NOTES ON NORTHERN ALASKA

supplementing

REPORT OF INVESTIGATION OF PETROLEUM SEEPAGES,

ARTIC SLOPE AREA, ALASKA. OCTOBER, 1943

Introduction

During the oil reconnaissance trip in northern Alaska, made by a U. S. Bureau of Mines field party between August 22 and September 14, 1943, information was obtained on a variety of subjects which could not conveniently be included in the formal report. Some of this information, together with inferences drawn from it, is submitted here because it may be of use to subsequent field parties.

Vegetation

In general, the Arctic Plateau and Coastal Plain are similar in appearance and support the same types of vegetation as the treeless parts of the lower Yukon and Seward Penninsula regions. Most of the surface is covered by a rather dense growth of grasses, sedges, mosses and flowering plants. Flowering plants are abundant, both in amount and variety, and include most of the species found above timber in interior Alaska. During June and July much of the tundra is evidently covered by flowers, but by late August the flowering season had passed and large, white patches of Alaska cotton afforded the only relief from the dull greens and browns of the surface cover.

Clumps of bunchgrass forming "niggerheads" are found in parts of both the plateau and coastal plain, but they are neither as large nor as common as in interior Alaska. Thus, except in the swampy parts of the coastal plain, footing is generally good.

Willows and alders, some of them 15 feet high, are plentiful in the Colville River valley within about 30 miles of the coast. They are said to be absent farther downstream, although it is likely that stunted willows grow nearly to the coast. Similar conditions are said to prevail in other large valleys. In general the willows are relatively large in the mountain and plateau regions and become progressively smaller to the north. Dwarf willows a few inches high grow on the tundra close to the coast, but they are too small to be of much use for firewood.

Most of the dry willows suitable for firewood were found as driftwood on the river banks and bars, where they were left by ice and high water. We used green willows and alders on several occasions when dry wood was scarce. Contrary to experience in interior Alaska, green willows burned somewhat better than green alders.

When dry firewood is unavailable, the small, evergreen shrub, Cassiope tetragona, may be used. This shrub, called "Piliararuk" by the Barrow Eskimos, is found both in Arctic Alaska and in interior Alaska above timber. Since it burns well when green, it is especially valuable on the tundra away from large valleys, where the willows grow only a few inches high. Ebbley and Simon Panea, one of our guides, used it when they spent several days hunting for the Fish River seep. Other shrubs related to C. tetragona are probably also flamable.

Dwarf birch or buckbrush grows in abundance on benches of the Colville River, just above the fringe of alders and willows. Labrador tea occurs widespread over the tundra. Leaves of the Labrador tea are occasionally used by the Eskimos for tea and apparently as a tonic.

The Eskimos make use of a considerable number of plants, although they constitute only a small part of the total food consumed. As far as I could learn, they eat mainly meat, fish and birds, together with imported foods such as flour and sugar. Probably during hard times they eat a larger proportion of plants, although the same ones do not seem to be eaten by all the natives. But even when meat is plentiful, a number of green plants are eaten, either fresh during the summer or preserved in oil during the winter. Several types of starchy roots are also used and some of the native families store them for the winter. Berries are apparently used to a greater extent than green or starchy plants. They are eaten fresh, sometimes after being annointed with seal oil or mixed with caribou or reindeer fat. According to Simon Paneak, willow buds and catkins are sometimes eaten in the spring when they are tender and tasteful. Dandelions and several varieties of saxafrage, wild rhubarb (Kwarag) and many other edible green plants that also grow in interior Alaska are gathered and eaten by the Eskimos.

One of the more important food plants is called "massu", "mashu" or "muchu", according to the locality. It supplies a large root up to several feet in length, which is eaten either raw, boiled or baked. I was unable to identify the massu with certainty because I saw only a part of a single root that had been carried down a cut bank by a mud slide. I ate about a foot ($\frac{1}{2}$ pound) of this root, after cleaning off the mud; and found it to be fairly tender, slightly sweet and altogether palatable. It apparently contains considerable starch and some sugar.

The use of "massu" by the Eskimos is noted on page 81 of U. S. Geological Survey Bull. 815, where it is identified as either _Polygonum bistorta_, _P. viviparum_, or _P. fugax_. This identification was apparently based on a description of the plant rather than on specimens, and I do not believe it is correct. Several polygonum species are used by the natives, but the roots are bulbous and small rather than long and fleshy. The "massu" cannot be finally identified without a specimen, but it is probably a hedysarum - either _H. boreale_ or _H. mackenzii_, or a similar species.

Most of the berries found above timber line in interior Alaska grow on the Arctic slope. Blueberries are abundant in the plateau region and the low-bush or mountain cranberry grows on the tundra clear up to the coast. The cloudberry (_Rubus chamaemorus_), called salmonberry by the Eskimos, is also widely distributed and greatly relished. The bearberry (_Arctostaphylos alpina_) and the crowberry (_Empetrum nigrum_) grow in a number of places and are used to some extent.

On page 80 of U. S. Geological Survey Bull. 815, the belief is stated that blueberries require two seasons to mature; that the bushes flower and produce green berries one summer and ripe berries early in the following summer. This would be interesting if true, but according to my observations, supported by statements of several natives, Arctic slope blueberries ripen in a single season, just as do normal blueberries elsewhere. Along the Colville River they had ripened by mid-August and by late August they were somewhat past their prime. I saw no immature berries in the late summer. It is not unlikely that the observers quoted in Bull. 815 found berries that had ripened the preceding summer and remained on the bushes overwinter, a not uncommon occurrence in other regions.

Mushrooms are widely distributed, but are not abundant; however their relative abundance may vary considerably from one summer to another. Various types of puffballs were probably the commonest observed. Other varieties were too old to be identified. I saw no Amanita muscaria, a poisonous mushroom that is common in interior Alaska.

Animals.

Caribou were plentiful during the late summer along the middle course of the Colville and in much of the plateau region. In mid-September, on our return from Barrow, we flew over hundreds of small herds between the Colville River and Anaktuvuk Pass. Caribou were constantly in view; the total must have amounted to many thousands. So far as I could learn, moose are found north of the Brooks Range only in the Colville River valley and near the head of the Mead River. We saw a number of them from the plane in the Colville River valley.

Wolf tracks were seen on most of the bars of the Colville River on which we landed. Wolves are doubtless numerous wherever caribou are plentiful. Brown and grizzly bears are apparently not numerous. Sig Wien flew over one near the Umiat Mountain seep on the Colville River and we saw several near the Anaktuvuk River.

Farther west reindeer are herded, both by Thomas Brower, whose range is along the Ikpikpuk and Chipp Rivers, and by the Office of Indian Affairs, whose range is closer to Barrow. Brower's herd is in good shape and large enough so that a considerable number of animals may be slaughtered each year. The Indian Affairs' herd, on the other hand, is badly depleted because of improper herding and management, and at present no animals are being slaughtered. The Eskimos eat much of their caribou and reindeer meat raw and partly dried, at least during the summer. Raw meat is generally more tender than cooked meat, although it is less palatable to white people.

Ptarmigan are abundant almost everywhere in northern Alaska. By the middle of September they had started to band into very large flocks. Ducks, geese, brandt and other waterfowl were also plentiful, but probably much less so than earlier in the summer. Grayling evidently live in all clear streams. Whitefish are abundant along the coast and in lakes and rivers. They are an important item of food and are generally eaten frozen and raw. Raw, frozen whitefish, called "kwok", is tender, mild-flavored and nutritious. Because "kwok" is rich and oily, it is especially prized by the Eskimos. Salmon are said to be found very rarely along the northern coast.

White fox are plentiful most years. As in other Arctic regions where seal and polar bear are found, the foxes spend much of the winter on the sea ice, living on the remains of seals killed by bears. Little trapping has been done in the region east of Barrow during the past several years.

Charlie Brower of Barrow told me that a new mammal was shot several years ago by an Eskimo somewhere east of Barrow. The Eskimo knew that Mr. Brower purchased rare specimens, so he laboriously prepared the skin and skeleton, with the expectation of getting at least fifty dollars for his discovery. When he brought it in, however, the new mammal proved to be a horse; possibly one that had strayed from a boundary survey party. It was of course a new animal to the Eskimo.

Bowhead whales, ugruk (bearded seals) and walrus are hunted at Barrow but are said to be uncommon between Barrow and Herschel Island. The small Point Barrow seal is apparently plentiful all along the Arctic coast.

Indications are that at present game and fur-bearing animals in northern Alaska are increasing in number, because they are less hunted than formerly.

Natives

Northern Alaska is at present more sparsely populated than at any time in the historic past. As stated in an informal report by Norman Ebbley, Jr. to R. S. Sanford, there are now only about 130 natives between Barrow and Demarcation Point. Between 50 and 200 people formerly lived in the native village near Point Barrow, but this site has been abandoned for several years. A decrease is also reported in the number of people living more or less permanently along the coast east of Point Barrow and inland along the rivers.

According to accounts of earlier observers, there has been a decline in population since the first advent of the whites. Much of this decline is apparently the result of the introduction of new diseases against which the Eskimos had little immunity. In recent years, however, many of the natives have moved to Barrow from the Colville River region and other regions to the eastward, while others are said to have moved into Canada. One cause of this emigration was apparently poor hunting conditions several years ago. One result is that the native population of Barrow is considerably larger than can be supported by the resources of the surrounding region.

Barrow is well lowated for whaling and trading, and therefore would normally support a relatively large number of people. Many other Eskimos live there because they are employed in the various establishments of the Federal government, and still others because they depend on imported food to a considerable extent. The presence of the hospital, school and church also make it convenient to live at Barrow, both for the natives and for the whites in charge of these establishments.

The hospital and school are undoubtedly beneficial, particularly since they help the Eskimos adjust themselves to the inevitable changes brought about by contact with white people. Considerable effort is made to prevent and control tuberculosis and other communicable diseases, but apparently with indifferent success because of the unfavorable living conditions of the natives and because of their disinclination to isolate themselves when sick. Venereal diseases, on the other hand, are now virtually nonexistant around Barrow and to the eastward, according to Dr. Edward Seinfeld, residant physician at the Barrow hospital. In view of this statement, the remark by Simon Panea that his wife had syphilis "plenty bad" for a number of years before she died and that he did not contract it because of his "strong blood", should be regarded with skepticism (see Ebbley informal report).

Most of the younger natives can read, write and speak English, while many of the older ones can read and write, but have not learned to speak English. Considerable progress is also made in teaching various manual arts, at which the Eskimo is naturally adept. Whalebone baskets are being made in increasing numbers and their quality is constantly improving. During the past year their price at Barrow has doubled because of the increased demand.

Most of the natives at Barrow live in small, poorly constructed and insulated frame houses, instead of in sod igloos as formerly. Their frame houses are generally overcrowded and difficult to keep warm with the limited supply of fuel available, and these conditions are doubtless responsible for many of the respiratory infections that are prevalent. It must be pointed out, however, that housing conditions at Barrow are no worse than in other towns in Alaska where natives congregate.

For a number of years the wage rate at Barrow for native labor has been five dollars a day. After the war there may be a demand to adjust wages to conform to those in other parts of Alaska, because a number of Eskimos are now working on war jobs at high wages in other parts of Alaska. Many of the younger men have also entered military service.

Manning Point Oil Seeps

In addition to those listed on page 13 of the Ebbley-Joesting report, the Manning Point seeps near Barter Island were visited by Joe Alkire and George Kraebel, according to information obtained when Alkire was in Fairbanks in 1942. These men prospected in the Hulahula and Canning River regions in 1940 and 1941. Alkire formerly worked in the Independence mine at Willow Creek, and is said to be now living in Anchorage.

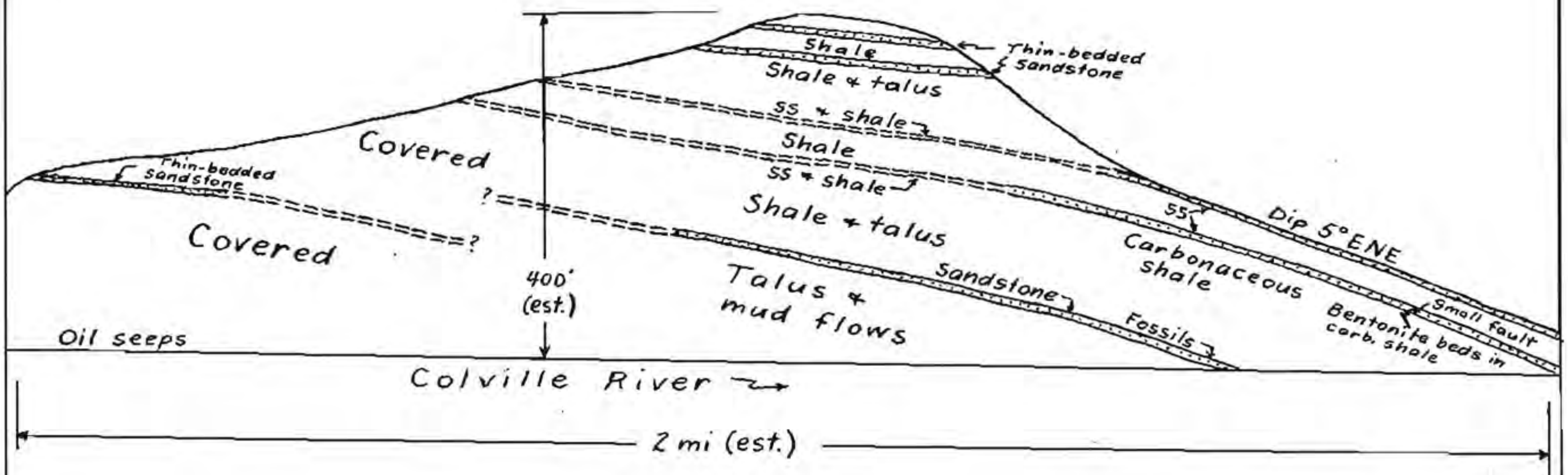
Geology and Oil Seeps in the Umiat Mountain Area

The Umiat Mountain seeps are the farthest south of all the seeps found in northern Alaska, and the only seeps near which consolidated rocks are exposed. Shale and sandstone are exposed in cliffs that are more or less continuous for several miles along the north side of the Colville River. The seeps occur along the river bank and on a low bench at the foot of the cliffs. (Fig. 2, Ebbley-Joesting report).

The rocks in the Umiat Mountain area consist predominantly of dark shales, interbedded with minor amounts of light brown and gray sandstone. In general, the sandstone is more resistant to weathering and caps the steeper parts of the cliffs. The total thickness of section exposed is about 500 feet (see accompanying sketch).

Much of the shale is carbonaceous and in places it is interbedded with numerous coaly seams that are rarely over 1mm. thick. For the most part it is soft, but it also contains a few well indurated beds, as well as a number of spheroidal concretions measuring up to a foot along the bedding and six inches across the bedding. About two miles east of the seeps the carbonaceous shale in the cliff face is interbedded with numerous beds of nearly pure bentonite with a maximum thickness of $1\frac{1}{2}$ feet. Considerable alum and other salts have leached from the shale and deposits on the surface, and a few small, secondary veins of calcite have formed. Mud flows consisting of disintegrated shale occur wherever surface water has percolated into the shale along the cliff. Alternate freezing and thawing, combined with the clay-like nature of the shale, have made the mud unusually soft and fluid.

The sandstone members of the section reach a thickness of 20 to 30 feet and appear massive at a distance. Many of them, however, are interbedded with shale, and some of them grade into sandy shale



IDEALIZED SECTION, UMIAT MT. AND VICINITY

Vertical scale greatly exaggerated

View NW

H.R.J. 1943

along the bedding. The sandstone is moderately fine-grained and thin bedded. One piece of float with ripple marks was found, but these indications of near-shore deposition are not as common as in exposures 50 miles upstream. Numerous inoceramus fossils and casts were found in a sandstone bed in the lower part of the exposed section. Specimens of these fossils were collected and submitted for identification.

In the high cliffs east of the oil seeps the beds dip ENE at about 5 degrees, while still further east they are nearly flat. West of the high cliffs, near the seeps, the beds are also nearly flat. Thus the oil seeps are near the upper change of dip of a broad monoclinal fold.

Unit 13

A small thrust fault occurs near the east end of the cliff, about two miles from the oil seeps. This fault extends for only a short distance, however, and all of the displacement is in the soft shale. Several pieces of slickensided sandstone float were found in the cliff just north of the seeps,,but no fault was exposed. Apparently none of the faults in this area are large or continous, since no displacement was observable in any of the sandstone beds.

Most of the sandstone beds are sufficiently porous to serve as reservoir beds for oil. This was demonstrated by tests on a large piece of oil-saturated sandstone float, similar to the sandstone exposed in the cliffs, which was found on the beach upstream from the seeps. A half-pound piece of the float yielded about 5 cc. of oil with the appearance and viscosity of light lubricating oil. Since the rock was not found in place it is of course not certain that the oil was not introduced from the seep while the rock lay on the beach.

Although no rocks are exposed in the immediate vicinity of the seeps, it is considered likely that the oil is escaping directly from oil-bearing beds which have been uncovered by erosion, rather than along faults from deeper lying beds. It is doubtful if there are any faults of sufficient continuity to provide channels for the escape of oil from underlying beds.

The rocks in the Umiat Mountain area lie in the northern part of the broad east-west belt of upper Cretaceous rocks that extends across northern Alaska (Plate 2, U. S. Geological Survey Bull. 815). Since the general dip is north and since the dip gradually decreases to the north, the rocks in this area - and also the oil-bearing beds - must then lie [redacted] in the upper part of the upper Cretaceous series.

Cape Simpson Area

No rock exposures are found in the Cape Simpson area, consequently little can be determined from surface studies of the structure or stratigraphy of the formations with which the oil is associated. Information was obtained, however, on the relative thickness of the unconsolidated Quaternary and Tertiary formations that overlie the oil-bearing formations.

Several of the seeps issue from mounds which were apparently formed by oil escaping under considerable pressure. On the mounds were found a number of angular fragments of well indurated sandstone. Based on lithologic evidence, these fragments are from the upper Cretaceous, rather than from the poorly consolidated Tertiary series. They were apparently carried to the surface with the escaping oil, and since it is unlikely that they could be so-carried from great depths, it is inferred that the upper Cretaceous rocks lie within a few hundred feet of the surface.

Stratigraphic Position and Depth of Oil-bearing Horizons

That oil-bearing horizons in northern Alaska occur in the upper part of the upper Cretaceous series and thus are at relatively shallow depths in the seepage areas is indicated both by the areal distribution of seeps and by geologic evidence in the Umiat Mountain area.

All of the known seeps are in the northern part of the region, where the upper part of the upper Cretaceous series is present. Conversely, no seeps have been found farther south where these rocks are absent, in spite of structural conditions that favor their occurrence. If oil were present in the lower part of the upper Cretaceous series, or in still older rocks, seeps should occur where these rocks are exposed.

The seeps near Umiat Mountain, which are the farthest south of any known, apparently issue directly from oil-bearing sandstone beds. These beds are above the middle part of the upper Cretaceous series and are probably in the upper quarter of the series.

The thickness of the upper Cretaceous series in northwest Alaska is estimated to be between 10,000 and 17,000 feet (U. S. Geological Survey Bull. 815, p. 218). East of the Colville River the series may decrease considerably in thickness. In the Canning River region upper Cretaceous rocks were not identified by Leffingwell (U. S. Geological Survey Prof. Paper 109), but it is probable that some of the rocks classified as Tertiary may eventually be correlated with the upper Cretaceous.

If the upper Cretaceous rocks are 17,000 feet thick, the oil-bearing horizons exposed in the Umiat Mountain area should lie within 8,500 feet of the top of the series. Since the Tertiary and Quaternary deposits which overlie the upper Cretaceous on the coastal plain are probably not over a few hundred feet thick, the maximum depth to oil horizons in this region would not be over about 8,500 feet. The actual depth is probably considerably less than 8,500 feet.

Henry R. Joesting
Assoc. Mining Engineer
Territorial Dept. of Mines
Nov. 15, 1943

I-1

UNITED STATES
DEPARTMENT OF THE INTERIOR

Report
of
Investigation of Petroleum Seepages
Arctic Slope Area
Alaska

by

NORMAN EBBLEY, JR.
MINING ENGINEER
U. S. Bureau of Mines

HENRY R. JOESTING
ASSOC. MINING ENGINEER
Territorial Dept. of Mines

October, 1943

Copies: Mr. Gardner, Regional Office, Central Region.
Mr. Sanford, District Office, Juneau, Alaska.(2)
Mr. Ebbley
Dr. Joesting

PREFACE

In order to avoid duplication of work and to present a report combining the observations and opinions of the members of the field party, this report has been prepared jointly by the representatives of the United States Bureau of Mines and the Alaska Territorial Department of Mines.

TABLE OF CONTENTS

SUMMARY

During the period from August 22 to September 14, 1943, a field party 1/ under the direction of the Bureau of Mines, investigated rumors of petroleum seepages in the Arctic slope area. The primary purpose of this investigation was to obtain information bearing upon the occurrence of petroleum in this area and to establish data proving the existence of additional seepages other than those at Cape Simpson.

Prior to this investigation the state of information on petroleum occurrences in Naval Petroleum Reserve No. 4, as established through examination by the Geological Survey over a period of several years was that "The only seepages that are now actually know are those near Cape Simpson." 2/ The investigations by the Geological Survey had convinced that organization that "extreme skepticism" should be felt as to the validity of other rumored occurrences.

The recent work by the Bureau of Mines does not, however, support the findings of the Geological Survey in this respect. Upon investigation by the Bureau, the rumors of oil occurrences invariably proved to be actual petroleum seepages. These seepages are found to exist throughout an area 325 miles in length along the Arctic coastal plain, and to extend inland for 100 miles. A total of six separate localities containing evidences of petroleum were examined, samples being collected from twelve seepages in these areas.

That petroleum-bearing formations exist over a considerable portion of Northern Alaska is demonstrated by the occurrences of active seeps. The writers feel that indications are sufficiently favorable to justify an exploratory program for the purpose of obtaining definite information concerning the accumulation of oil in commercial amounts.

Reconnaissance geological surveys of parts of the region have been made by the U. S. Geological Survey, but the information obtained is fragmentary and insufficiently detailed. More detailed surveys to obtain stratigraphic and structual information are necessary for purposes of petroleum exploration.

In the Arctic Plateau, this information may be obtained by a geol-

1/ Norman Ebbley, Jr., of the U. S. Bureau of Mines
Henry Joesting of the Territorial Department of Mines
Captain Henry Thomas of the U. S. Army Engineers

2/ Smith, Philip S., Mertie, J. B. Jr., Geology and Mineral Resources of Northwestern Alaska: U. S. Geological Bulletin 815, p. 275, 1930.

ogical survey, but in the Arctic Coastal Plain, where most of the oil seeps were found and where rock outcrops are almost non-existant, it must be obtained by geophysical surveys and exploratory drilling.

Since considerable time must necessarily elapse, particularly in Northern Alaska, between the initiation of exploratory work and actual production of oil, it is recommended that the exploratory program be started early in 1944.

A study of the existing terrain and climatic conditions of the area between central Alaska and the Arctic coastal plain has indicated the feasibility of a pipe line in the event that exploratory work showed the existence of commercial oil reserves. The cost of developing the reserves, and the installation of the necessary inter-Alaska pipe lines would compare favorably with the Canol installation from the Fort Norman wells in Canada.

INTRODUCTION

Interest in the oil possibilities of northern Alaska had reached the point where in February 1923, President Harding, acting on the advice of the Bureau of Engineering of the Navy Department, appropriated an area of about 35,000 square miles in northwestern Alaska as Naval Petroleum Reserve No. 4. Subsequently, the Navy Department requested the Geological Survey to investigate, at the Navy's expense, the oil possibilities of this large, relatively unexplored area. Reports of oil seepages along the coast had persisted for many years but geological knowledge of the greater part of the area was lacking.

The Geological Survey had begun a systematic exploration of the Territory as early as 1899, and by 1910 had sent seven reconnaissance parties into the area later included in Naval Petroleum Reserve No. 4. The recent Geological Survey expeditions in northern Alaska instigated by the Navy Department began in 1923 and continued each season until the end of 1925. During this period eight separate parties were sent into the area, "the primary underlying purpose . . . . (being) . . . . to investigate the possibilities of obtaining oil in this region." 3/ However, the need for general geological information was apparent to round out any comprehensive study of the problem, so "therefore, while centering attention on the direct problem of finding oil, the Geological Survey parties have collected as much additional information as possible, in the belief that all of it would sooner or later be found to be pertinent to the 'classification, examination, and preparation of plans for development' of the reserve." 4/

3/ Smith, Philip S., Mertie, J. B. Jr., Geology & Mineral Resources of Northwestern Alaska: U. S. Geological Survey Bulletin 815 P. 1, 1930.
4/ Op. cit., P. 275

The members of the Geological Survey who took part in these investigations are to be commended for their tenacity and determination, characteristics which were necessary to make these arducus expeditions possible. While the "primary underlying purpose" of this work was not entirely attained, the expeditions were of considerable value in other respects. Many thousands of square miles were mapped, the areal geology and the topography being commendably accurate considering the difficulties encountered in traversing the region by dog teams and canoes.

The cessation of field work by the Geological Survey in 1926 ended all active investigation in the Arctic slope region and interest apparently remained quiescent until the present war activities revived speculation on the possibility of obtaining oil from this vast area. Activity in the Fort Norman oil district in Canada, and the Canol pipe lines from Skagway, Watson Lake and Fort Norman to Whitehorse and on to Fairbanks; combined with constant talk of Alaska being the post-war hub of trans-polar air transportation, furnished the impetus to revive interest in obtaining definite information concerning oil possibilities in northern Alaska.

Early in 1943 the eastern boundary of Naval Petroleum Reserve No. 4 was extended to include all the region of the Arctic slope as far east as the Canadian border. Officials of the Bureau of Mines, anticipating the need for additional evidence relative to the occurrences of petroleum in the region, decided late in the summer of 1943 to send a field party into northern Alaska to investigate various rumors of seepages other than those at Cape Simpson. It was believed that by utilizing a float-plane the party would be able in a month or six weeks to investigate the different localities which were reported to contain petroleum seepages.

LOCATION AND ACCESSIBILITY

The present area included in Naval Petroleum Reserve No. 4 is approximately 80,000 square miles. It extends from Icy Cape on the west at Longitude 161°45', 520 miles to the Canadian border on the east; and from Point Barrow on the north 250 miles south at the widest point. However, the area pertinent to this report with boundaries determined by the known petroleum occurrences is considerably smaller. This area, in the form of a triangle, is bound on the northwest by Dease Inlet, on the east by Demarcation Point and on the south by Latitude 68°20'. (Fig. 1) The area included is approximately 18,000 square miles, the larger portion of which is the flat terrain of the Arctic Coastal Plain. (Refer to aerial photographs 1 to 16)

FIG. 1 INDEX MAP SHOWING AREA OF PETROLEUM SEEPAGES

No regular scheduled mode of transportation into this area is maintained, nor is there any means of communication. The nearest radio contact is the Army Signal Corps station at Barrow. One boat a year is scheduled to Barrow; it arrives there usually during the early part of September. The Wien Alaska Airlines maintains an unscheduled plane service between Fairbanks, Nome and Barrow, averaging about one trip a month. Any transportation along the coast east from Barrow or inland on the Arctic slope must be on a charter basis.

The opening of navigation along the Arctic coast generally occurs during the last half of July, and it is not safe to remain in the Point Barrow vicinity with a vessel much after the first of September.

PHYSICAL FEATURES AND CLIMATE

Topographically, the Arctic slope is divided into three separate provinces. Although these main divisions grade somewhat into each other, the general line of demarcation can be fairly well established. The different provinces trend east and west, paralleling the general line of the Arctic coast and of the Brooks range. The most northern, the Arctic Coastal Plain province, is a gently sloping plain extending along the coast, the southern boundary being approximately coincident with the seventieth parallel. Aerial photographs Nos. 1 to 16 illustrate the flatness and uniformity of the coastal plain provinces. The next division is the Arctic Plateau province. It extends south to the Brooks Range and in places comes within about 15 miles of the Arctic coast. Ground elevations range from only a few feet above sea level near the coastal plain to about 3,500 feet near the Alpine province. Aerial photographs Nos. 18 to 26 illustrate the smooth uplands and cut valleys characteristic of the plateau region. The most southerly province is the mountainous highland called the Brooks Range. This province is about 150 miles wide and separates the Arctic slope from central Alaska. It extends from the arctic Ocean to the Canadian boundary. The altitude of the peaks probably averages between 6,000 and 7,000 feet, although a few are as high as 9,000 feet. Several low passes, running generally north and south, such as the Chandlar and Anaktuvuk passes, permit easy traverse through the Brooks Range province. Aerial photographs Nos. 29, 30 and 31, illustrate its characteristically rugged topography. (See Key Map for locations and directions of all aerial photographs)

The Arctic slope climate is severe, based on temperate zone standards. Temperatures are prevailing low; from December to March the mean temperature is -15° to -20° F, while during the summer months from May to September, it is 20° F to 40° F. Temperatures not uncommonly drop to -50° F in the winter and to 26° in July and August.

Precipitation in the Arctic Slope area is very low, seldom averaging more than five or six inches annually. Along the coast the snow fall is light while in the mountains it is somewhat heavier and three to four feet of snow usually accumulates during the winter.

Probably the greatest handicap to outside work is the constant driving wind which never seems to subside. Velocities of 100 miles an hour have been recorded at Barrow, with yearly averages as high as 14 miles an hour. Hourly averages during heavy blows are commonly as high as 60 to 70 miles an hour. Foggy weather is the rule rather than the exception. This condition seriously handicaps air transportation. The frequent fogs, especially along the coastal plain, combined with subfreezing temperatures are flying conditions which invariably cause icing of the plane - a hazard even to local flying.

However, although climatic conditions are unfavorable, it is entirely possible for people properly dressed to attend to their regular duties, and only during the worst blizzards is travel impossible.

Travel

In general east-west travel on the Arctic slope is difficult during the summer and fall months. Numerous large, north-flowing streams segment the entire Arctic plain and form a hazard which prevents any extensive trips on foot, except near the Alpine province where the streams are small. No timber is available for rafts. North-south travel, on the other hand, can be easily accomplished by utilizing canoes and following the rivers. In addition to the difficulty caused by rivers, travel by foot is made slow and tedious by the marshy condition of the tundra, and because of the many large lakes which in some places form an impassible maze. Aerial photographs accompanying the report illustrate this condition. Travel along the coast may be safely done in small boats during the months of August and September while the ice-pack is away from the shore. Sufficient protection is afforded by offshore reefs to permit travel even by canoe, providing close watch is kept for storms.

Transporation by dog-team, snowmobile or tractor is feasible from November to early in June. For extensive trips fuel caches should be established in advance. A comprehensive description of the difficulties of Arctic slope travel is given in the U. S. Geological Survey, Bulletin 815.

Air travel has proven its value in Alaska. In northern Alaska, particularly, airplanes provide the most practicable transportation. Types of planes suitable for use in the Arctic during the various months are as follows: (No landing-fields)

Type	Operating Period	Load Efficiency	Ability to land near objective	Safety
Float	July-Aug.-Sept.	Poor	Fair	Good
Wheel	June-July-Sept.-Oct.	Excellent	Poor	Poor
Ski	Oct. through June	Good	Excellent	Excellent

Flying conditions are best during March, April, May, and June, and sometimes during October. However, the coast is generally foggy, and clear days are exceptional. Gasoline and oil for the planes is indeed a problem, and gasoline caches must be established throughout the area before any extensive flying program is started. At present, Barrow is the only place on the north Arctic coast where aviation gasoline is available.

By traveling light and utilizing the float-plane for all but localized foot travel, the Bureau of Mines party was able to investigate in a three week's period all the localities where petroleum seepages were rumored to occur. Although the reconnaissance trip required only a relative short time, it was necessary to fly over 8,000 miles to complete the work.

Clothing

In general, the clothes used throughout central Alaska can be safely worn during the summer months on the Arctic slope. The addition of a heavy cloth parka is advisable to serve as a wind-break. Shoe-packs or native waterproof boots and heavy underwear are necessary. During the winter months it is advisable to wear the usual native clothes: fur inside against the skin and fur outside, and fur cap and fur boots. A well-built tent is advisable to have throughout the summer as a protection from the wind. Any standard cold-weather sleeping bag is sufficient for summer use. The native-built, reindeer or caribou bags are needed during the winter months. An excellent discussion of suitable clothing and of living problems in the Arctic is contained in Professional Paper 109, by Ernest de K. Leffingwell.

GEOLOGY

Information concerning the geology of northern Alaska is contained in several publications of the U. S. Geological Survey. 5/ These have

5/ Ernest de K. Leffingwell, the Canning River Region, Northern Alaska; Professional Paper 109, 1919.

P. S. Smith and J. B. Mertie, Jr., Geology and Mineral Resources of Northwestern Alaska: Bulletin 815, 1930.

References to earlier work are given in these publications.

been freely drawn on in preparing this summary. Somewhat less than half of northern Alaska has been covered by reconnaissance methods, in which areal geologic mapping was necessarily the primary concern. Except in a general way, therefore, little stratigraphic and structural information is available.

The oldest, most highly indurated and structurally complex rocks are found in the Brooks Range; and they become progressively younger, less indurated and structurally simpler to the north in the Arctic Plateau and Arctic Coastal Plain. In general the formations dip north and thus progressively younger rocks are exposed north from the Brooks Range.

In the Brooks Range the rocks are preCambrian or early Paleozoic to Jurassic in age, and are for the most part metamorphosed and complexly folded and faulted. In the Arctic Plateau they are mainly Cretaceous in age and are in general moderatley well indurated. To the south near the mountains, the rocks are close-folded and considerably faulted; but farther north the structure becomes simpler and the rocks dip gently north, with occassional reversals in dip to form broad, open folds. In the Arctic Coastal Plain, the rocks are upper Cretaceous, Tertiary, and Quatornary in age. According to the relatively few exposures, the upper Cretaceous and Tertiary rocks in the Coastal Plain are poorly consolidated and in general dip north at a low angle. The Quaternary formations which form the surface cover are unconsolidated and flat-lying.

Since this report is concerned with the occurrence of petroleum in Northern Alaska, no further mention will be made of the formations other than upper Cretaceous. The older rocks are structurally complex and it is unlikely that they contain significant amounts of petroleum.

Upper Cretaceous rocks, which are the oldest rocks structurally favorable to accumulation of oil, outcrop in a wide belt along the northern part of the Arctic Plateau and in the adjoining southern part of the coastal plain, and probably underlie the unconsolidated coastal plain deposits at shallow depths. They are also found along the Arctic coast in Peard Bay, southwest of Barrow. They have not been recognized east of the Colville River, but it is possible that closer correlation will prove that upper Cretaceous rocks exist here also. Where it has been recognized, the formation is dominantly shale and sandstone of both marine and terrigenous origin. Coal and carbonaceous shale is found in the terrigenous members. Because they contain abundant carbonaceous material these rocks are considered to be a likely source of petroleum. However, nothing definite is known concerning the existence or stratigraphic position of source horizons or of horizons suitable for the accumulation of petroleum. No complete measurements of the thickness of the upper Cretaceous formations are available, but estimates place it at between 10,000 and 15,000 feet. A number of broad, open anticlines have been observed where the formation is exposed in river valleys in the plateau region.

Tertiary deposits are found near the mouth of the Colville River and in the Canning River region. In the former area they are flat-lying, gray, calcareous silts and find sands, with a thickness of about 100 feet; while in the Canning River region they are mainly soft shale dipping northeast at fairly steep angles with a thickness of 200 feet or more. Tertiary rocks may also underlie the unconsolidated surface deposits in parts of the coastal plain.

Covering most of the coastal plain are relatively thin, shallow water, marine sands, and silts of Pleistocene age. These deposits are modified locally by rivers. Pleistocene morainal deposits left by retreating glaciers are found in parts of the plateau region, especially in the larger valleys.

DESCRIPTION OF SEEPAGES

Following is a description of the areas visited and of the petroleum seepages sampled:

Umiat Mountain Area

The Umiat Mountain area is located on the north side of the Colville River, approximately 15 miles west of the confluence of the Anaktuvuk and the Colville rivers. (Seepages in this area are shown in Fig. 2.)

One seepage was found in a small lake about a mile west of Umiat Mountain and about 100 yards from the north bank of the Colville River. The lake is about 200 yards across. A slow but steady oil seep together with gas bubbles appears mainly on the north side of the lake. The oil has the appearance of a light distillate. A sample was obtained by stirring the moss and vegetable matter in a pot-hole and then skimming off the oil which collected on top of the water.

A second petroleum indication in the form of oil-bound sand and gravel, appears on the river bank south of the lake. (Fig. 3) Sample No. 2 was collected from a pit dug into the oil-saturated gravel. The oil is of high gravity and is apparently similar to that found in the nearby lake.


High Bluff - Can be seen for
many miles from the south.
Low Ridge
Sandstone Exposures
750
Flat
(Old Channels)
Flat Ridge
Flat Ridge
Sample No 1
Sample No 2
Low Ridge
S70W
Bluff
500 ft
cut bank
N50W
Gravel
Willow Bar
Gravel bar
Willow Bar
Bar
River
Camp
4 Miles Bluff to Bluff
26
25
34
23
(Willow flat with old channels)
Colville
25 Indicates Aerial-Photo No.
Oil Evidence (See Report)
See Key Map
Sketch Map
UMIAT MT. OIL SEEPAGES
COLVILLE RIVER
Aug 24. 1943
U.S.B.M.
Approx 1 Mile

FIG. 2

UMIAT MOUNTAIN
Sectional Sketch of River Bank
(Looking West)

Aug. 24, 1943

U.S.B.M.
M.E.Jr.

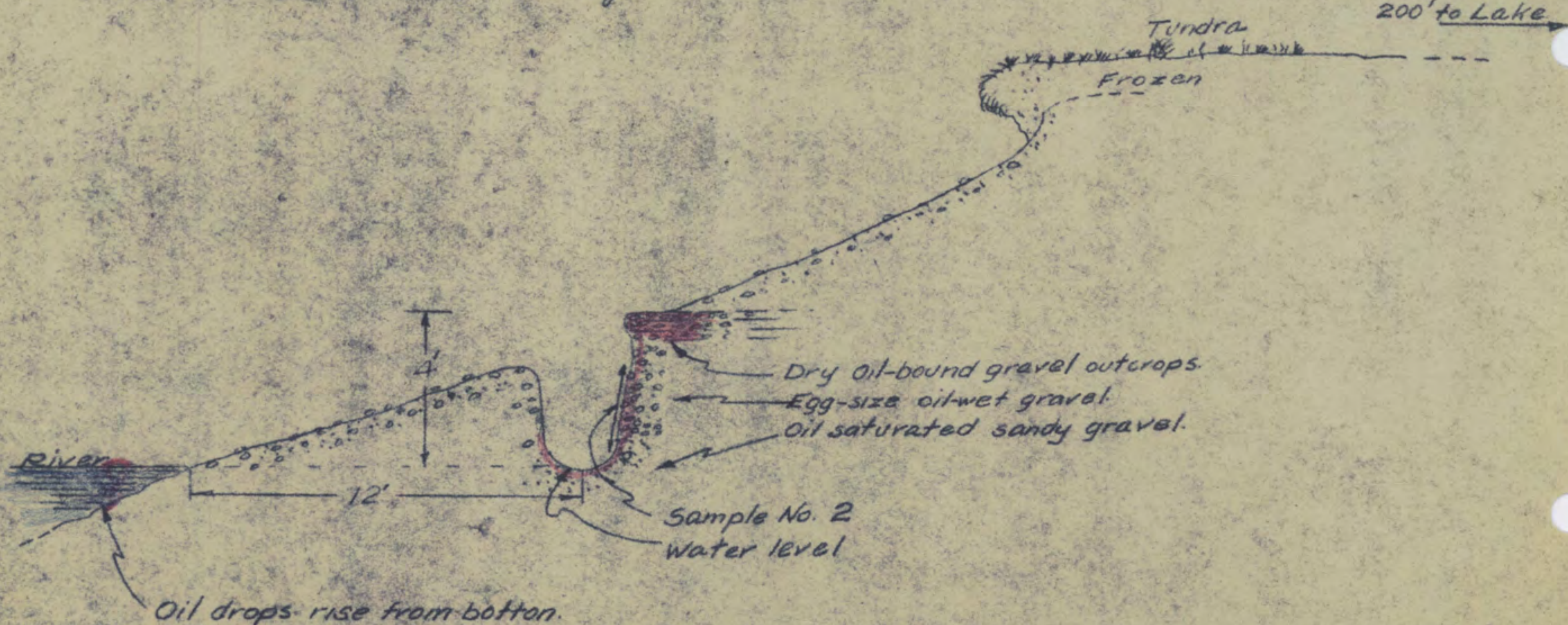


FIG. 3

A third seepage area was found in a lake about a mile west of the first-described seep. In this area light oil and gas rise from the lake bed, but no residue was found along the shore. The seepages were examined from a portable rubber boat. No samples were collected.

An oil film also appears at intervals in the Colville River near the west end of Umiat Mountain, and about 600 feet below the cut shown in Fig. 3.

The oil seep previously reported to occur near the Colville River and which was supposed to flow four or five barrels of oil in 24 hours, has been determined to be the Umiat Mountain seep. Seven years ago the oil-saturated gravel on the bank of the river, from which Sample No. 2 was collected was actually flowing a small trickle of oil into the river. At that time a gallon sample was collected by Simon Paneak, a guide for the Bureau of Mines party, and taken to the Arctic Ocean where it was burned in a lamp by Jack Smith, a former trader at Beachy Point.

5 Harrison Bay

Fish River Seep

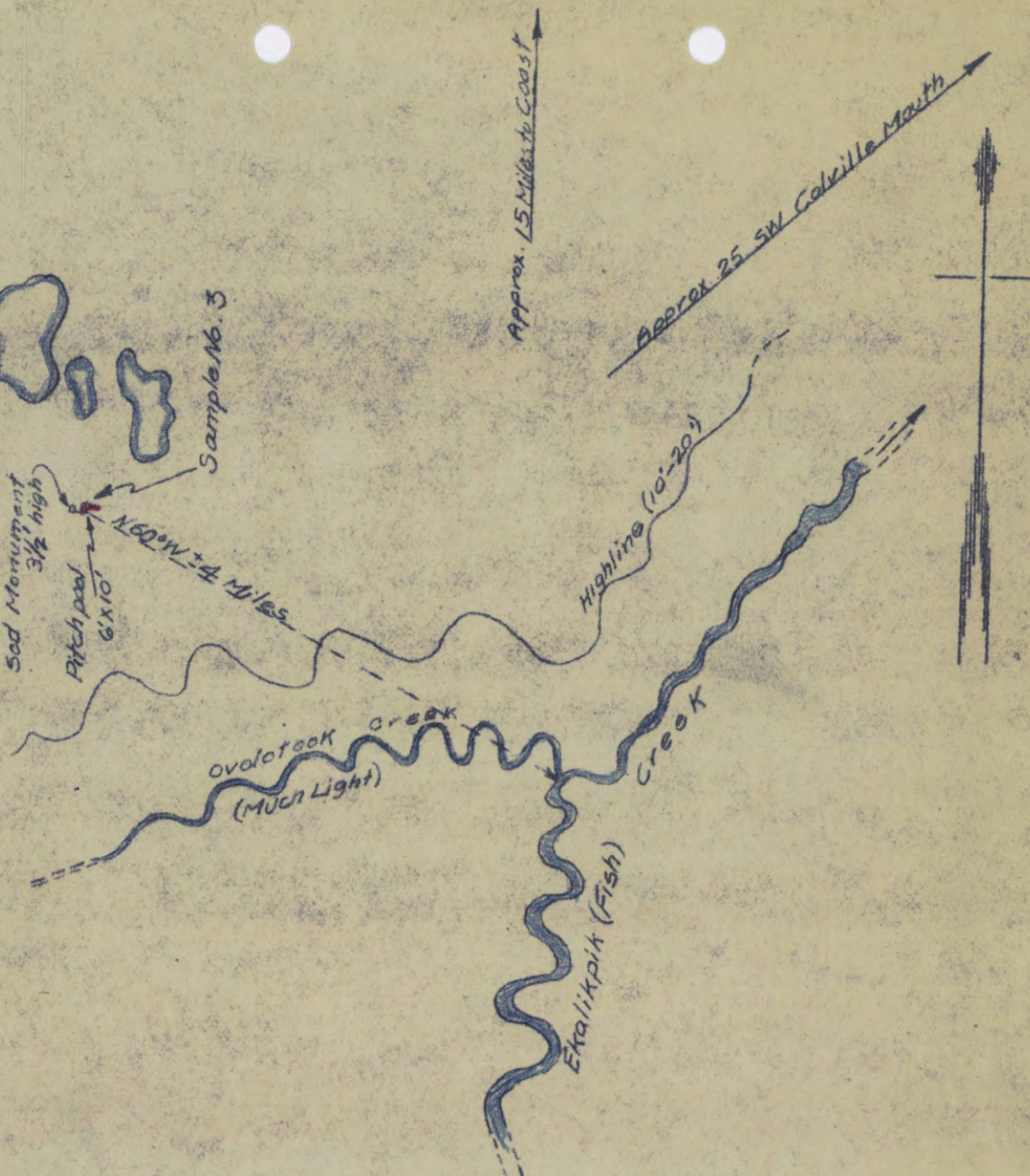
This area, located approximately 25 miles southwest from the mouth of the Colville River has a petroleum (pitch) seep about 6 feet wide and probably 20 feet long. (Fig. 4) The "pitch" pool is a solid, tarry material, having no apparent thin oil on the surface. This gummy residue has caught a great number of birds and small rodents. The seep, more specifically located, is 4 miles N.60° W. from the confluence of the Ovolotuk Creek and Fish River. Sample No. 3 was collected from this seep.

Dease Inlet Seep

Teshekpuk 4

This seep is located about one and one quarter miles east from Doonakavik Cove on the east side of Dease Inlet. (Fig. 5) Doonakavik is about four and one half miles northeast of Thomas Bower's warehouse, which is on Dease Inlet near the mouth of the Chipp River. The seep consisted of heavy petroleum residue coming from a low mound. This material was also observed beneath the moss in several places around the mound. Most of the residue had apparently been long exposed to the air and was almost hard enough to walk on at an air temperature of 35°F. Several hundred sacks of pitch have been mined for fuel by the natives from a pit about 20 feet by 30 feet. (Fig. 6) Some fresher material of lower viscosity was also seen near the center of the seep. Sample No. 4 was taken from the fresher part of the seep.

About 200 yeards east, pitch-soaked moss and silt were found along the edge of a low bench for a distance of about 300 feet. Pitch was



Sketch Map
OVOLOTOOK CREEK
AREA
Showing Location Oil Seep
Sept. 2, 1943

U.S.B.M.
N.E.Jr.

(FISH RIVER)

FIG. 4

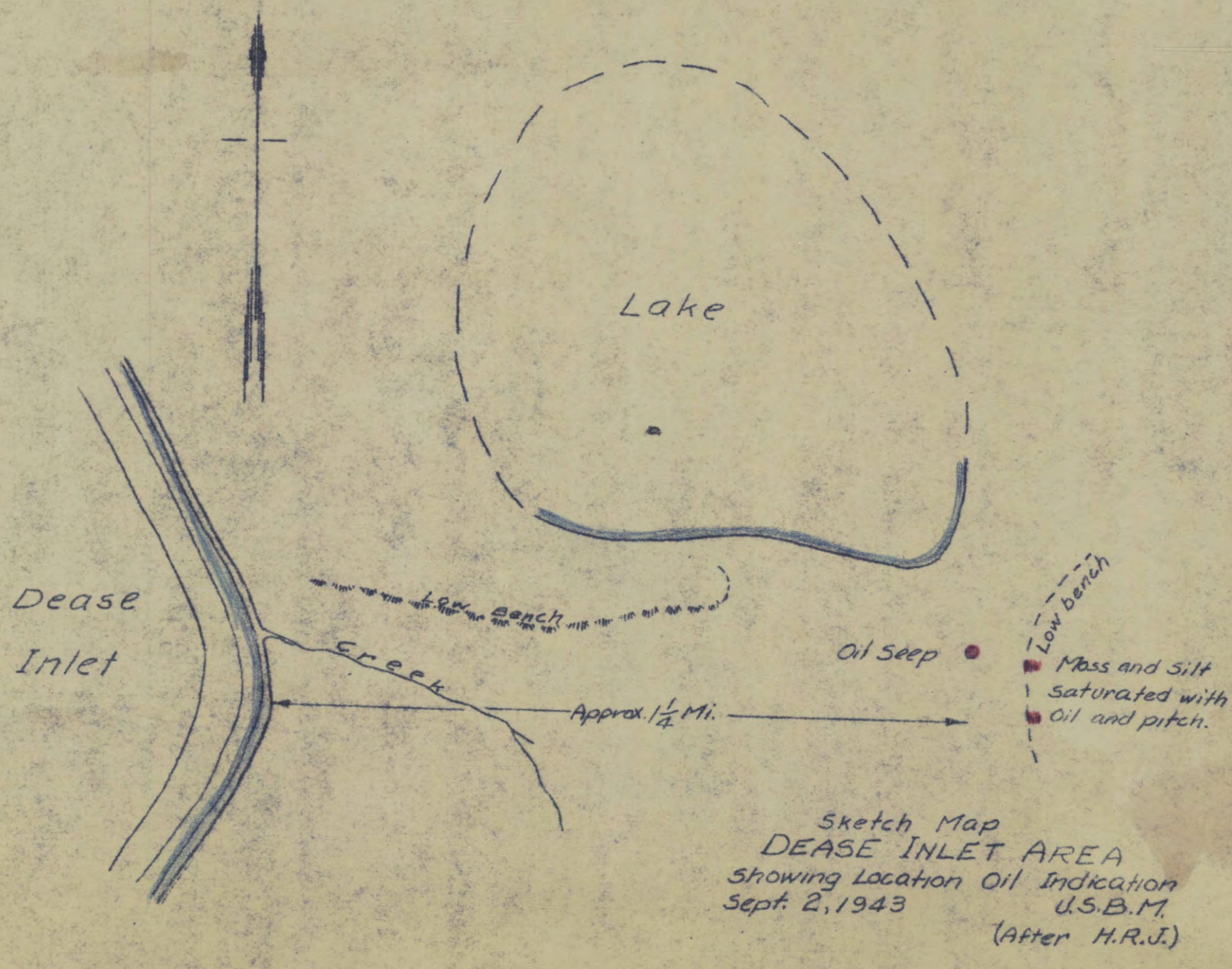

Lake
Dease
Inlet
Low bench
Creek
Oil Seep
Low bench
Moss and silt
saturated with
oil and pitch.
Approx. 1 1/4 Mi.
Sketch Map
DEASE INLET AREA
Showing Location Oil Indication
Sept. 2, 1943
U.S.B.M.
(After H.R.J.)

FIG. 5

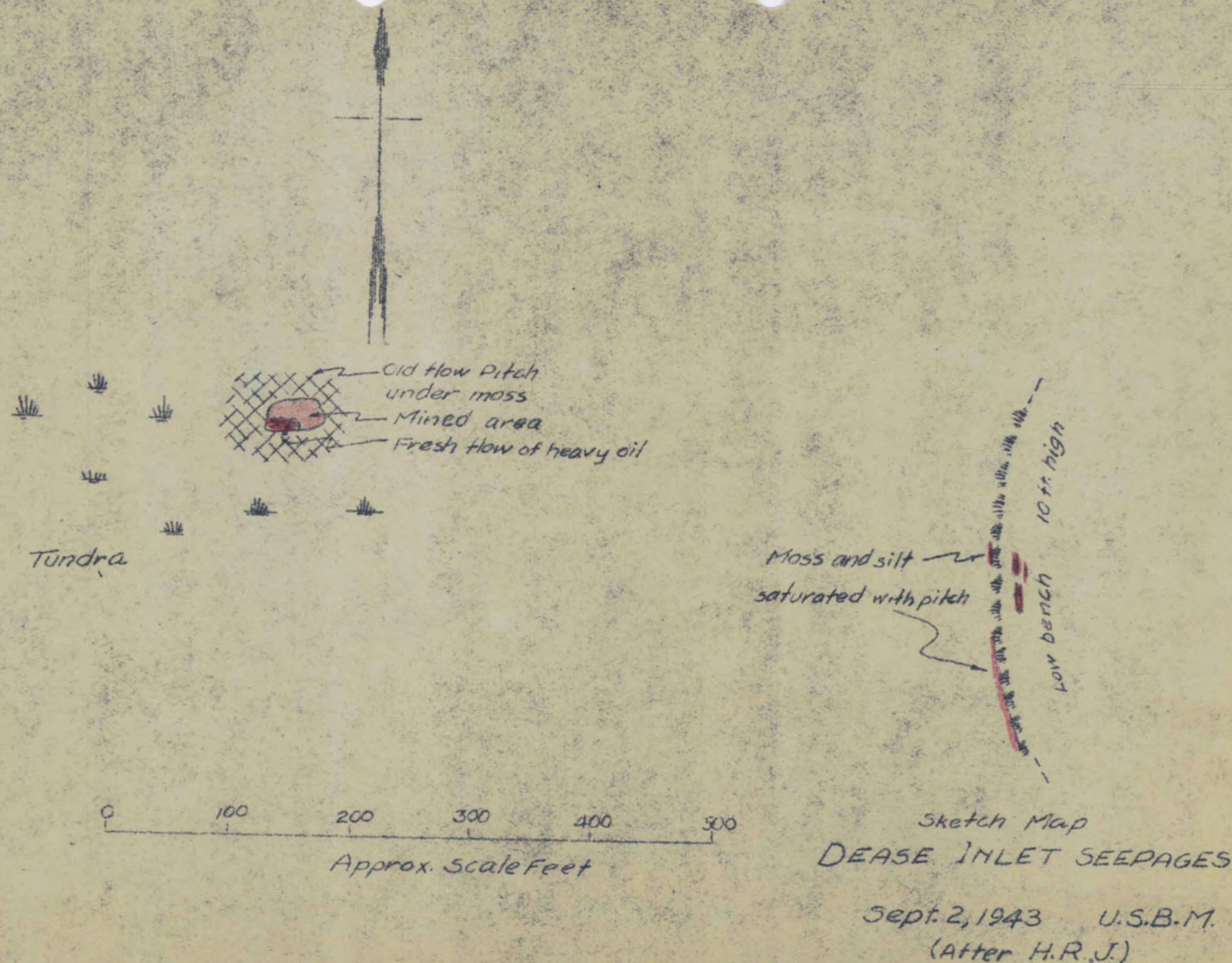

Old flow Pitch under moss
Mined area
Fresh flow of heavy oil
Tundra
Moss and silt saturated with pitch
10 ft. high
Low bench
0
100
200
300
400
500
Approx. Scale Feet
Sketch Map
DEASE INLET SEEPAGES
Sept. 2, 1943 U.S.B.M.
(After H.R.J.)

FIG. 6

also found under the moss at several places on the bench. (Fig. 6) Sample No. 5 was taken from the higher grade pitch-impregnated moss found along the edge of the bench.

Cape Simpson Area

Three seeps were visited near Cape Simpson. They emerge from rather prominent mounds aligned roughly north and south. (Fig. 7)

Seep No. 1 is four miles northwest from Cape Simpson and about 500 yards south of the Arctic Ocean. This seep has an actual surface flow about 800 feet in length and about 200 feet average width. (Fig. 8) It has been exposed to a great extent by mining of the pitch by the natives from Barrow. Several smaller pitch pools not connected from the main flow were noted, the pitch apparently underlying the tundra for a distance of approximately 1200 feet east and west and 800 feet north and south. As a rule, wherever the surface vegetation or tundra has been removed, the underlying pitch oozes to the surface. Sample No. 7 was collected from this exposure and is comprised partly of the harder residue and partly of the fresher flow directly underlying the hard surface. Another sample, marked No. 8, was collected by skimming a thinner oil which appeared near the top of the knoll.

Seep No. 2 is approximately three and one half miles south from seep No. 1. It flows out of a round knoll for a distance of 600 feet and runs into a small lake. The actual surface flow averages about 150 feet in width. (Fig. 8) This seep has also been mined for pitch by the natives. As in Seep No. 1, the petroleum residue underlies the tundra for a distance of 700 feet north and south and approximately 500 feet east and west. Numerous small pitch pools, separate from the main flow, were noted. Sample No. 9 was collected from the hard pitch. Sample No. 10 was collected from greenish, thin oil flowing near the top of the knoll.

Seep No. 3 is approximately 3 miles south of Seep No. 2. (Fig. 8) This seep, while not as large as seeps No. 1 and 2, is still of considerable size. Its exposed surface flow is about 300 feet east and west and 100 feet north and south. The surface tundra apparently overlies pitch over an area 800 feet north and south and possibly 1000 feet east and west. Mining of this seep has not been as extensive as in the other seeps, probably because of its greater distance from the ocean. Sample No. 6 was collected from the harder pitch which is being mined by the natives.

These 3 seeps in the Cape Simpson area, have been mined for their pitch by the Arctic slope Eskimos for a number of years. At the present time, approximately 3000 sacks weighing roughly 100 pounds

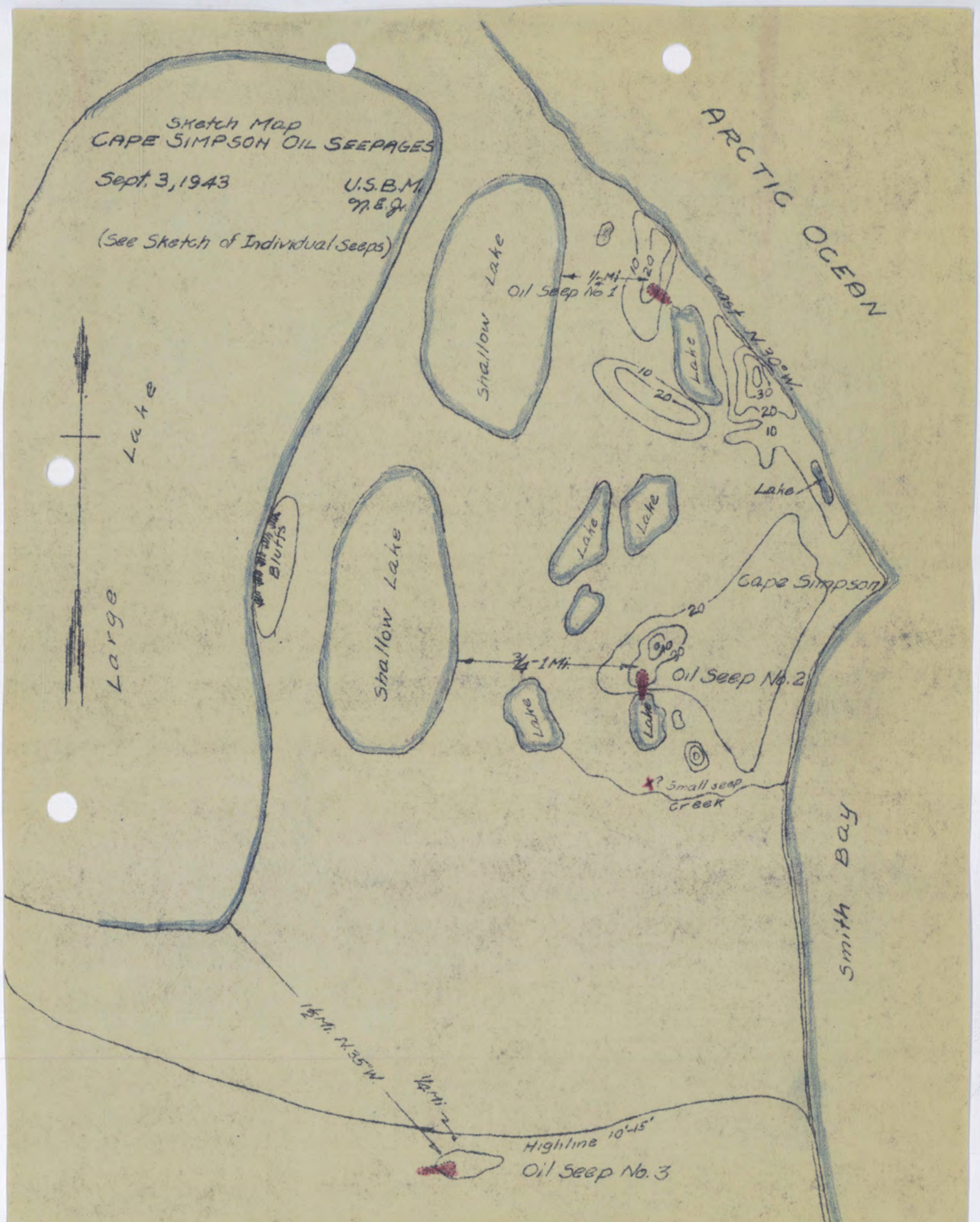

Sketch Map
CAPE SIMPSON OIL SEEPAGES
Sept. 3, 1943
U.S.B.M.
(See Sketch of Individual Seeps)
ARCTIC OCEAN
Shallow Lake
1/2 Mi.
Oil Seep No 1
Coast N.30°W.
Lake
Large Lake
Bluffs
Shallow Lake
Cape Simpson
3/4-1 Mi.
Oil Seep No. 2
? Small seep
Creek
Smith Bay
1 1/2 Mi. N.35°W.
1/4 Mi.
Highline 10'-15'
Oil Seep No. 3
Approx. 1 Mile

FIG. 7

(Sketches)

CAPE SIMPSON OIL SEEPAGES

Sept. 3, 1943 U.S.B.M. N.E.Jr.

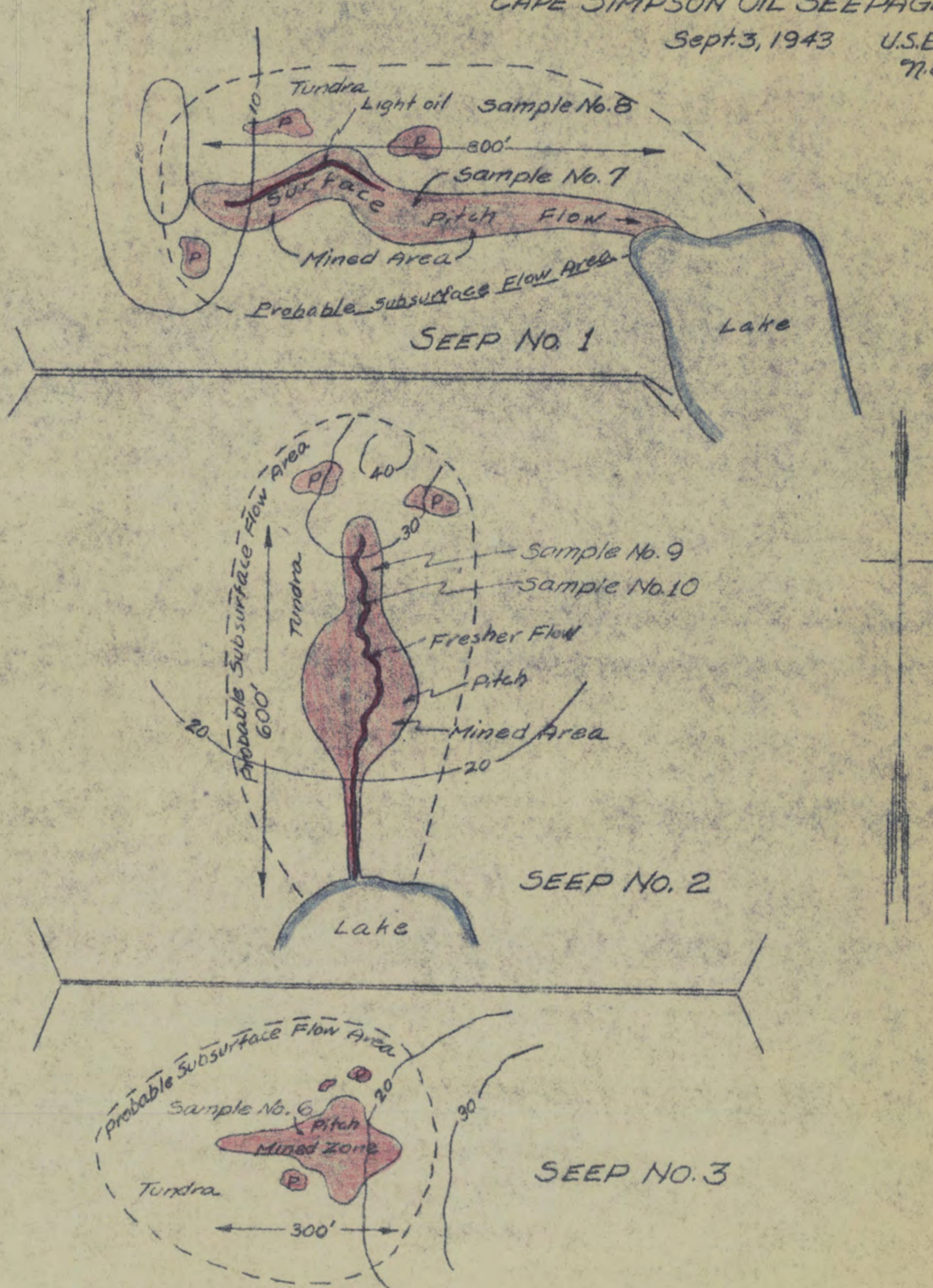


FIG. 8

apiece are mined each summer. The material, while very sticky and difficult to handle, is successfully burned in the Point Barrow area. It was noted that in all of the Cape Simpson seeps, numerous birds and small animals as well as reindeer and even wolves, have been trapped. Seeps No. 1 and No. 2 have been described in U. S. Geological Survey Bulletin 815.

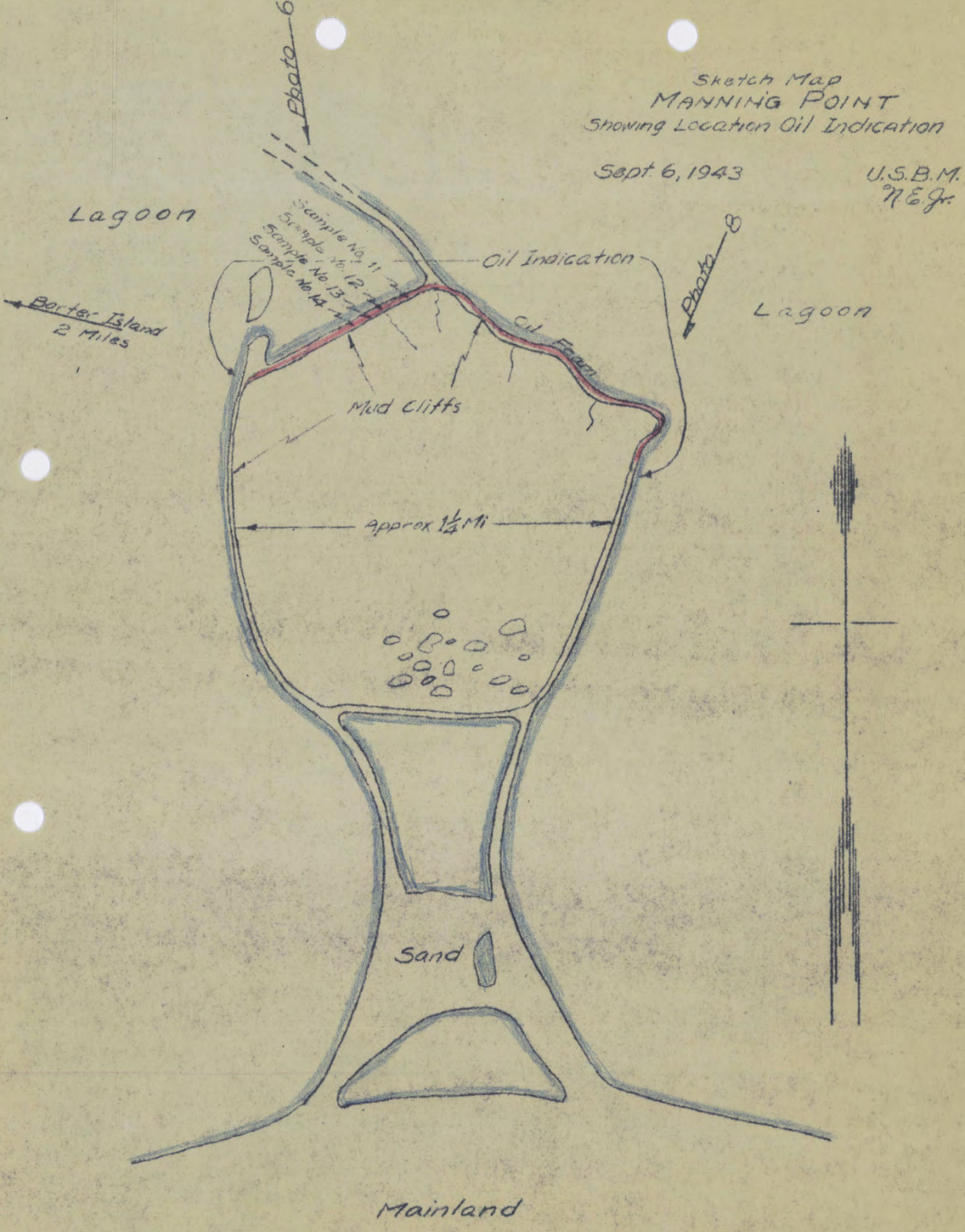
Three other petroleum seeps are known to exist in the Cape Simpson area. One of these is a small seep a short distance southeast of seep No. 2; the other two lie approximately 10 miles west of Cape Simpson.

Barter Island Area

The oil seepages in the Barter Island area are located on Manning Point approximately 2 miles southeast from Barter Island. (Fig. 9) This point is on tide water and during high tide it becomes an island a mile and a half in diameter. No actual pitch residue was note; however, the northwest and northeast beaches which form the point are lined with oil froth for a mile and a half. A considerable portion of the beach, particularly on the northwest side, consists of an oil-bound silt, and numerous boulders of soft oil-bound, reddish brown sands were observed. Several trickles of water, carrying an oil film, cross the narrow beach. Oil-soaked peat was noted in several places along the sloughed bank. Sample No. 11 was taken from the oil-bound silt found in layers along the northwest beach. An unconsolidated oil-soaked silt underlies the surface. Sample No. 12 was skimmed from the several small streams of water flowing from the bank to the ocean. Sample No. 13 was collected from exposures of an unconsolidated oil-bound, brownish-red sand which appeared in places along the bank. Sample No. 14 consisted of an oil-soaked vegetable debris found along the bank throughout the entire mile and a half distance. The oil has the appearance of a light distillate, and when dried and heated on a stove the oil-bound silt and sand burns readily and gives off a strong odor of kerosene.

Un-goon Point Area

Un-goon Point is 7 miles east of Humphrey Point and is approximately 40 miles west of Demarcation. Un-goon is the Eskimo term for pitch. Three evidences of petroleum seepages were found on Un-goon Point. (Fig. 10) The largest of these seeps is a mile and a quarter south from the sod house on the point. The pitch is black and hard, and is extremely difficult to dig. A small amount of mining has been carried out and the pitch has appeared in several small holes where the tundra has been removed. The general area is approximately 300 feet north and south and 100 feet east and west. Sample No. 15 was collected from several of the small pools.



Sketch Map
MANNING POINT
Showing Location Oil Indication
Sept. 6, 1943
U.S.B.M.
Photo 6
Lagoon
Sample No. 11
Sample No. 12
Sample No. 13
Sample No. 14
Oil Indication
Photo 8
Lagoon
Barter Island
2 Miles
Oil Foam
Mud Cliffs
Approx 1¼ Mi
Sand
Mainland

FIG. 9

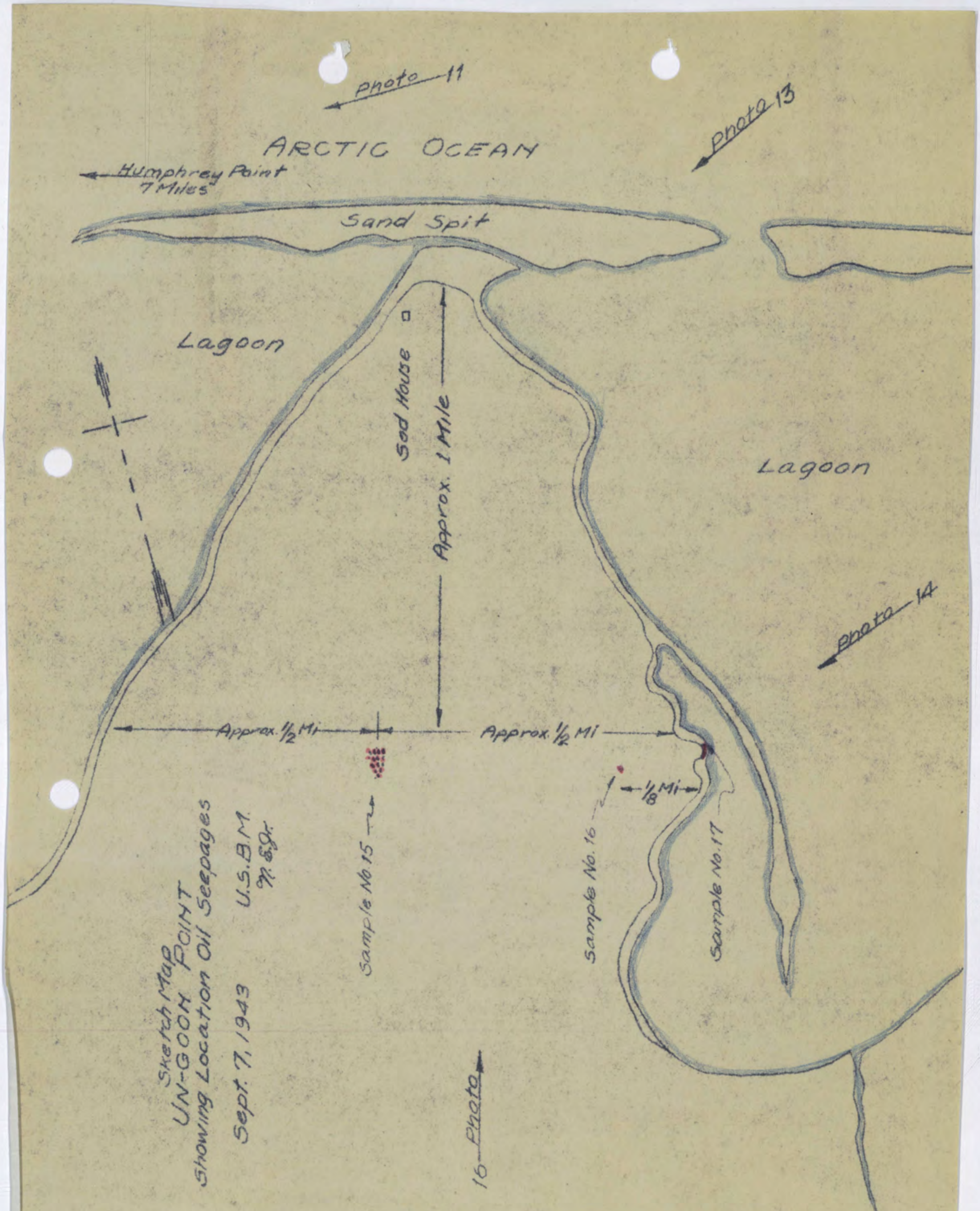


Photo 11
Photo 13
ARCTIC OCEAN
Humphrey Point
7 Miles
Sand Spit
Lagoon
Sod House
Approx. 1 Mile
Lagoon
Photo 14
Approx. 1/2 Mi
Approx. 1/2 Mi
1/8 Mi
Sample No 15
Sample No. 16
Sample No. 17
Sketch Map
UN-GOON POINT
Showing Location Oil Seepages
Sept. 7, 1943
U.S.B.M.
16 Photo

FIG 10

Six hundred yards east and about two hundred and fifty yards from the east beach, a small pitch pool has been excavated in the center of a small hummock. Sample No. 16 was taken from this material which has the same consistency as the large exposure. On the east side of Un-goon Point and in line with the two seeps mentioned above, an exposure of oil-bound sand four feet thick appears along the bank for a distance of about 30 feet. Sample No. 17 was collected from this oil-bound sand which somewhat resists the erosive action of the waves; the loose sand and silt are washed away, leaving the oil-bound material as an outcrop. This deposit is located one and one half miles southeasterly along the beach from Un-goon Point proper.

White Mountain Area (Kupowruk River)

A petroleum seepage is reported to occur about five or ten miles north of the "White Mountains", between the East Fork and the West Fork of the Kupowruk River. (Fig. 11) A search was made for this seep, but it was unsuccessful principally because of the lack of time and inaccurate knowledge of the location. The Eskimo guide had not been to the seep but thought he could find it from a description given him years ago. According to the Eskimos, about thirty years ago several of them found the seep and "a wooden-ramrod which had been thrust down into the oil, burned readily when touched with a lighted match." Apparently most of the old men have since died and no natives were found that were sure of the exact spot. However, a rumor is sufficiently persistent to make further investigation worthwhile. Information collected later during the trip indicates the search fell just short of reaching this seep.

Persons Knowing Location of Seepages

For record purposes and as an aid in future examination, individuals reported to know the actual location of the various seepages are listed here. An asterisk indicates that the person has been to the seep and actually knows the exact location; an "X" indicates that he has been reported to know the location but does not; no mark indicates the person is rumored to know the location but has not been questioned.

Colville Seep (Umiat Mountain)

*	Simon Paneak	Eskimo	Chandlar Lake
X	Charlie Suklok	"	Bettles
*	Sig Wien	White	Fairbanks
	Stan Morgan	White	Fairbanks
*	Henry Joesting	White	Fairbanks
*	Norman Ebbley, Jr.	White	Fairbanks

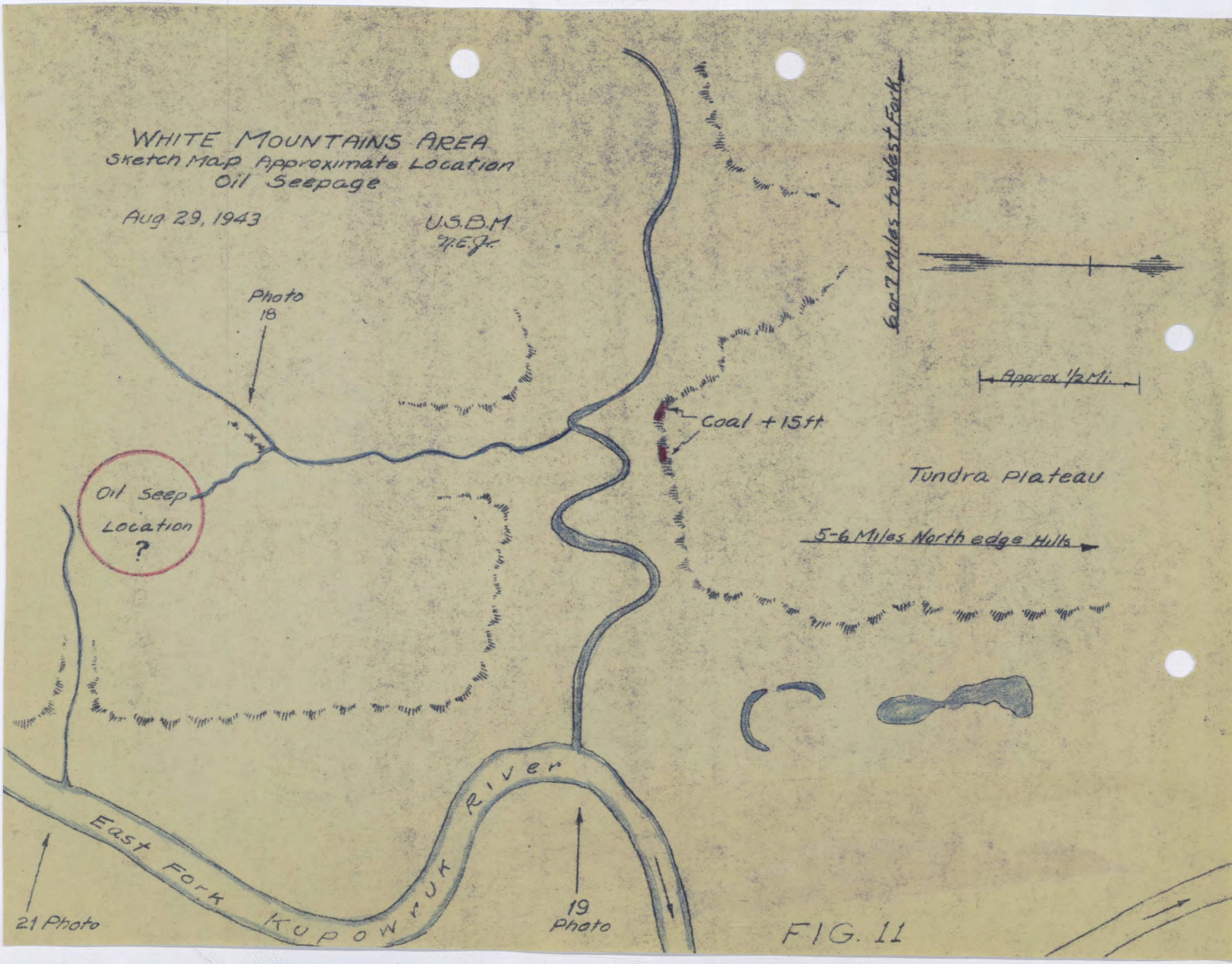

WHITE MOUNTAINS AREA
Sketch Map Approximate Location
Oil Seepage
Aug 29, 1943
U.S.B.M.
N.E.Jr.
Photo 18
Oil Seep Location ?
Coal + 15 ft
6 or 7 Miles to West Fork
Approx ½ Mi.
Tundra Plateau
5-6 Miles North edge Hills
East Fork Kupowruk River
21 Photo
19 Photo

FIG. 11

Kupowruk (North of White Mountain)

X	Simon Paneak	Eskimo	Chandler Lake
X	Charlie Sukick	"	Bettles
X	Mathews Ethiklik	"	Lower Colville
X	Mark Olock	"	Beechy Point
	Mathew's brother	"	Itpikpuk River
X	Old Akoblok	"	Chandler Lake
X	Abraham Stien	"	Beachy Point
X	Clay Lynn	"	" "

Ovolotook Creek (Southeast of Lake Teshekpuk)

X	Simon Paneak	Eskimo	Chandlar Lake
*	Baxter Adams	"	Cape Halkett
*	Samuel ?	"	Tommy Brower's
*	Ruben Teuseauk	"	Fish River
X	Richard ?	"	Colville River
*	Sig Wien	White	Fairbanks
*	Norman Ebbley, Jr.	"	Fairbanks

Cape Simpson (6 seeps)

*	Tommy Brower	Eskimo	Lower Itpikpuk Camp
*	Any native of Barrow	"	Barrow
*	Sig Wien	White	Fairbanks
*	Henry Joesting	"	Fairbanks
*	Capt. Henry Thomas	"	Fairbanks
*	Norman Ebbley, Jr.	"	Fairbanks

Dease Inlet Seep (4 miles east Doonakavik Cove near Cape Simpson)

*	Any of Tommy Brower's crew	Eskimos	Tommy Brower's Camp
*	Henry Joesting	White	Fairbanks
*	Capt. Henry Thomas	White	Fairbanks

Manning Point (By Barter Island)

*	Charlie Gordon	Half Breed	Barter Island
X	John Olson	White	Humphrey Point
*	Any Barter Is. Natives	Eskimos	Barter Island
*	Sig Wien	White	Fairbanks
*	Norman Ebbley, Jr.	White	Fairbanks

Un-goon Point (East of Humphrey Point)

*	Luke Enukok	Eskimo	Un-goon Point
X	John Olson	White	Humphrey Point
	Gordon Clan	Half Breed	" "
*	Sig Wien	White	Fairbanks
*	Norman Ebbley, Jr.	"	Fairbanks

Lake Teshekpuk (See Ovolotook Creek)

Fish Creek (See Ovolotook Creek)

Anaktuvik River

This rumor was checked and found to be incorrect. Probably refers to the seepage reported on the Kuparuk.

PROPOSED EXPLORATORY WORK

Although petroleum occurs widespread in northern Alaska, as indicated by a number of active seeps, little is known of its manner of occurrence and distribution of the depth at which it might be encountered or of the existence of rock structures which would permit its accumulation in commercial quantities. About one-third of the region in which seeps are known to occur has been covered by reconnaissance geologic surveys. These furnish some information concerning the distribution of rocks with which petroleum is apparently associated, but they tell little about the actual occurrence of petroleum. The remaining two-thirds of the region has not been mapped and no information is available. For this reason, considerable preliminary work is necessary before production drilling for oil can be undertaken.

An exploratory program to determine the petroleum resources of northern Alaska is outlined here. The primary aims of this program are to determine:

1. The areal extent of the source and reservoir beds of petroleum.

2. The stratigraphy of the formation with which the petroleum is associated, and of overlying formations.

3. The position, type and extent of rock structures favorable to accumulation of petroleum.

4. The depths of reservoir beds beneath the surface in favorable structures.

With information obtained through such a program it will be possible to drill wells with some knowledge of the depths of oil horizons and with a reasonable expectation of encountering oil. Haphazard drilling would not only be extremely costly, but would almost certainly result in failure.

Because conditions affecting petroleum exploration vary in different parts of northern Alaska, several methods of exploration are necessary. In the Arctic Plateau region, the rocks are sufficiently exposed so that the necessary information can be obtained by a geological investigation. On the Arctic Coastal Plain, on the other hand, rock exposures are almost nonexistent, so that geophysical methods supplemented by exploratory drilling must be largely used. On the area in which the presence of petroleum is indicated by seeps, somewhat more than half is in the Coastal Plain region, while the remainder is in the plateau region.

Geological methods are in general more rapid and inexpensive than other exploration methods and therefore should be used where surface exposures are adequate. Geophysical methods are intermediate in rapidity and cost between geological methods and exploratory drilling, and should be used only where sufficient information cannot be obtained from surface exposures. In addition, geophysical data must be supplemented and correlated by direct information obtained from surface studies and drilling. Exploratory drilling to obtain stratigraphic and structural information is relatively slow and costly, consequently it should be undertaken only to supplement or check information obtained by other methods.

Aerial Photographic Surveys

Maps of river valleys and of other areas where rocks are exposed should be available for geological investigations. These maps could best be made from aerial photographs, otherwise it would be necessary to map the areas by ground methods. Some aerial photographic mapping has been done by the U. S. Army Air Corps, and it is understood that this work will be continued. It is not known to the writers, however, whether the areas of possible petroleum occurrence have been or will be mapped.

If maps are not available from the Air Corps, the necessary photography and map compilation should be carried out by some other agency before the geologic work is started. Although desirable, it is not essential that ground control be established before the photographs are taken.

Geological Exploration

Geological investigations would necessarily be confined mainly to the larger river valleys, since most of the rock exposures are found in these valleys. In the plateau region, the investigations should extend from the Alaska-Canada boundary west to the middle course of the Colville River, and farther west if warranted by findings. In the coastal plain region several areas are known where older rocks outcrop through the unconsolidated overburden, particularly along the Meade and lower Colville Rivers and along the coast at Peard Bay, and other areas doubtless exist. Geological examinations should be made of these areas because some of them are near active seeps.

Since most of the rock outcrops are near the larger rivers, boats can be used for much of the geological work. Personnel, equipment and supplies can be brought into the region and transported to various areas by airplane. Vertical aerial photographs of the area to be studied should be used as base maps.

The time required to complete a geological survey of the type indicated here depends not only on the professional qualifications of the geologic personnel and on their being supplied with adequate equipment and transportation, but also on the ability of all the personnel to adapt themselves to new and strange conditions. If properly qualified and equipped personnel can be obtained, it should be possible for three field parties to complete the necessary geological surveys in a single field season. One party could work in the plateau region east from the middle course of the Colville River, the second could work west from near the Alaska-Canada boundary, while the third could work the areas in the coastal plain where rock outcrops are found. Field plans should be sufficiently flexible to permit their adjustment to fit unforeseen conditions.

The first two parties should consist of a geologist as party chief, three geological assistants capable of working under only general supervision, a cook, a camp hand, and an Eskimo guide. The third party should be identical, except that only two geological assistants would be required. All field work should be under the supervision of a chief geologist. A plane should be furnished him to permit him to visit each party and direct and coordinate their work. A portable radio transmitter and receiver should be furnished each party, to enable them to communicate with the plane and with each other. Caches of gasoline and food should be landed at convenient locations before field work starts.

Geological equipment should be essentially the same as that required for similar work in other regions. For each party it should include planetable outfits, tapes, aneroids, and cameras. Lightweight outboard motors and collapsible boats fitted for outboards should be furnished to each party. For work along the coast, a motor boat could be hired locally or at Barrow.

Camp equipment for each party should include one lightweight 10 x 12 mosquito-proof wall tent and two similar 8 x 10 tents. Sleeping bags should preferably be made of reindeer skin. A light, waterproof ground cloth and a caribou or reindeer ground covering should be furnished with each bag, as well as a small fly to serve as a shelter during trips away from the main camp. Personal and other equipment should be restricted to the essentials, since transportation from one area to another will be mainly by airplane.

Dehydrated food should be used as much as possible, because of weight limitations imposed by the use of airplanes. For trips of two or more days away from the main camp, rations similar to U. S. Army "K Rations" or "Mountain Rations" should be used, because they require little cooking. Fish, caribou, bear, and birds are generally obtainable in much of northern Alaska, and should be used to supplement the regular camp fare.

Each party should be furnished one light sheet-iron stove with a small oven and two small Primus kerosene stoves or Coleman gasoline stoves. Except near the coast, willows and alders suitable for firewood are found along the larger rivers. Along the coast drift wood is generally present, but driftwood as well as willows may be difficult to find in the winter when the ground is snow covered.

Normally, geologic field work can be started in March and continued until sometime in October. Previous to the breakup of the navigable rivers, which occurs about June 1, field work can be facilitated by the use of skis and a ski-equipped plane could be used to move camp. During breakup, when the snow is too soft for ski-landings, a period of restricted activity may be anticipated. After breakup, boats and a pontoon plane could be used, and later in the summer and in the fall when river bars are available for landing, a wheel plane could be used.

Geophysical Exploration

Since rock exposures are generally lacking, geophysical surveys must be used to locate and outline structures favorable to oil accumulation in the coastal plain region. For exploratory purposes these surveys should be run in straight north-south lines, across the regional structure. Detailed measurements should then be taken in structurally favorable areas.

Normally, geophysical surveys are made subsequent to geological surveys, so that use may be made of geological information. However, because much of the coastal plain is covered by lakes, it is recommended that the geophysical survey be made in the late winter and spring, between about February 15 and breakup. During this period the required lines may be run and equipment and supplies readily moved, whereas during the summer the inumerable lakes would make the operation extremely difficult.

Of the geophysical methods available, the magnetic, gravity meter and refraction seismic methods have been most used in exploratory surveys for petroleum. Of these the magnetic and gravity meter methods can be readily adapted for use in northern Alaska. They require relatively light, compact instruments and small crews, and field methods are comparatively simple and rapid. Little information is available concerning the use of any geophysical method in Arctic regions, consequently some experimental work will be necessary to determine what instrumental changes are required and to devise suitable field techniques.

Magnetic measurements will detect structural irregularities when differences exist in the magnetic properties of the underlying rocks. In Arctic regions magnetic surveys are handicapped by frequent and irregular variations in the earth's magnetic field, the more violent of which are known as magnetic storms. Conventional field methods may be modified, however, so that magnetic surveys can be carried out during magnetic storms of moderate intensity; in addition it is possible to obtain reasonably certain forcasts of periods of magnetic calm and of magnetic storm. Aside from being uncomfortable to the operator, low temperatures do not affect magnetic measurements, but field instruments must be fitted with thermometers that will read temperatures as low as minus 40° C, and care taken to prevent condensation of frozen moisture inside the instrument. Magnetic measurements are not affected by frozen ground.

Gravity meters, which measure variations in the earth's gravitational field resulting from differences in the densities of underlying rocks, operate at a temperature that may vary not more than about 0.01° C for most instruments. In temperate climates a constant temperature about 10 degrees above air temperature is maintained by the use of batteries and a heating devise controlled by thermostats. In northern Alaska the same method could be used, but some experimentation would be necessary to determine the characteristics of the instrument at low temperatures. Permanently frozen ground may give rise to gravity anomalies, particularly if it is deeply and irregularly frozen; however, it is believed that they may be distinguished from anomalies associated with larger structural features.

Refraction and reflection seismic methods are used to determine the depths of horizontal or nearly horizontal formation boundaries at depths not greater than about 4,000 feet by measuring the velocity of artificially created seismic waves. Normally, the surface layer transmits waves at a low velocity, but in northern Alaska the permanently frozen surface layer has a relatively high velocity. Thus the permanently frozen ground presents difficulties in the application of seismic methods that would probably require considerable experimental work to overcome. For this reason their use is not recommended for the proposed exploratory work, although an experimental program to determine the value of reflection seismic methods for detailed work would be of later value.

Gravity Meter and Magnetometer Field Methods

Gravity meter and magnetometer field methods are sufficiently similar so that the two surveys may be conducted simultaneously and thereby permit use of a smaller total number of men. Measurements by both methods should be taken along straight parallel lines, spaced about 10 miles apart and run north and south so as to cross regional structural features. These lines should extend across the coastal plain from the Arctic coast, to the plateau regions. Some of them should extend into the plateau region, to permit correlation of geophysical data with structural features observable from surface outcrops. Detailed measurements should also be taken over all structures indicated by the preliminary survey. These measurements, made on a grid or net work of stations, should cover areas sufficiently to outline the structures.

Spacing of gravity meter stations along each line will necessarily be regulated by the size of structural features. Initially, a spacing of 5,000 feet should be used; later this spacing may be altered to suit conditions as determined by field measurements. For detailed measurements a grid with stations 2,500 to 5,000 feet apart will probably be found suitable.

About 1,500 gravity meter stations would be required to complete the preliminary survey of the coastal plain region where oil indications have been found. An unknown additional number of stations, probably totalling at least 1,000, would be required to outline structures indicated by the preliminary survey. Under conditions prevailing, stations can probably be occupied at an average rate of about 10 a day. Thus, 150 days would be required for one gravity meter party to complete the preliminary survey and possibly an additional 100 days to complete detailed surveys.

Since there are barely 100 days between February 15 and breakup, it will be necessary either to extend the work over more than one field season, or to use several field parties. In view of the difficulties and delays that will undoubtedly be experienced by crews unaccustomed to working under Arctic conditions, it is recommended that only one field party be used, at least during the initial stages of the work.

The rate at which magnetic stations may be occupied depends largely on the frequency, duration and intesity of magnetic storms. According to experience in interior Alaska, it should be possible to occupy at least 20 stations a day on the Arctic Coastal plain. Magnetic stations should be so spaced that the magnetic and gravity meter surveys advance at the same rate; thus they would be 2,500 feet apart if the gravity meter stations were 5,000 feet apart. The same lines may be used for both surveys.

Frequent magnetic storms in Arctic regions are a serious handicap to determinations of magnetic variations associated with rock structures. The effects of magnetic storms, and of smaller variations in the earth's field may be eliminated by the use of two magnetometers, with similar characteristics. Simultaneous readings are taken with the two instruments set up at adjoining stations; the rear instrument is then moved ahead and simultaneous readings are again taken; thus the survey proceeds in a leap-frog fashion. 1/

With stations spaced at 2,500 feet difficulty in signalling for simultaneous readings may be experienced during stormy or foggy weather. This may be overcome by use of signalling devises, such as very light radio sets capable of transmitting and receiving code over short distances.

Gravity meter and magnetic stations are most satisfactorily located by transit surveys of a relatively low order of precision. Each line of stations should be tied in one or more places to permanent landmarks, either natural or constructed. Ties should also be made with geodetic stations of known latitude and longitude. Line bearings must for the most part be determined by stellar or solar observations. A semi-permanent mark should be placed at each station so they may be readily found by the geophysical crews and by later field parties. These marks could be wood stakes, about 4 feet long, painted black and white and marked with the station number. They should be set into the ground below the surface in most tundra-covered areas. Holes for planting the stakes may be made with a small crowbar and hammer.

Instruments, Equipment, and Personnel

A wide variety of types of gravity meters, weighing between 50 and 150 pounds, are used in gravimetric surveys. For the proposed survey the gravity meter should be capable of operating at low temperatures, should permit of ready adjustment and calibration in the field, and should be relatively insensitive to shock. Since the instrument will be permanently mounted on a sled, no weight limitations need be imposed. Present availability would probably be a factor in the choice of a gravity meter.

1/ Hubert De Beck, An Accurate Simplified Magnetometer Field Method: Geophysical Prospecting, Trans. A.I.M.E. Vol. 110, pp. 326-333, 1934

The Schmidt vertical magnetometer is generally used for exploratory magnetic surveys and is suitable for Arctic use. Two magnetometers fitted to operate at temperatures as low as minus 40° C., together with calibrating equipment, would be required. Two small portable radio transmitters and receivers for code communications up to a few miles are also required, to permit taking simultaneous readings with the two magnetometers.

Equipment for transit surveys should be essentially similar to that used in other regions for similar surveys. The transit should be graduated to read angles to one minute of arc. For cold weather operation the transit must either be dry or lubricated with non-solidifying oil, and manipulated parts should be made of ivory or plastic, or covered with adhesive tape. Since most of the coastal plain is flat, transit courses up to a mile or more will be possible; consequently 500 or 1,000 foot tapes should be used for most linear measurements.

Snow conditions in the coastal plain in late winter are well suited to the use of tractors and large sleds. Personnel and equipment could therefore be housed in wannigans mounted on sleds, and drawn by a light tractor equipped with a small bulldozer. An additional wannigan would be necessary for use as a shop and a small wannigan or tent mounted on a sled to house the gravimeter. A snowmobile should be furnished the gravimeter operators. Oil should be used for heating and cooking.

Other equipment should include a radio transmitter and receiver, a motor-generator for charging batteries and for lights, and automotive repair tools and parts.

A total of 12 men would be required to make up a geophysical field party, as shown in the following list:

1 Gravimeter operator
1 Assistant
2 Magnetometer operators
2 Assistants
1 Transit operator
2 Rod and chainmen
1 Tractor operator
1 Cook
1 Computor and party chief

All equipment, supplies and personnel must be brought in by plane. Ski landings on the snow may be made almost anywhere on the coastal plain.

Snowstorms accompanied by high winds are not infrequent in the coastal plain region during the late winter. For this reason field men should be prepared to spend several days away from camp if they are prevented from returning by low visibility and strong winds. The gravity meter crew should carry bedding and emergency rations in the gravity meter wannigan. The magnetometer and transit survey crews would be unable to carry bedding, since they would be working on foot, but they should carry rations and wear native clothing which would permit them to hole up safely and without too much discomfort.

Exploratory Drilling

Exploratory drilling is mainly for the purpose of obtaining direct, positive information on structures already indicated by geophysical methods and to aid in stratigraphic correlation of formations with which petroleum may be associated. Because this type of drilling is relatively rapid and inexpensive it is commonly done in advance of actual production drilling for oil.

Petroleum exploration drilling is known as "slim-hole" drilling because the drilling holes are less than 7 inches in diameter. For portability the drilling rigs are mounted on trucks or skids and have folding masts. With the larger "slim-hole" rigs, 7 inch holes can be drilled to depths of 6,000 feet. The weight of these rigs is between 30 and 40 tons, not including drill pipe.

For rapid drilling of smaller diameter holes to depths of a few hundred feet, several types of light, mobile drilling rigs have been developed. These machines are used principally in connection with seismic exploration, but they would be of considerable use in obtaining stratigraphic and structural information on the coastal plain where the overburden is thin.

Drilling rigs for use on the coastal plain should be mounted on skids or caterpillar-type tracks and tractors should be used for moving them. During most summers it would be possible to transport this equipment to the north coast by boat. Whether or not it could then be hauled overland during the summer to the area to be drilled depends on whether a route could be found around the coastal plain lakes. During the winter, after freezeup, overland transportation is entirely feasible, either from Barrow or from the northern coast. An alternative method of transporting drilling equipment is by airplane from Fairbanks. If transported by airplane the length and weight of any individual part would be limited to the capacity of the airplanes available.

No close estimate may be made of the time required to complete an exploratory drilling program, because nothing is known of the number of structures favorable to oil accumulation, or of the number of test holes necessary on any structure. Progress may also be delayed by difficulties in moving from one structure or area to another. It is safe to assume, however, that at least several years would be required to check stratigraphy and structure in the large coastal plain area in which oil indications have been found.

Exploratory drilling could best be done during the summer although some winter drilling may be necessary because a large part of the coastal plain is covered by water. Winter drilling would require insulated wannigans for the crew and a heated shelter around the base of the drill.

Two wannigans mounted on skids or sleds would be required for a bunkhouse and a mess house. A radio transmitter and receiver should be included in the equipment. A large tractor, with a small wannigan for tools and parts, would be needed to assist in moving the drill and casing.

A drill crew should consist of six men. These are one driller and two helpers, one tractor operator, one cook, and one geologist for examination of cores. Two additional men should be included if a light drill is used in addition to the larger "slim-hole" rig. Two shifts on the larger rig may be desirable when more is known as to the amount of exploratory drilling required. In this event, four additional men, including a camp hand, will be necessary.

COST ESTIMATES

The cost of a program of geological and geophysical exploration and of exploratory drilling in northern Alaska may be determined with some degree of certainty, since the aims of the program and the methods of accomplishing them are known. Cost estimates of any subsequent development, on the other hand, can at present be only tentative, since a development program cannot be definitely planned until the results of the exploratory program are evaluated. Thus, drilling costs cannot be estimated until something is known of the number and size of favorable oil structures and of the depths to oil horizons; nor can refinery and distribution costs be estimated until something is known of the size of oil reserves and the rate of production.

In addition, the volume of production and methods of distribution of oil from northern Alaska would be governed to a large extent by future economic and military needs. To determine these needs and the ability of present producing fields to compete with northern Alaskan fields in supplying them is beyond the scope of this report.

However, in spite of these unknown factors, the possible cost of drilling, refining, and distributing oil are given here, in addition to the costs of exploration, in order to present a complete program.

Geological Exploration

1. Salaries and wages		
21 men @ $400.00 a month for 5 months		$42,000.00
2. Travel		
15 men @ $300.00 a round trip	$4,500.00	
Salaries 15 x 12 x 20 days	3,600.00	
Expenses 15 x 6 x 20 days	1,800.00	
		9,900.00
3. Equipment		
Tents, rubber boats, radios, camp supplies, etc.		7,000.00
4. Airplane hire		
One Bellonca (or equal) on floats, skis and wheels - charter basis for 150 days		37,500.00
5. Food		
21 men - 150 days @ $3.00 a day per person		9,450.00
Total:		$105,850.00

Geophysical Exploration

1. Salaries and wages		
12 men @ $425.00 average for 4 months		$20,400.00
2. Travel		
12 men @ $300.00 a round trip	$3,600.00	
Salaries 12 x 2/3(425)	3,400.00	
Expenses 12 x 6 x 20	1,440.00	
		8,440.00
3. Equipment		
1 Gravity meter and accessories	$12,000.00	
2 Magnetometers and accessories	3,000.00	
1 Transit, chains, etc.	700.00	
2 Tractors (D-2 or equal) equipped with dozer & winch at Fairbanks	8,300.00	
3 Wannigans (8 x 16) Cork lined on sleds	3,600.00	

2 Wannigans (6 x 8) on sleds	$1,600.00	
1 Snowmobile	1,500.00	
Radios and motor-generator	1,000.00	
Misc. tools and equipment	2,000.00	$33,700.00
4. Fuel		
Gasoline, 1,000 gallons @ $.30	$300.00	
Diesel, 1,500 gallons @ $.25	375.00	
Grease and lubricating oil	100.00	775.00
5. Airplane Hire		
Approximately 33 tons via Tri-motor Stinson @ $1200.00 a ton	$39,600.00	
Additional smaller plane service	12,000.00	51,600.00
6. Food		
12 men - 120 days @ $3.00 a day		4,320.00
First season - TOTAL		$118,235.00
Probably require 3 seasons; additional at $50,000.00 each season		100,000.00
Total cost for 3 seasons		$218,235.00

Exploratory Drilling

1. Salaries and wages		
6 men @ $450.00 a month, averaging 6 months	$16,200.00	$16,200.00
2. Travel		
6 men @ $300.00 round trip	$1,800.00	
Salaries 6 x 2/3(450)	1,800.00	
Expenses 6 x 6 x 20	720.00	4,320.00
3. Equipment		
One "slim-hole" exploratory drill	$40,000.00	
Casing, bits, and drill pipe	12,000.00	
D7 (or equal) tractor, dozer, winch, and accessories	10,500.00	
Two No. 6 medium sleighs (included in drill price)		
Two cork-lined wannigans (10 x 12) on sleds	2,400/00	
Consore Exploration drill (or equal)	4,000.00	
Misc. small tools, etc.	2,100.00	71,000.00

4. Fuel		
2,500 gallons diesel oil - drill		
500 gallons diesel oil - tractor		
300 gallons fuel oil - heating		
3,300 gallons @ $.07 - Seattle	$230.00	
300 gallons gasoline @ $.20	60.00	$ 290.00
5. Food		
6 men - 180 days @ $3.00 a day		3,240.00
6. Freight		
60 tons @ $65.00 a ton		3,900.00
7. Airplane Hire		
$1,500 a month for 6 months		9,000.00
First season - TOTAL		$107,950.00
Probably require 3 seasons; additional at $50,000.00 each season		100,000.00
Total cost for 3 seasons		$207,950.00

Office Work In Connection With Exploration

Preparation for field work, computations, reports, etc.	$30,000.00
TOTAL for exploratory work	$562,035.00
Additional 10 percent for contingencies	56,204.00
	$618,239.00
Plus contractors fixed fee (approx. 4 percent) (Excluding geological exploration)	20,761.00
GRAND TOTAL for exploratory work	$639,000.00

Well Drilling

In the event the exploratory work as outlined indicates the existence of oil reserves, it is reasonable to assume a minimum of 250,000 feet of hole would be required to bring one field into production and to prove several additional areas. Estimated total drilling cost a foot - $20.00 — $5,000,000.00

Refinery

A tentative cost estimate of $10,000,000.00 is made here for erection of a refinery. This estimate is subject to revision when more is known of refinery requirements — $10,000,000.00

Pipe Line Installations

Closely related to the problems of exploration and development of the oil reserves in northern Alaska is that of transporting the product, either crude or refined, to points where it can be distributed and utilized. This latter problem naturally cannot be definitely solved until it is known whether oil reserves exist in economic quantities and until data are collected to establish the need of an oil supply from northern Alaska.

No information is available to the writers as to the present and probable future consumption of oil in Alaska and the western United States, or as to the oil reserves in fields now serving these regions. Cost data are available, however, on the Canol pipe line installations from the Fort Norman oil field to Whitehorse and to Fairbanks; and they permit some comparisons to be made concerning the relative merits of the Canol installation and one from northern Alaska.

The original cost estimates of the Canol installation, excluding exploration, drilling, and construction of refineries, was $86,500,000.00. Later changes and additions have raised this figure to over $140,000,000.00. This installation includes Canol No. 1, the 4 inch line from the Fort Norman wells to Whitehorse; Canol No. 2, the 4 inch line from Skagway to Whitehorse; Canol No. 3, the 2 inch line from Carcross to Watson Lake; and Canol No. 4, the 3 inch line from Whitehorse to Fairbanks. All of these installations include the necessary pumping stations, loading facilities and appurtenant structures capable of delivering aviation gasoline (Crude in Canol No. 1 line) at the rate of 3,000 barrels a day in the 3 inch line and 6,500 barrels a day in the 4 inch line. Also included are piping connections, control valves and manifolds necessary for the storage of the petroleum products in 130 steel tanks with a total capacity of approximately 1,150,000 barrels, plus suitable facilities for the housing of the operating personnel. The total length of the various lines comprising the Canol installation is about 1,500 miles.

It is rather surprising to realize that this line is approximately two and one half times longer than a pipe line route from any of the oil occurrences on the Arctic Coast to Fairbanks. A pipe line from the Cape Simpson area, also tapping the Lake Teshekpuk and Colville River oil occurrences, through the Anaktuvuk pass to Livengood and Fairbanks would be about 625 miles in length. A pipe line from near Barter Island, including the Un-goon Point area, through the Chandalar region to Fort Yukon, Circle and Fairbanks would be approximately 550 miles in length. The terrain along the projected northern Alaska route is comparable to that between Fort Norman and Whitehorse and between Whitehorse and Fairbanks - if anything, it is less difficult for road and pipe line construction.

Other possible distribution routes are by tanker from the Arctic coast, and by pipeline to an ice-free port in Alaskaand then thence by tanker. To ship by tanker from the Arctic coast is of questionable feasibility, because of the short and uncertain season for navigation. Any pipeline to an ice-free port would probably pass near Fairbanks.

Following is a hypothetical cost estimate of a proposed pipeline from Cape Simpson to Fairbanks. Although this estimate is not based upon actual surveys, the Canol installation was used for comparative study. The error would hardly be greater than that in cost estimates of other Alaskan installations.

<u>Cape Simpson to Fairbanks</u>

<u>Item I Pipe</u>

625 miles 3 inch I.D., 7.57 lbs. a foot, seamless pipe.
12,500 tons at $80.00 a ton $1,000,000.00
(The question of using a larger pipe, either a 4 inch or 5 inch I.D., should be given serious consideration, since the number of pumping stations could be cut down and the line pressure greatly reduced. This would be an important factor in operation and maintenance.)

<u>Item II Pumping Stations</u>

Number required - 14
Two (2) units each station

Pumping units	$24,000.00	
Manifolds and Installation	12,000.00	
Tank and connections	3,000.00	
Lighting units	1,500.00	
	$40,500.00	$567,000.00

Item III Storage Tanks

1 -	80,000 bbl. tank	$150,000.00	
5 -	10,000 bbl. tanks	68,500.00	
	Gauges	3,500.00	
	Valves, fittings, and controls	15,000.00	
			$237,000.00

(Main storage tanks at Fairbanks already installed.)

Item IV Labor

		No. Men	Days	Man Days
1.	Administration	172	240	41,280
2.	Camp Employees	172	240	41,280
3.	Transportation	731	160	116,960
4.	Road Maintenance	200	240	48,000
5.	Pipe Line	172	240	41,280
6.	Storage Tanks	20	100	2,000
7.	Pumping Stations	62	100	6,200
8.	Communication	90	100	9,000
9.	Housing	425	150	63,750
		2,004	Av. 175	369,750

at $12.00 a man-day $4,437,000.00

Item V Field Transportation

(a) Materials

	Tons
Pipe	11,000
Equipment	3,000
Food	1,200
Structures (Perm. & Temp.)	7,000
Petroleum Products	6,000
Tanks, pumps, valves, etc.	1,000
Misc. tools, rigs, & supplies	2,300
	31,500

(b) Average haul
Fairbanks to Cape Simpson 310 miles.

(c) Average load
Assume average load of 6 tons

(d) Ton miles a day-truck
Assume truck will do 120 miles a day, three shifts, return empty. Then 120 divided by 2 equals 60 miles a day pay-load. 6 x 60 equals 360 ton miles a day per truck.

(e) Total ton miles
Fairbanks to Cape Simpson
310 x 31,500 equals 9,765,000 Ton Miles

(f) Operating time
Fairbanks to Cape Simpson
240 days x 2/3 equals 160 working days.

(g) Trucks required
Fairbanks to Cape Simpson

$$\frac{9,765,000 \text{ T.M.}}{360 \text{ T.M./Trk/Day} \times 160 \text{ days}} = 170 \text{ trucks.}$$

(h) Operating Costs

Item	Costs Each Truck
Truck	$2,500.00
Fuel, 30 GPD at 1.00 x 160	4,800.00
Lube and grease	160.00
Extra tires	100.00
Repairs	500.00
	$8,060.00

Fairbanks to Cape Simpson x 170 trucks $1,370,200.00

Item VI Rail and Sea Transportation

31,500 tons at $75.00 a ton $2,362,500.00

Item VII Housing

(1)	Office Buildings	$240,000.00
(2)	Housing, 300 man camp, at $1,000.00 a man	300,000.00
(3)	Housing, 14 - 200 man camps, at $500.00 a man	1,400,000.00
(4)	14 Shops and garages at $15,000.00 each	210,000.00
(5)	14 Mess halls, $20,000.00 each	280,000.00
(6)	2 Warehouses, $50,000.00 each	100,000.00

$2,530,000.00

Item VIII Communication

Telegraph and Telephone Lines
3 speaking and one phantom circuit for control of pumps. Station and dispatching at $1,365.00 a mile. 625 miles at $1.365 a mile $853,125.00

Item IX Travel

2,044 men at $300.00 round trip	$613,200.00	
Travel Salaries 2,044 x 12 x 10 days	245,280.00	
Travel Expense 2,044 x 6 x 10 days	122,640.00	$981,120.00

Item X Air Transporation and Freight on Job

Construction of road and pipe line.
2 Planes at $300.00 a day each Av.
600.00 x 500 days — $300,000.00

Item XI Administration

Telegraph, Telephone, Maintenance, etc.	$26,000.00	
Stationary and Supplies	32,000.00	
Furniture, Office machines, etc.	20,000.00	$78,000.00

Item XII Subsistence

2,044 men for 175 days (av.)
$2.00 a day for each man — $715,400.00

Item XIII Road

625 miles total - less Fairbanks-Livengood road
550 miles at $15,000.00 a mile — $8,250,000.00

Item XIV Transportation, Maintenance & Const. Equipment

Total estimated cost — $2,500,000.00

Item XV Insurance, Taxes and Contingencies

Overtime and come-back labor	$420,000.00	
Ins., Social Security & Payroll Taxes	500,000.00	
Contingencies and Miscellaneous	1,800,000.00	$2,720,000.00

TOTAL:	$28,901,345.00
Plus contractors fixed-fees (Approx. 4 percent)	1,098,655.00
TOTAL:	$30,000,000.00

Barter Island Area to Fairbanks

In the event exploratory drilling established appreciable petroleum reserves in the Barter Island - Un-goon Point area, a pipe line tapping both of these localities and ending in Fairbanks could probably be installed for the following estimated amount:

Based upon above estimates of the Cape Simpson-Fairbanks line:

Cape Simpson-Fairbanks Line	$28,901,345.00	Total cost estimate
Cape Simpson-Fairbanks Line	8,250,000.00	Road estimate
Cape Simpson-Fairbanks Line	$20,651,345.00	Less road estimate

Pipe Mileage

Fairbanks-Barter Island 550 / Fairbanks-Cape Simpson 625 x 20,651,345.00 = $18,173,168.00 =

Estimated cost of pipe line, Fairbanks to Barter Island area.

Road Estimate - Fairbanks-Barter Island

540 miles less Fairbanks-Circle road = 378 total miles new road

378 miles x 15,000 a mile =	$5,670,000.00
Plus pipe estimate	18,173,168.00
TOTAL:	$23,843,168.00
Plus Contractors fixed-fee (Approximately 5 percent)	953,727.00
TOTAL:	$24,796,895.00
or	
Say -	$25,000,000.00

Recapitulation of Cost Estimates

Exploration - geological and geophysical surveys and exploratory drilling	$639,000.00
Drilling	5,000,000.00
Refinery	10,000,000.00
Pipe Line - Cape Simpson to Fairbanks	30,000,000.00
GRAND TOTAL:	$45,639,000.00

CONCLUSION

The existence of oil in northern Alaska is indicated by the occurrence of a number of active seeps. These seeps were found over a large area in which geological conditions are similar and in general favorable to the accumulation of oil.

Reconnaissance surveys in northwest Alaska by the Geological Survey likewise indicated that the geological structure in several areas is not unfavorable to the accumulation of oil. Apparently the unfavorable conclusions of that organization concerning the likelihood of finding oil in significant amounts were based largely on the assumption that the only seeps in northern Alaska are those in the Cape Simpson area.

Because of the general favorable conditions for accumulation of oil, it is recommended that consideration be given to the exploratory program as outlined in this report.

Seep No. 1 Cape Simpson (From Top of Knoll Easterly)

Seep No. 1 Cape Simpson Showing Mined Areas

Seep No. 2 Cape Simpson Showing Reindeer Caught in Oil Seep. All light areas are Petroleum Residue.

Seep No. 3 Cape Simpson (From Above Looking Westerly)

Seep No. 3 Cape Simpson Sacked Pitch

Up-goon Point Sig Wien and Luke Enukok Standing
On Small Pitch Pool

Fish Creek Seep. Showing Sod Mound Marker.
Norman Ebbley and Ruben Teuseauk

Fish Creek Seep. Extent of Seepage Showing Fresh
Oil Flow on Surface

Çessna Aground in Lake Near White Mountains Area

Travelair Fogged-in at Chandlar Lake

Bureau of Mines Party at Dease Inlet
(l. to r.) Capt. Henry Thomas, Pilot Sig Wien, Norman Ebbley
Simon Paneak, Henry Joesting

Eskimo Kayak at Chandlar Lake

COPY

1943

UNITED STATES
DEPARTMENT OF THE INTERIOR
Bureau of Mines

Fairbanks, Alaska
Sept. 14, 1943

Mr. Robert S. Sanford
District Engineer
U. S. Bureau of Mines
Juneau, Alaska

Re: Arctic Slope Oil Reconnaissance Trip

Dear Mr. Sanford:

Persuant to your request, I am submitting a brief outline of the oil reconnaissance trip recently completed on the Arctic slope. A Bureau of Mines party consisting of Dr. Henry Joesting of the Territorial Department of Mines, Captain Henry Thomas of the U. S. Army Engineers and myself, left Fairbanks on August the 22nd and returned today, September 14th. Due to the limited capacity of the small plane which we were forced to use to complete the trip, it was necessary to leave Captain Thomas in Barrow. It is the intention of Sig Wien, the pilot who accompanied us while we were in the field, to return to Barrow as soon as possible and bring Captain Thomas and our field supplies back to Fairbanks.

All samples taken from the various petroleum seeps visited during the exploration trip were brought back by Joesting and myself.

A brief description of the areas where oil seepages occur is as follows:

Umiat Mountain Area

The Umiat Mountain area, located on the north side of the Colville River, approximately 15 miles west of the confluence of the Anaktuvuk and the Colville rivers, has the following oil seeps:

A small lake about a mile west of the Umiat Mountain lies about 100 yards from the Colville River on the north side. This lake, approximately 200 yards in diameter, has a slow but steady oil seep in the form of bubbles which appear mainly on the north side of the lake. This oil has the appearance of a light distillate. A sample marked No. 1, was taken from a small pot-hole on the north rim of this lake. This sample was obtained by stirring the moss and vegetable matter in this hole and then skimming off the oil which collected on top of the water.

The second petroleum indication in the form of oil-bound sand and gravel, appears on the river bank directly north of the lake. Sample No. 2 was collected from a pit dug into this oil-saturated gravel; the oil apparently being of the same high gravity as that noted in the lake above.

A third indication of petroleum in this area was observed in the form of oil drops rising in a lake approximately one mile west of the first lake. This oil indication was examined by utilizing our rubber boat, but it was not possible to collect a sample.

The oil seep previously reported to occur near the Colville River and which was supposed to flow four or five barrels of oil in 24 hours, has been determined to be the Umiat Mountain seep. Seven years ago the oil saturated gravel on the bank of the river, from which sample No. 2 was collected, was actually flowing a small trickle of oil into the river. At that time a gallon sample was collected by Simon Paneak, our guide, and taken to the Arctic Ocean where Jack Smith, a trader, actually burned it in a lamp.

Fish River Seep

This area, located approximately 25 miles southwest from the mouth of the Colville River has a petroleum (pitch) seep about 6 feet wide and probably 20 feet long. The "pitch" pool is a solid, tarry material, having no apparent thin oil on the surface. This gummy residue had caught a great number of birds and small rodents. The spot, more specifically located, is a distance of 4 miles N 60° W from the confluence of the Ovolotuk Creek and Fish River. Sample No. 3 was collected from this seep.

Dease Inlet Seep

This seep is located about one and one fourth miles east from Doonakavik Cove on the East side of Dease Inlet. Doonakavik is about four and one half miles northeast of Thomas Brower's warehouse which is on Dease Inlet near the mouth of the Chipp River. The seep consisted of heavy petroleum residue coming from a low mound. This material was also observed beneath the moss in several places around the mound. Most of the residue had apparently been long exposed to the air and was almost hard enough to walk on at an air temperature of 35° F. Several hundred sacks of this material have been mined for fuel by the natives from a pit about 20 feet by 30 feet. Some fresher material of lower viscosity was also seen near the center of the seep. Sample No. 4 was taken from the fresher part of the seep.

About 200 yards east, pitch-soaked moss and silt were found along the edge of a low bench for a distance of about 300 feet. Pitch was also found under the moss at several places on the bench. Sample No. 5 consists of the higher grade pitch-impregnated moss found along the edge of the bench.

Cape Simpson Area

The petroleum seeps at Cape Simpson appear as three distinct mounds and are spaced over an area six miles north and south.

Seep No. 1 is located four miles northwest from Cape Simpson point, and about 500 yards south of the Arctic Ocean. This seep has an actual surface flow area of 800 feet in length and averages about 200 feet in width. This deposit has been exposed to a great extent by mining of the pitch by the Barrow natives. Several smaller pitch pools not connected with the main flow were noted, the pitch apparently underlying the tundra for an area of approximately 1200 feet east and west and 600 feet north and south. Generally speaking, wherever the surface vegetation or tundra has been removed, the underlying pitch comes to the surface. The sample marked No. 7 was collected from this exposure and is comprised partly of the harder residue and partly of the fresher flow directly underlying the hard surface. Another sample, marked No. 8, was collected by skimming a thinner oil which appeared near the top of the knoll.

Seep No. 2, located approximately three and one half miles due south from seep No. 1, flows out of a round knoll for a distance of 200 yards and runs into a small lake. The actual surface flow averages about 150 feet in width. This seep has also been mined for pitch by the natives. As in the case of the No. 1 seep, the petroleum residue underlies the tundra for a distance of 700 feet north and south and approximately 500 feet east and west. Numerous small pitch pools, separate from the main flow, were noted.

Seep No. 3 is located approximately 5 miles due south of seep No. 2. This seep, while not as large as seep No. 1 and 2, is still of considerable size. Its exposed surface flow is about 300 feet east and west and 100 feet north and south. The surface tundra apparently overlies a reservoir of pitch for an area 800 feet north and south and possibly 1000 feet east and west. Mining of this seep has not reached the proportions as evidenced by the other seeps, primarily because of its greater distance from the ocean. Sample marked No. 6 was collected from the harder pitch which is being mined by the natives.

These 3 seeps in the Cape Simpson area, have been mined for their pitch by the Arctic slope Eskimos for a great number of years. At the present time, approximately 3000 sacks weighing roughly 100 lbs. apiece are mined each summer. The material, while very sticky and difficult to handle, is successfully burned in the Point Barrow area. It was noted that in all of the Cape Simpson seeps, numerous birds and small animals as well as reindeer and even wolves, have been trapped. Seep No. 1 and No. 2 have been described in U. S. Geological Survey Bulletin 815.

Three other petroleum seeps are known to exist in the Cape Simpson area. One of these is a small seep a short distance southeast of seep No. 2; the other two lie approximately 10 miles west of Cape Simpson.

Barter Island Area (Approximately 60 miles from Demarcation Point)

The oil seep in the Barter Island area is located on Manning Point approximately 2 miles southeast from Barter Island. This point is on tide water and during high tide it becomes an island a mile and a half in diameter. No actual pitch residue was noted; however the northwest and northeast beaches which form this point are lined for a distance of a mile and a half with oil froth. A considerable portion of the beach, particularly on the northwest side, consists of an oil-bound silt, and numerous boulders of soft oil-bound, reddish brown sand were observed. Several narrow trickles of water, carrying an oil film, cross the narrow beach. Oil-soaked peat was noted in several places along the sloughed bank. Sample No. 11 was taken from the oil-bound silt found in layers along the northwest beach. An unconsolidated oil-soaked silt underlies the surface. Sample No. 12 was skimmed from the several small streams of water flowing from the bank to the ocean.

Sample No. 13 was collected from several exposures of an unconsolidated oil-bound, brownish-red sand which appeared in places along the bank. Sample No. 14 consisted of an oil-soaked vegetable debris found along the bank throughout the entire mile and a half distance. This oil has the appearance of a light distillate, and the oil-bound silt and sand, when dried and heated on a stove burns readily and gives off a strong odor of kerosene.

Un-goon Point Area

This area is located 7 miles east of Humphrey Point and is approximately 40 miles from Demarcation. There are three evidences of petroleum seeps on Un-goon (Eskimo for pitch) Point. The largest of these seeps is located a mile and a quarter south from the sod house located on the point. The pitch is a hard, black material and is extremely difficult to dig. A small amount of mining has been carried out and the pitch has made its appearance in several small holes where the tundra has been removed. The general area is approximately 300 feet long north and south and 100 feet east and west. Sample No. 15 was collected from several of these small pools.

Six hundred yards east and about two hundred fifty yards from the east beach, a small pitch pool has been excavated in the center of a small hummock. Sample No. 16 was taken from this material which is of the same consistency as the large exposure. On the east side of Un-goon Point and in line with the two seeps mentioned above, an exposure of oil-bound sand four feet thick, appears along the bank for a distance of about 30 feet. Sample No. 17 was collected from this oil-bound sand which somewhat resists the erosive effects of the wave action, the loose sand and silt being washed away, leaving the oil-bound material as an outcrop. This deposit is located one and one half miles along the beach from Un-goon Point proper.

This information has been submitted for your immediate consideration and will be supported by a more complete report by Dr. Joesting and myself. At that time we shall also submit a proposed program for further exploration of the oil possibilities on the Arctic slope.

As it so happened, your telegram, sent to Point Barrow, supporting Dr. Dean's recommendations to discontinue the investigation, was not received until the investigation had been completed. The utter lack of communication in the Arctic slope area, along with the exigencies of the Arctic slope weather, were such that the above situation was unavoidable.

Yours very truly,

(Sgd) NORMAN EBBLEY, Jr.
Mining Engineer

cc - Rolla
Dr. Joesting
File

ALASKA'S ARCTIC OIL RESERVE

MELODRAMA OR FARCE?

by

Norman Ebbley, Jr.
Mining Engineer
U. S. Bureau of Mines
Juneau, Alaska

January
1944

Editor's Note

Foreward

Late in the summer of 1943, the United States Bureau of Mines, under the direction of the Department of the Interior, sent a field party into the Arctic slope area to investigate rumors of petroleum seepages, previously unexamined. The expedition found six separate areas containing many seepages - the areas being spread along the Arctic coast for 325 miles east and west, and 100 miles north and south. Prior to this only one seepage area - Cape Simpson - was known to exist.

Subsequently, a joint report (U. S. Bureau of Mines) was written by Norman Ebbley, Jr., Mining Engineer for the Bureau of Mines, and Dr. Henry R. Joesting, Geologist, for the Territorial Department of Mines, Alaska. This report, which proposed consideration of an immediate four-way exploration program, is now being considered by officials of the Bureau of Mines, Geological Survey, and other members of the Department of the Interior.

Much of the factual data on the Arctic slope country contained in Mr. Ebbley's article has been taken from the above report. Proposed methods, cost data, and recommendations for exploration are only briefly mentioned in the following article.

ALASKA'S ARCTIC OIL RESERVE - ELDORADO OR FAMINE?

How many times in the last few years have you heard variations of the expression "Alaska's huge oil reserves?" How many times within the past few months or days (since the Canol investigation) have you heard congressmen and newspaper men patriotically speak of "our own" large oil reserves in Northern Alaska? These conscientious gentlemen, slightly misinformed, but with an eye for protecting the taxpayers money, have been in a few instances perhaps over enthusiastic in their factual statements relative to the usage of the expression "oil reserve".

The question then is apropos - just what is up there? Is there actually oil or is it simply a ghost petroleum used pre-eminently to lubricate the vociferous organs of certain "learned colleagues"? It is true there exists a "reserve" - established in 1923 by late President Harding designated as Naval Petroleum Reserve No. 4. This reserve, appropriating an area of about 35,000 square miles, had been set aside upon the advice of the Bureau of Engineering of the Navy Department, and was based upon the existence of petroleum seepages at Cape Simpson on the Arctic coast.

These seepages have been known for fifty years and indicate the presence of oil at the surface - nothing more! On the other hand, would a deer hunter pass by a ridge that was carpeted with fresh deer "sign" for another area entirely void of indications. Certainly not! The fresh "sign" is sure-fire proof that if the deer are not there now they were there, and may not now be far away. Although the seepages may, within the realm of possibility, be only remnants of former pools, it is still excellent logic to "hunt" for oil in the locality or in the general area nearby. The existence of "sign" in fact, indicates one thing - that the ridge has the physical requisites necessary for the existence of the deer. So also - the presence of petroleum seepages indicate one thing - that the underlying structures are favorable as source rocks and contain, or did contain oil in some form or another.

HISTORY OF INVESTIGATION

Before endeavoring to throw any light on the question "Just what is up there?", a brief outline of the steps taken to investigate the possibilities of Arctic oil may be of interest.

Directly following the establishing of Naval Petroleum Reserve No. 4, the Navy Department with their customary follow-through, requested the United States Geological Survey to investigate, at the Navy's expense, the oil possibilities of this large, relatively unexplored area. Reports of various oil seepages along the coast had persisted for many years but geological knowledge of the greater part of the area was lacking. As early as 1899 the Geological Survey had begun a systematic exploration of Alaska, and by 1910 had sent seven reconnaissance parties into the area later included in Naval Petroleum Reserve No. 4. The recent Geological Survey expeditions in northern Alaska instigated by the Navy Department began in 1923 and continued each season until the end of 1926. During this period eight separate parties were sent into the area, "the primary underlying purpose . . . . (being) . . . . to investigate the possibilities of obtaining oil in this region."

Numerous rumors of oil occurrences were investigated by these field parties but the signs apparently mistaken for petroleum proved to be films of iron oxide on stagnant pools. Although the examinations covered tens of thousands of square miles in an exploratory or reconnaissance manner, no additional seepages, other than those already known at Cape Simpson, or other direct evidence of petroleum were found. The members of the Geological Survey who took part in these investigations are to be commended for their tenacity and determination, characteristics which were necessary to make these arduous expeditions possible. While the "primary underlying purpose" of this work was not entirely attained, the expeditions were of considerable value in other respects. Many thousands of square miles were mapped, the areal geology and the topography being commendably accurate considering the difficulties encountered in traversing the region by dog teams and canoes.

The seepages at Cape Simpson were visited in 1921 by geologists of a private oil company, and several times later from 1923 to 1926 by members of the Geological Survey. The cessation of field work by the Geological Survey in 1926 ended all active investigation in the Arctic slope region - with no additional seepages having been found. Interest apparently remained quiescent until the present war activities revived speculation on the possibility of obtaining oil from this vast area. Activity in the Fort Norman oil district in Canada, and the Canol pipe lines from Skagway, Watson Lake and Fort Norman to Whitehorse and on to Fairbanks; combined with constant talk of Alaska being the post-war hub of trans-polar air transportation, furnished the impetus to revive interest in obtaining definite information concerning oil possibilities in northern Alaska.

Early in 1943 the eastern boundary of Naval Petroleum Reserve No. 4 was extended to include all the region of the Arctic slope as far east as the Canadian border. Officials of the Bureau of Mines, anticipating the need for additional evidence relative to the occurrences of petroleum in the region, decided late in the summer of 1943 to send a field party into northern Alaska to investigate various rumors of seepages other than those at Cape Simpson. It was believed that by utilizing a float-plane the party would be able in a month or six weeks period to investigate the different localities which were reported to contain petroleum seepages.

The primary purpose of the Bureau of Mines expedition was to obtain information bearing upon the occurrence of petroleum in this area and to establish data proving the existence of additional seepage other than those at Cape Simpson. The party spent slightly over three weeks on the Arctic slope investigating rumors of oil occurrences which invariably proved to be actual petroleum seepages. Seepages were found to exist throughout an area 325 miles in length along the Arctic coastal plain, and to extend inland for 100 miles. A total of six separate localities containing evidences of petroleum were examined, samples being collected from twelve seepages in these areas.

DESCRIPTION OF SEEPAGES

Following is a description of the areas visited and of the petroleum seepages sampled:

Umiat Mountain Area

The Umiat Mountain area is located on the north side of the Colville River, approximately 15 miles west of the confluence of the

Umiat 3

Anaktuvuk and the Colville rivers.

One seepage was found in a small lake about a mile west of Umiat Mountain and about 100 yards from the north bank of the Colville River. The lake is about 200 yards across. A slow but steady oil seep together with gas bubbles appears mainly on the north side of the lake. The oil has the appearance of a light distillate. A sample was obtained by stirring the moss and vegetable matter in a pot-hole and then skimming off the oil which collected on top of the water.

A second petroleum indication in the form of oil-bound sand and gravel, appears on the river bank south of the lake. Sample No. 2 was collected from a pit dug into the oil-saturated gravel. The oil is of high gravity and is apparently similar to that found in the nearby lake.

A third seepage area was found in a lake about a mile west of the first-described seep. In this area light oil and gas rise from the lake bed, but no residue was found along the shore. The seepages were examined from a portable rubber boat. No samples were collected.

An oil film also appears at intervals in the Colville River near the west end of Umiat Mountain.

The oil seep previously reported to occur near the Colville River and which was supposed to flow four or five barrels of oil in 24 hours, has been determined to be the Umiat Mountain seep. Seven years ago the oil-saturated gravel on the bank of the river, from which Sample No. 2 was collected was actually flowing a small trickle of oil into the river. At that time a gallon sample was collected by Simon Paneak, a guide for the Bureau of Mines party, and taken to the Aretic Ocean where it was burned in a lamp by Jack Smith, former trader at Beechy Point.

Fish River Seep

Harrison Bay

This area, located approximately 25 miles southwest from the mouth of the Colville River has a petroleum (pitch) seep about 5 feet wide and probably 20 feet long. The "pitch" pool is a solid, tarry material, having no apparent thin oil on the surface. This gummy residue has caught a great number of birds and small rodents. The seep, more specifically located, is 4 miles N. 60° W. from the confluence of the Ovolotuk Creek and Fish River. Sample No. 3 was collected from this seep.

Dease Inlet Seep

This seep is located about one and one quarter miles east from Doonakavik Cove on the east side of Dease Inlet. Doonakavik is about four and one half miles northeast of Thomas Brower's warehouse, which is on Dease Inlet near the mouth of the Chipp River. The seep consisted of heavy petroleum residue coming from a low mound. This material was also observed beneath the moss in several places around the mound. Most of the residue had apparently been long exposed to the air and was almost hard enough to walk on at an air temperature of 35° Fahrenheit. Several hundred sacks of pitch have been mined for fuel by the natives from a pit about 50 feet by 30 feet. Some fresher material of lower viscosity was also seen near the center of the seep. Sample No. 4 was taken from the fresher part of the seep.

Teshekpuk 4

About 200 yards east, pitch-soaked moss and silt were found along the edge of a low bench for a distance of about 300 feet. Pitch was also found under the moss at several places on the bench. Sample No. 5 was taken from the higher grade pitch-impregnated moss found along the edge of the bench.

Cape Simpson Area

Three seeps were visited near Cape Simpson. They emerge from rather prominent mounds aligned roughly north and south.

Seep No. 1 is four miles northwest from Cape Simpson and about 500 yards south of the Arctic Ocean. This seep has an actual surface flow about 800 feet in length and about 200 feet average width. It has been exposed to a great extent by mining of the pitch by the natives from Barrow. Several smaller pitch pools not connected with the main flow were noted, the pitch apparently underlying the tundra for a distance of approximately 1200 feet east and west and 800 feet north and south. As a rule, wherever the surface vegetation or tundra has been removed, the underlying pitch oozes to the surface. Sample No. 7 was collected from this exposure and is comprised partly of the harder residue and partly of the fresher flow directly underlying the hard surface. Another sample, marked No. 8, was collected by skimming a thinner oil which appeared near the top of the knoll.

Seep No. 2 is approximately three and one half miles south from Seep No. 1. It flows out of a round knoll for a distance of 600 feet and runs into a small lake. The actual surface flow averages about 150 feet in width. This seep has also been mined for pitch by the natives. As in seep No. 1, the petroleum residue underlies the tundra for a distance of 700 feet north and south and approximately 500 feet east and west. Numerous small pitch pools, separate from the main flow, were noted. Sample No. 9 was collected from the hard pitch. Sample No. 10 was collected from greenish, thin oil flowing near the top of the knoll.

Seep No. 3 is approximately 3 miles south of seep No. 2. This seep, while not as large as seeps No. 1 and 2, is still of considerable size. Its exposed surface flow is about 300 feet east and west and 100 feet north and south. The surface tundra apparently overlies pitch over an area 800 feet north and south and possibly 1000 feet east and west. Mining of this seep has not been as extensive as in the other seeps, probably because of its greater distance from the ocean. Sample No. 6 was collected from the harder pitch which is being mined by the natives.

These 3 seeps in the Cape Simpson area, have been mined for their pitch by the Arctic slope Eskimos for a number of years. At the present time, approximately 3000 sacks weighing roughly 100 pounds apiece are mined each summer. The material, while very sticky and difficult to handle, is successfully burned in the Point Barrow area. It was noted that in all of the Cape Simpson seeps, numerous birds and small animals as well as reindeer and even wolves, have been trapped. Seeps No. 1 and No. 2 have been described in U. S. Geological Survey Bulletin 815.

Three other petroleum seeps are known to exist in the Cape Simpson area. One of these is a small seep a short distance southeast of seep No. 2; the other two lie approximately 10 miles west of Cape Simpson.

<u>Barter Island Area</u>

The oil seepages in the Barter Island area are located on Manning Point approximately 2 miles southeast from Barter Island. This point is on tide water and during high tide it becomes an island a mile and a half in diameter. No actual pitch residue was noted; however, the northwest and northeast beaches which form the point are linedwith oil froth for a mile and a half. A considerable portion of the beach, particularly on the northwest side, consists of an oil-bound silt, and numerous boulders of soft oil-bound, reddish brown sands were observed. Several trickles of water, carrying an oil film, cross the narrow beach. Oil-soaked peat was noted in several places along the sloughed bank. Sample No. 11 was taken from the oil-bound silt found in layers along the northwest beach. An unconsolidated oil-soaked silt underlies the surface. Sample No. 12 was skimmed from the several small streams of water flowing from the bank to the ocean. Sample No. 13 was collected from exposures of an unconsolidated oil-bound, brownish-red sand which appeared in places along the bank. Sample No. 14 consisted of an oil-soaked vegetable debris found along the bank throughout the entire mile and a half distance. The oil has the appearance of a light distillate, and when dried and heated on a stove the oil-bound silt and sand burns readily and gives off a strong odor of kerosene.

Barter Island 8

<u>Un-goon Point Area</u>

Un-goon Point is 7 miles east of Humphrey Point and is approximately 40 miles west of Demarcation. Un-goon is the Eskimo term for pitch. Three evidences of petroleum seepages were found on Un-goon Point. The largest of these seeps is a mile and a quarter south from the sod house on the point. The pitch is black and hard, and is extremely difficult to dig. A small amount of mining has been carried out and the pitch has appeared in several small holes where the tundra has been removed. The

Demarcation Pt 16

general area is approximately 300 feet north and south and 100 feet east and west. Sample No. 15 was collected from several of the small pools.

Six hundred yards east and about two hundred and fifty yards from the east beach, a small pitch pool has been excavated in the center of a small hummock. Sample No. 16 was taken from this material which has the same consistency as the large exposure. On the east side of Un-goon Point and in line with the two seeps mentioned above, an exposure of oil-bound sand four feet thick appears along the bank for a distance of about 30 feet. Sample No. 17 was collected from this oil-bound sand which somewhat resists the erosive action of the waves; the loose sand and silt are washed away, leaving the oil-bound material as an outcrop. This deposit is located one and one half miles southeasterly along the beach from Un-goon Point proper.

White Mountain Area (Kuparuk River)

A petroleum seepage is reported to occur about five or ten miles north of the "White Mountains", between the East Fork and the West Fork of the Kuparuk River. A search was made for this seep, but it was unsuccessful principally because of the lack of time and inaccurate knowledge of the location. The Eskimo guide had not been to the seep but thought he could find it from a description given him years ago. According to the Eskimos, about thirty years ago several of them found the seep and "a wooden-ramrod which had been thrust down into the oil, burned readily when touched with a lighted match". Apparently most of the old men have since died and no natives were found that were sure of the exact spot. However, the rumor is sufficiently persistent to make further investigation worth-

Sagavanirktok

while. Information collected later during the trip indicates the search fell just short of reaching this seep.

An oil seepage is simply an indication that there is probably petroleum somewhere in the neighborhood. These occurrences make their appearance when there is a natural escape of petroleum to the surface, either directly from an outcrop of the oil sands or through a fault zone which acts as a feeder or channel from the source rock. When the oil reaches the surface it either flows away, as in the case of wet climates, or dries up as is usually the case in the Arctic. The oil in the seep usually has little resemblance to the oil found in the formation.

The A.P.I. gravities of all of the samples of petroleum residue collected by the Bureau of Mines party indicate that the oil has been severely weathered - oil from which all the lighter materials such as gasoline and kerosene have evaporated. With five exceptions the hydrocarbons ranged from 10 up to 19 A.P.I. Three of the samples had A.P.I. gravities lower than 10 indicating that they were definitely "asphalts". The ones ranging from 10 up to 19 A.P.I. would probably be classed as "semi-asphalts". Two samples were weathered samples of naphthene base oils.

COUNTRY, NATIVES, LIVING CONDITIONS

There is only about one chance in 100,000 that the reader has been north of the Brooks Range in Northern Alaska, so it probably would be proper to give a brief description of the country. The writer will not overlook the fact that this also gives him a chance, as the saying goes, to "speak more freely"!

Topographically, the Arctic slope is divided into three separate provinces. Although these main divisions grade somewhat into each other, the general line of demarcation can be fairly well established. The different provinces trend east and west, paralleling the general line of the Arctic coast and of the Brooks Range. The most northern, the rctic coastal plain province, is a gently sloping plain extending along the coast, the southern boundary being approximately coincident with the seventieth parallel. Aerial photographs Nos. 1 and 6 illustrate the flatness and uniformity of the coastal plain province. The next division is the Arctic plateau. It extends south to the Brooks Range and in places comes within about 15 miles of the Arctic Coast. Ground elevations range from only a few feet above sea level near the coastal plain to about 3,500 feet near the Alpine province. Aerial photograph No. 25 illustrates the smooth uplands and cut valleys characteristic of the plateau region. The most southerly province is the mountainous highland called the Brooks Range. This province is about 150 miles wide at the widest point and separates the Arctic slope from central Alaska. The altitude of the peaks probably average between 6,000 and 7,000 feet, although a few are as high as 9,000 feet. Several low passes, running generally north and south, uch as the Chandlar and the Anaktuvuk passes, permit fairly easy traverse through the Brooks Range. Aerial photograph No. 31 illustrates its characteristically rugged topography.

The Arctic slope climate is severe, based on temperate zone standards. Temperatures are prevailing low; from December to March the mean temperature is -15 to -20 degrees Fahrenheit, while during the summer months from May to September, it is from 20 to 40 degrees Fahrenheit.

Temperatures not uncommonly drop to -50 degrees in winter and to 26 degrees Fahrenheit in July and August.

Precipitation in the Arctic slope area is very low, seldom averaging more than five or six inches annually. Along the coast the snow fall is light while in the mountains it is somewhat heavier, usually accumulating to a depth of three or four feet during the winter.

Probably the greatest handicap to outside work is the constant driving wind which never seems to subside. Velocities of 100 miles an hour have been recorded at Barrow, with yearly averages as high as 14 miles an hour. Hourly averages during heavy blows are commonly as high as 60 to 70 miles an hour. Foggy weather is the rule rather than the exception. This condition seriously handicaps air transportation. The frequent fogs, especially along the coastal plain, combined with sub-freezing temperatures are flying conditions which invariably cause icing of the plane - a hazard even to local flying.

However, although climatic conditions are unfavorable, it is entirely possible for people properly dressed to attend to their regular duties, and only during the worst blizzards is travel impossible.

In general east-west travel on the Arctic slope is difficult during the summer and fall months. Numerous large, north-flowing streams segment the entire Arctic plain and form a hazard which prevent any extensive trips on foot, except near the Alpine province where the streams are small. No timber is available for rafts. North-south travel, on the other hand, can be easily accomplished by utilizing canoes and following the rivers. In addition to the difficulty caused by rivers, travel by foot is made slow and tedious by the marshy condition of the tundra, and because of the many large lakes which in some places form an impassible maze. Travel along the coast may be safely done in small boats during the months of August and September while the ice-pack is away from the shore. Sufficient protection is afforded by offshore reefs to permit travel even by canoe, providing close watch is kept for storms.

Transportation by dog-team, snowmobile or tractor is feasible from November to early in June. For extensive trips fuel caches should be established in advance. Air travel has proven its value in Alaska. In northern Alaska, particularly, airplanes provide the most practicable transportation. Flying conditions are best during March, April, May, and June, and sometimes during October. However, the coast is generally foggy, and clear days are exceptional. Gasoline and oil for the planes is indeed a problem, and gasoline caches must be established throughout the area before any extensive flying program is started. At present, Barrow is the only place on the north Arctic coast where aviation gasoline is available.

By traveling light and utilizing the float-plane for all but localized foot travel, the Bureau of Mines party was able to investigate in a three week's period all the localities where petroleum seepages were rumored to occur. Although the reconnaissance trip required only a relative short time, it was necessary to fly over 8,000 miles to complete the work.

In general, the clothes used throughout central Alaska can be safely worn during the summer months on the Arctic slope. The addition of a heavy cloth parka is advisable to serve as a wind-break. Shoe-packs or native seal-skin waterproof boots and heavy underwear are necessary. During the winter months it is advisable to wear the usual native clothes - fur inside against the skin and fur outside, and fur cap and fur boots. A well built tent is advisable to have throughout the summer as a protection from the wind. Any standard cold-weather sleeping bag is sufficient for summer use. The native built, reindeer or caribou bags are needed during the winter months.

A considerable surprise to the members of the Bureau of Mines expedition was the lack of inhabitants in the Arctic plateau and along the Arctic coast. It is estimated that the population of the entire area from Point Barrow to Demarcation Point on the Canadian Border, including all the country as far south as the southern edge of the Brooks Range, does not exceed 130 people. Of this number only one is white, one questionable white, the rest about equally half-breeds and Eskimos. As far as the half-breeds are concerned it is usually safe to say they are either Gordons or Browers - the offspring of two old boys that apparently were as rugged as the Arctic. The country included represents an area containing approximately 100,000 square miles.

It is understood that only a few years ago, the natives along the Arctic coast numbered several times the present population. This decline can probably be traced in part to the gradual increasing difficulty of obtaining local food and to congregating in towns along the west Arctic coast where they are now having greater difficulties in obtaining living necessities. This congregating, along with the lack of sufficient food and fuel, has resulted in a greater degree of sickness, especially of the respiratory type. The few families living away from these communities are apparently well fed and healthy.

Even in the smaller of these scattered camps there is usually one or more of the natives that can speak and understand a small amount of English. They are usually very friendly, although timid, and invariably do all in their power to aid the traveler in locating various reported outcrops or other occurrences. The Bureau of Mines party had the experience of flying over several of these camps and not being able to see any sign of occupation other than the dogs which are always tied. Upon landing and walking to the tents or sod-houses, cautious heads would begin appearing. This experience happened several times before the reason was learned - it seems a year or so ago they had been told about the possibility of the Japs invading the Arctic by plane and no chances were being taken! It was the personal observation of one member of the party that the United States ought to give the Arctic slope to the Japs and make them live there - that it would serve them right!

The reliability of the native reports are, on the whole, none too good. This condition may be more a result of misunderstanding of questions and answers than from outright mis-statement. The native has an inherent though shy desire to impress a new-comer with his knowledge and ability, especially as a hunter and authority on the country. This enthusiasm quite often gets the better of his truthfulness and he may claim that he has been to a certain spot himself, when actually it was his cousin or uncle who had been there and he had only heard about it second-hand. Thus, it is generally a good policy not to be too sure the first time a native tells you - let it cool off and then question him several times later on. This practice will pay dividends in the long run. Care must be taken in not wording questions such as: "You have not been to this place?" If he has not been there, he will answer, "Yes", meaning, "Yes, I have not been there". Or again, "You did not shoot the caribou?" If he did not, he will answer "Yes!" Grammatically speaking, he is correct - the questions being structurally wrong. This is a very common practice and can be most confusing and may lead to many a long, useless trek.

Living conditions are discussed very thoroughly in Geological Survey Professional Paper 109, by Ernest de K. Leffingwell, whose experiences in the Arctic form a sound basis for planning expeditions in that country. Clothing, briefly discussed above, should be warm and light. Food should be the best obtainable and condensed as much as possible and should not require a great deal of preparing and cooking. The field rations "C" and "K" and the "Mountain" rations, put up for the U. S. Army, are excellent for this type of work. Game other than ducks and fish, is scarce, and a field party should not plan on "living off of the country", even in a small degree. However, in the Arctic plateau country there are quite a number of caribou, and moose are found along the upper Colville from the Anaktuvik to the Killik Rivers. Mountain sheep are plentiful in the Alpine province. Berries, in general are scarce, although in the fall wild cranberries are abundant along the upper Colville River.

The fuel situation is always a problem. Along the coastline sufficient drift wood can be obtained for most purposes. However, from the coast inland for a distance of from 30 to 50 miles there is not suitable fuel to be found. The willows are as small as a pencil and do not grow much higher than twelve inches and are very scarce. A type of small yellow moss can usually be gathered, and diligent search for an hour or so will generally reward the traveler with a sufficient amount to pile around his coffee pot so that the water will at least get warm. Large willows, as high as fifteen feet, are found along the upper Colville River, and along the smaller streams throughout the plateau country. Numerous large and small coal seams outcrop along the river banks in the plateau area, and any permanent camp should be established near one of these outcrops so that the coal could be burned for fuel.

GENERAL GEOLOGY

Information concerning the geology of northern Alaska is contained in several publications of the United States Geological Survey. 1/ These have been freely drawn on in preparing this article. Somewhat less than one third of northern Alaska has been covered by reconnaissance methods, in which areal geologic mapping was necessarily the primary concern. Except in a general way, therefore, little stratigraphic and structural information is available.

The oldest, most highly indurated and structurally complex rocks are found in the Brooks Range; and they become progressively younger, less indurated and structurally simpler to the north in the Arctic plateau and Arctic coastal plain. In general the formations dip north and thus progressively younger rocks are exposed north from the Brooks Range.

In the Brooks Range the rocks are preCambrian or early Paleozoic to Jurassic in age, and are for the most part metamorphosed and complexly folded and faulted. In the Arctic plateau they are mainly Cretaceous in

1/ Ernest de K. Leffingwell, the Canning River Region, Northern Alaska; Professional Paper 109, 1919.
P. S. Smith and J. B. Mertie, Jr., Geology and Mineral Resources of Northwestern Alaska; Bulletin 815, 1930.
References to earlier work are given in these publications.

age and are in general moderately well indurated. To the south near the mountains, the rocks are close-folded and considerably faulted; but farther north the structure becomes simpler and the rocks dip gently north, with occasional reversals in dip to form broad, open folds. In the Arctic coastal plain, the rocks are upper Cretaceous, Tertiary, and Quaternary in age. According to the relatively few exposures, the upper Cretaceous and Tertiary rocks in the coastal plain are poorly consolidated and in general dip north at a low angle. The Quaternary formations which form the surface cover are unconsolidated and flat-lying.

Since this article is concerned with the occurrence of petroleum in northern Alaska, no further mention will be made of the formations other than upper Cretaceous. The older rocks are structurally complex and it is unlikely that they contain significant amounts of petroleum.

Upper Cretaceous rocks, which are the oldest rocks structurally favorable to accumulation of oil, outcrop in a wide belt along the northern part of the Arctic plateau and in the adjoining southern part of the coastal plain, and probably underlie the unconsolidated coastal plain deposits at shallow depths. They are also found along the Arctic coast in Peard Bay, southwest of Barrow. They have not been recognized east of the Colville River, but it is possible that closer correlation will prove that upper Cretaceous rocks exist here also. Where it has been recognized, the formation is dominantly shale and sandstone of both marine and terrigenous origin. Coal and carbonaceous shale is found in the terrigenous members. Because they contain abundant carbonaceous material these rocks are considered to be a likely source of petroleum. However, nothing definite is known concerning the existence or stratigraphic position of source horizons or of horizons suitable for the accumulation of petroleum. No complete measurements of the thickness of the upper Cretaceous formations are available, but estimates place it at between 10,000 and 17,000 feet. A number of broad, open anticlines have been observed where the formation is exposed in river valleys in the plateau region.

Tertiary deposits are found near the mouth of the Colville River and in the Canning River region. In the former area they are flat-lying, grey, calcareous silts and fine sands, with a thickness of about 100 feet; while in the Canning River region they are mainly soft shale dipping northeast at fairly steep angles with a thickness of 200 feet or more. Tertiary rocks may also underlie the unconsolidated surface deposits in parts of the coastal plain.

Covering most the coastal plain are relatively thin, shallow water, marine sands, and silts of Pleistocene age. These deposits are modified locally by rivers. Pleistocene morainal deposits left by retreating glaciers are found in parts of the plateau region, especially in the larger valleys.

WHAT THEN, IS THE NEXT MOVE?

Although we now know that petroleum occurs widespread in northern Alaska, as indicated by a number of active seepages, little is known of its manner of occurrence and distribution, of the depth at which it might be encountered, or of the existence of rock structures which would permit its accumulation in commercial quantities. About one-third of the region in which seepages are known to occur has been covered by reconnaissance geologic surveys. These furnish some information concerning the distribution of rocks with which petroleum is apparently associated, but they tell little about the actual occurrence of petroleum. The remaining two-thirds of the region has not been mapped and no information is available. For this reason, considerable preliminary work is necessary before production drilling for oil can be undertaken.

Any exploratory program designed to give information on the petroleum resources of northern Alaska should aim to determine:

1. The areal extent of the source and reservoir beds of petroleum.
2. The stratigraphy of the formation with which the petroleum is associated, and of overlying formations.
3. The position, type and extent of rock structures favorable to accumulation of petroleum.
4. The depths of reservoir beds beneath the surface in favorable structures.

With information obtained through such a program it will be possible to drill wells with some knowledge of the depths of oil horizons and with a reasonable expectation of encountering oil. Haphazard drilling would not only be extremely costly, but would almost certainly result in failure.

Because conditions affecting petroleum exploration vary in different parts of northern Alaska, several methods of exploration are necessary. In the Arctic plateau region, the rocks are sufficiently exposed so that the necessary information can be obtained by a geological investigation. On the Arctic coastal plain, on the other hand, rock exposures are almost nonexistent, so that geophysical methods supplemented by exploratory drilling must be largely used. Of the area in which the presence of petroleum is indicated by seepages, somewhat more than half is in the Coastal plain region, while the remainder is in the plateau region.

Geological methods are in general more rapid and inexpensive than other exploration methods and therefore should be used where surface exposures are adequate. Geophysical methods are intermediate in rapidity and cost between geological methods and exploratory drilling, and should be used only where sufficient information cannot be obtained from surface exposures. In addition, geophysical data must be supplemented and correlated by direct information obtained from surface studies and drilling. Exploratory drilling to obtain stratigraphic and structural information is relatively slow and costly, consequently it should be undertaken only to supplement or check information obtained by other methods.

A tentative exploratory program has been advanced and is now under consideration. This program embodies a combination of geological and geophysical exploration, aerial photographic surveying, and exploratory drilling. The cost of such a program may be determined with some degree of certainty, since the aims of the program and the methods of accomplishing them are known. The program, requiring three years to complete, is estimated to cost $800,000. Cost estimates of any subsequent development, on the other hand, can at present be only tentative, since a development program cannot be definitely planned until the results of the exploratory program are evaluated. Thus, drilling costs cannot be estimated until something is known of the number and size of oil structures and of the depths of oil horizons; nor can refinery and distribution costs be estimated until something is known of the size of oil reserves and the rate of production.

In addition, the volume of production and methods of distribution of oil from northern Alaska would be governed to a large extent by future economic and military needs.

IS THIS EXPENDITURE JUSTIFIED?

Whenever the taxpayer's money is being thrown around we feel it should be for a just and sensible cause. Even the most naive of us sometimes wonder if this policy is always strictly adhered to. One of these questionable enterprises, having a top billing on the doubtful list, is the Canol project. If one-half of what we read concerning this project is true it is going to be a Number One flop for the American taxpayer - at the tune of $140,000,000.

In a recent congressional hearing a spokesman for the U. S. Army, testifying in defense of the Canol project, stated in part, "Fortunately we struck oil far in excess of our wildest expectations. It is certain to be a 50,000,000 barrel field, probably 100,000,000 barrel field." Simple mathematics would indicate this reserve, if theoretically available for immediate use, would only be sufficient to supply the American consumption, rationing and all, for about twelve days. At an Alaskan bonus price of approximately $1.50 a barrel, the value of the crude product would be $75,000,000. How is this going to work out when the cost to the American taxpayer is admittedly $140,000,000? The statement that the Canol development in Canada was made imperatively necessary b the "desperate outlook" of the war in the dark days of 1940 is unquestionably true. The crisis in the Pacific war theater demanded drastic action. But does this explain why our own northern Alaska oil possibilities were left uninvestigated.

Is the crisis passed - well not so it can be noticed! It is true the war picture in Alaska and on the Pacific coast looks immeasurably brighter, but how about the crisis in oil? The situation today calls for immediate action - in any channel that appears to have a reasonable chance of alleviating the shortage and in increasing our reserves.

Since 1937, the United States has been losing, by wider margin each year, the race to keep new oil discoveries up to consumption. During 1942 only one fifth of every barrel of petroleum products used was offset by oil found in new fields. The present yearly oil consumption is nearly 1,600,000,000 barrels - almost 4,500,000 barrels every day. The United States oil reserves are now estimated at 20 billion barrels which may take from 40 to 50 years to extract. Some geologists put this figure as high as 75 years - the annual production if extracted efficiently should amount to only 4 or 5 percent of the ultimate reserves. Last years maximum production just reached the national demand, and the yearly consumption is increasing. This increase is not necessarily due to the war, as the percentage rise in yearly demands from 1935 to 1939 was greater than the war-time increase from 1939 to the expected rate at the end of 1943.

This trend if continued will mean that from 50 to 60 billion barrels will have to be discovered during the next 20 years to maintain present ratios of reserves to consumption. Petroleum geologists generally agree that this possibility is definitely on the remote side. During the last few years the ordinary stimulation of the search for oil has been retarded by frozen oil prices and the restriction on materials. Nevertheless, last year and the year before the number of geophysical prospecting crews in the field searching for new oil was the largest in history, and a record number of wildcat wells were drilled in the United States, which resulted in a record number of fields being discovered. Mr. E. L. De Golyer, Assistant Deputy Petroleum Administrator for War, presents an interesting fact: Although 493 successful wildcat wells were drilled in 1942 only 317 million barrels of oil were discovered. This ratio has been steadily decreasing since 1937 when 222 successful wildcat wells were drilled and 2119 million barrels of oil were found.

Senator R. Owen Brewster, who has just completed a 45,000 mile tour of our battle fronts revealed a point in a recent magazine article which should make the American public look at their hole-card and ask themselves if they are not playing the part of the world's biggest fool! He states that exclusive of Russia, the United States has approximately 40 percent of the oil reserves of the United Nations. We are supplying 80 percent of the oil! British petroleum reserves approximately equal those of the United States, but they are supplying only 8 percent of the oil used by the United Nations. At the present rate of use Great Britain's oil reserve will last 100 years, ours less than 15 years. Perhaps we do need a policy! At this rate it would not take very long before the "future" of America's petroleum industry would be behind us!

What about oil and gasoline from coal and oil shale? The petroleum industry has been fully aware of the crisis in oil for several years. Consequently considerable thought and discussion has recently taken place in the United States on the economic importance of low grade coals and oil shales. Oil distilled from oil shale or from coal using the hydrogenation process appears to be the logical substitute for petroleum. The public has been given the impression that we have no need to fear - that there is a tremendous supply of cannel and low grade coals with almost equally important amounts of oil shales, sufficient when converted to liquid fuel to furnish petroleum products for a thousand years. Although this statement is correct, it should be pointed out that as far as the United States is concerned the hydrogenation of coal and the distillation of oil shales is still in an infant stage - in fact, that is putting it a bit strong- "experimental" would be more appropriate. It is generally agreed that when the industry is properly developed it will form an important economic defense in assuring a tremendous home supply of oil in case of a future war. Shale oil and oil obtained from coal cannot compete with petroleum from wells at the present price. Instead it will probably be a gradual successor as the reserves of petroleum diminish. Large investments will have to be made before the liquefaction industry of coal and oil shale becomes commercially important. It is estimated that an industry of this type of sufficient magnitude to completely replace the petroleum industry would represent a sum of nearly 15 billion dollars. This does not take into consideration the cost of developing subsidiary industries which are necessary to complete the picture.

HOW BIG IS THE JOB?

It will be neither a simple nor a pleasant task - exploring and developing the northern Alaska oil fields. The job will take careful planning and years of hard bitter work under conditions which will be abominable. Once begun there will be no quitting - no reprieve - no stopping until the job is finished. The Arctic gives no quarter and asks none! It will mean certain failure to plow in blindly with scores of men and tons of equipment - intending to conquer by sheer weight - to make the Arctic knuckle-under! No - that will never work in this case, as it has in the case of the Alaskan Highway - which may yet be reclaimed by nature after the war.

It will take careful supervising and managing by men familiar with northern Alaska - men who know how to roll with the punch and who will never forget that the Arctic packs a wallop. The Arctic is kind only to those few who really understand her, and who recognize her as boss! Expert geologists, geophysicists, and well-drillers obtained from the United States will be required to carry out the program, but these men and their work will necessarily be subordinate to the dictates of the supervising engineer, or sourdough as the case may be, who is familiar with the country.

From a construction and maintenance standpoint it is entirely feasible to build a road and pipe line from the Cape Simpson area on the Arctic coast to Fairbanks in the interior. The road and pipe line, which would also tap the Lake Teshekpuk and Colville River oil occurrences, would pass through th Anaktuvuk pass to Livengood and Fairbanks - the total distance being about 525 miles. It is rather surprising to realize that this line is only about one-third as long as the total length of the Canol installation. The estimated cost of the pipe line and road from the Arctic would not be in excess of $30,000,000.

Even though actual development and production of the Arctic oil may be put off for 20 years or more, the need for immediate exploration is apparent to determine if there is an oil reserve and of what magnitude. From a standpoint of an inventory of national resources and as a backlog for future consideration this program should not be shelved any longer. All together now, boys, 'Let's spend our money in our own backyard!'

Illustrations to Accompany Oil **Article**

1. Index Map of Alaska, showing location of area containing petroleum seepages. Also showing relationship between Canol Installation and a proposed pipe line from the Arctic slope to Fairbanks, Alaska.

2. Key Map of Northern Alaska, showing localities of petroleum seepages. U. S. Bureau of Mines - 1943.

3. Aerial Photographs from the U. S. Army:

   No. 1 Arctic coastal plain near Barter Island. Taken from 2000 foot elevation.

   No. 6 Manning Point - east of Barter Island area. Taken from 1800 foot elevation.

   No. 25 Colville River at Umiat Mountain - Plateau Province. Taken from 1500 foot elevation.

   No. 31 Brooks Range near Anaktuvuk Pass. Taken from 8000 foot elevation.

4. Photographs:

   1. Seepage No. 2 at Cape Simpson showing a reindeer caught in the petroleum residue. All light appearing areas are oil.

   2. Eskimo baby utility **suit**. Reindeer skin with the fur inside. Built from a practical standpoint.

   3. At Chandler Lake in the Brooks Range. Eskimo caribou-skin kayak used when spearing caribou in the lake. This lake contains mackinaw trout reported to weigh as much as 75 to 80 pounds.

   4. "Pitch" petroleum residue sacked at Seep No. 3, Cape Simpson. Barrow natives have burned as much as 3,000 sacks of this material for fuel in one season. It is very disagreeable to use; being extremely adhesive and having a stench of dead animals.

   5. Bureau of Mines field-party. (L. to R.) Capt. Henry Thomas, U. S. Army Engineers; Sig Wien, Pilot of Wien Alaska Airlines; Norman (Duff) Ebbley, Chief of party, U. S. Bureau of Mines; Simon Paneak, Eskimo guide; Dr. Henry R. Joesting, Geologist, Territorial Dept. of Mines.

TERRITORY OF ALASKA

DEPARTMENT OF MINES

College, Alaska
Sept. 17, 1943

Mr. B. D. Stewart
Commissioner of Mines
Juneau, Alaska

Dear Mr. Stewart

A copy of a letter written at Barrow is enclosed, since the original may be delayed in reaching you.

Ebbley and I returned to Fairbanks Sept. 14, after a five-day trip from Barrow. We left Capt. Thomas in Barrow, as he plans to wait around anyway until Ebbley and I get out a report on our trip. Sig Wien has left Fairbanks to get Thomas, and what is more important, to try to take our Eskimo guide back to Chandlar Lake where his family is staying and to bring our equipment back to Fairbanks.

This letter has been delayed by several pressing matters that had to be attended to on my return and by an infected throat that developed from a cold which I picked up in Bettles at the start of the trip and which I couldn't shake off. I probably was wet too much. The throat is now responding to some pretty stout medicine and to Dee's tender care. Also, during my absence the Army finally took over part of the College, and everything in my office, which amounts to an amazing amount of heterogeneous equipment, samples and supplies, is now piled in one spot in the Assay Lab next door to Glover's lab. Until a partition is built to give me some privacy and to keep out a cold breeze that circulates from the outside through the tunnel, I will not be able to start putting things where I can find them. However, Sanford told me that he had telegraphed you that we had returned and had found a gratifying number of seeps, so I knew that you would not be wondering how we were faring.

As explained in the enclosed letter, I had to wait in Barrow while Wien and Ebbley went eastward to look for some more seeps. (The telegram directing us to discontinue our work was not received until they had already left; besides, Sig Wien had to make the trip anyway. That's our story and noone can prove differently). They were able to find two seeps on the coast, but were unable to find the one east of the Colville and some distance inland. It doubtless exists, but no natives now living could be found who had actually seen it. It is in a hungry country and consequently has been little visited..

Meanwhile, the other plane we had sent for did not come, and Thomas, our original guide and I were still in Barrow when they returned. So Ebbley and I set out with Wien for Fairbanks, with practically nothing but our samples because of the small capacity of the Cessna plane. On the first day we returned to Barrow because of bad weather. On the second day we made about 80 miles before everything closed in tight and on the third day we managed to reach the Colville about 20 miles above the Anaktuvuk. Here we had cached gasoline, grub, samples and other supplies. The next morning the temperature was 25° F and the plane was covered with snow and ice, so we has quite a time getting off. Near the coast it had been frezing for over a week but the salt water kept us from icing down. On the Colville, however, ice formed rapidly on the floats and wings, which made xxxxxxx it more serious. On top of that, the planes starter wouldn't work and the booster coil went haywire. Sig finally fixed it so that he could start the motor by hand, which is no easy job on a float plane. After he started it Ebbley and I would head the plane right and then jump on the pontoons and climb aboard as it got underway. This was not as risky as it sounds and was really a lot of fun. But it took us eight tries before we finally were able to rise from the river. Before the final effort we threw out everything but ourselves and the samples to lighten the plane. We made Bettles that night and Fairbanks the next day, on Sept. 14.

On the whole the trip was not particulary tough physically. We were cold and wet some of the time, but with the plane to carry us no very long hikes were necessary. We kept Capt. Thomas in Bettles as long as possible, so that it was necessary for him to spend only six days in the field. This was for his own good, as well as for ours. During the last day, before going to Barrow, we walked him perhaps 10 miles over not bad footing and that nearly finished him. On arriving in Barrow he spent two days in the hospital getting fixed up. The country is somewhat tougher to work than most of the interior because there is no timber and the wind is blowing most of the time. Except near the coast, however, there are plenty of willows along the larger streams and game and fish are fairly generally present, so that one could generally make out in case the plane were wrecked.

As soon as Ebbley gets some other business out of the way we will knock out a report. Meanwhile, I am catching up on some correspondence and on developments at the Gilmore Dome tungsten project. I hope to spend another week or two there on surface work before winter sets in.

A shipment each of Pamphlets 1 and 2 arrived today. Following your suggestion, I shall send a list of those who have asked for copies of them. Dee tells me that she and R. L. have carried on a pleasant and satisfactory correspondence during my absence, pertaining to Department of Mines matters.

One of the highlights of the trip, which I almost forgot to mention, was our arrival at Barrow. It was drill night for the home guard and about 80 Eskimos with rifles were on the beach to meet us, besides several hundred women and children. They were most impressive as they stood there. As the plane floated in to the shore, driven by a 40-mile wind, the Captain, who happened to be closest to the door, grabbed out mooring line and clambered out on the pontoon. It wasn't necessarry to heave the rope ashore because of the wind, but he heaved it anyway and in his enthusiasm heaved himself into the water as well. He made a beautiful three-point landing in about two feet of water and was hauled ashore by several natives. The natives didn't know whether to laugh or not, but it looked so funny that we started to laugh and that gave the natives their queue and a merry time was had by all. To the credit of the Captain, I must add that after he was dried out and warmed up he also saw the humor of the situation.

The people in Barrow were most kind to us and I enjoyed my stay there in spite of the enforced inactivity.

Sincerely yours
Henry R. Joesting
Henry R. Joesting
Assoc. Mining Engineer

UNITED STATES
DEPARTMENT OF THE INTERIOR
Bureau of Mines

Fairbanks, Alaska
Sept. 14, 1943

Mr. Robert S. Sanford
District Engineer
U. S. Bureau of Mines
Juneau, Alaska

Re: Arctic Slope Oil Reconnaissance Trip

Dear Mr. Sanford:

Persuant to your request, I am submitting a brief outline of the oil reconnaissance trip recently completed on the Arctic slope. A Bureau of Mines party consisting of Dr. Henry Joesting of the Territorial Department of Mines, Captain Henry Thomas of the U. S. Army Engineers and myself, left Fairbanks on August the 22nd and returned today, September 14th. Due to the limited capacity of the small plane which we were forced to use to complete the trip, it was necessary to leave Captain Thomas in Barrow. It is the intention of Sig Wien, the pilot who accompanied us while we were in the field, to return to Barrow as soon as possible and bring Captain Thomas and our field supplies back to Fairbanks.

All samples taken from the various petroleum seeps visited during the exploration trip were brought back by Joesting and myself.

A brief description of the areas where oil seepages occur is as follows:

<u>Umiat Mountain Area</u>

The Umiat Mountain area, located on the north side of the Colville River, approximately 15 miles west of the confluence of the Anaktuvuk and the Colville rivers, has the following oil seeps:

A small lake about a mile west of the Umiat Mountain lies about 100 yards from the Colville River on the north side. This lake, approximately 200 yards in diameter, has a slow but steady oil seep in the form of bubbles which appear mainly on the north side of the lake. This oil has the appearance of a light distillate. A sample marked No. 1, was taken from a small pot-hole on the north rim of this lake. This sample was obtained by stirring the moss and vegetable matter in this hole and then skimming off the oil which collected on top of the water.

The second petroleum indication in the form of oil-bound sand and gravel, appears on the river bank directly north of the lake. Sample No. 2 was collected from a pit dug into this oil-saturated gravel; the oil apparently being of the same high gravity as that noted in the lake above.

A third indication of petroleum in this area was observed in the form of oil drops rising in a lake approximately one mile west of the first lake. This oil indication was examined by utilizing our rubber boat, but it was not possible to collect a sample.

The oil seep previously reported to occur near the Colville River and which was supposed to flow four or five barrels of oil in 24 hours, has been determined to be the Umiat Mountain seep. Seven years ago the oil saturated gravel on the bank of the river, from which sample No. 2 was collected, was actually flowing a small trickle of oil into the river. At that time a gallon sample was collected by Simon Panoak, our guide, and taken to the Arctic Ocean where Jack Smith, a trader, actually burned it in a lamp.

Fish River Seep

This area, located approximately 25 miles southwest from the mouth of the Colville River has a petroleum (pitch) seep about 6 feet wide and probably 20 feet long. The "pitch" pool is a solid, tarry material, having no apparent thin oil on the surface. This gummy residue had caught a great number of birds and small rodents. The spot, more specifically located, is a distance of 4 miles N 60° W from the confluence of the Ovolotuk Creek and Fish River. Sample No. 3 was collected from this seep.

Dease Inlet Seep

This seep is located about one and one fourth miles east from Doonakavik Cove on the East side of Dease Inlet. Doonakavik is about four and one half miles northeast of Thomas Brower's warehouse which is on Dease Inlet near the mouth of the Chipp River. The seep consisted of heavy petroleum residue coming from a low mound. This material was also observed beneath the moss in several places around the mound. Most of the residue had apparently been long exposed to the air and was almost hard enough to walk on at an air temperature of 35° F. Several hundred sacks of this material have been mined for fuel by the natives from a pit about 20 feet by 30 feet. Some fresher material of lower viscosity was also seen near the center of the seep. Sample No. 4 was taken from the fresher part of the seep.

About 200 yards east, pitch-soaked moss and silt were found along the edge of a low bench for a distance of about 300 feet. Pitch was also found under the moss at several places on the bench. Sample No. 5 consists of the higher grade pitch-impregnated moss found along the edge of the bench.

Cape Simpson Area

The petroleum seeps at Cape Simpson appear as three distinct mounds and are spaced over an area six miles north and south.

Seep No. 1 is located four miles northwest from Cape Simpson point, and about 500 yards south of the Arctic Ocean. This seep has an actual surface flow area of 800 feet in length and averages about 200 feet in width. This deposit has been exposed to a great extent by mining of the pitch by the Barrow natives. Several smaller pitch pools not connected with the main flow were noted, the pitch apparently underlying the tundra for an area of approximately 1200 feet east and west and 800 feet north and south. Generally speaking, wherever the surface vegetation or tundra has been removed, the underlying pitch oozes to the surface. The sample marked No. 7 was collected from this exposure and is comprised partly of the harder residue and partly of the fresher flow directly underlying the hard surface. Another sample, marked No. 8, was collected by skimming a thiner oil which appeared near the top of the knoll.

Seep No. 2, located approximately three and one half miles due south from seep No. 1, flows out of a round knoll for a distance of 200 yards and runs into a small lake. The actual surface flow averages about 150 feet in width. This seep has also been mined for pitch by the natives. As in the case of the No. 1 seep, the petroleum residue underlies the tundra for a distance of 700 feet north and south and approximately 500 feet east and west. Numerous small pitch pools, separate from the main flow, were noted.

Seep No. 3 is located approximately 3 miles due south of seep No. 2. This seep, while not as large as seep No. 1 and 2, is still of considerable size. Its exposed surface flow is about 300 feet east and west and 100 feet north and south. The surface tundra apparently overlies a reservoir of pitch for an area 800 feet north and south and possibly 1000 feet east and west. Mining of this seep has not reached the proportions as evidenced by the other seeps, primarily because of its greater distance from the ocean. Sample marked No. 6 was collected from the harder pitch which is being mined by the natives.

These 3 seeps in the Cape Simpson area, have been mined for their pitch by the Arctic slope Eskimos for a great number of years. At the present time, approximately 3000 sacks weighing roughly 100 lbs. apiece are mined each summer. The material, while very sticky and difficult to handle, is successfully burned in the Point Barrow area. It was noted that in all of the Cape Simpson seeps, numerous birds and small animals as well as reindeer and even wolves, have been trapped. Seep No. 1 and No. 2 have been described in U. S. Geological Survey Bulletin 815.

Three other petroleum seeps are known to exist in the Cape Simpson area. One of these is a small seep a short distance southeast of seep No. 2; the other two lie approximately 10 miles west of Cape Simpson.

Barter Island Area (Approximately 60 miles from Demarcation Point)

The oil seep in the Barter Island area is located on Manning Point approximately 2 miles southeast from Barter Island. This point is on tide water and during high tide it becomes an island a mile and a half in diameter. No actual pitch residue was noted; however the northwest and northeast beaches which form this point are lined for a distance of a mile and a half with oil froth. A considerable portion of the beach, particularly on the northwest side, consists of an oil-bound silt, and numerous boulders of soft oil-bound, reddish brown sand were observed. Several narrow trickles of water, carrying an oil film, cross the narrow beach. Oil-soaked peat was noted in several places along the sloughed bank. Sample No. 11 was taken from the oil-bound silt found in layers along the northwest beach. An unconsolidated oil-soaked silt underlies the surface. Sample No. 12 was skimmed from the several small streams of water flowing from the bank to the ocean.

Sample No. 13 was collected from several exposures of an unconsolidated oil-bound, brownish-red sand which appeared in places along the bank. Sample No. 14 consisted of an oil-soaked vegetable debris found along the bank throughout the entire mile and a half distance. This oil has the appearance of a light distillate, and the oil-bound silt and sand, when dried and heated on a stove burns readily and gives off a strong odor of kerosene.

Un-goon Point Area

This area is located 7 miles east of Humphrey Point and is approximately 40 miles from Demarcation. There are three evidences of petroleum seeps on Un-goon (Eskimo for pitch) Point. The largest of these seeps is located a mile and a quarter south from the sod house located on the point. The pitch is a hard, black material and is extremely difficult to dig. A small amount of mining has been carried out and the pitch has made its appearance in several small holes where the tundra has been removed. The general area is approximately 300 feet long north and south and 100 feet east and west. Sample No. 15 was collected from several of these small pools.

Six hundred yards east and about two hundred fifty yards from the east beach, a small pitch pool has been excavated in the center of a small hummock. Sample No. 16 was taken from this material which is of the same consistency as the large exposure. On the east side of Un-goon Point and in line with the two seeps mentioned above, an exposure of oil-bound sand four feet thick, appears along the bank for a distance of about 30 feet. Sample No. 17 was collected from this oil-bound sand which somewhat resists the erosive effects of the wave action, the loose sand and silt being washed away, leaving the oil-bound material as an outcrop. This deposit is located one and one half miles along the beach from Un-goon Point proper.

This information has been submitted for your immediate consideration and will be supported by a more complete report by Dr. Joesting and myself. At that time we shall also submit a proposed program for further exploration of the oil possibilities on the Arctic slope.

As it so happened, your telegram, sent to Point Barrow, supporting Dr. Dean's recommendations to discontinue the investigation, was not received until the investigation had been completed. The utter lack of communication in the Arctic slope area, along with the exigencies of the Arctic slope weather, were such that the above situation was unavoidable.

Yours very truly,

(Sgd) NORMAN EBBLEY, Jr.
Mining Engineer

cc - Rolla
Dr. Joesting
File

Barrow, Alaska, Sept. 8, 1943

Mr. B. D. Stewart
Commissioner of Mines
Juneau, Alaska.

Dear Mr. Stewart:

Before starting this letter I had to practically rebuild this old Underwood, which looks as though it had been taken out on several strenuous whaling trips.

We came to Barrow from the eastward several days ago, with the intention of getting additional information about some more oil seepages. On our arrival, however, we found a telegram sent through Thorne directing us to ~~xxx~~ call off the work because it would be done by the U.S.G.S. next summer. But since we ~~xare~~ are using a small Cessna plane that cannot take all of our party at one time, it was decided that Sig Wien and Ebbley would fly east to Barter Island and to the upper Kukpowruk R. to locate 3 seeps about which we have quite definite information. Meanwhile, Sig sent for another float plane, which would be able to take Capt. Thomas and me back to Fairbanks by way of the Colville R., where we have some samples cached, and by way of Chandler Lake, where we must return one of our guides.

To date we have found the following indications of petroleum: (1) an area of seepages on the north side of the Colville, where the material consists of the lighter petroleum fractions and smells like a mixture of kerosene and diesel oil (2) one heavy oil and pitch seepage on a tributary of the Kalikpik (Fish) R. about 20 miles west of the Colville and 10 miles from the coast (3) four seepages of heavy oil and pitch in the area between C. Simpson and Dease Inlet. All of these seepages appear to contain parrafin base petroleum, or more or less saturated hydrocarbons. In addition to those mentioned we have definite and reliable information of seeps near Barter Island, one on the upper Kukpowruk R. and 3 more in the C. Simpson-Dease Inlet area. As already stated Wien and Ebbley are now looking for those to the eastward, with the help of natives who have been to them. Those in the C. Simpson-Dease Inlet area will also require a guide because the country is so featureless to our inexperienced eyes that we could never find them alone.

If Wien and Ebbley are successful in locating the seeps to the eastward - and the only thing that might stop them is bad weather - then we will have located practically all of those about which the natives have definite knowledge. It is not unlikely that others exist, but to find them would be like looking for the needle in a very large haystack. As a matter of fact, we would have been unable to find any of them if we hadnt engaged native guides who had already visited them. In view of the easewith which we have been able to obtain reliable information and guides, it seems strange that the U.S.G.S. was successful in locating only 2 seeps.

Two factors have been instrumental in delaying us. First, the plane has been grounded a good part of the time by low fog. This, of course, is unavoidable. Second because of a combination of a small plane and an overly large party, we have been forced to double trip so that considerable time was spent sitting down waiting for the plane. But for this second factor we would have finished the job several days ago.

As I had feared, Capt. Thomas turned out to be a millstone of no inconsiderable proportions. Besides the weight taken up by himself and an unreasonable amount of baggage, which could have been better used for gasoline, his poor physical condition, marked hypochondriacal tendencies and utter ignorance of how to take care of himself caused us a lot of trouble and annoyance. In addition, he knows nothing of petroleum exploration and thus could make no positive contribution. As I had earlier surmised, his only contact with the oil industry has ~~been~~ apparently been from the promotional side. Sig Wien, Ebbley and I are firmly of the opinion that he is extremely eccentric, if not actually nuts, and you may quote me on this if you wish.

While we have not accomplished as much on this trip as we should have under happier circumstances, we have at least obtained definite information as to the location of seepages over a large area, and have of course taken samples. Considering the lateness of the season, this is about as much as we could expect to do. Our work should serve as a basis for any detailed work that may follow.

Ebbley and I plan to prepare a joint report on our work, the nature of which will presumably depend on what the U.S.B.M. wants. I shall submit a copy of this report to you, as well as any recommendations and supplementary information that is not covered by our joint report.

Sincerely yours

Henry R. Joesting

Henry R. Joesting
Assoc. Mining Engineer

OIL SAMPLES

(For exact location refer to report sketches)

Sample No. 1

This sample was taken from a small pot-hole on the north side of Umiat Mountain Lake. The sample was obtained by stirring the moss and vegetable matter in this hole and then skimming off the oil which collected on top of the water. The oil has the appearance of a light distillate and has a distinct kerosene odor.

Sample No. 2

Sample of an oil-saturated gravel taken from a cut six feet deep to water level along the rivær bank. The location was directly north 300 feet from Umiat Mountain Lake. This oil seem to be of the same hihh gravity as that noted in the lake above.

Sample No. 3

"Pitch" sample taken from a small seep 4 miles N 60°W from the confluence ofOvolotuk Creek with Fish River. The general location is about 25 miles southwest of the mouth of the Colville River. The pitch pool is a solid, tarry material having no apparent thin oil on the surface.

Sample No. 4

This sample consists of a heavy petroleum residue which extrudes from a low mound about 4½ mikes northeast of Thomas Brower's warehouse which is on Dease Inlet near the mouth of Chipp River. This residue had apparently been long exposed to the air and was almost hard enough to walk on at an air temperature of35° F. A fresher material of lower viscosity appeared nearer the center of the seep.

Sample No. 5.

This sample was taken from a pitch-soaked moss and silt found along the edge of a low bench about 200 yeards east from the location of the pitch pools where sample No. 4 was collected. Sample No. 5 consists of the higher grade pitch-impregnated moss found along the edge of the bench.

Sample No. 6

This sample was collected from seep No. 3 in the Cape Simpson area. The sample consists of the hard pitch material which is being mined for fuel by the natives.

Sample No. 7

This sample consosts of both the hard pitch material and the fresher flow directly under the hard surface. This material is being mined by the natives for fuel. Sample No. 7 has been taken from seep No. 1.

Sample No. 8

Also collected from seep No.1 locatedin the Cape Simpson area, this sample represents a thinner oil which appeared near the top of the knoll. The oil had a greenish color and actually was flowing down the slight slope at a temperature of 33°F.

Sample No. 9

This sample was taken from the hard pitch material exposed in seep No. 2 of the Cape Simpson area. This material is being mined for fuel by the natives.

Sample No. 10

This a sample of greenish colored thin oil, which is flowing on the surface near the head of the knoll at seep No. 2.

Sample No.11

A sample of oil-bound silt found in layers along the northwest beach at Manning Point in the Barter Island area. Digging into the oil-bound silt exposed unconsolidated oil-soaked silt [illegible] underlying the surface.

Sample No. 12

Sample collected by skimming off the surface of several small streams of water which were flowing from the bank to the ocean in the above area.

Sample No. 13.

Collected from several exposures of unconsolidated oil-soaked, brownish red sand whic appears in several places along the bank in the above area.

Sample No. 14

Oil-soaked vegetable debris found along the bank throughout the entire mile and a half distance covered by the north beach. The oil from the above four samples has the appearance of a light distillate ~~oil~~ and/the oil-bound silt and sand,when dried and heated on a stove, burns readily and gives off a strong odor of kerosene.

Sample No. 15

Collected from several pitch pools located one and one-half miles south of Un-goon Point which is located 7 miles east of Humphrey Point on the Arctic Ocean. The pitch is hard, black material and is extremely difficultto dig. A smallamount of mining has been carried out and the pitch has made its appearance in several small holes where the tundra has been removed.

Sample No. 16

The material appears identical with that from which Sample No. 15 was taken, and is located approximately 600 yards east. A small pitch pool has been excavated in the center of a small hummock.

Sample No. 17

This sample was collected from an oil-bound sand which somewhat resists the erosive effects of wave action along the beach 250 yards east from the location where sample No. 16 was obtained. This oil-bound sand is exposed for 30 feet along the bank and appears to be at least four feet thick. This location is one and one-half miles along the beach from Un-goon Point proper.

All of the above samples were collected during August and September, 1943 by the Bureau of Mines reconnaissance party.

MARCH 1, 1946
THE FARTHEST-NORTH COLLEGIAN

Barrow Oil Project Is Outlined

The first official statement on the work to be done in developing the Navy's Petroleum Reserve No. 4, in the Point Barrow region, was released recently in Fairbanks, with the arrival of high U. S. Navy and civilian officials connected with the project.

The party was headed by Commodore W. G. Greenman, U.S.N., chief of naval petroleum reserves, accompanied by A. F. Daily, who will be project manager for Arctic Contractors, the civilian combine formed to do the work at Barrow.

Declaring that the Navy Department believes sufficient evidence has been established to indicate large accumulations of oil can be found in its 35,000 square mile petroleum reserve along the Arctic coast, Commodore Greenman said that a program of reconnaisance will be conducted through the summer of 1949 at an estimated cost of $10,662,000, contingent upon appropriation of additional funds. A $1,000,000 contract has been placed to cover the work planned for the calendar year 1946.

The program of exploration includes reconnaisance by airborne magnetometer, aerial photography, geological surface mapping, subsurface reconnaisance by gravity meter and seismograph, and finally the drilling of test wells.

"In view of the unusual nature and technical range of the work involved," Commodore Greenman said, "it was finally decided that the Navy's interests could best be served by employing the U. S. Geological Survey for the geological work and as consultants, and to obtain the services of a combination of firms which would include a technical organization for over-all-management and advice, well drilling and geophysical work, and a construction firm for camp maintenance and operation, freighting and construction."

Examination of the technical qualifications and financial ability of several firms led to the selection of the joint venture of Hoover, Curtice and Ruby, mining and petroleum engineering contract manager, combined with C. F. Lytle Company and Green Construction Company to take the contract. These joint venturers have designated themselves as Arctic Contractors for the purpose of carrying out the Point Barrow project.

The U. S. Geological Survey will conduct field work and maintain a laboratory at Fairbanks, while Arctic Contractors will establish principal offices at Fairbanks, with associated offices at Point Barrow and Seattle. Commander P. D. Koon, CEC, USNR, the naval officer-in-charge of supervising the work, will be located in Fairbanks in the principal office of the contractor. Operations of Arctic Contractors will be directed this winter by A. F. Daily, project manager, with C. Moriarty, as assistant project manager. Daily, former F. E. Company engineer here, is from the staff of Hoover, Curtice and Ruby, and Moriarty is from the Lytle and Green Construction Company.

BARROW OIL CONTRACTS AND DRILLING PROGRAM CONFIRMED AT CAPITAL

Alaska Weekly - 11 Jan. 1946

New York Firm to Perform Chief Exploration Work, Assisted by Sub-Contractors and Geological Staff

WASHINGTON.—The navy has awarded a prime contract to Hoover, Curtis and Ruby of New York to continue exporation for oil in the Barrow reserve, Delegate E. L. Bartlett announced here. He said:

"The cost-plus fixed-fee contract was awarded following approval of such procedure by the House Naval Affairs Committee on the request of the navy. Release of experienced naval men from the armed forces who have been working on the project necessitated turning the work over to civilian contract.

"Lytle and Green of Des Moines, Iowa, prominent construction contractors during the war years in the Territory, have been awarded a subcontract for freighting in connection with the Barrow reserve.

"The Geological Survey will continue doing all geological work, and the navy will contribute all its supplies and equipment now on the reserve and will provide air and water transportation with associated facilities, as in the past.

"Hoover, Curtis and Ruby, a branch of United Geophysical Company of California, is experienced in oil field development and is identified with extensive development of oil fields in South America, England and throughout the United States.

Big Oil Reserve

The navy previously reported that a well sunk at Umiat mountain, to the depth of 1,800 feet, had penetrated five separate oil bearing sands.

"I have been told by an experienced oil man who has worked in all the great reserves of the world," Bartlett said, "that the prospect for the navy reserve in Alaska surpasses anything he has ever seen. He believes the reserve eventually will develop into a field that would produce five to ten billion barrels of oil."

NEW STREET NAMES

ANCHORAGE.—The city has adopted a street-naming system that eliminates the "east" streets and substitutes the names of Alaska towns. East B becomes Barrow Street, East C Cordova Street, East F Fairbanks Street, and so forth.

EXPEDITION ARRIVES AT CAPE SIMPSON FOR OIL DRILLING PROGRAM

Permanent Picked Crew of 200 Seabees With Wide Oil Experience Under Command of Lieut. Bill Rex All Set for Extensive Campaign With Full Equipment and Supplies Already Landed

ALASKA WEEKLY 8/25/44

Following the arrival last August 6 of two Liberty ships off Cape Simpson, 50 miles east of Barrow, Seabee crews started unloading cargo for a camp and oil exploratory and drilling operations in Naval Petroleum Reserve No. 4 which extends from near Wainwright on the west to the lower Colville River on the east, and embraces some 30,000 square miles of land.

According to Jessen's Weekly the ships anchored off Barrow and were met by Lieut. W. T. Foran, U. S. Navy, geologist in charge of the geological and general field work for the U. S. Navy. They remained at anchor until late Sunday afternoon when, piloted by a PBY flying boat, they proceeded slowly eastward to the point of discharge.

This is the first attempt ever made to prove the area, one that geologists who have examined it, believe may prove to be one of the greatest oil producing areas in the history of the oil industry.

Ice conditions in the Arctic Ocean complicate the handling of cargo, all of which must be lightered to the campsite. The ships are anchored some three miles offshore. Smaller, powerful LCM boats will move loaded barges from the vessel to the site across a shifting sand-bar at the mouth of a lagoon. A small boat keeps continuous watch over the bar, constantly taking depth soundings and marking the channel as it changes from time to time.

Seabees Handle Cargo

Four hundred Seabees, brought with the expedition, are handling the cargo. Two hundred of these will remain at the camp. The first job will be to erect a permanent camp, after which drilling will start on a location selected by the geologists.

In the cargo is everything necessary for exploratory and development work, as well as for establishing a permanent, winter camp and comfortable living quarters during the Arctic winter. There are four drill rigs, trucks, tractors, Athey wagons for hauling the rigs, portable camp buildings and supplies from point to point as the drilling progresses. There is ample food for the winter. Right now the big push is getting all of this cargo ashore and housed, and getting the mother ships out of the Arctic before winter shuts down.

Picked Crew For Operation

The camp construction, its operation and drilling will be under the direction of Lieut. Bill Rex, who has as his assistant, Lieut. N. S. Hitchcock, executive officer. The entire crew of 200 is made up of picked, trained, and experienced oil men, each selected for his qualifications. All have worked in various oilfields and are skilled in exploratory and drilling operations. They came mostly from Texas, Oklahoma and California.

First Arctic Adventure

This is the first Arctic adventure for them, but they are going about it like veterans. In other words, there is a job to be done and the Seabees are getting it done. Preliminary estimates call for the first well to be down in about 30 days. Succeeding wells will go down in considerably less time, possibly in a week. Initial drilling will be done in the vicinity of Cape Simpson, near two large oil seepages. This is not the peat that has been used for fuel for a number of years at Barrow, but a true oil, resembling Pennsylvania lube, and burns readily.

Its presence has been known more than half-century. It's first known discovery was made in 1886 by Charles Brower, "King of the Arctic," trader, whaler, explorer, and author, and a resident of Barrow since 1884.

It wasn't in demand then and for many years, so nothing was done about it. Back in 1918 or 1919, an old-time prospector, Alexander Malcolm (Sandy) Smith, fell into one of the seeps and recognized it for oil. He staked some claims and later succeeded in interesting California oil companies in it. Two parties went north in 1922 and looked over the field. However, early in 1923 President Warren G. Harding proclaimed it a naval reserve, taking in all of the known area. Later other fields were found to be in the same area and these were included, extending the reserve to the lower Colville River.

Reserve Is Extended

Since the war began, a duration order has been issued which puts the entire American Arctic slope, between the Colville and the Canadian boundary at Demarcation Point, under a military withdrawal. This, unless executive or congressional action is taken, will be lifted at war's end. The entire area contains some 70,000 square miles, all of which is said to be of a highly favorably geological structure.

Foran Head Geologist

Lieut. Foran and a trained crew of geologists and engineers have been in the area since last March. In six weeks time they surveyed the Colville River field, covering an area in that time that under ordinary conditions the same size crew would have required six months.

He will sample the cores from the drill rigs and spot the drills for the several holes in the different fields. He is an enthusiast. He was in the field in 1923 and 1924, making surveys for the United States Geological Survey. Since then he has worked for the Standard Oil Company in South America and Arabia as well as in the United States. He was chief geologist for the company when he was called into service by the Navy, and assigned to the Barrow work.

BARROW OIL AREA IS LARGEST UNDEVELOPED FIELD OF HEMISPHERE

ALASKA WEEKLY — Dec. 14, 1945

Extensive Seepages and Tests to Date Encouraging, According to Chief of Recent Exploration Work

Arriving in Seattle last Thursday from Point Barrow en route to Washington, D. C., to submit detailed reports of the oil exploration work which has been carried on in that area the last two years, Lt. Comdr. William T. Foran made a general appraisal here of the region as being the best-looking undeveloped oil field on the western hemisphere. Foran has been in charge the last two years as chief geologist of the work here, which is now concluded, under the Navy department.

Present plans, it has been indicated in advices from Washington, is to have the exploration work resumed next spring on a contract basis.

The so-called Point Barrow oil region is known as Naval Petroleum Reserve No. 4, covering some 3,500 square miles, extending about 300 miles along the Arctic coast and 200 miles inland, all barren land and tundra-covered and devoid of any tree growth save for scrub willows and alder along the main streams and tributaries. The region is a flat and featureless plain.

Foran will report to the navy department in Washington on the geologic findings and results of the work to date, especially that of the last summer. The exploration work thus far was done with a crew of 250 Seabees who are now at Point Barrow.

Main Drainage

The main area under exploration is drained by two trunk streams, the Colville and Ikpikpuk Rivers and tributaries.

With the Seabees and equipment, said Foran, the navy drilled a group of shallow structural wells at Cape Simpson to augment geophysical studies, and at Umiat started a well which is one-third completed. Four residue sands were touched. This, he said, is quite promising. Summarized conclusions indicate the oil and gas seepages of the area would lead to the belief there is oil of economic value in the vicinity. On the crest of closed structures and recently acquired geologic information, said the geologist, there are indications of decentralization of oil in the region, occurring in sand reservoirs, in locations where the structure of the country rock is favorable for its accumulation, which may prove economically valuable. The structure being tested at Umiat, he said, is typical of the region.

Umiat Well Test

The Umiat dome, he said, should give a fair test for the southern part of the reserve. He believed the results of the Umiat well will be a helpful guide to source beds and interpretation of stratographic and structural conditions in the concealed area of the North. With the saturated wells of the Umiat area under cover, the pooling of oil in commercial volume might not be considered within the reserved limits and it is likely big pools may even extend far beyond present reserves. The aerial magnitude of the region, he said, apparently affects a comparatively extensive oil area in the broad Barrow basin. It is indicated, said Foran, the quality of oil will have a comparatively low pour point, and the seepage oil indicates a general supply.

Favorable Position

The Umiat well, said Foran, is situated in the most favorable position for the southern part of the reserve.

A complete and adequate crew of skilled men and technicians was engaged at Umiat, said Foran. The well, which was put down 1,816 feet, was shut down due to demobilization, and the experienced men are back in industrial work. Equipment used is described as the best, and everything used in that respect is now on the ground ready for use by contractors whom it is expected will resume the drilling next year under the new plan.

Foran stated that a large intermediate region of probable economic importance exists in the east central part of the reserve and its future will be determined by thorough geophysical study and subsequent well tests.

To get the oil of the Barrow area out of the country to some year-round, ice-free port of Alaska appears perfectly feasible by pipelines, which would have to cross divides of no greater elevation than 2,000 feet, extending southerly to some coastal port south of Cook Inlet, said Foran.

No Arctic Terrors

Rigors of the Barrow area have no terror for Lt. Commander Foran. He reports that all the men engaged

—CONTINUED ON PAGE SEVEN—

—CONTINUED FROM PAGE ONE—

there in the oil exploration work never before enjoyed better health, and there was nothing for the doctor to do, and all who have gone outside left in better health and condition than they had on going there. The Seabee base is being maintained at Barrow and all the oil crew members of that force are there for the winter.

Foran took the first two expeditions to the Barrow area and years ago led a preliminary expedition across the country to a southern point, mushing with the entire party for weeks. Later he worked in the Matanuska area. He has been all over the world in his oil and geologic work and for more than 20 years was with the Standard Oil of New Jersey and other large companies in Persia and many other oil regions, and is the author of an invaluable treatise on the oil, asphalt and petroleum deposits of the Babylonian and other ancient regions, telling how the ancients obtained much of their oil and similar products in those regions. Much of his data was correlated from references in the old books of the Bible.

Born and reared in Seattle, Lt. Commander Foran started his career as a boy with the Seattle Post-Intelligencer and he is a graduate of the University of Washington (1921) where he majored in geology.

Work by Seabees

FAIRBANKS.—The work performed in the drilling at Umiat by the Seabees was under direction of Commander Bill Rex, who finished his service about 90 days ago and went Outside. Work has shut down in the field, owing to winter conditions. Lack of water forced the drills to close down several weeks ago, according to Jessen's Weekly.

Present navy plans, it is indicated, call for resumption about next April but on a contract basis. Washington advices report a subcommittee reported out a measure carrying some $9,000,000 to continue operations. Bids for transportation of supplies and materials from the main camp to location sites where work will be done next year as well as drilling, it is understood, will be let early next year.

BARROW OIL PROMISES TO BE VAST

Naval Authority Believes Field Is One of Best; Conference Deals With Plans for Development

WASHINGTON.—The surface indications of the potential oil fields in northern Alaska are the best ever seen by Captain Bart Gillespie, according to his recent testimony before the House Naval Affairs Committee.

Captain Gillespie, USNR, has been in active charge of the oil exploration project in the Barrow, Alaska, reserve, and has been in the oil business for many years prior to his service with the navy.

The committee meeting was held to determine the desirability of continuing the exploration work through private contract, since most experienced naval men who have been at the field will be released from service. It was agreed that testimony proved the value of continuation, and the navy will let a contract at an early date.

All witnesses were optimistic as to the possibility of discovering real oil fields in northern Alaska. Commodore W. G. Greenman, USN, director, Naval Petroleum Reserves, stated that he believed it was altogether possible the Barrow fields could be as extensive and valuable as those in California.

Commodore Greenman stated that a preliminary pipe line survey has been completed, furnishing the basis for a detailed pipe line location survey if oil is found in sufficient quantities to warrant the installation of such facilities. The flow of oil in northern Alaska is such that its transportation during the winter offers no problem. The pipe line would be a minimum of sixteen inches, laid on the surface at a cost of between sixty and ninety million dollars, depending upon its location and terminus.


A146-
LF)(9-18-43)
12"-F.11-1


BARTER ISLAND
NO. 3


NO. 4


NO.5


MANNING POINT
NO. 6

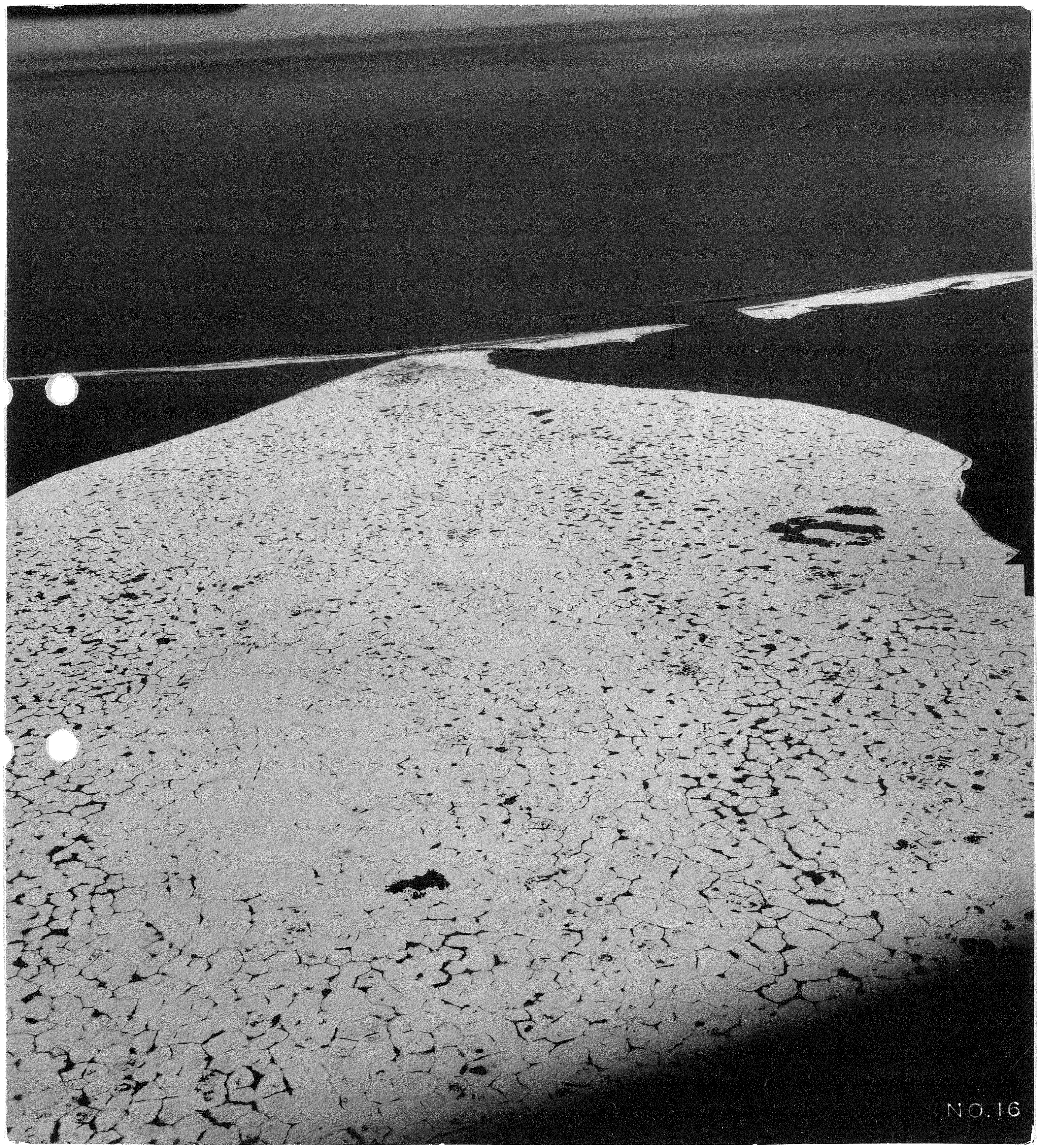

NO. 8


HUMPHREY POINT
NO. 10

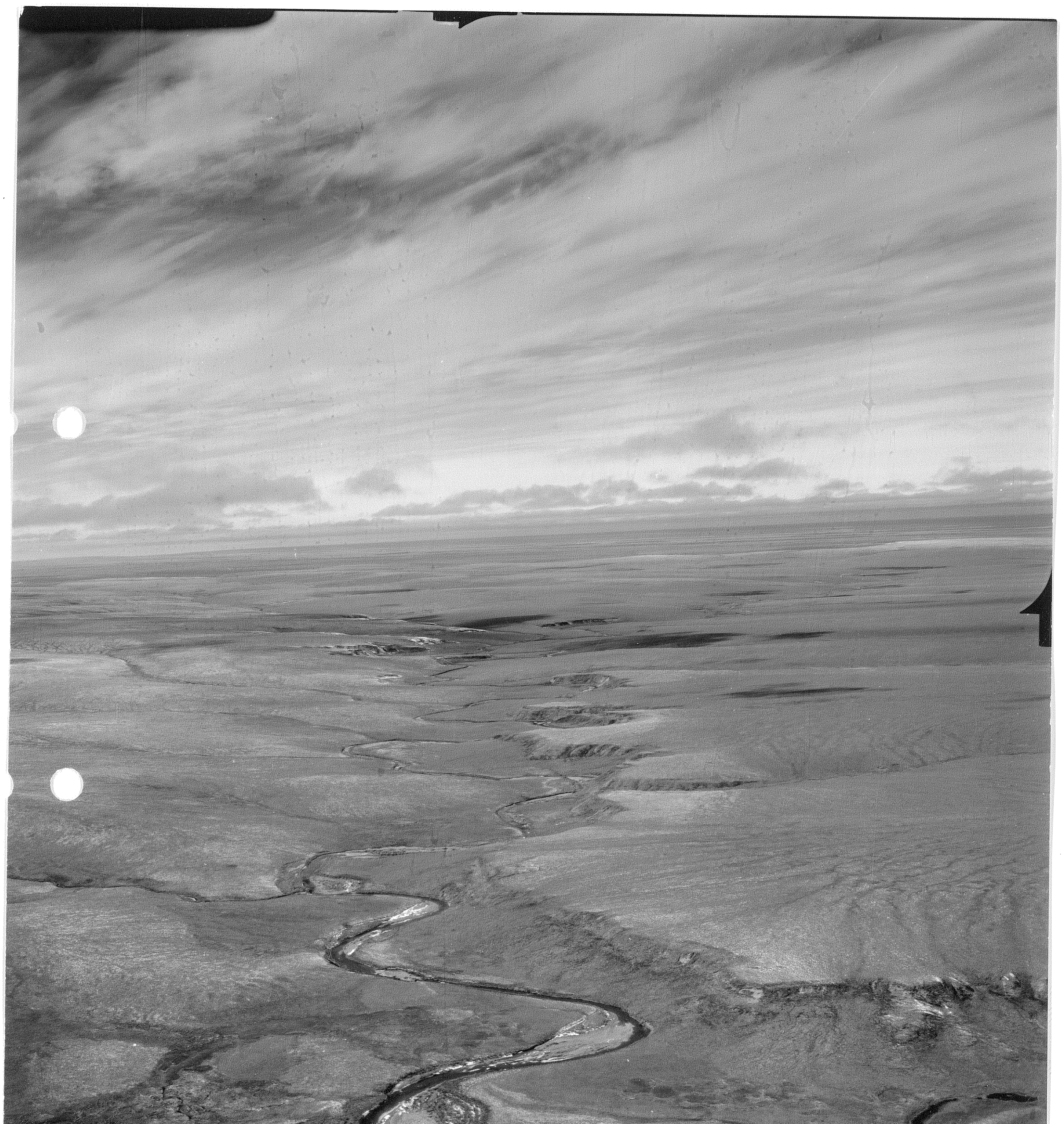

NO.11


NO.13


NO. 14


NO.16


WHITE MTS.
NO.18


NO.19


(9-18-43)
12"-F.11-1/13
NO.21


NO. 23


NO.24


NO. 25


NO.26