environment. Marine

Palynomorphs. The Turonian - Coniacian section has consistent and abundant occurrences of *Isabelidinium globosum*. The species *Nelsoniella aceras*, which is often associated with *I. globosum*, was not present.

4800-7530'

Age. Early Cretaceous
Middle to Late Albian

Zone. P-M17

Environment. Marginal Marine to Marine

Palynomorphs. This interval is characterized by the appearance of the dinocyst marker species *Luxadinium propatulum*, *Spinidinium vestitum* and *Wigginsiella grandstandica*.

7530-7620'

Age. Early Cretaceous
Barremian to Early Aptian

Zone. P-M18a

Environment. Marine

Palynomorphs. The abundance and consistency of the dinocysts *Cyclonephelium distinctum* and *Oligosphaeridium complex* separate the Barremian - Early Aptian interval. The acritarch form *Micrhystridium* sp. A also tops within this interval.

7620-7650'

Age. Early Cretaceous
Probable Hauterivian

Zone. Probable P-M19

Environment. Marginal Marine

Palynomorphs. The Hauterivian zone is not well defined at this location. The dinocyst evidence is sparse and sporadic. The significant recorded species are *Gardodinium trabeculosum* and *Lunatadinium dissolutum*.

7650-8340'

Age.	Early to Middle Jurassic Undifferentiated
Zones.	P-M24 to P-M23
Environment.	Marine to Marginal Marine
Palynomorphs.	A dramatic change in the dinocyst assemblage marks this section. The assemblage includes the species *Nannoceratopsis gracilis*, *N. senex*, *Parvocysta cracens*, *P. nasuta* and *Phallocysta subconica*.
Discussion.	The assemblage suggests that the top of this interval may begin in Toarcian age strata. The top of zonule P-M24 is at about 7890 feet where the dinocyst species essentially drop out. Occurrences of reworked Paleozoic spores become consistent in the bottom part of this interval.

8340-9000'

Age. Late Triassic
Probable Rhaetian

Zone. Probable P-M25

Environment. Marginal Marine

Palynomorphs. This interval has a diverse palynomorph assemblage, but the majority of forms are reworked Paleozoic spores. The Triassic forms, some of which may also be reworked, are not as numerous.

The reworked assemblage includes *Ancyrospora*, *Calamospora*, *Densosporites*, *Endosporites*, *Hystricosporites grandis*, *Lycospora*, *Vittatina* and many others.

The presumed indigenous spore-pollen include *Classopollis classoides*, *Ricciisporites tuberculatus*, *Taeniaesporites* and *Vitreisporites pallidus*.

The microplankton constituents are represented by *Micrhystridium* and *Suessia swabiana*.

Discussion. The presence of *Ricciisporites* and *Suessia swabiana* and the absence of older Triassic dinocysts are the main criteria on which the probable Rhaetian age assignment is made.

9000-9240'

Age. Late Triassic
Norian

Zone. P-M26

Environment. Marginal Marine

Palynomorphs. Most of the same forms recorded above continue into the Norian interval. The important markers appearing here are *Noricysta fimbriata* and *Sverdrupiella* sp.

9240-9420'

Age. Permian? to Early Triassic
Undifferentiated

Zones. P-T18? to P-T16

Environment. Marginal Marine

Palynomorphs. This interval is marked by the occurrences of *Ovalipollis ovalis*, *Striatites richteri* and *Taeniaesporites*. Three specimens of the Permian form *Vittatina* were also recorded. Considering the large amount of reworking seen in the Triassic section, these very rare Permian specimens could easily be reworked in the Early Triassic strata.

The reworked Paleozoic spore assemblage continues into this interval with only a slight reduction in diversity and abundance.

9420-9650'T.D.

Age.	Indeterminate
Environment.	Indeterminate
Palynomorphs.	Some of the forms from the above assemblage continue to slough into this interval. Even species from the Cretaceous sections up-hole were recorded this far down-hole.
Discussion.	Thick, dark brown to black organic material begins to be recovered from the cuttings. These dark organics probably represent the indigenous component of this interval.

CONCLUSIONS

Palynological analysis of the Phillips Alaska (ARCO) Fireweed No. 1 (OCS-Y-0267) well provides the following generalized palynostratigraphic succession:

- Pliocene - Pleistocene strata, which contain no palynomorph evidence of marine deposition, occur down to 660 feet.

- Marginal marine strata of Oligocene - Miocene age are present between 660 feet and 1210 feet.

- Nonmarine to marginal marine strata of Paleocene and possibly Late Eocene age are identified between 1210 feet and 2200 feet.

- Nonmarine and marine strata of Late Cretaceous age occur from 2200 feet to 4800 feet. These strata include intervals of Maestrichtian, Campanian, possible Santonian - Campanian and Turonian - Coniacian ages.

- Three intervals of marine Early Cretaceous strata, ranging in age from probable Hauterivian to Late Albian, are present between 4800 feet and 7650 feet.

- A large hiatus is apparent with the absence of Valanginian to probably Middle Jurassic age strata.

- Marine strata of Early to Middle Jurassic age are identified between 7650 feet and 8340 feet. The youngest Jurassic seen in this interval may be of Toarcian age.

- Marginal marine, Late Triassic age strata that include a probable Rhaetian and a Norian interval occur from 8340 feet to 9240 feet. Both of these intervals contain a very large amount of reworked Paleozoic spores.

- The bottom interval from 9420 feet to 9650 feet total depth is of indeterminate age. No indigenous palynomorphs were recovered. Only the black organic recoveries are considered in-place.

KEROGEN MATURATION REPORT

Interpreted by:

Hideyo Haga

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

The maturation levels of kerogen residues from the Phillips Alaska (ARCO) Fireweed No. 1 (OCS-Y-0267) well were determined by visual means, Thermal Alteration Index (T.A.I.) estimates, and by vitrinite reflectance (V.R.) measurements. A chart correlating the two methods with hydrocarbon generation is given in Figure 1.

An unoxidized fraction of selected kerogen samples were used to make T.A.I. slides and V.R. resin mounts. The V.R. resin "plugs" were cut and polished in preparation for the reflectance measurements.

Thermal Alteration Index

Thirty-four (34) T.A.I. samples were prepared and analyzed. The samples consist mostly of 90-foot composites taken at about 200-foot intervals.

The T.A.I. and percentage estimates for the major organic constituents are presented in Table I. A generalized organic classification scheme is used and 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 the well is within the immature/mature transition level for organic maturation down to about 6800 feet. Below 6800 feet, and extending down to about 9500 feet, there is indication that at least early mature levels of maturation are encountered. The bottom of the well enters into the overmature level of thermal alteration.

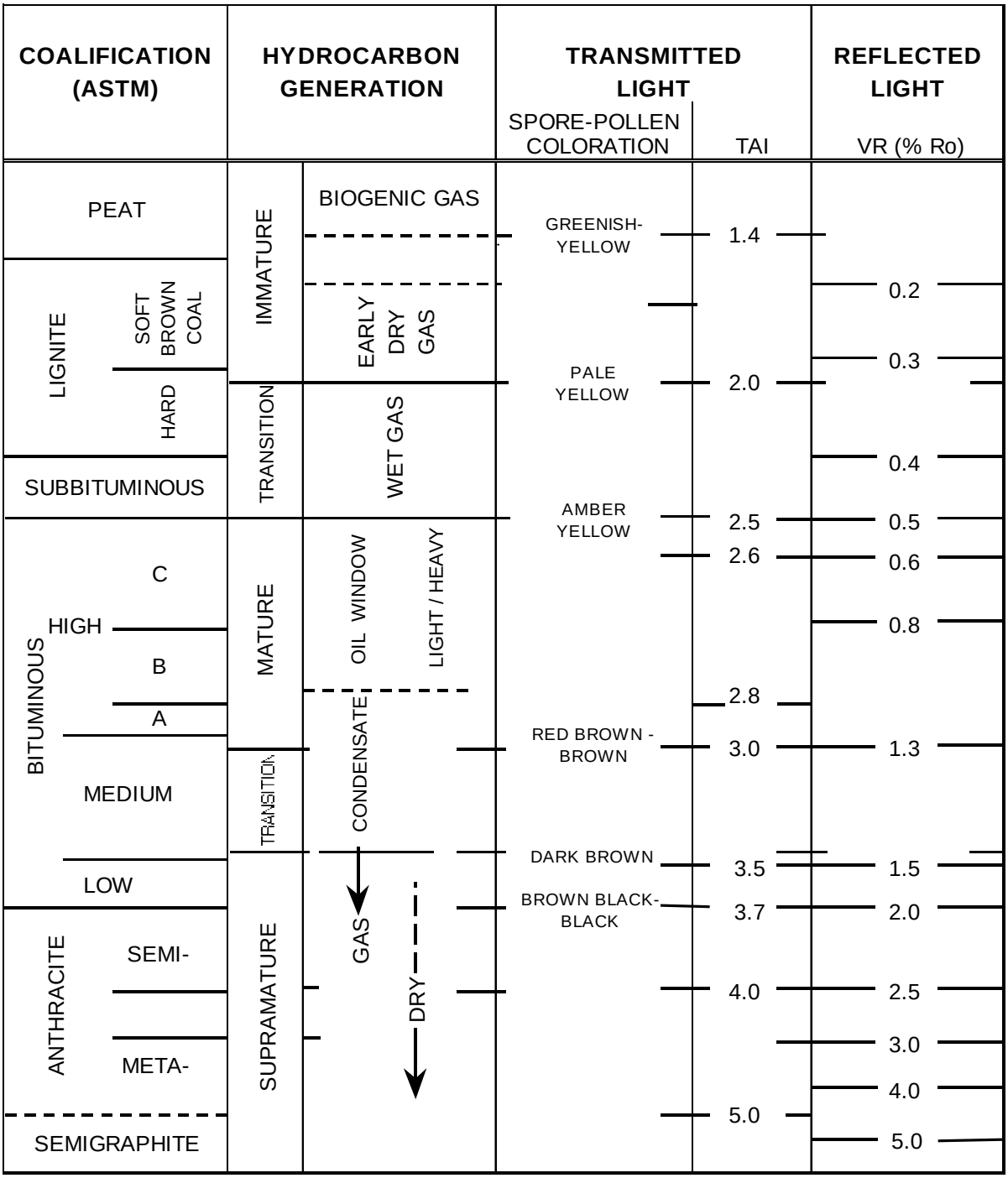


Figure 1. Correlation of Thermal Alteration Index (TAI) and Vitrinite Reflectance (VR) values to hydrocarbon generation. Modified from Heroux, Y., Chagnou, A. and Bertrand, R., (1979).

PHILLIPS ALASKA (ARCO) Fireweed No.1 (OCS Y-0267)

	SAMPLE (Feet)	TAI	KEROGEN TYPES (%) A	H	W-F	VR (Avg Ro)	REMARKS
1	480-570	2.0-2.3		10	90		Much dark, reworked organics
2	750-840	2.0-2.3		20	80	0.22	
3	1020-1120	2.0-2.3		40	60		
4	1300-1390	2.3		20	80	0.43	
5	1570-1660	2.0-2.3		10	90		
6	1840-1930	2.0-2.3		10	90	0.43	
7	2110-2200	2.0-2.3		5	95		
8	2380-2470	2.0-2.3		10	90	0.50	
9	2650-2740	2.0-2.3		10	90		
10	3000-3090	2.3		20	80	0.57	
11	3270-3390	2.3	T	20	80		
12	3540-3630	2.3	20	10	70		
13	3810-3900	2.3	10	20	70		
14	4080-4170	2.3	10	20	70	0.47	
15	4350-4440	2.3	T	15	85		
16	4620-4800	2.3		15	85	0.50	
17	4890-4980	2.3		20	80		
18	5160-5250	2.3	T	20	80		
19	5430-5520	2.3		10	90		
20	5700-5790	2.3-2.5	T	20	80	0.47	
21	6030-6120	2.3		20	80		
22	6300-6390	2.3	T	20	80		
23	6570-6660	2.3		20	80		
24	6840-6930	2.3-2.5	50	10	40	0.49	
25	7180-7260	2.3-2.5	T	30	70		
26	7420-7500	2.5	T	20	80	0.54	
27	7710-7800	2.3-2.5	90	T	10		
28	7980-8070	2.3-2.5	80	10	10		
29	8250-8340	2.3	70	20	10		
30	8520-8610	2.3	30	50	20	0.43?	Sparse vitrinite
31	8790-8880	2.3-2.5	30	40	30		
32	9030-9120	2.3-2.5	50	40	10		
33	9300-9390	2.3-2.5	70	20	10		
34	9600-9650 TD	3.8	T	30	70	4.20	Amorph. & herb. = sloughed

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).

The organic quality is dominated by gas-prone material down to about 7500 feet. Below 7500 feet, the organic material becomes more oil-prone. This change toward oil-prone organics occurs in the Neocomian, Early to Middle Jurassic and Late Triassic strata.

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.

Twelve (12) samples were used for V.R. (R_o) measurements. One sample yielded sparse vitrinite particles and has a questionable value. 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 suggest that almost the entire well is within the immature/ mature transitional and early mature levels for organic maturation. The top and bottom samples are exceptions.

The top sample (750-840 feet) is from the younger Tertiary and has an immature, 0.22 $R_{o,}$ average. The bottom sample (9600-9650 feet) has a supermature, 4.20 $R_{o,}$ average. These two exceptions are probably separated from the moderately altered part of the well by unconformities.

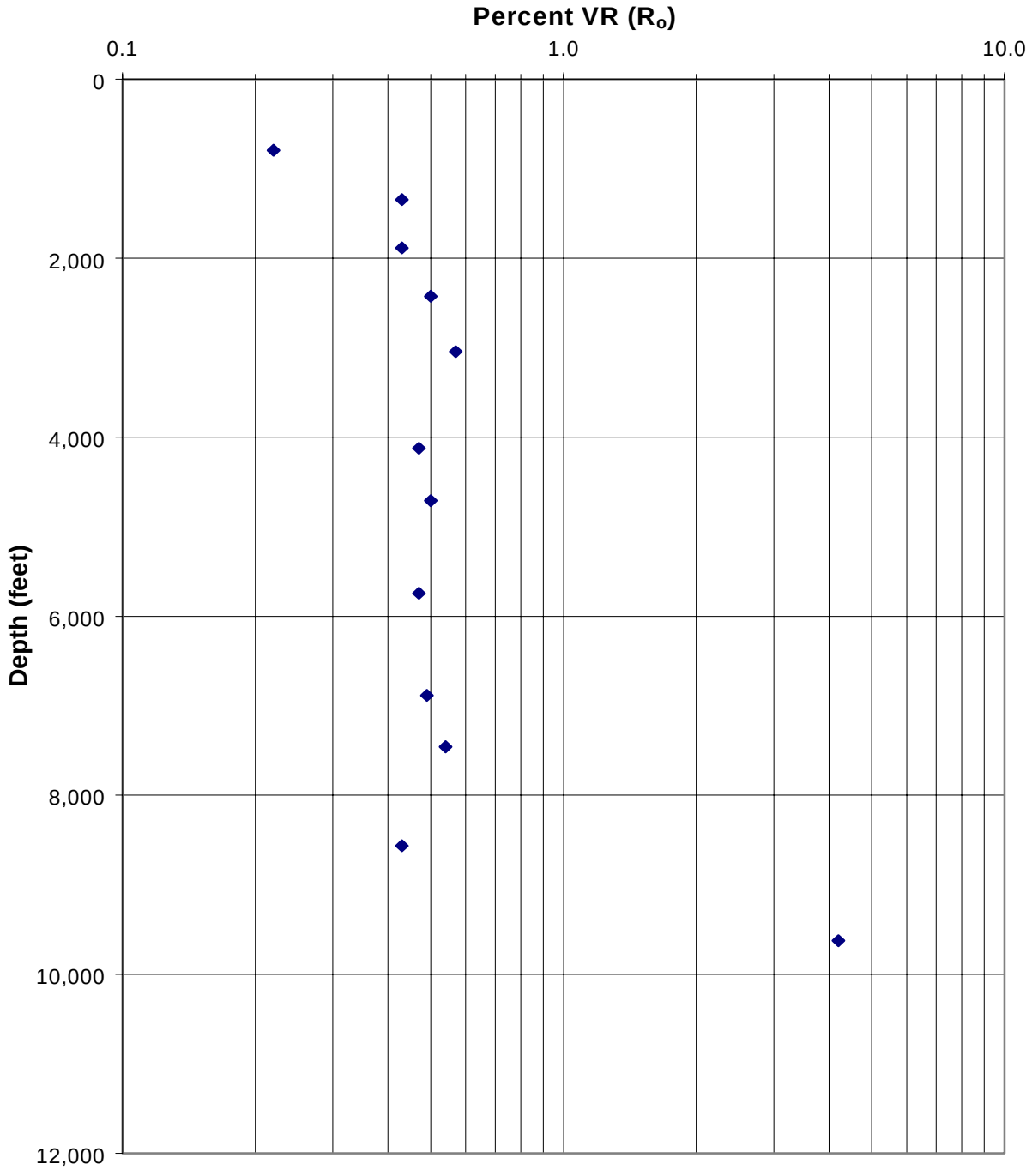


Figure 2. Plot of average R_o (%) verses depth,
Phillips Alaska (ARCO) Fireweed No.1 (OCS-Y-0267) well.

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

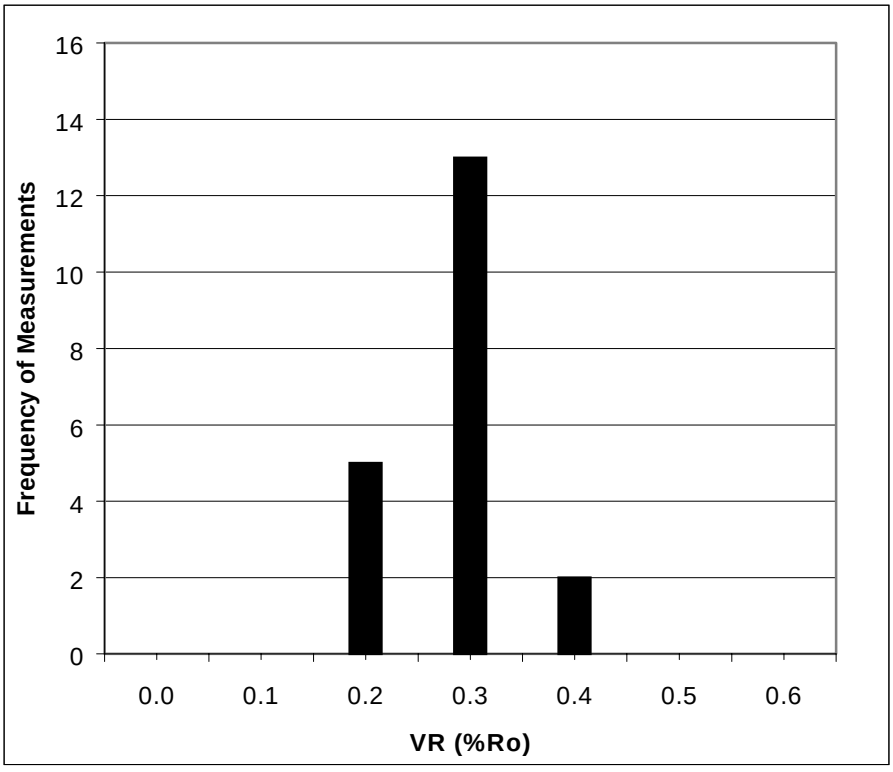
Phillips Alaska (ARCO) Fireweed No.1 (OCS-Y-0267)

Sample Depth: 750-840' Ditch

VR Measurements:

0.13	0.22				
0.15	0.23				
0.16	0.23				
0.17	0.23				
0.18	0.23				
0.20	0.23				
0.20	0.25				
0.20	0.26				
0.20	0.31				
0.21	0.32				

Number of meas:	20	**Median:**	0.22
Average:	0.22	**Stand. Dev:**	0.05



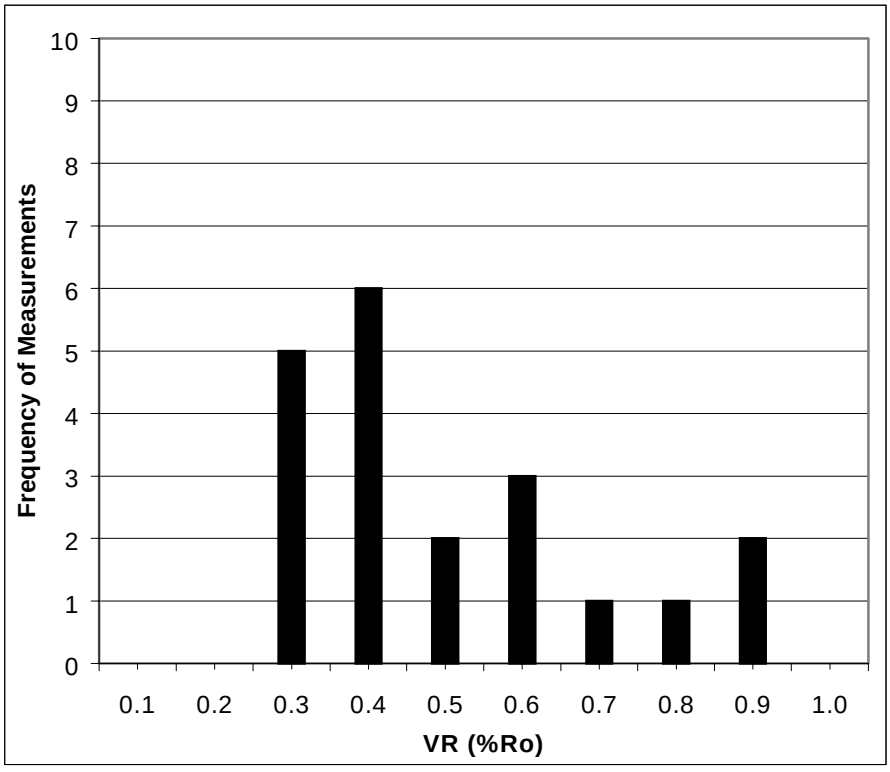
Phillips Alaska (ARCO) Fireweed No.1 (OCS-Y-0267)

Sample Depth: 1300-1390' Ditch

VR Measurements:

0.20	0.39				
0.21	0.40				
0.22	0.43				
0.22	0.50				
0.29	0.54				
0.30	0.55				
0.30	0.60				
0.31	0.76				
0.31	0.83				
0.32	0.84				

Number of meas:	20	**Median:**	0.36
Average:	0.43	**Stand. Dev:**	0.20



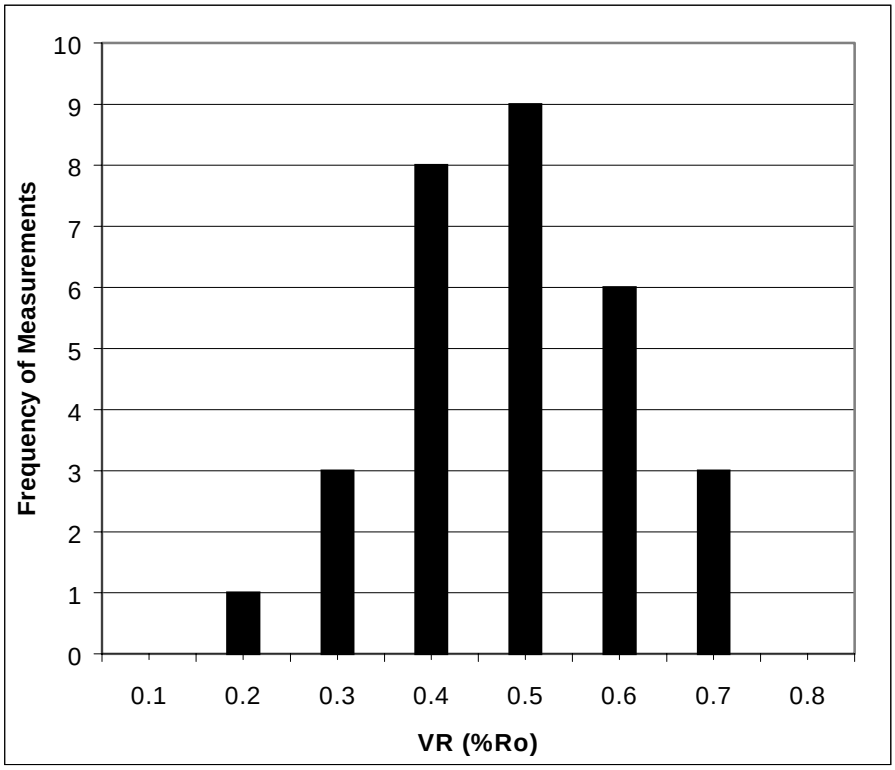
Phillips Alaska (ARCO) Fireweed No.1 (OCS-Y-0267)

Sample Depth: 1840-1930' Ditch

VR Measurements:

0.19	0.36	0.49			
0.22	0.38	0.50			
0.26	0.40	0.54			
0.27	0.41	0.55			
0.30	0.42	0.55			
0.30	0.43	0.58			
0.33	0.45	0.59			
0.34	0.46	0.61			
0.35	0.46	0.64			
0.36	0.48	0.69			

Number of meas:	30	**Median:**	0.43
Average:	0.43	**Stand. Dev:**	0.13



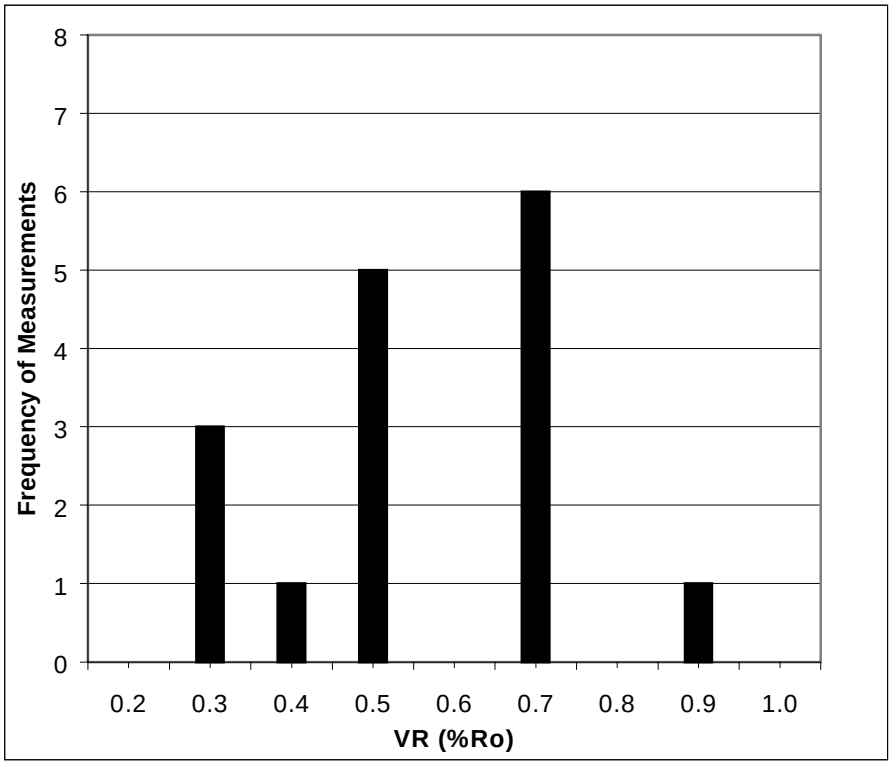
Phillips Alaska (ARCO) Fireweed No.1 (OCS-Y-0267)

Sample Depth: 2380-2470' Ditch

VR Measurements:

0.23	0.62				
0.24	0.62				
0.25	0.64				
0.35	0.65				
0.43	0.66				
0.45	0.81				
0.46					
0.47					
0.49					
0.62					

Number of meas:	16	**Median:**	0.48
Average:	0.50	**Stand. Dev:**	0.17



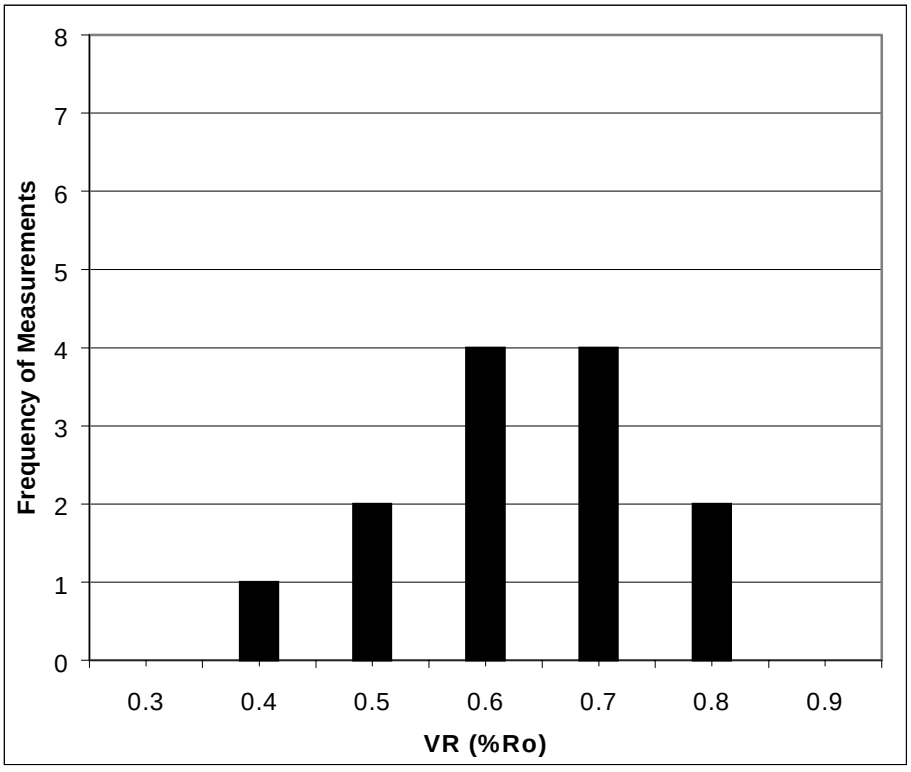
Phillips Alaska (ARCO) Fireweed No.1 (OCS-Y-0267)

Sample Depth: 3000-3090' Ditch

VR Measurements:

0.36	0.63				
0.46	0.75				
0.47	0.76				
0.50					
0.53					
0.54					
0.56					
0.61					
0.61					
0.62					

Number of meas:	13	**Median:**	0.56
Average:	0.57	**Stand. Dev:**	0.11



Phillips Alaska (ARCO) Fireweed No.1 (OCS-Y-0267)

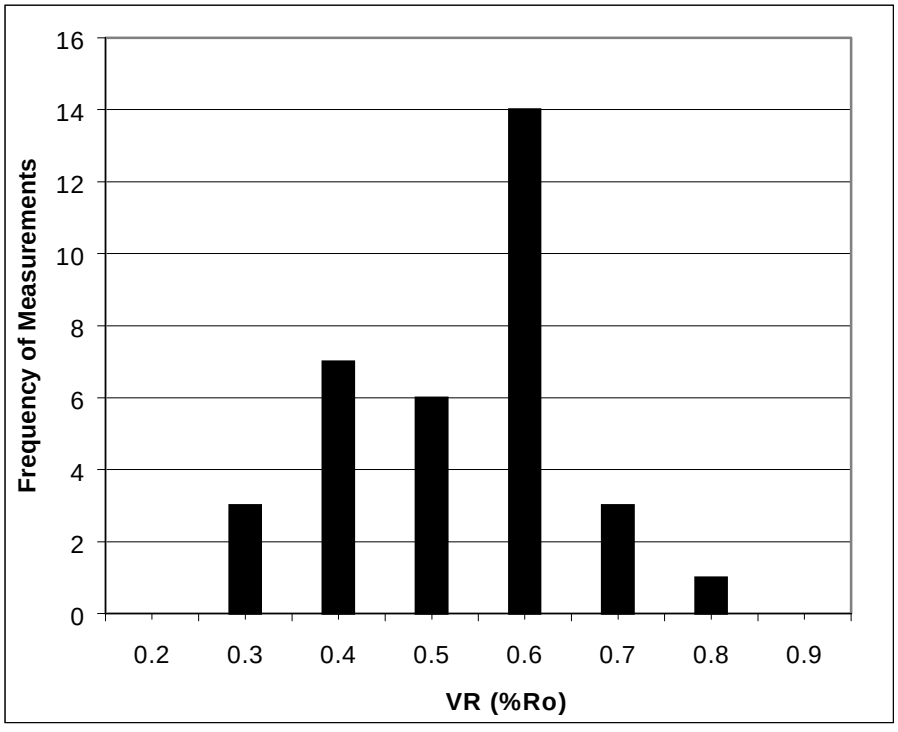
Sample Depth: 4080-4170' Ditch

VR Measurements:

0.27	0.40	0.52	0.63		
0.28	0.40	0.52	0.64		
0.29	0.41	0.53	0.68		
0.30	0.45	0.54	0.78		
0.31	0.48	0.54			
0.31	0.49	0.55			
0.32	0.50	0.57			
0.34	0.50	0.57			
0.36	0.50	0.58			
0.37	0.51	0.59			

Number of meas: 34 **Median:** 0.50

Average: 0.47 **Stand. Dev:** 0.13



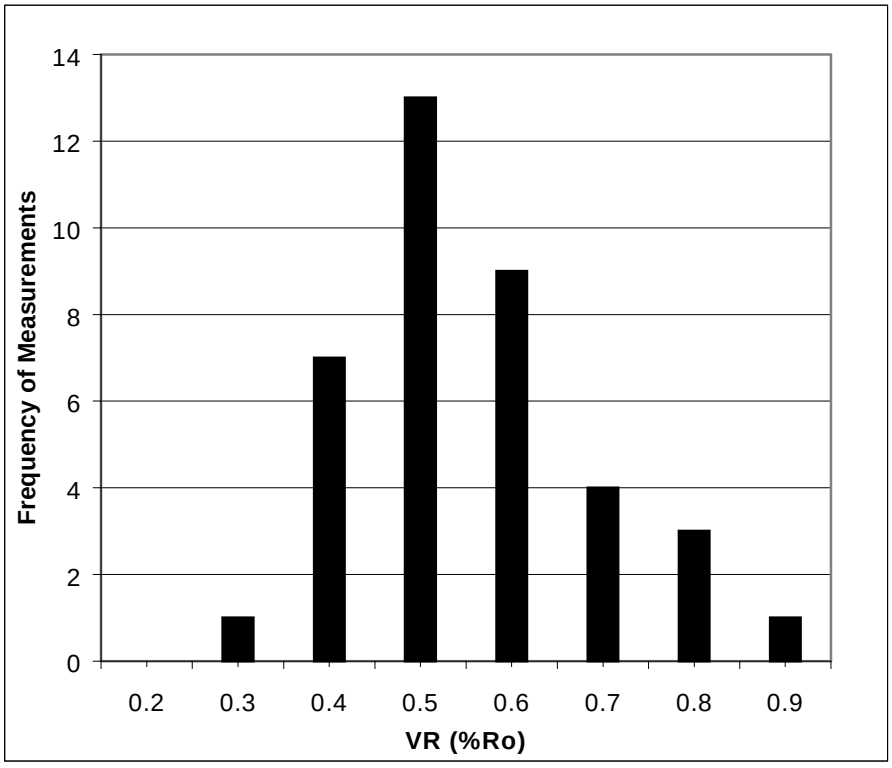
Phillips Alaska (ARCO) Fireweed No.1 (OCS-Y-0267)

Sample Depth: 4620-4800' Ditch

VR Measurements:

0.29	0.40	0.49	0.60		
0.34	0.41	0.50	0.60		
0.35	0.43	0.51	0.61		
0.36	0.43	0.52	0.69		
0.38	0.44	0.54	0.73		
0.39	0.44	0.55	0.76		
0.39	0.44	0.56	0.77		
0.39	0.46	0.56	0.81		
0.40	0.48	0.57			
0.40	0.48	0.57			

Number of meas:	38	**Median:**	0.48
Average:	0.50	**Stand. Dev:**	0.13



Phillips Alaska (ARCO) Fireweed No.1 (OCS-Y-0267)

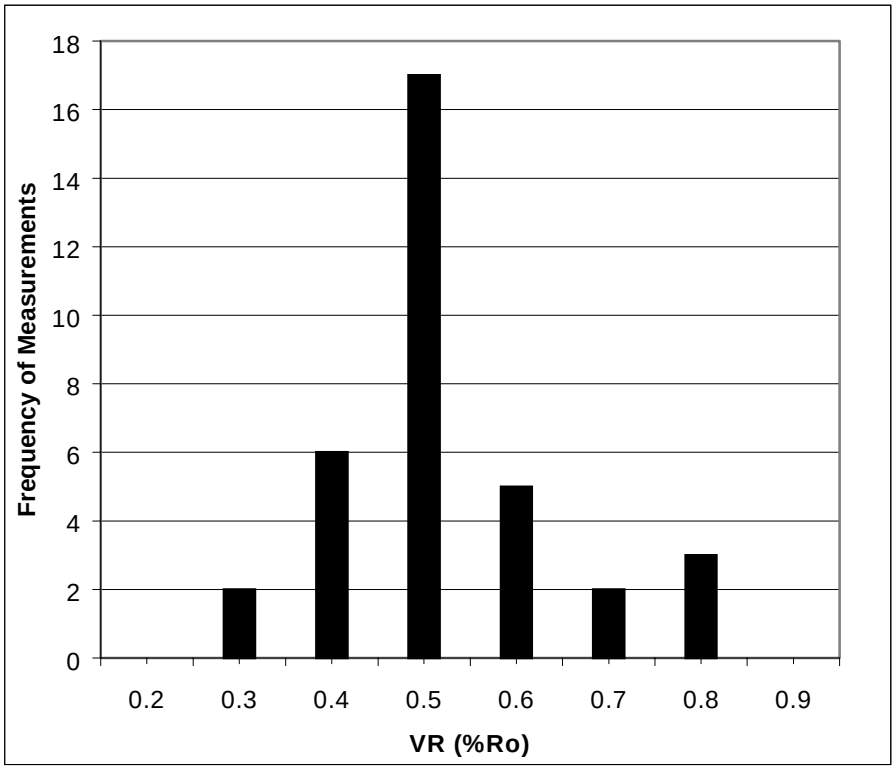
Sample Depth: 5700-5790' Ditch

VR Measurements:

0.29	0.40	0.46	0.69		
0.29	0.40	0.47	0.69		
0.31	0.42	0.48	0.70		
0.31	0.43	0.48	0.76		
0.33	0.43	0.48	0.78		
0.35	0.44	0.52			
0.36	0.44	0.54			
0.37	0.45	0.58			
0.40	0.46	0.58			
0.40	0.46	0.59			

Number of meas: 35 **Median:** 0.45

Average: 0.47 **Stand. Dev:** 0.13



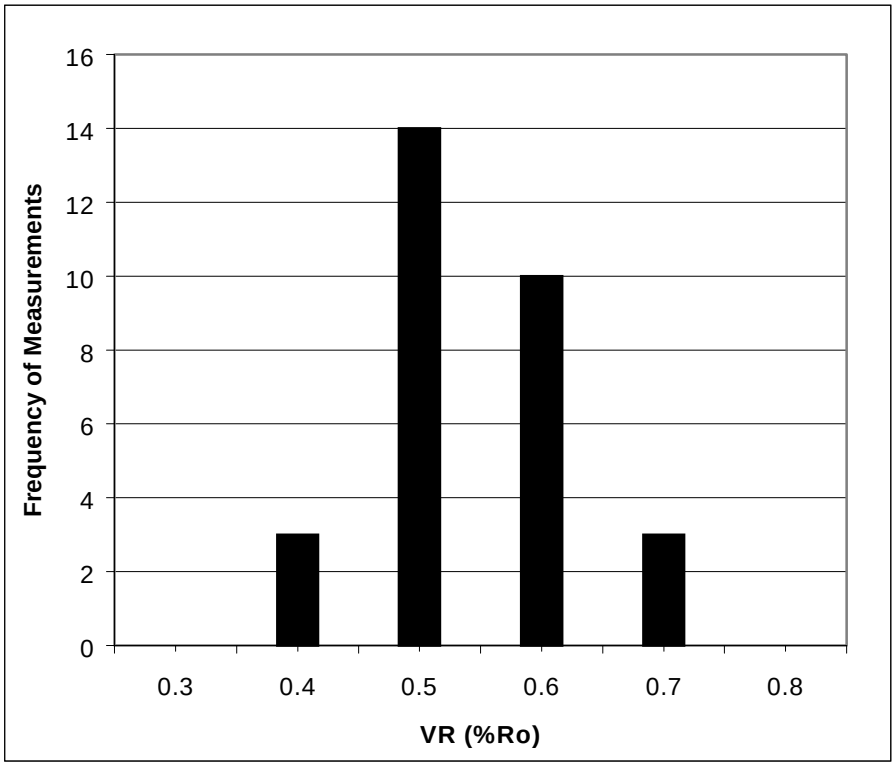
Phillips Alaska (ARCO) Fireweed No.1 (OCS-Y-0267)

Sample Depth: 6840-6930' Ditch

VR Measurements:

0.31	0.46	0.52			
0.31	0.47	0.53			
0.39	0.48	0.54			
0.40	0.48	0.54			
0.42	0.48	0.54			
0.44	0.49	0.55			
0.44	0.49	0.59			
0.45	0.51	0.60			
0.45	0.51	0.60			
0.46	0.52	0.64			

Number of meas:	30	**Median:**	0.49
Average:	0.49	**Stand. Dev:**	0.08



Phillips Alaska (ARCO) Fireweed No.1 (OCS-Y-0267)

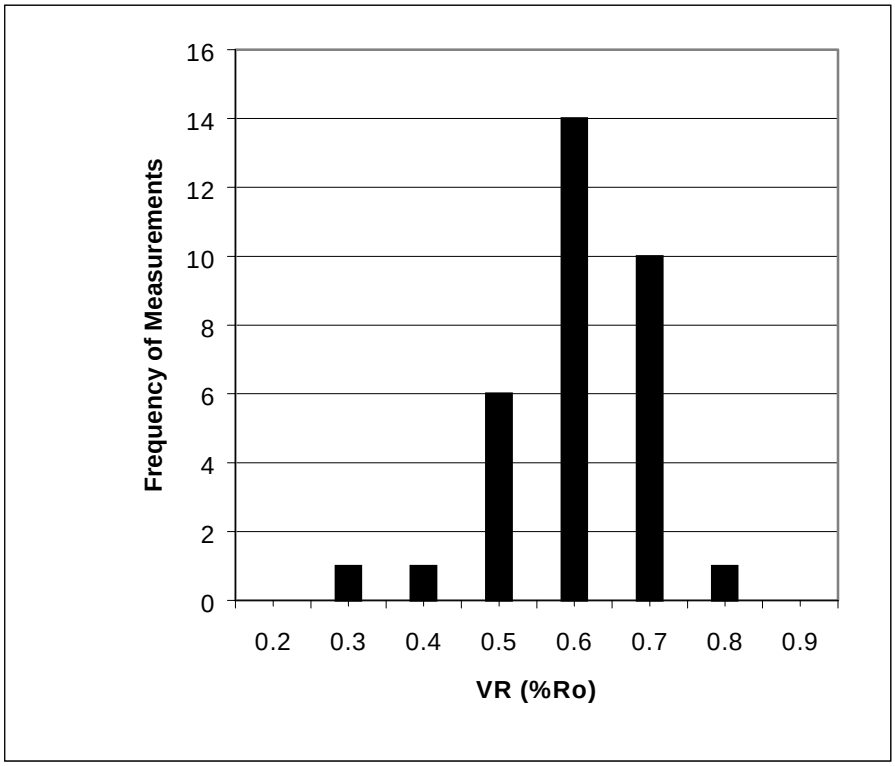
Sample Depth: 7420-7500' Ditch

VR Measurements:

0.29	0.51	0.56	0.64		
0.31	0.53	0.57	0.69		
0.42	0.54	0.60	0.74		
0.43	0.55	0.60			
0.45	0.56	0.61			
0.46	0.56	0.61			
0.48	0.56	0.61			
0.49	0.56	0.62			
0.50	0.56	0.62			
0.51	0.56	0.62			

Number of meas: 33 **Median:** 0.56

Average: 0.54 **Stand. Dev:** 0.09



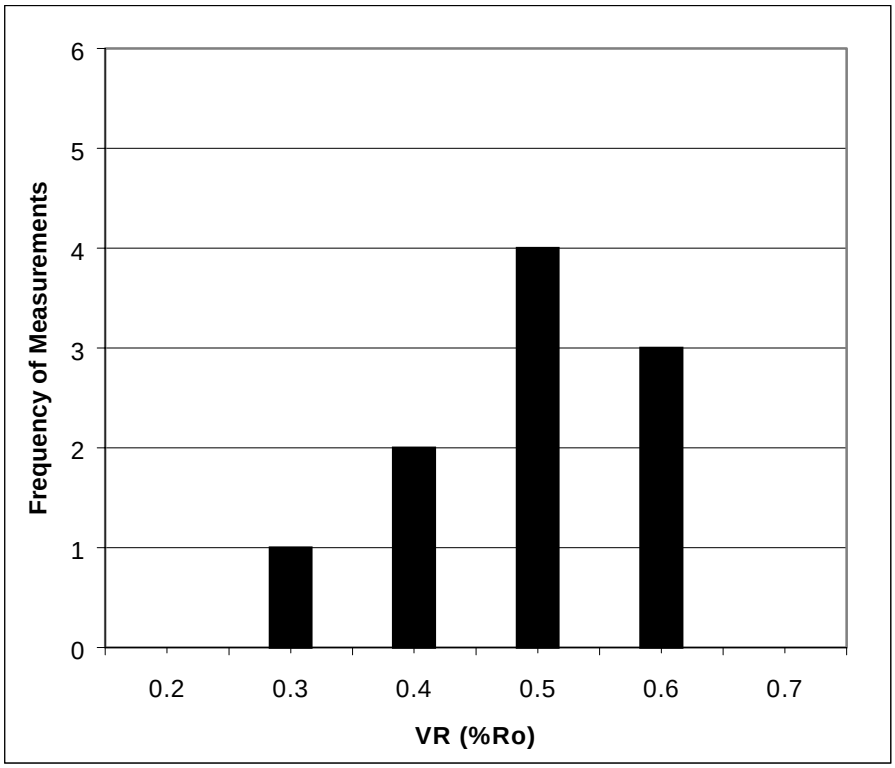
Phillips Alaska (ARCO) Fireweed No.1 (OCS-Y-0267)

Sample Depth: 8520-8610' Ditch

VR Measurements:

0.27					
0.33					
0.39					
0.40					
0.41					
0.43					
0.49					
0.50					
0.51					
0.57					

Number of meas:	10	**Median:**	0.42
Average:	0.43	**Stand. Dev:**	0.09



Phillips Alaska (ARCO) Fireweed No.1 (OCS-Y-0267)

Sample Depth: 9600-9650' TD Ditch

VR Measurements:

3.03	4.19	4.62			
3.33	4.20	4.66			
3.61	4.24	4.66			
3.65	4.32	4.70			
3.73	4.33	4.71			
3.73	4.41	4.81			
3.91	4.42				
4.05	4.45				
4.11	4.51				
4.13	4.59				

Number of meas:	26	**Median:**	4.28
Average:	4.20	**Stand. Dev:**	0.46