

PRELIMINARY GEOLOGICAL REPORT

PERMITS 1334, 1335, 1336,

1474 and 1475

PEEL PLATEAU AREA

YUKON TERRITORY

December, 1957

BULLOCK, HUGHES & TILLMAN LTD.,
CONSULTING GEOLOGISTS

CONTENTS

Abstract

| | |
|--|----|
| Introduction | 1 |
| Introductory Statement | 1 |
| Location and Area | 1 |
| Type and Method of Survey | 2 |
| Accessibility | 3 |
| Climate, Vegetation and Wildlife | 4 |
| Acknowledgements | 5 |
| Physiography | 8 |
| Physical Features | 8 |
| Drainage | 8 |
| Glaciation | 9 |
| History of Exploration | 11 |
| Geology | 13 |
| General Statement | 13 |
| Stratigraphy | 13 |
| Structural Geology | 25 |
| Conclusions and Recommendations | 29 |
| References | 31 |
| Appendix 'A' | |

ILLUSTRATIONS

Index Map in pocket

Geologic Map in pocket

Air photo mosaic in pocket

ABSTRACT

Surface geological reconnaissance mapping was conducted on Permits 1334, 1335, 1336, 1474, and 1475 during the summer of 1957. The study, designed to provide a preliminary evaluation of the acreage with respect to hydrocarbon potentialities, showed that a thick series of sediments underlie the permits. Porous Pennsylvanian sandstones and the possibility of reef conditions in the Upper Devonian offer good reservoir potentialities. Structural conditions, though difficult to map on a reconnaissance basis, offer some potential traps particularly along the western edge of the permits. Detailed surface field studies, designed to provide additional stratigraphic and structural data, are recommended.

INTRODUCTIONIntroductory Statement

The area dealt with in this report is located west of Peel River in the Yukon Territory. It lies within the Peel Plateau area which is currently undergoing extensive exploration for hydrocarbon accumulations. The purpose of this study and report is to evaluate the permit acreage with respect to hydrocarbon potentialities.

Location and Area

Yukon Territories Oil and Gas Permits 1334, 1335, 1336, 1474, and 1475 are located between Road and Trail Rivers west of Peel River in the Yukon Territory. They lie between Latitudes 66° 30' and 67° 00' N and between Longitudes 135° 00' and 135° 30' W. Permit 1336 contains 50,946 acres, Permits 1335 and 1475 contain 50,604 acres each and Permits 1334 and 1474 contain 50,262 acres each. A total of 252,678 acres are contained in the five permits.

Type and Method of Survey

The nature of the work done on the region was planned to evaluate the hydrocarbon potential of the acreage, using reconnaissance surface geological methods. The techniques employed during the summer involved the use of a helicopter expedited surface geological survey. Attitudes of the beds were obtained by either measurement with a Brunton compass or strike and dip estimation from the helicopter. Where it was impossible to land in order to examine outcrops, the helicopter was flown as close as possible to the rock units consistent with safety.

Surface geological studies were supported by local photogeological studies and by a compilation of published information. Field work was carried out from June 21st to June 26th and from September 17th to September 20th, 1957. Office work was carried out between October 1st and January 1st, 1957.

During the period of the field study,

the party was based at Ft. McPherson with fly camps established near the mouth of Road River. Supplies were purchased at Ft. McPherson and moved to Road and Trail Rivers by native river scow and Bullock, Hughes & Tillman Ltd.'s river boat. Aviation gasoline was supplied by the Imperial Oil Refinery at Norman Wells, Northwest Territories.

It is important for the reader to note that this report is of reconnaissance quality and should be regarded as preliminary in value pursuant to detailed studies.

Accessibility

The permit areas under discussion in this report are so located as to be reasonably accessible during summer months but rather more difficult of access during winter months. Peel River is navigable to shallow draft barges during June and July. Loads of 20 tons or more have been moved up as far as Caribou River from Ft. McPherson which is in turn served from outside points by regular freighting companies.

During winter months roads would have to be constructed to the permit areas. Tractor trains operate between Aklavik or East Three and McPherson but to utilize this facility an access road would have to be built from McPherson to the permits. A tractor train road, built from Dawson City to the Mackenzie River near Fort Good Hope as an aid to DEW Line construction, passes south of Peel River canyon. This road could be used to move heavy equipment into the permits if a connecting road were built from the permits south to meet the DEW line road (a distance of 70 airline miles).

Charter Flying services are available from Aklavik, Northwest Territories, Dawson City, Yukon Territory, and Fort Yukon, Alaska. These points are each served by regular airline flights.

Climate, Vegetation and Wildlife

Low temperatures and light precipitation are characteristic of the region in which

the permits are located. The average mean temperature for Aklavik is reported to be 16° F, while the average total precipitation is approximately 9 inches. Snow begins to fall in early September and has mostly gone by mid-June.

Temperatures of 80° F and higher are not uncommon in the summer time. During the field season of 1957 July proved to be the wettest month and August the dryest. Normally, wet unsettled weather occurs from August 15th to September 15th, when freeze-up commences. (The reader is referred to Appendix "A" for details of hours of daylight and related data.)

The area under discussion has a heavy bush cover composed mostly of stunted black and white spruce with underbrush of alder and dwarf willow. Mosses, lichens and sedges cover the ground and coarse 'moose' grasses are to be found along the water's edge. Muskeg is common in the area and makes walking difficult.

Wildlife is plentiful in the area. Caribou, moose, grizzly bear, wolves and ground

squirrel are numbered among these. (The caribou migrate northward into the tundra regions of the Arctic Plateau in early spring. There they give birth to their young and feed throughout the summer months. Late in August these herds of Caribou return from the tundra regions into the shelter of the wooded areas to the south where they winter.) Waterfowl, (ducks and geese) are plentiful along the rivers and in many of the lakes. Ptarmigan inhabit the hillsides and mountain ridges. The white or bald eagle is commonly found in this area. Whitefish, coney, grayling, trout and jackfish are present in many lakes and streams.

Acknowledgements

The writer wishes to express his appreciation to the members of the geological staff who ably assisted him in the field. Jack L. Tillman rendered valuable assistance through his stratigraphic studies, Daniel M. Johnson and Thomas M. Williams were willing and enthusiastic assistants. Thanks also is given to Glen H. Goodland, cook,

Ed Cronan, pilot of the helicopter, Barney Akins, helicopter engineer, and to John Langdon, pilot of the fixed wing aircraft. Without the help of each member the survey could not have succeeded.

PHYSIOGRAPHY

Physical Features

The area discussed in this report is located in the Peel Plateau area which is characterized by a flat table-land into which stream valleys have been etched. Along the western edge of the permits a series of low structural ridges mark the edge of the plateau area and the beginning of the foothills belt. Relief is moderate with elevations varying between 500 feet and 1,500 feet above sea level.

Drainage

The permit areas are drained by the Peel River drainage system which empties into the Arctic Ocean. Trail, Road and Vittrekwa Rivers, which are tributary to Peel River, traverse the permit areas. Their valleys are deep and U shaped in the eastern portion of the map area, but become shallow near their headwaters. The main stream

channels are braided.

The area is generally well drained.

Only a few lakes exist in the permafrost and these are probably caused by glacial clays. The direction of the main stream channels is in part controlled by bedrock structure particularly in the western portion where bedrock is more resistant. Underlying shales of the eastern portion of the area give rise to a well developed dendritic drainage system. Permafrost is universally present throughout this area. Muskeg covers all lowlands adjacent to streams and in the interstream areas.

Glaciation

Most of the area east of the Richardson Mountains has been glaciated by continental-type glaciers from the east and northeast. Huge glacial erratics of pink granite, granite porphyry and other igneous rocks are present in most of the stream valleys. Glacial boulder clays cover the area and are in some places host to Mammoth remains which

10.

have been frozen since glacial times. Erratics and glacial tills were noted from stream valleys and ridge tops within the permit area. At one location an esker-type deposit of rounded boulders was noted. Thickness of the glacial deposits vary from zero to 150 feet.

HISTORY OF EXPLORATION

Alexander Mackenzie was the first white man to explore the Mackenzie River. He made his first trip to the Arctic coast from Great Slave Lake via this route in 1789, making the return trip from Fort Chipewyan on Lake Athabasca in one hundred and two days! Sir John Franklin, in 1826, further explored the lower Mackenzie and Arctic coast. He was followed in 1848 by Dr. John Richardson, who had accompanied Franklin on his early trip.

Thomas Simpson and Peter Warren Dease, officers of the Hudson's Bay Company, carried on important exploration in the Arctic coast and Mackenzie River areas in 1837. Others of this same company were active in the Mackenzie River area for several years following.

William Ogilvie, sent out by the Department of Interior, Ottawa, in 1887, entered the Mackenzie Basin from Yukon by way of Porcupine and Bell Rivers, McDougall Pass and Rat River.

The Geological Survey of Canada continued this work and in 1888 R. G. McConnell descended the Mackenzie to the Peel which he ascended to Ft. McPherson. After making an exploratory trip up Mat River, he crossed to La Pierre House by way of Peel River portage, descended the Porcupine River and carried on exploration in the Yukon.

During the Second World War the Governments of Canada and the United States joined with oil companies in studying the Mackenzie River basin to locate oil for use in the Arctic regions as a measure for Hemispheric Defense. This project was successful in producing a vast amount of valuable geologic information and culminated in the Norman Wells oil field. Since that time most of the major oil companies have studied the area. Recently a great deal of attention has been centered on the Peel Plateau and Eagle Plains areas. This activity has resulted in one company drilling a well on the Eagle Plains side of the Richardsons at the same Latitude as the permits herein reported.

GEOLOGYGeneral Statement

The Peel Plateau, in which Permits 1334, 1335, 1336, 1474, and 1475 are located, is underlain by a thick series of sedimentary rocks. Structural deformation of the sedimentary strata has been very moderate in most of the area. Foothills-type structures occur in the western portion of the permits. Good exposures provide ample opportunity to evaluate stratigraphic and structural conditions. The area lends itself to photogeologic studies.

Stratigraphy

Strata of Upper Cretaceous age are exposed in the eastern portion of the mapped area and strata of Carboniferous and Upper Devonian ages crop out in the western portion of the mapped area. Terminology employed by the Geological Survey of Canada is used in this report. Although rocks of Silurian, Ordovician and Cambrian ages are not present

at the surface in the vicinity of the permits they are believed to underlie the area and are briefly described here because of their importance to the evaluation of the permits. The sediments are discussed according to their age from oldest to youngest.

Cambrian

Gabrielse (1957) reports the presence of 'mottled, blue and grey, steeply dipping limestone and associated strata 8 miles north-northeast of Rat Lake' which are said to contain Cambrian fossils. Cambrian rocks are known to be present as mapped on the Geological Map of Yukon Territory (1957). The writer has not studied sediments of this age in this area but believes them to be poor hydrocarbon reservoir or source beds because of their highly indurated state.

Ordovician

Hard, black shale, black siltstone and chert characteristic of Ordovician strata occupy the core of the Richardson Mountains east of the

permit area. These strata contain abundant Graptolites. The writer has examined similar beds at the south end of the Richardson Mountains in sections exposed along Peel River. To the best of the writer's knowledge there are no reservoir beds in this assemblage. Good source rock characteristics do exist however, Gabrielse estimates there are 5,000 feet of these and Silurian beds present in the region.

Silurian

Black shales and limestones with interlensing black chert characterize the strata of Silurian age in the Richardson Mountains. Rocks of this age are very hard and generally strongly fractured. They crop out along the western flank of the Richardson Mountains where a nearly complete section is exposed. These beds are poor source or reservoir beds in this locality. Thicknesses of 2,000 feet could be expected in the subsurface below the permit areas.

Devonian

Only Upper Devonian age strata are present in the vicinity of the permits. Middle Devonian limestones common in the Ogilvie Mountains to the south are absent, probably because of non-deposition, in this area. At least part of the Upper Devonian in this area is represented by shales and sandstones of Imperial Formation age.

There is a general coarsening of the sediments of Upper Devonian age from south to north across the Peel Plateau area. On the Peel River at the southern end of the Peel Plateau, Upper Devonian strata consist of a basal limestone conglomerate, a thick sequence of black marine shales with limestone interbeds and a brackish water sandstone-shale sequence. In the Vittrekwa River area north of the permits concerned in this report, Gabrielse describes the Upper Devonian as a basal cobble conglomerate containing chert, quartzite and siltstone overlain by a sequence which includes 'grit, sandstone, shale and pebble conglomerate' which 'contain abundant

angular to subangular fragments of black chert and siltstone presumably derived from the underlying Ordovician and Silurian map-unit'.

The writer examined a thick series of inter-bedded shales and sandstones which are presumably Upper Devonian in age. Although no fossils were obtained from these beds they have the appearance of Upper Devonian strata and were overlain by Carboniferous age sandstones and conglomerates. The sandstones assigned to the Upper Devonian do not exhibit good reservoir characteristics but are generally quite shaly and lacking in visible porosity. The sandstones may represent deltaic type deposits with source areas in the north and deep water to the south.

Upper Devonian marine shales, equivalent to the Fort Creek formation, crop out at Ft. McPherson, Northwest Territories. These shales are very similar in appearance to those that crop out on Peel River east of the Lower Canyon and in the foothills of the Ogilvies to the south. The shales in the foothills enclose reef-growths. It

is possible that the reef facies of the Upper Devonian may extend to the area enclosed by the permits. The reef facies would be expected to be present near the base of the Upper Devonian sections where marine conditions are known to exist.

A composite stratigraphic section in the vicinity of the permits is as follows:

| | |
|---------------------------|---|
| 1,000 feet / or - | Sandstone and conglomeratic sandstones, brown, shaly with pebbles and grains of quartzite, chert and siltstone. |
| 500 feet to 1,000 feet | Shale, dark grey, limy, crumbly with limestone lenses and thin interbeds dark grey argillaceous shale, iron staining along joint faces. |

It is probable that there is a pronounced facies change in the Upper Devonian from east to west as well as from south to north. The marine shale facies exposed at Ft. McPherson may have been replaced by conglomerate in the west. Gabrielse indicated the possibility of a conglomerate as the basal member of the Upper Devonian sequence in the Vittrekwa River area.

The sandstones at the top of the

Devonian are very similar in outcrop section to the overlying Carboniferous sandstones. No fossils were obtained from the clastic strata of either age and hence the boundary between them is arbitrary.

Gabrielse indicated a thickness of 5,000 feet to 7,000 feet of these beds. This thickness is believed to be excessive and may have resulted from repeated section caused by faulting. A thickness of approximately 3,000 feet seems to be more accurate.

Carboniferous

Strata of Carboniferous age crop out in an anticlinal ridge that cuts across the western portion of the mapped area. The only fossils collected from these strata were found in a conglomerate near the top of the sequence. These fossil were identified by Dr. V. J. Okulitch of the University of British Columbia as being Equisetum and Sigillaria of possible Carboniferous age. Gabrielse reports the presence of Pennsylvanian strata from the Vittrekwa River area to the north of this

area. On the basis of stratigraphy the writer believes these beds to be Pennsylvanian in age.

Pennsylvanian (?) sandstones and conglomerates crop out along Road and Trail Rivers. A composite section from those areas is as follows:

| | |
|-------------------------|---|
| 150 feet | Conglomerate, light grey-brown, with clay-iron cement and abundant iron stain in the cement. Pebbles of grey, green and black chert and greenish grey quartzite varying from pea-size to $2\frac{1}{2}$ inches. Contains plant fragments. |
| 200 feet | Sandstone, grey, coarse, kaolinitic. |
| 300 feet to 500 feet | Sandstone, grey, clayey cement, medium to coarse and in part conglomeratic along bedding planes. Few thin interbeds grey, soft shale, |
| 500 feet + or - | Sandstone and shale interbedded. |
| 80 feet | Sandstone light grey, coarse to conglomeratic, massive, cross-bedded with sub rounded chert and quartz grains in chalky clayey cement. |

The conglomerate that crops out on Road River at map location B579-17-3 is not present at map location B579-18-4 on Trial River. This bed may be faulted out but it is more likely that the conglomerate facies is replaced by a coarse sandstone.

At the latter location a thick sandstone described as light grey-brown, medium subangular, well sorted quartz grains, grey kaolinite grains in clay-iron cement and containing abundant clay-ironstone nodules and Equisetum plant fragments, may be the stratigraphic correlative of the conglomerate on Road River.

Sandstones of the Pennsylvanian (?) studied in this area are similar to those studied west of the Richardson Mountains. It is believed that the excellent porosity encountered in Peel Plateau Exploration's Eagle Plains No. 1 well was of Pennsylvanian age. Sandstones of this age group mapped on Trail River were found to be massive, crossbedded and porous. These strata may prove to be excellent reservoir beds in subsurface section in this area.

Base of the Pennsylvanian (?) is arbitrarily placed at the base of a thick, massive, crossbedded sandstone. Contact between the underlying Upper Devonian strata is unconformable. Northwest of the permits this unconformity is very angular.

A thickness of approximately 1,500 feet of Pennsylvanian (?) strata are present in the vicinity of the permits.

Cretaceous

Shales of Cretaceous age crop out over the entire eastern portion of the permits. These shales are dark grey to black, soft and contain numerous clay-ironstone nodules and lenses. There are a few sandstone beds near the base of the shales. These sandstones are grey, shaly and contain ironstone cement. They are cross bedded and in places ripple marked. Beds of up to 2 feet are common over a thickness of approximately 100 feet. The sandstones are inter-bedded with grey silty shales.

No reservoir sands were found in the Cretaceous strata. Source bed characteristics of the shale are not without merit.

No fossils were collected from the Cretaceous beds but they are probably of Lower Cretaceous age as they occupy the same stratigraphic

position as similar shales on the Peel River near the mouth of Caribou River which contain Lower Cretaceous ammonites. There are approximately 1,200 feet of Cretaceous beds in the vicinity of the permits.

Pleistocene

Glacial boulder clays, tills and erratics are common over the entire Peel Plateau area. Glacial till covers the area to thicknesses from zero to 100 feet. These deposits are frozen the year round and are reported to contain the preserved remains of pre-historic Mammoths. Natives of Ft. McPherson area tell stories of wolves finding and devouring these carcasses when they are exposed by weathering. The writer unsuccessfully attempted to track down these stories.

Glacial erratics weighing several tons and frequently ten feet or more in diameter are often found in the bottom of stream valleys. These erratics are mostly granites or granite porphyries. They probably originated on the shield areas to the

east of the Mackenzie River delta.

Eskers and marginal outwash deposits at map locations B579-18-1 and B579-18-2 contain rounded pebbles and boulders of granite, granite prophyry, schists, chert, sandstone and black shale. These deposits are quite common between Road and Trail Rivers and cap the ridges of that interstream area.

Surficial Deposits

River gravels, silts and muds are present along stream courses. They vary in thickness but were never found to be more than fifteen feet thick. As the stream channels change these deposits are worn away to be redeposited at a different location. The gravels are composed of rocks from the sediments through which the streams flow.

STRUCTURAL GEOLOGY

Structural deformation of the sedimentary rocks underlying the mapped area has resulted in two types of structural province: Plateau province, and foothills province. Sediments underlying the eastern portion of the area have been affected only slightly and belong to the Plateau type while those underlying the western border of the permits belong to the foothills type.

Sediments in the plateau area have a slight regional dip to the west - toward the Richardson Mountains. The area is apparently an old peneplain which has been uplifted and is now undergoing peneplanation. The drainage pattern is very young and attests to the recent age of the regional uplift. Glacial deposits in the main stream valleys also help to date the age of the streams and the orogeny which rejuvenated them.

In the foothills area the structural history is complex and typical of foothills type of deformation. The foothills belt occupies only a

small portion of the mapped area but continues westward beyond the permit boundaries to the Richardson Mountains.

A large anticlinal flexure which marks the first fold of the foothills belt strikes northwest-southeast across Permits 1475 and 1336 traversing the southwest corner of each permit. This anticline is formed in Pennsylvanian strata at the surface. The east limb of the structure is faulted where it crosses Permit 1475 near Road River. This faulting is apparently back limb thrusting as a result of too great a pressure from the west. At map location B579-17-4 Pennsylvanian sandstones and conglomerates are dipping at 80° E in the vicinity of the fault. The west flank of this anticline is also faulted in its northern extension. The faulted anticlinal structure extends northwestward beyond the permit but its detail is obscured by mantle.

Southeastward, along strike, the anticline becomes well defined where it is breached by Road River. Here Pennsylvanian sandstones arch

up in a tight anticline with steep limbs. Dips in the sandstones average approximately 50 degrees near the axis of the structure and become 15 to 20 degrees farther east on the limb near the Pennsylvanian-Cretaceous contact. The west limb is faulted, and some faulting is present on the east limb.

Between Road and Trail Rivers there are very few bedrock exposures and as a result the extension of the anticline is not clearly defined. On Trail River just south of Permit 1336 a narrow anticlinal structure is exposed in the river cuts. It is not known whether or not this anticline represents the entire structure on Road River or merely one branch of the parent structure. The structural picture in the vicinity of Trail River is further complicated by the pinchout of Pennsylvanian beds from north to south. Detailed studies will be required to evaluate the structure and the stratigraphic pinch out of the Pennsylvanian.

A major fault zone involving Pennsylvanian and Upper Devonian strata strikes north-south along the western edge of the mapped area

(in the vicinity of $135^{\circ} 30'$ W Longitude). The significance of this zone was not apparent from this study because the zone lies beyond the permits and would have involved considerable study to evaluate.

CONCLUSIONS AND RECOMMENDATIONS

Structural conditions along the western boundary of the mapped area appear to offer some potential for trapping conditions. Details of closure were not readily attainable from this reconnaissance study and must await more detailed studies of the area. Detailed traverses of the upper Road and Trail Rivers would provide structural and stratigraphic data essential to the proper evaluation of the permits. Studies should also be made of the fault zone described above, the angular unconformity between Pennsylvanian and Devonian strata and the northern extension of the one major anticline into the Vittrekwa River area. Detailed facies studies of the lower part of the Upper Devonian strata along the front of the Richardson Mountains may provide important information regarding reef growths in this horizon. The abundance of bitumen residues present in Fort Creek shale along Peel River to the south

south provide incentive for further exploration in this area. The permits are well located in the sedimentary basin and appear to have good potential for hydrocarbon accumulations.

The writer recommends that additional surface geological studies be programmed on the permits to provide details essential to the discovery of oil and/or gas accumulations which may exist within the permit areas.

D. B. Bullock
D. B. Bullock, P. Eng.

Consulting Geologist

REFERENCES

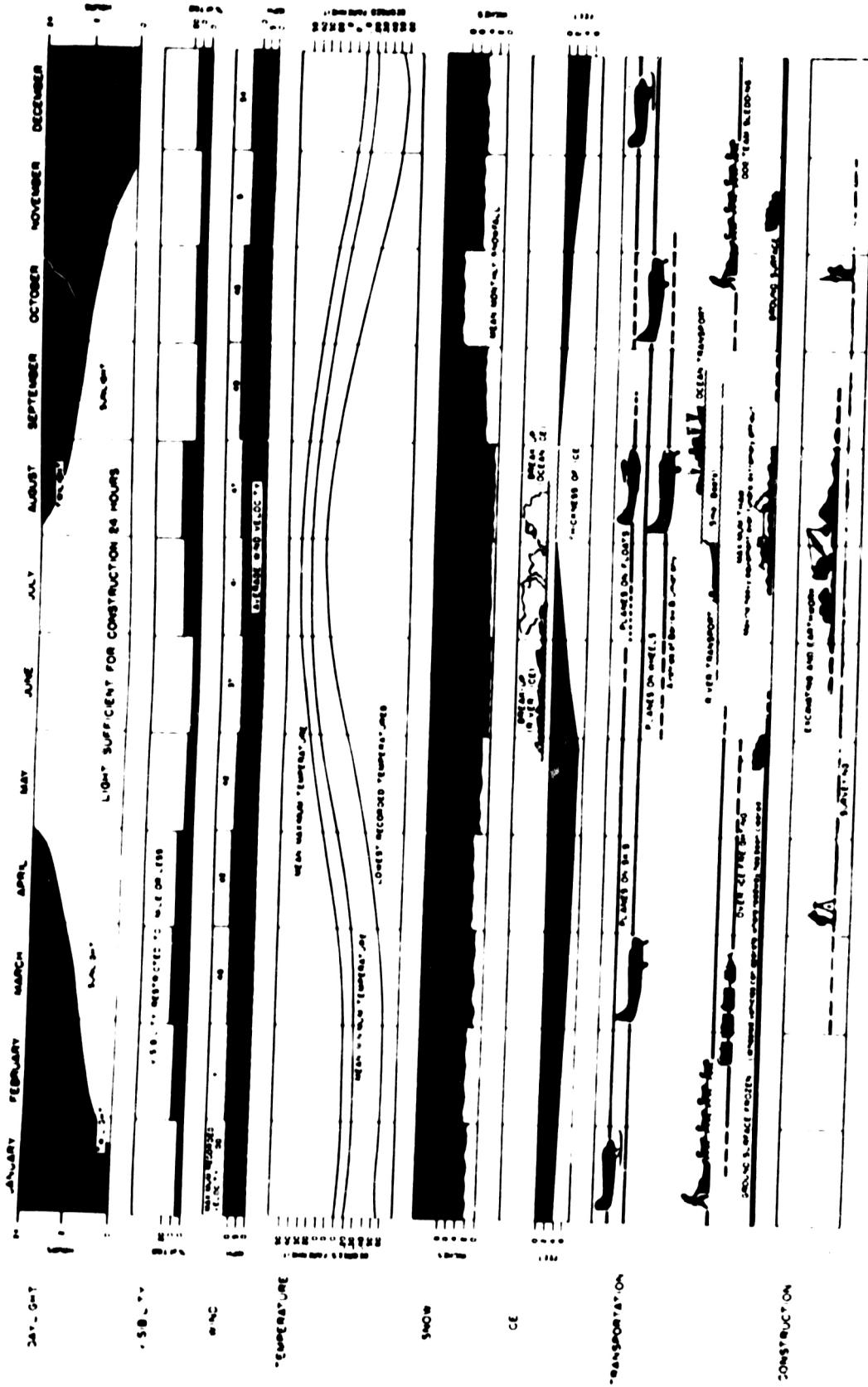
- Bostock, H.S.: Physiography of the Canadian Cordillera, with special reference to the area north of the fifty-fifth parallel; Geol. Surv., Canada, Mem. 247, 1948.
- Camsell, Charles: Report on the Peel River and Tributaries, Yukon and Mackenzie; Geol. Surv., Canada, Ann. Rept., vol. XVI, 1906, pt. CC.
- Gabrielse, H: Geological Reconnaissance in the Northern Richards on Mountains Yukon and Northwest Territories; G.S.C. Paper 56-6, 1957.
- Hume, G.S.: The Lower Mackenzie River Area, Northwest Territories and Yukon; Geol. Surv., Canada, Mem. 273, 1954.
- Maddren, A.G.: Geologic Investigations Along the Canada-Alaska Boundary; U.S. Geol. Survey, Bull. 250-K, 1912, pp. 297-314.
- McConnell, R.G.: Report on Explorations in the Yukon and Mackenzie Basins, N.W.T.; Geol. Surv., Canada, Ann. Report., vol. IV, 1888-89, pt. D. (1890).
- Perry, R.G.: Geological Report on Exploration Work in Yukon and Northwest Territories for the Peel Plateau Exploration, Limited (Geological Map of Yukon Territory, 1957).

APPENDIX "A"

Work Feasibility Chart

WORK FEASIBILITY CHART

POINT BARROW, ALASKA
NAVAL PETROLEUM RESERVE NO. 1



from *World Oil*, July 1948

