Data compilation 1970 Amoco field party, western and central Brooks Range, Alaska

Fehlmann, R.H., and Amoco Oil Co.

GMC DATA REPORT 463

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2019
State of Alaska
Department of Natural Resources
Division of Geological & Geophysical Surveys
GEOLOGIC MATERIALS CENTER

Original

Amoco Production Company

Denver Division

CF 710036

AREA DENVER DIVISION - NW DISTRICT

STATE ALASKA

COUNTY BROOKS RANGE

SUBJECT "DATA COMPILATION 1970 AMOCO FIELD PARTY, WESTERN AND CENTRAL BROOKS RANGE, ALASKA"

DENVER DIVISION MEMORANDUM NO. 152

DATE OCTOBER, 1971

BY R. H. FEHLMANN

NO.	ENCLOSURES	SCALE
1.	Index Map, Amoco & Union Oil Surface Samples & Sections	1"=16 mi.
2.	Regional East-West Permian/Triassic Cross Section	1"=11 mi.
3.	Regional East-West Mississippian/Pennsylvanian Cross Section	1"=20 mi.
4.	Regional East-West Devonian Cross Section	1"=10 mi.
5.	Geochron Sample & Data Index Map	1"=16 mi.
6.	Oil Seeps & Shows Index Map	1"=16 mi.
7.	Source Rock Index Map	1"=16 mi.
8-21.	1970 Amoco Surface Data Quadrangles	1/250,000
22-48.	1970 Amoco Measured Sections	1"=100'

December 14, 1971

0036

Re: Denver Division
Memorandum #152

Mr. B. G. Newton
Tulsa General Office

Dear Sir:

Attached hereto for your information and file is Denver Division Memorandum #152 by R. H. Fehlmann. The purpose of this memorandum is to assemble in one place and in one convenient reference all of the basic data gathered in our 1970 Surface Program on the North Slope of Alaska.

The interpreting and incorporating of this surface work and the work of previous years is contained in Denver Division Report #82.

Very truly yours,
Original Signed
R. K. TAYLOR

R. K. Taylor

RKT:djb
Attachment

cc: Messrs: P. H. Garrison
G. F. Stansberry
W. R. Walton - Tulsa

Amoco Production Company
Security Life Building
Denver, Colorado 80202

December 8, 1971

Mr. R. K. Taylor
B u i l d i n g

RE: Denver Division Memo #152
1970 Surface Work by
R. H. Fehlmann - Oct., 1971

Dear Sir:

Denver Division Memorandum #152 by R. H. Fehlmann is a compilation of data obtained from the 1970 Amoco Surface Program. It includes all Amoco 1970 measured sections with summaries of each, the 1970 sample register, and the 1970 field notes. In addition, regional time stratigraphic cross-sections, a geochron map, source rock map, oil seep and show maps are included. This completes the compilation of surface data through 1970. The interpretation of this surface work is shown and discussed in Denver Division Report #82.

Conclusion #1 indicates that we still have discrepancies in age of some rock units and Recommendation #1 specifies that this work should continue. We have a large volume of Upper Paleozoic fossil collections which need to be processed, and recommendations have been made to hire a paleontologist to handle this work.

Conclusion #2 indicates that limited information is available concerning the structural style of the Brooks Range and foothills regions. Although Recommendation #2, to undertake a Brooks Range structural study, has been assigned a low priority at this time, Mr. Fehlmann is currently assembling an annotated collection of photographs for this future study.

Conclusion #3 points out the need for a detailed paleontologic control section in the Brooks Range and Recommendation #3 suggests that this be undertaken by the Research Center. Recommendation to undertake such a project should be deferred until the 1971 data on Upper Paleozoic megafossil work has been evaluated.

Conclusion #4 states that Amoco reconnaissance geologic field work in the western and central Brooks Range is complete. Although no detailed surface geologic field work is recommended, it is pointed out in Recommendation #4 that it may be necessary to do detailed surface studies in the future to solve specific problems. Amoco has no surface work planned for 1972 but Union Oil plans to spend six weeks working the Cretaceous of the eastern foothills belt.

Conclusions #5 through #10 discuss the lateral and vertical distribution of the paleozoic sediments exposed in the Brooks Range and the increase in metamorphism southward in the Brooks Range. The paleogeographic distribution of the Paleozoic rocks of the Brooks Range are shown on Enclosures #1 through #4 and the interpretations discussed in Denver Division Geologic Report #83. Mr. Fehlmann should be commended for an orderly compilation of such a large quantity of data.

Four copies of Memo #152 have been prepared for transmittal to Division, Tulsa, Union Oil Company and storage.

G. F. Stansberry

GFS:CLC:ss

OCTOBER, 1971

CF 71 0036

Denver Division Geological Memorandum No. 152
"Data Compilation 1970 Amoco Field Party, Western and Central Brooks Range, Alaska."
Project No. 69-17

Author:

R. H. Fehlmann

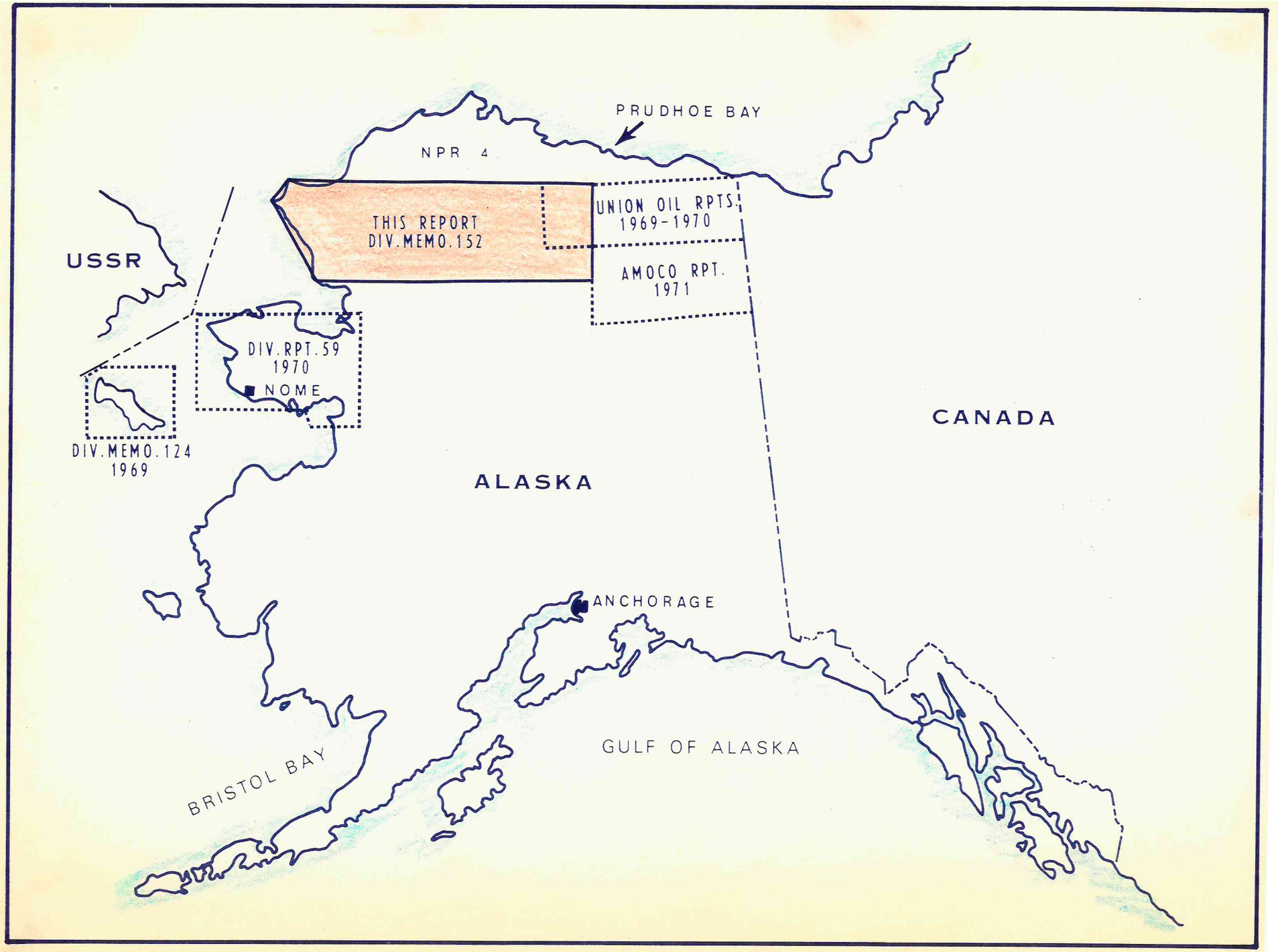

FIGURE 1

INTRODUCTION

During the summers of 1969 and 1970, Amoco and Union Oil conducted reconnaissance geologic field studies in the Brooks Range of Alaska. The field parties measured and collected selected stratigraphic sections and geologically reconnoitered the length of the Brooks Range (see Encl. 1). Denver Division Memo # 127 covers work done by Amoco in 1969, and Union Oil has distributed reports on their 1969 and 1970 field work.

The purpose of this memorandum is to compile and summarize the work and data obtained during the 1970 Amoco field season in the Central and Western Brooks Range. However, some of the data from Amoco's 1969 and Union Oil's 1969 and 1970 field parties is also included (IE: Regional cross-sections).

Denver Division Report # 82 contains revised paleogeographic maps, from Denver Division Memo # 127, for Devonian through Triassic sediments. The results of the 1971 field work in the southeastern Brooks Range will be combined with and tie together work summarized in both this memo and a memo concerning 1971 field work done in the Ft. Yukon Basin to the south.

As in 1969, emphasis in the field centered on Paleozoic and Triassic sediments. Cretaceous, Jurassic and Tertiary sediments are generally located outside the area of field work.

The objectives of the 1970 Amoco western and central Brooks Range Field Party were to:

1. Describe, measure and sample selected stratigraphic sections for establishment of a time stratigraphic framework.

2. Geologically reconnoiter and collect strategic spot samples for aid in interpretating depositional facies and paleoenvironments.

3. Establish the presence and characteristics of source and reservoir rocks.

4. Fill in gaps and extend the work accomplished in 1969 field season.

5. Finish geologic reconnaissance of the western and central Brooks Range.

6. Gain a general impression of the structural style of the Brooks Range.

Field methods consisted of measuring and collecting selected stratigraphic sections and making geologic reconnaissance traverses by helicopter to extend the stratigraphy and to locate new sections to measure. Laboratory work on paleontologic, palynologic, petrographic, x-ray, source rock, porosity and permeability, and radiometric dating is either completed or presently being conducted.

The field party consisted of W. D. Knapp (Party Chief), W. N. Dalness, D. L. Mikesh, D. Abrahamson (Union Oil Observer), R. J. Rosetter (Summer employee) and J. W. Erickson (Summer employee). ERA Helicopters, Inc. furnished one Bell Jet Ranger and one G-2 Helicopter with pilots Ed Hall and Ross Scott respectively. ERA mechanics were Nial Waggoner and Larry Grigsby. Universal Services expedited for the camp and provided the cook, John Knight and bull cook, Mark Johnson.

CONCLUSIONS

1. Disparities in age dates exist for certain samples when data derived from different types of fossils is compared. These problems are presently being studied and better correlation of ages from the various paleontological and palynological disciplines is being achieved.

2. Little detail is available concerning structural style of the Brooks Range and foothills regions.

3. Amoco lacks detailed and complete paleontologic control for the stratigraphy of the Brooks range. All work has been of the reconnaisance type which doesn't allow establishment of the exacting paleontologic time column necessary for detailed time stratigraphic subdivisions.

4. Reconnaissance geologic field work in the western and central Brooks Range is complete.

5. Five major east-west trending belts of rocks have been established in the Brooks Range. These are from north to south: A thin Lisburne (Mississippian) limestone belt, a Kanayut (Devonian) conglomerate belt, an Upper Hunt Fork (Devonian) sandstone/shale belt, a lower Hunt Fork shale/limestone belt, and finally, farthest south, a Skajit (Devonian?) carbonate belt. These lithologic bands extend continuously along the Brooks Range from the Canadian border to the Chukchi Sea.

6. The vertical sequence of Late Devonian rocks (Hunt Fork and Kanayut), throughout the Brooks Range, grades downward from non-marine conglomerates and sandstones to marine shales and carbonates. Thus, this vertical sequence mirrors the north-south facies sequence.

7. There is a transition between the shale and limestones of the lower Hunt Fork formation. This transition extends into Devonian aged Skajit carbonates. Devonian biohermal and biostromal carbonate buildups encased in shales have been observed in both the eastern and western Brooks Range. More paleontologic data is necessary to be certain that some of these buildups are not much older than Devonian because a Silurian Age has been determined on one carbonate in the Western Brooks Range.

8. There is apparently an east-west trending, gradational, southward increase in metamorphism in the Brooks Range. Shales grade southward to slates, phyllites and finally schists in the southern Brooks Range. Thus, fossils are obscure there and carbonates enclosed in shales to the south are undifferentiable as to age.

9. Petrologic and paleontologic data indicate a northward transgression of the sea from Late Devonian through Early Pennsylvanian time. This is indicated by non-marine Kanayut conglomerates grading vertically upward through marginal marine shales of the Stuver Member, and Lower Kayak shale, to limestones in the Upper Kayak and finally into the open marine, shelf carbonates of the Lisburne. Additional evidence is given by the Kayak and Lisburne formation's change from Early Mississippian in the southern Brooks Range to Early Pennsylvanian in the northeastern Brooks Range and Prudhoe Bay Areas.

10. This same Late Devonian to Mississippian lithologic and paleontologic sequence also exists on Wrangel Island. Therefore, the northward transgression occured in an east-west band which extended regionally from the Canadian border to Wrangel Island.

RECOMMENDATIONS

1. Work designed to eliminate age disparities, between the various paleontologic and palynologic disciplines (for specific sediments) should be continued.

2. A structural study of the Brooks Range should be undertaken. This study will be greatly aided by the compilation of annotated photographs of structures in the Brooks Range. These photographs are available from personal photograph and slide collections of geologists who have done field work in the Brooks Range.

3. The Tulsa Research Center should undertake detailed measurement and paleontologic collection of the most complete composite stratigraphic section available in the Brooks Range. This will allow detailed time-rock zonations and will help resolve age disparities (for specific sediments) that exist between the paleontologic disciplines.

4. Detailed surface geologic field work to resolve future specific problems in specific areas of the Brooks Range will be necessary.

REFERENCES

1. Chauvel, J. P., 1969, Geological Reconnaissance, 1969, Western Brooks Range, Alaska: Union Oil Alaska Miscellaneous Report P-3.

2. DeBenedetti, J. J., et al, 1970, Geological Field Report, 1970, Eastern Brooks Range, Alaska: Union Oil, Alaska Miscellaneous Report P-4.

3. Knapp, W. D. and Dalness, W. M., 1970, Progress Report on the Surface Geology of the Western Brooks Range, Alaska: Denver Division Geological Memorandum # 127.

4. Knapp, W. D., Ferguson, P. L., and Furer, L. C., 1971, Geology and Petroleum Prospects on the North Slope of Alaska: Denver Division Geological Report # 82.

5. Oles, K. F., Abrahamson, D. W., Hankinson, F. C., and Harrison, C. R., 1969, Geologic Field Report, Eastern Brooks Range, Alaska: Union Oil, Alaska Miscellaneous Report P-1.

ENCLOSURES

1. Index Map Amoco & Union Oil Surface Samples and Sections 1969-70

2. Brooks Range Regional East-West Permian/Triassic Cross Section, 1969-70 Surface Data, North Slope, Alaska.

3. Brooks Range Regional East-West Mississippian/Pennsylvanian Cross Section, 1969-70 Surface Data, North Slope Alaska.

4. Brooks Range Regional East-West Devonian Cross Section, 1969-70 Surface Data, North Slope, Alaska.

5. Surface 1969-71 Geochron Sample Index Map, Brooks Range Alaska.

6. Oil Seeps and Shows Index Map. Northern Alaska.
7. Source Rock Index Map, Northern Alaska.
8. 1970 Surface Data Point Hope Quad.
9. 1970 Surface Data Delong Mountains Quad.
10. 1970 Surface Data Misheguk Mountain Quad.
11. 1970 Surface Data Howard Pass Quad.
12. 1970 Surface Data Killik River Quad.
13. 1970 Surface Data Chandler Lake Quad.
14. 1970 Surface Data Philip Smith Mountains Quad.
15. 1970 Surface Data Arctic Quad.
16. 1970 Surface Data Noatak Quad.
17. 1970 Surface Data Baird Mountains Quad.
18. 1970 Surface Data Ambler River Quad.
19. 1970 Surface Data Survey Pass Quad.
20. 1970 Surface Data Wiseman Quad.
21. 1970 Surface Data Chandalar Quad.
22. Cape Dyer Measured Section
23. East Wulik River Measured Section
24. Flood Creek Measured Section.
25. Imikrak Creek Measured Section.
26. Hanging Glacier Mountain Measured Section
27. Ains Mountain Measured Section.
28. Autumn Creek Measured Section.
29. Cape Thompson Measured Section
30. Lower West Fork Wulik River Measured Section
31. Lower East Kelly River Measured Section
32. Lower Eli River Measured Section.
33. Upper West Fork Wulik River Measured Section.
34. Upper Agashashok River Measured Section.
35. Upper Alapah Creek Measured Section.
36. Slatepile Mountain Measured Section.
37. Nucleus Mountain Measured Section.
38. Nuka Ridge Measured Section.
39. Nachramkunga Mountain Measured Section.
40. Nasorak Creek Measured Section.

41. Nimiuktuk River Measured Section.

42. Mt. Bupto Measured Section.

43. Monotis Creek Measured Section.

44. Marshmallow Ridge Measured Section.

45. Marshmallow Mountain Measured Section.

46. Nuniviksak Ridge Measured Section.

47. Tiglukpuk Creek Measured Section.

48. Upper Omar River Measured Section.

DISCUSSION

General:

Geological discussions concerning the stratigraphy and interpretations of paleogeography of the sediments of the Brooks Range are set forth in Denver Division Geological Report # 82. Hence they will not be repeated here.

This memorandum is a compilation of data obtained from the 1970 Amoco Field Party. It includes: All Amoco 1970 measured sections with summaries of each, the 1970 sample register, and the 1970 field notes. In addition, regional time stratigraphic cross-sections showing all present surface paleontologic control, A geochron summary, a source rock summary and an oil seeps and shows summary are included.

The appendices contain copies of all company data and, where appropriate, a data source bibliography. In addition a short discussion for each of the various parts of this report follows.

Amoco 1970 Stratigraphic Section Summaries:

The following is a summary-description and an environmental interpretation and discussion of each 1970 measured section. In addition a short summary of presently available paleontologic and palynologic age data is included for each section.

Cape Dyer Section 1970 (Mississippian)

At Cape Dyer, Amoco Production measured an incomplete 1500 foot thick section, faulted at the top and covered below the base, which has been questionably assigned a Mississippian Age. This section is divisable into two lithologic units. The lower unit consists of 350 feet of interbedded, gray, non-fossiliferous, calcareous mudstones, claystones and black, carbonaceous shales.

The upper unit, seperated from the lower by a fault zone, consists of 1150 feet of interbedded, cyclical, non-marine, plant rich sandstones, shales, conglomerates, and coals. Sandstones in this upper unit are quartzose, poorly to moderately sorted, argillaceous, and micaceous. They exhibit scour and fill features, multidirectional cross laminations, ripple marks, and the lensoidal character commonly associated with fluvial deposits. Some tree trunks are preserved in upright position. A few of the sands have fair porosity and may be prospective reservoir beds in the subsurface.

Two different environments of deposition, which have been juxtaposed by faulting, are represented in this section. The lower

unit was probably deposited in a quiet, low energy, off-shore marine environment. The upper unit was deposited in a fluvial deltaic environment where deposition was rapid enough to preserve trees in living position.

The basal 340 feet of the section is barren of fossils and is undated. Palynomorphs give the upper 1150 feet an Osage to Meranec age with those in the uppermost two hundred feet closely resembling forms found in nearby Kayak sections.

East Wulik River 1970 (Kayak?, Utukok)

On the East Wulik River, Amoco Production measured 520 feet of predominantly gray, argillaceous limestone with lesser amounts of interbedded gray and black calcareous silts and shales. This incomplete section, eroded at the top and faulted at the base, has been assigned to the Utukok (Mississippian) Formation. However, since the base of the section is more argillaceous, it may instead represent part of the Kayak (Mississippian) Formation. Zones within the limestones show ripple marks and evidence of burrowing.

The depositional environment was that of a protected, marine, carbonate shelf with relatively shallow, but usually quiet enough water to permit deposition of silts and shales. One limestone layer grades upward from fine grained, carbonate muds, to a well sorted and winnowed grainstone. This indicates at least rare, probably local occurrences of higher energy water conditions.

Based on conodonts, the age of this section ranges from Fammenian to lower Osage.

Flood Creek 1970 (Lisburne, Sikukpuk?, Sadlerochit, Ivishak)

At Flood Creek, Union Oil (1969) measured 3260 feet of section which has been assigned to the Lisburne (Mississippian), Siksikpuk (Permian), Sadlerochit (Permian), and Ivishak (Triassic) Formations. During 1970 Amoco Production collected this interval for palynology and paleontology.

The lowermost 35 feet of the section is assigned to the Lisburne Formation, and consists of gray, crinoidal, lime packstones with black chert lenses.

The Siksikpuk Formation lies disconformably above the Lisburne and is 575 feet thick. It is divisable into three lithologic units. The lower unit, limited at the top and bottom by covered intervals, consists of fine grained, black to gray-black unfossiliferous limestones. The middle unit consists of dark gray, fossiliferous, brahiopod and solitary coral-bearing limestones. It grades into the upper unit which consists of 75 feet of coarser grained, fossiliferous limestones and some interbedded black, carbonaceous shales. This upper unit contains rare brachiopods, and burrows within the shales, and its limestones exhibit bioturbation and scour and fill structures.

Disconformably overlying the Siksikpuk is 35 feet of yellow-brown, fine-to-very-fine grained, quartz sandstone. It has been questionably assigned to the Sadlerochit Formation. Rare brachiopods occur at the base of the sandstone and the top two feet of the unit are marked by a red-brown weathered zone which may represent a paleosol.

The sediments resting on the "weathered soil zone" consist of 2615 feet of sediments divisable into two lithologic units and assigned to the Ivishak Formation. The lower Lithologic unit of the formation consists of 35 feet of iron stained conglomerate which grades upward, from the base, through sandstone to siltstone at the top. The upper unit consists of 2580 feet of dominantly gray-to-black, pyrite rich, rusty weathering siltstone interbedded with

thin layers of medium gray, unfossiliferous, fine grained limestone. The top of the Ivishak interval is covered making the section incomplete.

The environment of deposition of the Lisburne Formation was that of a shallow, marine, carbonate shelf. This is indicated by the fossil fauna as well as the depositional texture of the sediments.

The overlying Siksikpuk grades upward from an offshore, marine, carbonate shelf environment, through shallower water, nearer shore carbonates to a very near shore subtidal or intertidal environment.

The depositional environment of the thin, questionably Sadlerochit sandstone unit unconformably overlying the Siksikpuk was nearshore marine. This sandstone probably represents an offshore bar deposit. Subaerial exposure and weathering after deposition is indicated in the upper two feet of the unit by the paleosol.

The Ivishak represents a new cycle of marine transgression following the period of erosion indicated at the top of the Sadlerochit Formation. The Ivishak Formation grades upward, from basal conglomerate, through sandstones to siltstones at the top. This sequence was deposited in a very near shore or non-marine environment at the base and represents a deepening of the basin as it fines upward. The upper unit of interbedded limestone and siltstone represents deposition in an offshore, quiet water environment.

The basal 35 feet of the section, the Lisburne, contains a post-lower Morrowan conodont fauna, and probable Atokan forams. Palynology and megafossils indicate a Permian age for the Siksikpuk and lower to middle Permian brachiopods have been found at the base of the Echooka Formation. No diagnostic age fossils have been found in the Ivishak Formation but it disconformably overlies the Permian Sadlerochit.

Imikrak Creek 1970 (Siksikpuk, Shublik)

At Imikrak Creek, Amoco Production measured 360 feet of section assigned to the Siksikpuk (Permian) and Shublik (Triassic) Formations. Both the top and bottom of the section are covered.

The lower formation, the Siksikpuk is exposed for 310 feet and is faulted several times; thus its true stratigraphic thickness is unknown. It is dominantly interbedded, dark gray siltstone, shale, and claystone with minor chert lenses. The Siksikpuk grades upward into the Shublik Formation which consists of 60 feet of dominantly gray chert interbedded with minor black shales containing fossil clams. The probably conformable contact between the two formations is located within a ten foot covered interval.

The environment of deposition for the entire section is that of an offshore, quiet water, marine basin. The fossil clams were presumably planktonic types and hence do not indicate nearer shore waters.

All samples processed for age data were barren.

Hanging Glacier Mountain 1970 (Kayak, Lisburne)

On Hanging Glacier Mountain, Amoco Production measured 230 feet of section which is assigned to the Kayak (Mississippian) and Lisburne (Mississippian) Formations. The contact between the two formations is gradational and is picked arbitrarily at the top of the highest shale unit. The section is incompletely measured at the base because of covered outcrop and is eroded at the top.

It consists of a lower unit, 90 feet thick, of interbedded, lime wackestone and dark, slightly metamorphased shale. The lower unit grades into an upper 140 foot thick unit of crinoidal, lime grainstones with minor interbeds of packstone. Some of the limestones, especially those near the top of the section, contain finely crystalline dolomite. Dark chert lenses and nodules as well as shallow marine fossils are common throughout the section. The limited outcrop exposure of this section fits the transgressional model developed for the Kayak-Lisburne sedimentary sequence at other localities. The environment of deposition at the base ofof the section was one of alternating periods of quiet water deposition probably in a lagoon, with increasingly freqent, and longer periods of limestone deposition in shallow, agitated marine waters. Finally, open, marine shelf carbonates which characterize the upper unit of the section, were deposited.

This section is assigned an upper Meramec or lower Chester age based on a conodont assemblage found in a single sample.

Ains Mountain 1970 (Skajit?)

At Ains Mountain, Amoco Production measured 750 feet of dolomites which have been questionably assigned to the Skajit (Devonian) Formation. The section is eroded at the top and its lower portion is not exposed.

The basal lithologic unit of the section consists of very finely crystalline, gray dolomites. These dolomites occur in alternating cycles of intertidal sediments characterized by abundant burrows, and supratidal sediments with birdseye structures and broken, dessicated, concave up, algal mats. Overlying this unit, in a predominantly covered interval, are gray, largely recrystalized carbonates with some zones of massive, reef-like, porous dolomite rich in coral and other fossil debris.

The environment of deposition grades upward, in pulses, from supratidal to shallow, offshore marine. This is thus a transgressive sedimentary sequence.

This section of Skajit limestone is Givetian in age as indicated by megafossil determinations.

Autumn Creek 1970 (Shublik)

The Autumn Creek section consists of 230 feet of black and gray, to varicolored, very thin bedded siltstones, mudstones, shales, and bentonites with limestones occurring at both the top and base. The measured section is incomplete because neither its top nor its base is exposed. The sediments measured are assigned to the Shublik (Triassic) Formation. Fossils of large planktonic (?) pelecypods occur at intervals throughout the section. The limestones at the top and base of the section are argillaceous, sporadically interbedded with dark fissile shales, have fetid odor, and contain gilsonite filled vugs and veins. Mudstone and shale units between the limestone layers are intermittenly calcareous, ferruginous, and contain phosphate nodules.

The environment of deposition was that of a quiet, offshore basin with reducing bottom conditions favorable to the deposition and preservation of phosphates. Bentonites indicate nearby volcanic activity.

Palynomorphs indicate an upper Triassic to lower Jurassic age for this section. A more precise time division was not possible due to poor preservation of the palynomorphs.

Cape Thompson 1970 (Utukok)

At Cape Thompson, Amoco Production measured 190 feet of interbedded, gray, limestones, chert, mudstones, silts and shales

which have been assigned to the Utukok (Nasorak-Mississippian?) Formation. The entire section is rich in shallow water, marine fossils including crinoids, corals, brachiopods, and pelecypods. The section is incomplete because it is faulted at the base and has its upper portion covered.

The environment of deposition was that of a shallow protected marine shelf. Enough fine detrital sediment was present to cause periodic deposition of shale and silt layers within the normal carbonate depositional sequence.

Conodont faunas from the upper half of this section are upper Meramec or lower Chester in age.

Lower West Fork Wulik River 1970 (Lisburne, Siksikpuk)

At lower West Fork Wulik River, Amoco Production measured an incomplete section of Lisburne (Mississippian) 350 feet thick. The section is incomplete because its top is in fault contact with 50 feet of overlying red and green-gray chert float assigned to the Siksikpuk (Permian) Formation and its lower portion is covered. The entire section may be overturned because colonial coral heads were found in inverted growth positon.

The lower 180 feet of the Lisburne consists of gray, coral, brachiopod, and crinoid rich, lime wackestones and packstones. It also contains scattered zones of burrowed sediment, rare crossbedding, and abundant dark chert nodules, lenses, and beds. The upper 170 feet of the Lisburne unit is chert rich, lime wackestone and packstone similar to the lower 180 feet except for the absence of the fossils and burrowed sediments.

The depositional environment is that of a shallow, nearshore marine shelf. A slightly deeper, farther off shore environment may be indicated by the absence of fossils in the upper 170 feet of the section. If the section is overturned, then it represents a regressive sequence rather than a transgressive one.

Conodont and foram faunas yield an upper Meramec age for the Lisburne part of this section. The Siksikpuk, overlying the Lisburne, is barren of fossils.

Lower East Kelly River 1970 (Kayak)

At Lower East Kelly River, Amoco Production measured approximately 1150 feet of section assigned to the Kayak (Mississippian) Formation. The section is incomplete because of erosion at the top, a covered basal portion and an unknown amount of section missing, or repeated, by a fault zone 400 feet from the base. The 400 feet of section below the fault zone is argillaceous, crinoidal, and brachiopodal limestone interbedded with dark gray, calcareous shales. Above the fault zone, the section is composed of 750 feet of dominantly crinoidal, lime wackestones and mudstones with an upward increase in occurrence of packstone. There is minor dark chert throughout the section.

Since the Kayak has been fitted to a transgressive depositional model at other North Slope localities by the U.S.G.S., it is assumed that the depositional environment indicated in this section grades upward, in pulses, from a near shore, quiet or protected marine environment to a more open, marine carbonate shelf. The marine fauna in the section indicate a shallow marine depositional environment and not a deeper, offshore basinal one.

The upper half of this section, based on conodonts, is upper Meramec or Chester in age. The lower half lacks diagnostic fossils.

Lower Eli River 1970 (Skajit)

At the Lower Eli River, Amoco Production measured 1950 feet of dolomites and limestones which have been assigned to the Skajit (Devonian) Formation. The section is incomplete because its top is in fault contact with the overlying Eli Formation (Mississippian) and its base is covered. It is composed of two lithologic units. The lower unit is 1625 feet of crystalline, vuggy, dolomite which contains fossil hash, stromatoporoids, and burrows with amounts of each increasing upward. Several zones of stromatoporoid biostromes and some small reefal(?) buildups are present about 1100 feet from the base of the section. There are also minor, thin, silty layers near the top of the lower unit. The upper unit is made up of 325 feet of gray, recrystalized, limestone. There are minor stromatoporoids preserved near the base of this upper unit and some silty layers occur near its top.

The environment of deposition for the section was shallow, nearshore marine to probably intertidal for the highly burrowed units. Periods of slightly deeper water deposition may be indicated at the base of the section by the fewer number of stromatoperiods and burrow features preserved there.

The upper 350 feet of the section is Frasnian in age based on evidence from megafossils and conodonts. However, poor preservation of fossils in the lower 1600 feet allow only tentative dating as Frasnian or Givetian.

Upper West Fork Wulik River 1970 (Kayak, Lisburne)

1735 feet of sediments assigned to the Kayak (Mississippian) and Lisburne (Mississippian) were measured on the upper west fork of the Wulik River. The top of the section is eroded and the base is covered.

The lowermost 175 feet of section are assigned to the Kayak Formation and consist of interbedded black, calcareous shales and dark gray, argillaceous lime packstones and wackestones with lenses and nodules of black chert. Fossils are common and include crinoids, brachiopods, solitary and colonial corals and rare nautiloids.

The Lisburne conformably overlies the Kayak, and is 1560 feet thick. The contact with the Kayak is gradational, and is arbitrarily picked where the sediments cease to be argillaceous. The section consists of interbedded gray, fetid, lime packstones, wackestones, rare grainstones, and irregular gray to yellow chert nodules and lenses. Fossils present included crinoids, solitary and colonial corals and brachiopods. There is a biostromal layer about 100 feet from the top of the section composed of corals.

The depositional environment for the argillaceous and siltstone bearing Kayak was a protected marine shelf or lagoon. The section grades upward into the non-argillaceous, open marine shelf carbonates of the overlying Lisburne. This, as previously established, is the normal transgressive sequence represented by the Kayak-Lisburne sediments.

Conodont faunas give the Lisburne part of this section a Mississippian age, with the upper 900 feet being specifically upper Meramec. A Mississippian age has been determined for the Kayak.

Upper Agashashok River 1970 (Skajit)

Amoco Production measured 2350 feet of sediments on the Agashashok River which are assigned to the Skajit (Devonian) Formation. The section is faulted at the base and at the top. It is divisable into six lithologic units labeled A through F from bottom to top.

The lower unit, A, is 110 feet thick and consists of gray massive recrystalized limestones with cross cutting calcite veins.

Unit B is 75 feet thick and consists of thin to medium bedded alternating layers of gray laminated algal stromatolites and lime mudstones/wackestones. The number of algal laminations increases near the top and calcite veins similar to those in unit A are present.

Unit C is 655 feet thick. It consists of interbedded gray lime mudstones/wackestones and biostromal boundstones made up of colonial coral heads, domal and mat shaped stromatolites, and small branching stromatoporoids. Most of the lime mudstones are finely crystaline and unfossiliferous.

Unit D is 390 feet thick. It is dominantly gray finely crystalline, argillaceous, lime mudstones which contain abundant branching stromatoporoids relatively common algal domes and mats, and occasional colonial coral heads. Rare silicious nodules are also present.

Unit E is 1070 feet thick. It consists of fetid, argillaceous, sparsely fossiliferous, lime mudstones and wackestones. The fossils include rare allochthonous coral heads and algal laminations. The unit contains black siltstone layers which increase upward in abundance while fossils simultaneously decrease in abundance.

The uppermost unit, F, overlies Unit E with fault contact. Lithologically, it consists of massive, highly recrystalized limestones of which only the basal 50 feet were examined. They are similar in appearance to those at the base of the section in Unit A.

The depositional environment of this section grades upward from possibly intertidal in the stromatolite rich Unit B through shallow marine shelf of the coral, algae and stromatoporoid bearing C & D units to basinal in the silty Unit E.

An environmental interpretation of the recrystalized massive limestones of Units A and F is not attempted. The presence of algal stromatolite and stromatoporoids throughout the section indicates relatively shallow water throughout. The coral heads algae and stromatoporoids within the shallow shelf zone appear to be in growth position while those within Unit E are allochthonous. The ones in Unit E were probably washed by storms or currents into its deeper, quiet, silt depositing environment.

Megafossil identifications yield a Frasnian age for the lower 800 feet of this section, with the basal 250 feet possibly being Givetian. No age dates have yet been obtained for the upper 1500 feet of the section.

Upper Alapah Creek 1970 (Lisburne)

Cherty limestones 2700 feet thick, assigned to the Lisburne (Mississippian) were measured on Upper Alapah Creek. The lower contact with the Kayak shale is approximately located within a rubble covered slope. The Upper boundary is a fault.

The section grades upward from gray coarse grained, ripple marked, lime grainstones to interbedded gray lime packstones, wackestones and mudstones at the top. There is a large percentage of black chert present in the form of lenses, nodules and beds; some zones near the top are 75% chert. Fossils are abundant in the limestones and include crinoids, colonial and solitary corals, brachiopiods, and bryozoans. Many of the limestones have a fetid odor.

The environment of deposition for these sediments was on an open marine shelf. Water energy was high enough at the base of the section to allow formation of grainstones and ripple-crossbedded fossil coquinas. Slightly lower energy deposition occurred higher in the section.

Conodonts suggest a Mississippian age for the basal 300 feet of this section. The upper 2400 feet of the section is Meramec to lower Chester based on megafossil and foram determinations.

Slatepile Mountain 1970 (Kanayut)

1400 feet of section assigned to the Hunt Fork Formation (Devonian) were measured at Slatepile Mountain. The section is incomplete because it is inaccessable at the top and poorly exposed at the base.

The section consists of interbedded, quartzose sandstones and black, micaceous siltstones and shales. The sandstones are fine to medium grained, well sorted, well rounded and slightly calcareous. They are also current crossbedded, ripple marked, and have minor chert grains present. The percentage sandstone increases upward in the section and near the top, scour and fill channels become more common.

The siltstones and shales are calcareous, and micaceous. They contain ripple marks, mudcracks, burrows, and plant fragments. These features increase in number upward in the section; only burrows were noted in the lower portion of the section.

The depositional environment was nearshore marine to tidal flat. This is indicated by the plant rich, ripple marked, mud-yfcracked, siltstones and shales. The sandstones are deltaic tidal channel and bar deposits. Marine fossils although not found in this particular section, have been found elsewhere in the formation. The general upward increase of sands, plant fragments and current features indicates a shallowing trend; and thus, a regression is represented. Elsewhere, the gradationally overlying Kanayut conglomerate member is a non-marine deposit.

Poorly preserved palynomorphs indicate a probable Frasnian age for the section.

Nucleus Mountain 1970 (Utukok, Lisburne)

980 feet of section assigned to the Utukok (Mississippian) and Lisburne (Mississippian) Formations were measured at Nucleus Mountain. The section is incomplete because it is eroded at the top and covered at the base.

The lower 780 feet of the section, the Utukok, is divisable into three lithologic units. The lower unit consists of dark gray argillaceous, lime packstones containing crinoids and brachiopods. The middle unit is 280 feet thick and contains three covered intervals totaling 135 feet, the remainder is fractured black shale and siltstones with the uppermost 55 feet of the unit composed of medium grained calcareous quartz sandstone. This sandstone contains burrows and cross laminations. There are also minor, thin, sandy, lime wackestones at the base of the sandstone layer. Overlying the middle unit is 440 feet of dominantly argillaceous, lime wackestones. Minor crinoidal packstones are present and near the top of this unit there are rare thin, silicious siltstone layers. The limestones are cross laminated and fossiliferous containing burrows, trails, crinoids, brachiopods, pelecypods and solitary corals. The upper unit becomes finer grained and more argillaceous near its top.

Overlying the Utukok is 200 feet of section assigned to the Lisburne Formation. The contact between the two formations lies within a 50 foot covered interval which is probably a fault zone. This Lisburne consists of lime packstones and wackestones interbedded with dark chert. The entire exposed portion of the Lisburne is fossiliferous containing crinoids, solitary corals, and brachiopods with a few bioturbated zones occurring at the base of the formation.

The depositional environment of the section grades upward, in pulses, from protected, marine, carbonate shelf and lagoon for the Utukok to open, marine, carbonate shelf for the overlying Lisburne. This interpretation again fits the established transgressional model for the Lisburne formation.

Based on conodonts, the upper 200 feet of the Utukok and the basal Lisburne are both upper Kinderhook. The basal 600 feet of the section has not been dated.

Nuka Ridge Composite 1970 (Utukok?)

5100 feet of section assigned to the Utukok (?) (Mississippian) Formation were measured on Nuka Ridge. The section is eroded at the top, and the basal contact is covered. Outcrop exposures are scattered with many intervening covered intervals, which, based on float observations, are dominantly shale and siltstone. As about 50% of the section is covered, it is difficult to subdivide it into lithologic units.

The rocks consist of interbedded limestone, sandstone, siltstone, shale and chert. The limestones are most abundant at the top of the section and are predominantly fossiliferous lime packstones with minor sand and silt beds and lenses. Fossils include, crinoids, brachiopods, cephalopods, trilobites, and gastropods. Minor dolomites are present in the section and the silts and shales are black, calcareous, and contain trilobites, clams and rare inarticulate brachiopods. The sandstones are subangular, medium to coarse grained, poorly sorted, calcareous, and arkosic. They contain some cross laminations, channeling, and common reverse grading. Fossils found in the sandstones are productid brachiopods and crinoid debris. A few thin zones of green, argillaceous, chloritic (?) sandstones occur interbedded with limestones at the top of the section. Cherts are varicolored (especially red) and reach 500 feet in thickness. Occasional fossil debris occurs in silty lenses within these cherts.

The depositional environment of the section is marine. As interpreted by Sable and Tailleur (1963) the poorly sorted, fossiliferous sandstones, represent beach or near shore bar deposits, while the silts and shales represent basinal deposits of fine clastics which washed through the higher energy nearer shore environment. The beach and bar sand interpretation is likely, however, the silts and shales may represent deposits in shallow protected areas lying behind barrier bars or even lagoonal deposits. Overall, the section represents a series of deposition cycles along a shifting strandline.

The age of these sediments ranges from upper Meramec to Permian, but the boundaries between the various age rock units are not precisely determined. The upper part of the section is structurally complex. A. K. Armstrong (USGS, 1971 Personal Communication) has also noted faults and repeated faunas at the top of the section.

Nachramkunga Mountain 1970 (Kanayut, Kayak, Lisburne)

2170 feet of section assigned to the Stuver member of the Kanayut (Devonian), Kayak (Mississippian), and Lisburne (Mississippian) Formation were measured at Nachramkunga Mountain. The complete stratigraphic thickness of all three formations is unknown because of faulting, erosion and covered outcrop. Only the transitional contact zone between the Kayak and Lisburne is visible.

The basal 100 feet of section is assigned to the Stuver member of the Kanayut Formation. It consists of interbedded black non-calcareous, shale and siltstone. One thin bed of brown, iron rich, cross laminated sandstone is also present. The silts contain plant impressions, tracks, and trails on their bedding surfaces. The silts and sandstones weather "rusty" brown.

Overlying the Stuver Member, in fault contact, is 600 feet of section assigned to the Kayak Formation. The Kayak is divisable into two units. The lower lithologic unit is 250 feet of black, highly contorted shale. Overlying this shale unit is a 350 foot covered interval which contains, 45 feet above its base, a 15 foot thick, fetid, lime packstone containing crinoids, bryozoans and occasional brachiopods. The remainder of the covered interval is predominantly black shale as indicated by the float present. The contact between the Kayak and Lisburne is here arbitrairly picked at the top of the upper covered interval which is interpreted, on the basis of float observation, to be the uppermost black shale zone in the gradational sequence.

The Lisburne conformably overlies the Kayak and is 1460 feet thick. It consists of three lithologic units. The basal unit is 90 feet of thick-bedded, gray dolomite in which the crystal size of the dolomite grains increases upward. Mega ripples are preserved near this unit's top and a few thin, crinoidal, dolomite-replaced grainstones are also present. The middle unit is seperated from the lower by a 25 foot covered interval, which is here included as part of the middle unit. Above the covered zone, the middle unit consists of 840 feet of bioclastic limestones which grade upward from coarse grainstones, through packstones, to interbedded packstones and wackestones at the top. Fossils found at intervals within this unit include crinoids, solitary corals, bryozoans, and brachiopods. Fetid zones are common and dark chert is present throughout in the form of beds, nodules, and lenses. The upper lithologic unit consists of 800 feet of predominantly dolomitic lime packstones with interbedded limey dolomites, and dark chert. This upper unit is less fossiliferous than the middle one.

The environment of deposition of the Stuver Member was a fluvial river valley. The plant-rich shales were probably overbank deposits while the sandstones were channel deposits. The depositional environment of the Kayak is lagoonal, grading into a more open marine shelf. This fits the transgressive depositional model established by Armstrong et. al., (1969). The environment of deposition of the Lisburne grades upward, in pulses, from high energy, shallow, marine shelf to slightly deeper water or farther offshore shelf. This is indicated by the upward decrease in the grainstone content of the section. Interpreted in this way, the Lisburne also fits the transgressive model established by Armstrong et. al.(1969).

A single foram sample at the top of the section is Meramec.

Nasorak Creek 1970 (Lisburne)

1230 feet of section assigned to the Lisburne (Mississippian-? Devonian) were measured at Nasorak Creek. The section is incomplete because it is faulted at the top and covered at the base. Other faults within the section render the original stratigraphic thickness impossible to estimate. It is divisable into three lithologic units of which the lower unit, consists of 760 feet of interbedded lime packstones wackestones, grainstones, and dark chert. This lower unit is fossiliferous, containing brachipods, crinoid, coral and bryozoan debris with some of the colonial corals forming biostromal type buildups. A few argillaceous limestone zones are also present. The middle unit is in fault contact with the lower, and is 260 feet thick. Its lithology consists of interbedded limestones, dolomites and dark chert. The limestones are similar to the ones in the lower unit except that they exhibit more scour-and-fill and cross-lamination features. The dolomites are finely crystaline and they appear to have replaced limestones similar to those in the lower unit as they contain the same fossils and exhibit the same sedimentary features. The upper unit consists of 210 feet of dark gray, bedded chert. This chert exhibits relict cross-bedding, packstone and grainstone textures, fossils, and like the dolomites, appears to have replaced carbonates similar to those in the lower two units. The upper boundary of the unit is a fault.

The environment of deposition for the entire section appears to have been that of a shallow open, marine shelf. Short periods of slightly shallower water, higher energy deposition of grainstones alternated with periods of deeper, calmer water deposition of wackestones.

Conodont faunas indicate an upper Meramec age for the entire carbonate portion of this section. The cherts comprising the upper 200 feet of the section are undated.

Nimiuktuk River 1970 (Noatak)

900 feet of section assigned to the Noatak (Mississippian) Formation were measured on the Nimiuktuk River. The section is incomplete because it is faulted at the top and its basal contact is not exposed. The entire section consists of thin bedded fine to medium grained, quartzose sandstones, interbedded with dominantly covered, dark gray, micaceous shales. The sandstones, and some of the shales are limonite rich, so the section weathers yellow-brown. Fossils are absent and the sandstones commonly exhibit crossbedding.

The depositional environment was probably non-marine to very near shore marine (deltaic?). The crossbedded sandstones indicate relatively strong currents while the shales represent deposition in very quiet water.

Samples processed for age data were barren.

Mt. Bupto 1970 (Kayak(?), (Lisburne)

1100 feet of section assigned to the Kayak (?) (Mississippian) and Lisburne (Mississippian) Formations were measured at Mt. Bupto. The section is incomplete because its top is eroded and its base is covered.

The basal 30 feet of the section is Kayak(?). It consists of a lower 10 foot lime packstone, containing coral, brachiopod, and crinoid fossils. Overlying this packstone is 20 feet of dark gray shale and silty claystone. The shale and claystone weathers yellow-brown and contains burrows, brachiopods, bryozoans, and trilobites. The boundary between the Kayak and Lisburne is arbitrarily drawn at the top of the uppermost shale which is the dark gray shale overlying the packstone in this sequence.

The Lisburne conformably overlies the Kayak and is 1060 feet thick. It is divisable into two lithologic units. The lower unit is ten feet thick and consists of yellow, soft, crystaline, vuggy dolomite containing a few unidentified fossil fragments, and minor interbedded black cherts. The upper unit is 1050 feet thick and includes, at its base, a 350 foot covered interval which, based on observation of float, is interpreted to be the same lithology as the exposed upper part of the unit. The true stratigraphic thickness of this upper unit is unknown because of faulting indicated by breccias. The exposed portion of the upper unit consists of light gray dolomite and dark chert. The dolomite is vuggy due to leaching of crinoidal debris and many of these vugs contain dead oil. The chert, both bedded and nodular, is comon throughout the unit especially near the top where the uppermost 100 feet of the section is dominantly chert.

The depositional environment of this section grades upward from near shore marine to open, marine, carbonate shelf. This is indicated by the loss of the lagoonal type shales present in the Kayak. The rock sequence fits the transgressive, marine depositional model established for the Kayak/Lisburne sequence by Armstrong et. al., (1969).

Conodonts and megafossils indicate a probable Kinderhook age for the basal 40 feet of the section. The remaining 1160 feet

are undated.

Monotis Creek 1970 (Lisburne?)

150 feet of section assigned to the Lisburne (?) Formation was measured at Monotis Creek. The section was eroded at the top and covered below the base. It is divisable into two lithologic units. The lower 50 foot unit is primairly argillaceous lime wackestones, mudstones, and black chert with minor packstones. The packstones contain solitary coral, brachiopod, and crinoidal debris, while the wackestones, and mudstones are not fossiliferous. One, thin, phosphatic, oolite layer occurs near the base of the unit. This layer contains minor amounts of fracture filling Pyrite also. Fetid odor, bitumen-filled vugs and fractures are common throughout the lower unit. Overlying the basal unit is 100 feet of argillaceous lime mudstones which grade from thin bedded at the base to thick bedded near the top. The amount of argillaceous material increases upward in the unit and rare brachiopods, solitary corals, and crinoid debris occur at intervals throughout. Some pyrite filled, vertical burrows were also seen.

The depositional environment of this section was that of a shallow, marine, carbonate shelf edge where upwelling currents could precipitate calcium carbonate and phosphate. Water depth indicated by sediments at the base of the section was periodically shallow enough to allow formation of oolites and bioclastic packstones. The depositional environment changes upward in the section to deeper, quieter water where only fine sediment was deposited. Therefore, this is a transgressive rock sequence.

The basal 30 feet of the section have been dated, by conodonts, to be lower Chester. The upper 120 feet contained no diagnostic fossils but are probably also Chester.

Marshmallow Ridge 1970 (Kanayut, Kayak, Lisburne?)

1300 feet of section assigned to the Kanayut (Devonian), Kayak (Mississippian), and Lisburne(?) (Mississippian) Formations were measured at Marshmallow Ridge.

The portion Kanayut Formation measured at the base of the section is 320 feet thick and contains two lithologic units. The lower 260 foot unit consists of interbedded, black, plant-rich shales, quartzose, fine grained sandstones, and ferriginous, quartz and chert pebble conglomerates. The upper Kanayut unit is 60 feet of black, plant rich shale.

Conformably overlying the Kanayut Formation is the Kayak, which is divisable into three lithologic units. The basal unit consists of 50 feet of red weathering, well sorted, fine to medium grained, quartz sandstone and black, ripple marked shales. There are burrows and cross laminations within the sandstones. This basal unit grades upward into the 380 foot thick middle unit which consists of black, plant-rich, non-calcareous, burrowed shales. These shales in turn grade upward into the upper 450 foot thick unit of interbedded, gray, calcareous shale, and gray, fossiliferous, lime packstones, and grainstones.

Overlying the Kayak is 100 feet of interbedded lime packstones, grainstones and wackestones containing crinoids, brachiopods, corals and minor dark chert nodules. This unit is probably the basal portion of the Lisburne Formation. The contact between the Lisburne and Kayak is gradational and is arbitrairly picked at the top of the uppermost shale.

The environment of deposition for the section grades upward from the non-marine, fluvial Kanayut through the transitional non-marine, lagoonal, and near-shore-marine Kayak to the open marine shelf carbonates of the Lisburne.

Palynomorphs give the Kanayut at the base of the section a Fammenian age. The overlying Kayak Formation is all lower Mississippian in age.

Marshmallow Mountain 1970 (Kanayut, Kayak)

At Marshmallow Mountain, Amoco Production measured 1985 feet of section assigned to the Kanayut (Devonian) Formation and 80 feet section assigned to the Kayak (Mississippian) Formation. The lower 20 feet of the measured section consists of red weathering, chert and quartz pebble conglomerate with some chert clasts a maximum of 6 inches in diameter. This 20 foot interval is at the top of the conglomerate member of the Kanayut Formation. The Stuver Member of the Kanayut conformably overlies this conglomerate and is divisable into three lithologic units. Its lower unit consists of 785 feet of interbedded, fine grained, well sorted, quartz sandstones, and black, carbonaceous, plant rich shales. The middle unit is 1100 feet thick. Its basal 350 feet is crosslaminated, quartz sandstone similar to that seen in the lower unit. This sandstone grades upward into 750 feet of uniform, structureless chert and quartz pebble conglomerate which is similar to the conglomerate member with the largest clasts two inches in diameter. Overlying the conglomerate of the middle unit of the Stuver Member is 80 feet of ferruginous, black shale. Conformably overlying the Stuver Member is the Kayak Formation of which only the basal eighty feet was measured. It consists of fine, quartzitic, cross laminated sandstone.

The environment of deposition for this section was either that of a non-marine alluvial fan, or more likely, that of a fluvial, nonmarine flood plain.

Palynomorphs from the base of this section are Fammenian in age. Forams indicate an upper Mississippian age for the upper 200 feet.

Nuniviksak Ridge 1970 (Utukok, Lisburne)

On Nuniviksak Ridge, 4150 feet of sediments assigned to the Utukok (Mississippian/Devonian?) and Lisburne (Mississippian) Formations were measured. The lower contact of the Utukok is covered and only 50 feet of the overlying Lisburne were measured in 1970.

The Utukok Formation consists of interbedded sandstones, siltstones, and limestones. The base of the section is predominantly calcareous sand and silt, whereas argillaceous limestones dominate in the upper portion of the section. The upper 170 feet of the Utukok is entirely argillaceous limestone. Sandstones are quartzose, fine to very fine grained, calcareous, argillaceous and crossbedded. They contain brachiopods, abundant worm tracks, trails and bioturbated zones. Some of the sandstones are also ferruginous and weather a characteristic yellow-brown. Siltstones are dark gray, crossbedded and contain brachiopods, worm tracks, trails and bioturbated zones. Most are calcareous and many are ferriginous and weather yellow brown. The Utukok limestones are argillaceous, crinoid and brachiopod-bearing, packstones and wackestones in the lower portion of the section. Most fossils occur in scattered lenses. At the top of the section, the limestones become argillaceous, lime mudstones with crinoids, brachio- contact is arbitrarily chosen where chert and the limestones become less argillaceous. The 50 feet of Lisburne measured consists of gray, crinoidal lime mudstones which have a fetid odor and unlike the Utukok contain interbedded black chert.

The depositional environment was marine deltaic. This is indicated by the presence of abundant brachiopods, worm tracks, trails, and bioturbated sediments, plus the thick, highly crossbedded nature of the sediment. The upward increase in carbonate and simultaneous decrease in coarser clastics indicates a loss of clastic source or a shift of clastic deposition to a new location remote from this one.

Conodont faunas in this section range in age from upper Fammenian to Kinderhook.

Tiglukpuk Creek 1970 (Shublik)

390 feet of sediments assigned to the Shublik (Triassic) Formation were measured at Tiglukpuk Creek. The section is incompletely measured because an unknown amount of Shublik was covered at the base. The contact with the overlying Tiglukpuk (Jurassic?) is abrupt and probably conformable.

The Shublik consists of interbedded dark lime mudstones, black shales and black chert. Bentonites are present in the lower half of the section. The limestones are argillaceous, ferruginous, phosphatic and contain pelecypods, ammonites, and rare crinoidal debris. Shales and generally unfossiliferous and the cherts are thin bedded.

The environment of deposition indicated by the phosphatic and ferruginous, fine grained sediments is basinal.

Palynology has yielded a definite Triassic and possibly lower Triassic age for this section.

Upper Omar River 1970 (Skajit? Utukok)

On the Upper Omar River, Amoco measured 1870 feet of section assigned to the Utukok (Devonian/Mississippian) and Skajit (?) (Devonian) Formations. The top of the section is eroded and its base is covered.

The basal 475 feet of the measured section consists of strongly foliated, metamorphosed, calcareous, fine to medium grained, quartz sandstones which contain a few augen-like structures. Limonite grains present cause the sands to weather a yellow-brown. This unit rests on a structurally complex and dominantly covered zone which in turn overlies light gray probable Skajit limestones. Neither this covered zone nor the Skajit are a part of the measured section. Overlying the sandstone unit is a calcareous unit 1370 feet thick. It consists of interbedded, gray, silty and argillaceous very thin to massive bedded recrystalized limestone and calcareous siltstone. The basal half of this unit weathers yellow-brown to bright orange while its upper half weathers a normal gray color. A few cross-laminations and ripple marks are present in the limestones and burrows occur on many bedding planes throughout the section. The top of the unit is faulted and the overlying 30 feet of Skajit(?) is light gray, coarsely recrystalized limestone similar to that seen below the section's base.

The sandstone unit at the base of the section probably was deposited as nearshore marine bars. The limestone unit was deposited in a lagoonal or intertidal environment as indicated by the burrows, ripple marks, silt content, and its red weathering character.

A lower Mississippian age date based on conodonts was determined 1360 feet from the section's base. All other samples are barren.

Paleontology:

Appendix "C" contains copies of all surface paleontologic data. This includes mega fossil, conodont, small foram and large foram reports. Any additional paleontologic work will be added to this report as it is received.

All paleontologic age determinations, on rocks older than Jurassic have been interpreted and results shown on three regional East-West time stratigraphic cross-sections (Encls. 2,3, & 4). Not enough data on sediments from the Jurassic to the recent is presently available to warrant construction of a cross-section for these time periods.

Palynology:

Appendix "D" contains all palynological reports. Additional palynologic age determinations on Permo/Triassic sections in the Eastern Brooks Range are presently being completed. This age data should resolve problems of unconformity placement and facies relationships that exist between the Permian Siksikpuk to the west and Permian Echooka to the east (Encl. 2). If the ages of the two formations are the same, then the Echooka is the nearshore facies of the more basinal Siksikpuk and no unconformity exists between the two as shown. Palynologic age determinations have also been interpreted and the results plotted on the three regional east-west cross-sections (Encls. 2,3 & 4).

Geochron:

During the 1969-70 Alaska field seasons in the Brooks Range, Amoco Production collected 24 geochron samples. 16 of them have been dated. An additional three samples were collected by Union Oil in 1970 and two of these have been dated (see Encl. 5).

Five of the dates obtained are for metamorphic events and the remaining thirteen are from igneous rocks of various types. Twelve of the Potassium-Argon dates fall into the upper Mesozoic period between 55 and 160 million years ago. This supports the idea of a Cretaceous metamorphic-plutonic event (Churkin, 1970).

A group of U.S.G.S. Mid-paleozoic radiometric dates also supports the idea that an orogeny to the north of the present Brooks Range provided the source for the Devonian Kanayut Conglomerate wedge (Churkin, 1970).

In 1971, an additional twenty geochron samples were collected by the Amoco Field Party in the south eastern Brooks Range and Fort Yukon basin. None of these samples has yet been dated. Dates of metamorphism from these samples may or may not strengthen the theory that metamorphic grade in the Brooks Range increases gradually in a southerly direction and that many of the metamorphosed sediments there are Devonian in age.

Union Oil's sample RRR 190-A (granite from Mt. Hubley) has been dated, by biotite concentrate Ar^{40}/K^{40}, to be 148± 7 million years (Middle Jurassic). This date indicates that the granite intruded the Lisburne (Mississippian) limestones and that the Lisburne did not "onlap" the pre-existing granite pluton.

The U.S.G.S. (Tailleur 1971) believes that tectonics in the Western Brooks Range is Laramide and younger. But radiometric dates on samples 1099, 1083, 1072 etc., are pre-Laramide and gravity/magnetic data (Reno, 1971) indicates that igneous outcrops nearby have roots. Therefore, sediments in windows containing these older igneous intintrusives must be in place. Thus the surrounding thrust plates are thin and this precludes the idea that in this area there is a great thickness of thrust sheets piled one on top of another. Therefore drilling is possible in the area.

Appendix "D" contains a list of references for geochron data sources, and copies of all company radiometric age reports. The U.S.G.S. is compiling and will forward to Amoco a completed map for their presently available geochron data. This data will be incorporated into Appendix "D" when it is received.

Source Rock:

Copies of Amoco's and Union's 1969-70 source rock data are included in Appendix "G". Enclosure 7 is a map of Northern Alaska

containing all presently available surface source rock data.

Interpretations based on Amoco source rock analyses are included in the various technical reports. Since changes in analyses and interpretation of data have occurred one should examine the most recent reports in Appendix "G" for the up-to-date thinking.

Source beds other than the Cretaceous and Jurassic include the Permo-Triassic, Mississippian (Kayak) and Devonian (Hunt Fork) shales. Few samples have been run on the Paleozoics. Analyses of them should be made and the results incorporated into this memo.

Oil Seeps & Shows:

A compilation of oil seep, oil shale and oil bearing outcrop data in Northern Alaska is contained in Appendix "H". This data is summarized and plotted on a map (Encl. 6). In addition, a bibliography for the seeps and shows data is included as Appendix "H".

It is obvious, by glancing at the map, that Northern Alaska is rich in exposed hydrocarbons. The majority of oil seeps along the Arctic Coast are from Cretaceous age rocks. Many of the oil seep areas have been drilled (especially in NPR-4) but several have not such as the Ungoon Point seep.

A bibliography listing data sources is included at the beginning of the Appendix. Additional new data will be added as it is received.

Petrology:

Petrologic studies of surface samples, with associated porosity permeability and x-ray studies, will be undertaken by Gordon Henderson in the near future. He will issue a seperate report on this work.

APPENDICES

A. Section Register

B. Sample Register

C. Paleontology Data

D. Palynology Data

E. 1970 Field Notes

F. Geochron Data

G. Source Rock Data

H. Oil Seeps and Shows Data