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Engineer Intelligence Study No. 191, Terrain Analysis, Alaska Slope Region, Alaska, 1959

Military Geography Branch, USGS

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ENGINEER INTELLIGENCE STUDY NO. 191

TERRAIN ANALYSIS, ARCTIC SLOPE REGION, ALASKA (U)

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PREFACE

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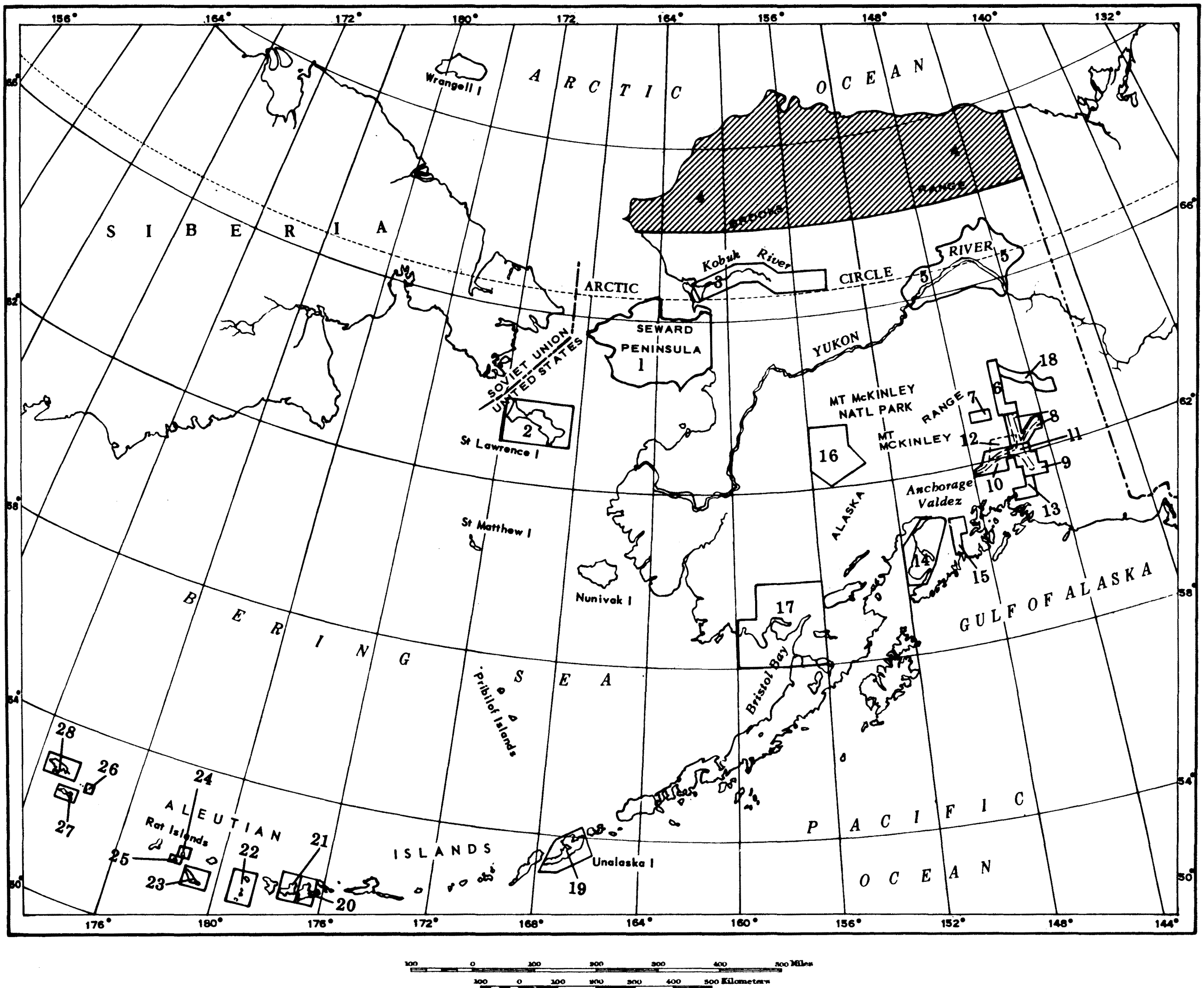

FIGURE 1 INDEX MAP

Areas of Alaska and the Aleutian Islands covered by Engineer Intelligence Studies in preparation under direction of the Chief of Engineers, Department of the Army, by Military Geology Branch, Geological Survey, U. S. Department of the Interior:

Area of this report (4 Geographic area – not EIS number)

1. Seward Peninsula
2. St. Lawrence Island
3. Kobuk River Valley
4. Arctic Slope
5. Yukon Flats
6. Delta River Region
7. Denali Area
8. Northeast Copper River Basin
9. Southeast Copper River Basin
10. Southwest Copper River Basin
11. Copper River Basin Highway net (in areas 8, 9, 10)
12. Central Copper River Basin (Operation Little Bear)
13. Valdez–Tiekel Belt
14. Kenai Lowland
15. Seward Portage Railroad Belt
16. Upper Kuskokwim Region
17. Bristol Bay Lowland
18. Alaska Highway, Gerstle River to Tok (Johnson River Project)
19. Unalaska Island
20. Adak–Kagalaska Islands
21. Kanaga Islands
22. Delarof Islands
23. Amchitka Island
24. Little Sitkin Island
25. Rat Islands
26. Shemya Island
27. Agattu Island
28. Attu Island

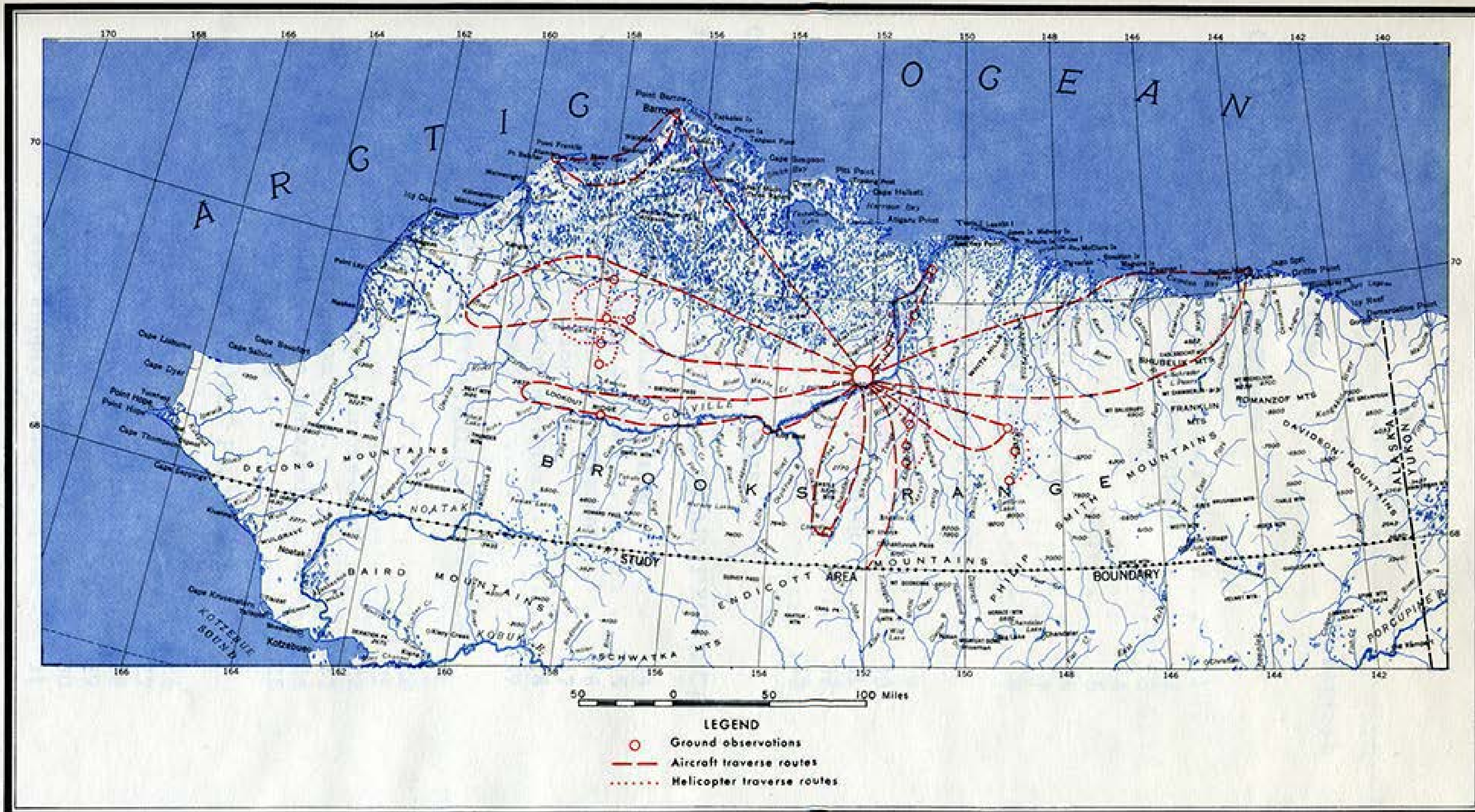

FIGURE 2: ARCTIC SLOPE REGION

Field Observations 1955

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FIGURES

PHOTOGRAPHS

SUMMARY

This EIS is a generalized description of the Arctic Slope Region, Alaska-an area covering approximately 70, 000 square miles. The study is based on a geologic reconnaissance carried out during the summer of 1955.

A physiographic map is presented at a scale of 1:1, 000, 000 and bedrock geology and surficial geology maps at a scale of 1:2, 500, 000. Access to the region and the feasibility of various access routes are discussed. Climate, permafrost, drainage, and vegetation are described. Location and extent of natural fuel supplies are given. Factors controlling outdoor work feasibility are summarized graphically. A terrain analysis of each of the three major physiographic provinces of the region (Arctic Coastal Plain, Arctic Foothills, and Brooks Range Provinces) is given; and the geologic factors which affect cross-country movement, construction, and water supply within these individual provinces are evaluated.

CHAPTER 1

INTRODUCTION

1. Purpose and scope

The Terrain Analysis, Arctic Slope Region, Alaska, EIS is based on fieldwork carried out in the summer of 1955 by geologists H. W. Coulter and Paul Seaber, both Military Geology Branch, U. S. Geological Survey personnel. Coulter is the author of the EIS. During the field season extensive discussions were held with officers of the 660th Engineer Group at Umiat concerning the type of information that would have been useful to them during the planning phases of the Corps of Engineers Northern Alaska Survey Program. As a result of these discussions, this EIS attempts to present data on the general and seasonal aspects of the terrain and climate that govern outdoor work feasibility, aircraft operations, cross-country movement, construction, and water supply, in a style and format that would be useful for future military planning. The vast size of the area - approximately 70,000 square miles - precludes detailed operational-level description of individual terrain aspects of the region. Instead, the area has been subdivided into broad-scale units and the discussion has been restricted to features and conclusions that are generally valid throughout the units so delimited.

Excellent logistic support furnished by the 30th Engineer Group, which was engaged in triangulation surveys in northern Alaska, enabled the field party to visit many more localities and to make many more low-altitude observational aircraft and helicopter flights than would ordinarily have been possible. (Figure 2 designates these aircraft and helicopter traverse routes; it also outlines the areas on which ground observations were made.) Further assistance in preparation of this EIS was obtained from published and unpublished reports of the U.S. Geological Survey, Arctic Research Laboratory, Boston University Keys Project and Arctic Contractors as well as from maps, charts, and aerial photographs (listed in Appendix).

2. Location and description

For purposes of this EIS, the Arctic Slope Region is considered to be that portion of northern Alaska bounded on the south by the crest of the Brooks Range and on the north by the Arctic Ocean. It has been subdivided into three main provinces: the Arctic Coastal Plain Province, the Arctic Foothills Province, and the Brooks Range Province (see Plate 1, Landforms and Physiographic Provinces Map.)

The Arctic Coastal Plain Province consists of the Teshekpuk Lake Section west of the Colville River and the White Hills Section east of the Colville River. The Teshekpuk Lake Section is underlain by flat-lying unconsolidated marine deposits. Local relief is low, in most places less than 100 feet; and slopes are generally less than 6 percent. The surface is characterized by abundant elongate lakes, many displaying a strong northwest orientation, swampy areas, wet tundra, and meandering, poorly integrated streams. The White Hills Section is underlain by gently folded, poorly cemented Tertiary rocks. The surface relief and slopes are intermediate between those of the Northern Foothills Section and the Teshekpuk Lake Section. Lakes are less abundant than in the Teshekpuk Lake Section and drainage patterns are better defined with streams more deeply incised.

The Arctic Foothills Province is a zone of topographic and geologic transition between the relatively level, featureless Arctic Coastal Plain and the rugged and structurally complex Brooks Range. It is subdivided into the Northern Foothills Section and the Southern Foothills Section. The Northern Foothills Section is characterized by broad, open, bedrock folds reflected at the surface by persistent ridges, mesas, and hills of 500- to 1,000-foot relief, slopes from 6 to 12 percent, and relatively accordant summits. The Southern Foothills Section is characterized by tightly compressed east-west bedrock folds reflected at the surface by irregular topography with isolated hills and ridges rising 500 to 2,000 feet above areas of low relief, with slopes from 12 to 24 percent.

The Brooks Range Province has been characterized as the Alaskan counterpart of the Rocky Mountains. It includes several east-trending, subparallel groups of rugged mountains with relief of 3,000 to 6,000 feet and maximum elevations of 3,600 to 9,000 feet. Slopes of 24 percent and greater are common.

East of the Sagavanirktok River the northern boundary of the Brooks Range Province swings abruptly northward for approximately 60 miles, with a consequent narrowing of the Arctic Foothills Province and the Arctic Coastal Plain Province in that area.

Morainal belts are conspicuous along the southern border of the Arctic Foothills Province and in most valleys in the Brooks Range. Outwash deposits containing a high percentage of medium-sized gravel, and deposits of windblown silt of variable thickness are common throughout the Arctic Foothills Province and along the major valleys in the Brooks Range.

3. Access

Access to the Arctic Slope Region except by air is very difficult.

Cross-country movement of all types at all seasons through the Brooks Range is prohibited by the steep narrow canyons along the drainage systems of the southern flank. In winter, tractor trains can operate up the western coast and eastward across the Arctic Coastal Plain, up the Porcupine River and down the Mackenzie River, or up the Coleen River and down the Firth River and thence westward along the Coastal Plain. (See figure 1.). The utility of all these routes is limited by the excessive distances involved.

Access by sea is restricted by the absence of good harbors and scarcity of protected anchorages north of Point Hope. An additional hazard is created by the permanent pack ice which lies close ashore east of Icy Cape. Northerly winds at any time during the short (July through September) navigable season may drive the pack ice aground, effectively blocking shipping in either direction. Pack ice is commonly grounded throughout the navigable season off Point Barrow and off Cross Island.

4. Climate

Available climatic data for the Arctic Slope Region are summarized on figures 3, 4, and 6, In general, the climate is characterized by low mean annual temperature, low annual precipitation, and a high incidence of cloudy and of windy days. The coincidence of periods of high winds and high precipitation at Barrow has resulted in inaccurate measurements, and consequently the recorded precipitation is less than the actual precipitation.

The persistence of cloud cover and fog along the coastal belt, results in uniformly low midsummer temperatures. Inland, however, the overcast is less persistent and very warm days with temperatures approaching 80°F. occur from time to time. Sudden violent storms accompanied by very strong winds can be expected on the exceptionally warm days.

A factor of great importance to landscape development and the origin of microrelief features in any area is the number of times per year that the temperature crosses the zero isotherm (0°C.). The Arctic Slope Region, in common with other high latitude areas, has a very limited number of days on which the zero isotherm is crossed; moreover, these days are restricted largely to periods when the ground is snow-covered. Therefore insofar as frost action is concerned, this region may be considered to have a yearly climate rather than a daily climate, with temperatures varying greatly by the month and very little by the day.

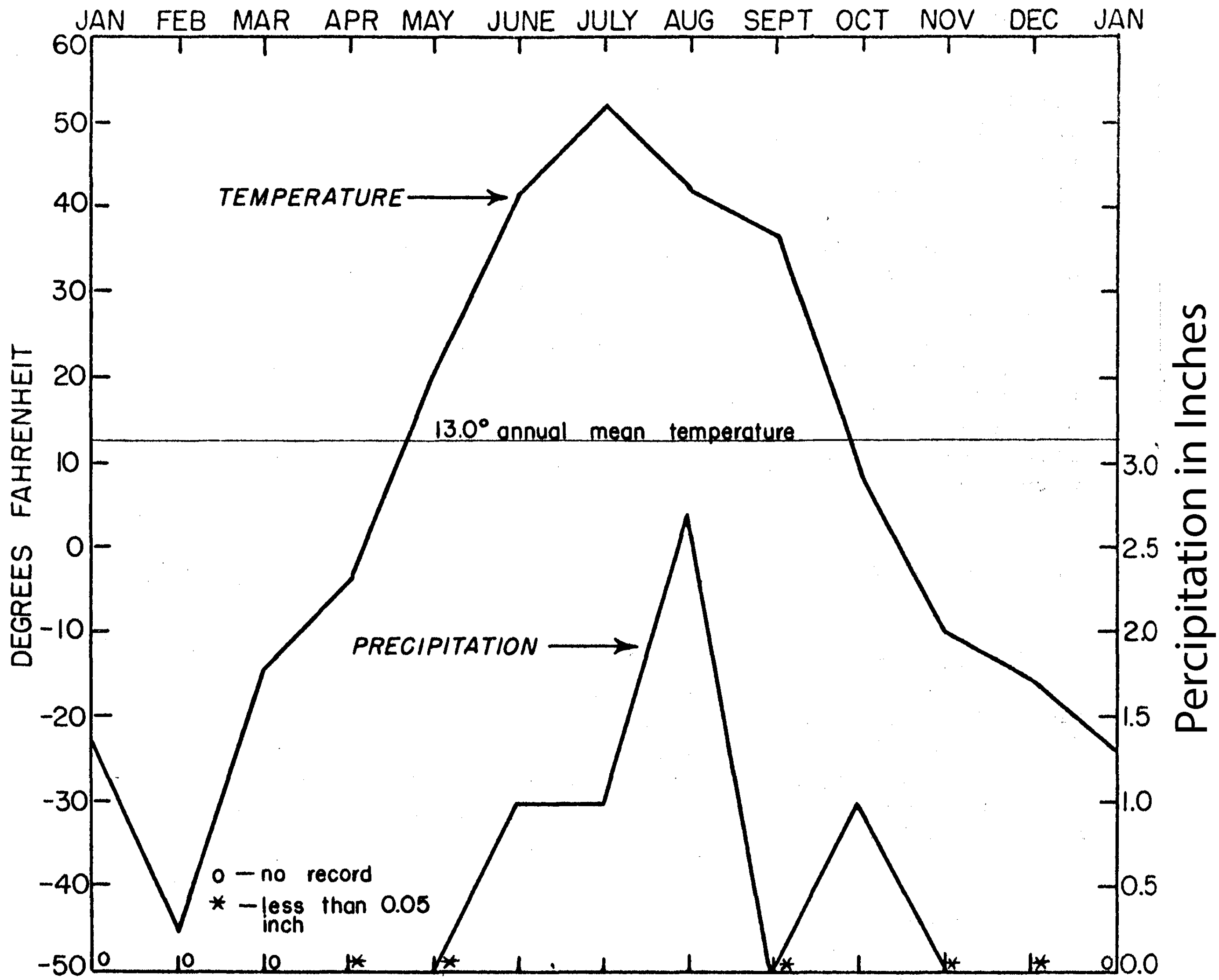
5. Permafrost

Permafrost (perennially frozen ground) appears to be present beneath the entire Arctic Slope Region. Data from drilled wells indicate that the thickness of frozen ground ranges from 600 to 1,300 feet. In most places the depth of seasonal thaw (active layer) ranges from ½ to 4 feet, depending on the nature of the surficial material, the vegetation cover, the drainage, and the exposure. Beneath the flood plains of major rivers, under deep lakes, and near hot springs the depth to permafrost is much greater.

6. Drainage

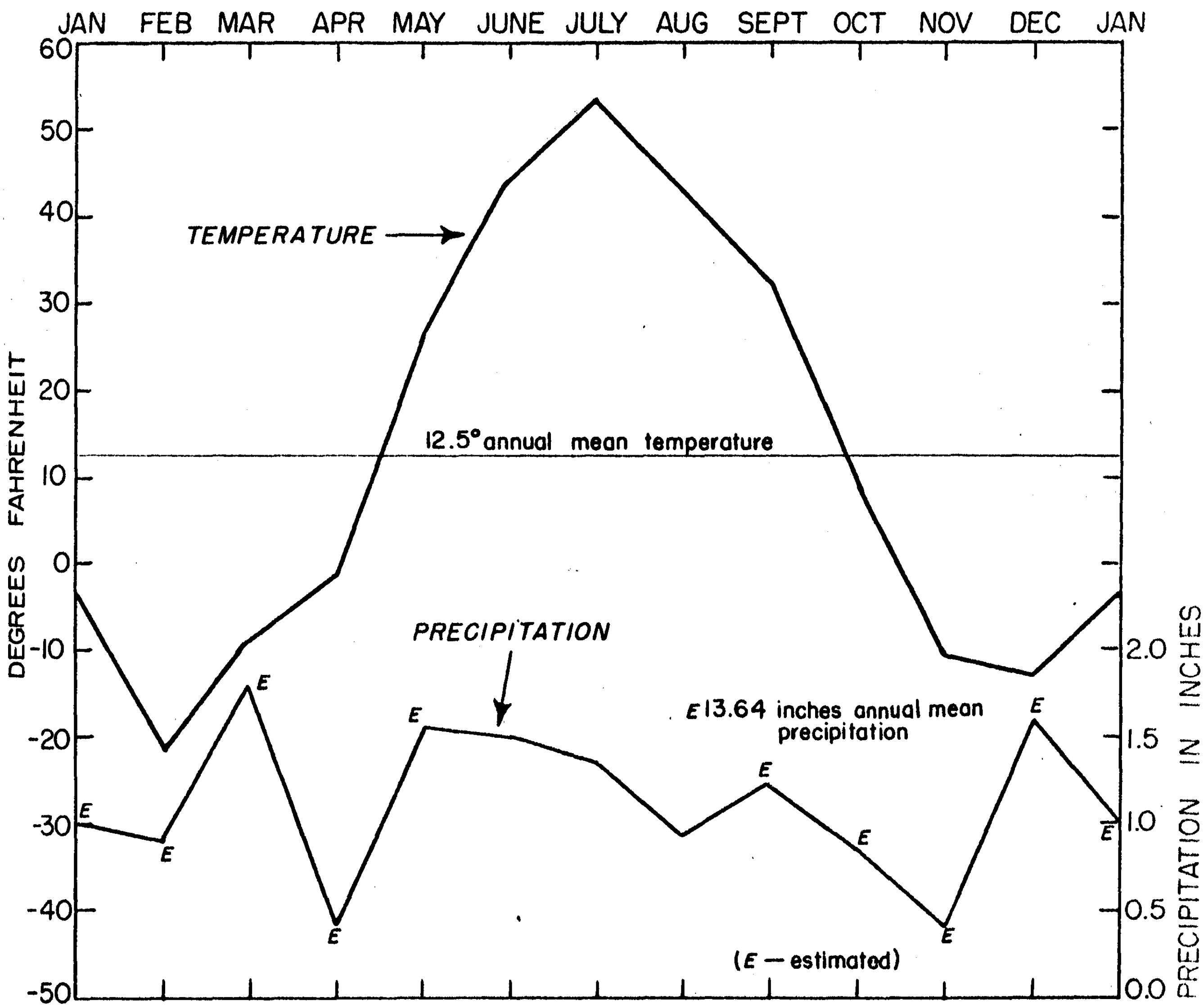
The general drainage pattern of the Arctic Slope Region is that of subparallel river systems flowing northward from the flanks of east-trending mountains into the Arctic Ocean. The major exception to this pattern is the headwater portion of the Colville River, the largest river in northern Alaska. It flows eastward for approximately 250 miles, receiving the discharge of many north-flowing tributaries before turning sharply northward itself 75 miles south of its mouth on the Beaufort Sea. (See Plate 1, Landforms and Physiographic Provinces Map).

The average thinness of the active layer above the permafrost table results in low storage capacity of the surface mantle and very rapid surface runoff of meltwater and rainfall. Consequently the major streams show unusually large and rapid fluctuations of discharge volume. Extreme floods during and immediately following the spring breakup period are succeeded by a very low water stage throughout the remainder of the summer season. Individual rainstorms commonly cause very sudden temporary increases in discharge volume during the low water stage. Winter observations indicate that flow of even the major rivers such as the Colville may cease entirely during February and March.



CLIMATOLOGICAL DATA — Two year record
Umiat, Alaska
Arctic Foothills Province

FIGURE 3



CLIMATOLOGICAL DATA — 1955

Anaktuvuk Pass, Alaska
Brooks Range Province

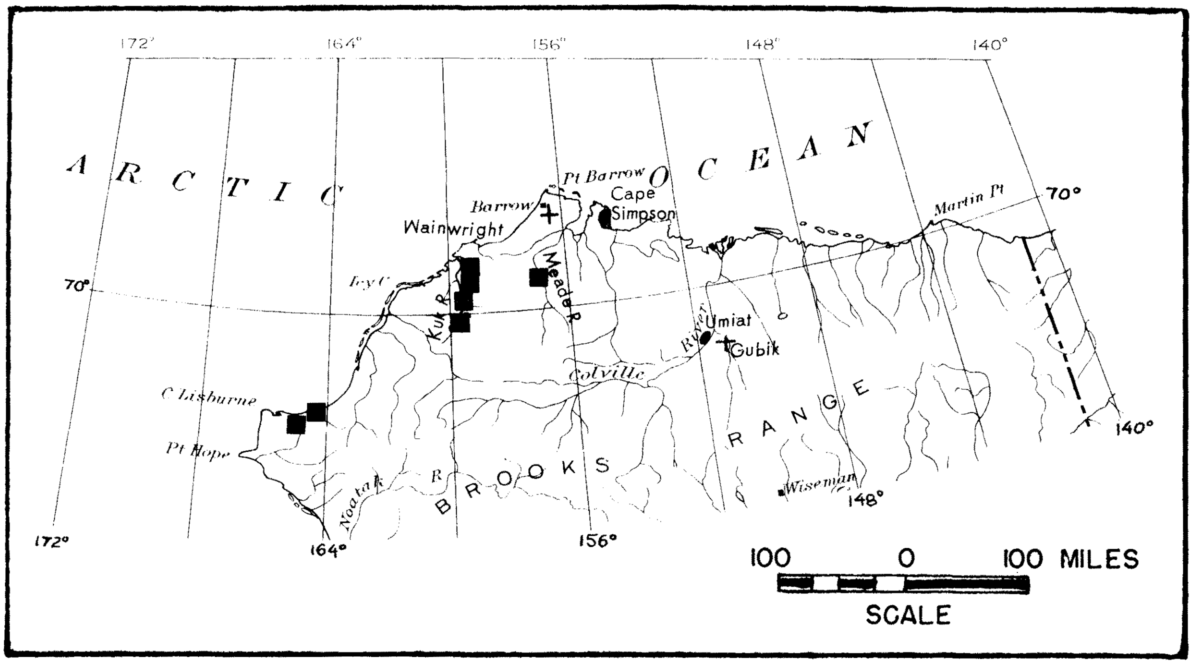
FIGURE 4

7. Vegetation

The entire Arctic Slope Region lies beyond the northern limit of spruce. Tall willows (up to 15 feet), alders, and occasional poplars grow along the larger stream channels in the southern part of the area. Tundra vegetation consisting of dwarf shrubs, grasses, sedges, lichens, and herbaceous plants cover the interstream areas except for the bare bedrock hills in the Brooks Range and the Foothills Provinces.

8. Natural fuel supplies

Natural fuels occurring within the Arctic Slope Region include petroleum, natural gas, and coal, as shown on figure 5. No organized development or exploitation of these resources has been carried out to date, although oil exploration and drilling has been done. Two oil fields, at Cape Simpson and at Umiat, have been defined by exploratory drilling. Thus far no use has been made of oil as fuel from either of these fields, although Simpson oil has been tested as a binder to aid in stabilizing the beach gravels at Barrow. Producing gas wells have been drilled at Barrow and at Gubik on the Colville River. Gas from the Barrow wells has been used extensively to heat the buildings of the large government camp there. Numerous widely distributed coal beds of subbituminous quality occur throughout the Upper Cretaceous rocks of the Arctic Coastal Plain Province (see Plate 2, Bedrock Geology Map). Limited mining operations have been undertaken along the Kuk River to supply the native village at Wainwright with this coal. Mining has also been carried out on the Meade River to supply coal to the native village at Barrow. Coal has been mined sporadically from the Paleozoic rocks in the Cape Lisburne region.



Natural Fuel Supplies Within The Arctic Slope Region, Alaska

- Oil Fields
+ Gas Wells
- Coal Mines

FIGURE 5

CHAPTER 2

OUTDOOR WORK FEASIBILITY

9. General limitations

Figure 6 is a graphic presentation of the factors, other than terrain expression, which determine the feasibility of outdoor work at Barrow, Alaska. Meteorological data in sufficient detail are not available to construct a comparable chart for other localities in the Arctic Slope Region; however, the major limiting factors are sufficiently similar to give the Barrow chart general applicability throughout the region. Available climatic data for the Arctic Foothills and Brooks Range Provinces are summarized on figures 3 and 4.

In general, daylight duration is constant throughout the region. Visibility is better inland than along the coastal belt and average temperatures are somewhat lower with a greater range of extremes.

The great abundance of biting insects (such as mosquitoes and black flies) is an additional factor which affects outdoor work feasibility in the Arctic Slope Region. At Barrow and in general along the coast, insects are no great problem; however, inland during July and August insect repellent, and at times protective clothing and head nets, must be used by men working out-of-doors. Individual susceptibility to insect nuisance varies greatly, of course, but in the Arctic Slope Region the problem is sufficiently severe so that some people are unable to operate effectively during peak insect activity.

10. Aircraft operations

Aircraft landings with wheel-equipped planes may be made throughout the year on airstrips at Barrow, Barter Island, and Umiat since the fields normally receive continuous maintenance. Wheel landings are also possible during July and August at auxiliary strips at Meade River City (Atkasuk) and at some of the radar sites along the Arctic Coast. (See Plate 3, Surficial Deposits Map). Small bush planes have landed on gravel bars along the larger rivers during the August low water stage and on beaches along the Arctic Coast.

The extreme development of tundra microrelief features, such as tussocks, frost boils, and ice-wedge polygons throughout the region, in general restricts the operation of wheel-equipped aircraft to the abovementioned sites.

The many lagoons along the Arctic Coast, the myriad lakes inland, and the long, ponded sections of the major rivers serve as excellent landing sites for float-equipped planes and flying boats during the summer months. In winter these same areas are suitable for landings by ski-equipped planes. The intense development of tundra microrelief features and the thin uneven snow cover throughout the area in general restricts the operation of ski-equipped planes to frozen bodies of water and prepared landing sites.

A lapse of approximately one month occurs during the spring breakup between the time when the ice becomes unsafe for ski landings and the time when there is sufficient clear water for float landings. A similar lapse occurs during the fall freezeup period between the time when freezing spray prohibits float operations and the time when the ice becomes thick enough for ski operations. During the breakup and freezeup periods the operation of ski- and float-equipped aircraft is impossible.

In general, helicopter operations are feasible throughout the year. The major limiting factors are periods of poor visibility, high winds, and landing hazards imposed by uncompacted snow.

11. Cross-country movement

The extreme unevenness of the surface throughout the year renders all cross-country movement slow and laborious. It also decreases the service life of vehicles, and increases maintenance problems.

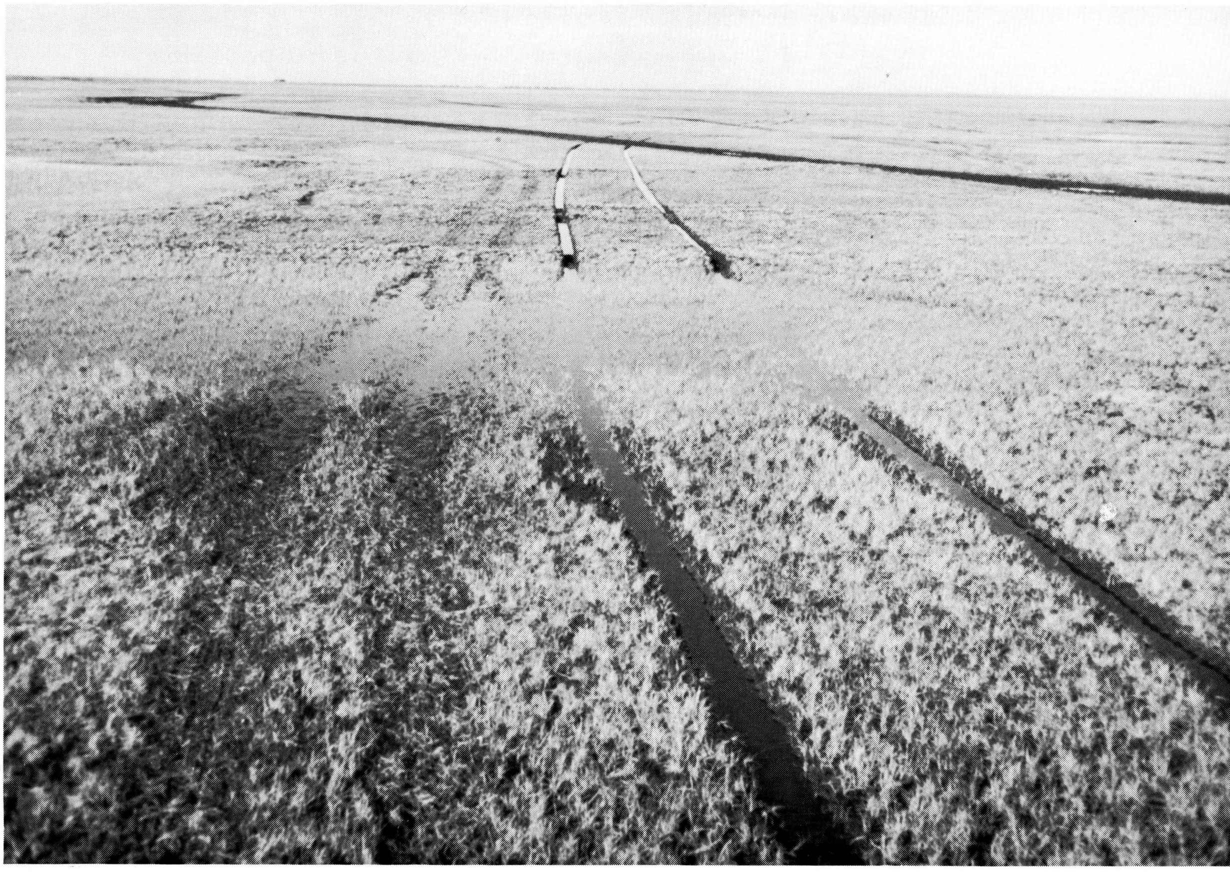
Widespread wet swampy ground in summer and uneven surface conditions caused by microrelief features at all seasons render off-road movement of wheeled vehicles and foot troops unsuitable throughout the Arctic Slope Region. Roads are nonexistent in northern Alaska except within the immediate confines of the airbases at Barrow, Barter Island, and Umiat. All traffic must therefore follow natural terrain, and is limited to tracked vehicles. In summer the numerous lakes, water courses, and marshy areas make mandatory the use of amphibious vehicles with ground pressure of not more than 2 pounds per square inch, such as the M 29C Weasel, which rides over the turf mat without breaking through. In some cases vehicles with higher ground pressures, such as the L. V. T., have been used. These heavier vehicles commonly cut through the turf mat and ride on top of the permafrost, experiencing considerable difficulty with highcentering (see photograph 1).

The optimum period for cross-country movement of heavy equipment is between October and April, when the active layer of the ground is frozen and ice on water bodies is thick enough to support maximum loads. Heavy freighting is normally accomplished at this time by tractor trains composed of a winterized D-8 tractor pulling 3 or 4 No. 9 Michler sleds, each loaded with 15 to 30 tons of equipment. The tractor trains are self-supporting, include messing and sleeping facilities for the crews, and operate 16 hours a day. The major difficulties during this period are the low temperatures and reduced visibility due to darkness and drifting snow.

12. Construction

The severe climate, the shallow depth to the permafrost table, and the great thickness of the permanently frozen zone plus the resulting poor drainage throughout the Arctic Slope Region combine to impose extreme difficulties upon all types of construction. Considerable experience has indicated that only the passive method of construction, wherein sufficient permafrost is preserved to be used for maximum structural value is satisfactory in northern Alaska.

In all cases, care must be taken to minimize the disruption of the existing heat balance and drainage; otherwise differential subsidence, slump, and flooding will result. Because of the large cold reserve of



Photograph 1. Tracks of Weasel (M 29C), left, and of an LVT, right, crossing tundra near Point Barrow. The Weasel rides on the surface without breaking the vegetation mat. The LVT breaks through and rides on the permafrost table. Heavily traveled tractor road in the background. (U. S. Geological Survey, 1955.)

the permafrost, most structures can be sufficiently well insulated so that they remain relatively stable. However, in some types of construction operations, for example, oil well foundations, it has been necessary to use artificial refrigeration to maintain the necessary stability.

13. Surveying

Surveying is possible throughout the period of sufficient daylight duration. However, unusual optical phenomena of great intensity are not uncommon in northern Alaska. The most typical of these phenomena which may seriously interfere with surveying operations are inferior mirage (the appearance of a false horizon below the true horizon, with the image of objects below the true horizon appearing between it and the false horizon), superior mirage (the appearance of an inverted image above an object), and looming (the appearance of an enlarged image of an object above its actual position). The 30th Engineer Group (Topographic Survey) in 1955 reported considerable difficulty in operating telescopic instruments during periods of clear relatively warm weather. This difficulty arose from serious heat wave conditions over the tundra areas, and necessitated restriction of surveying operations to early morning and late evening hours when minimum heat wave disturbance was experienced.

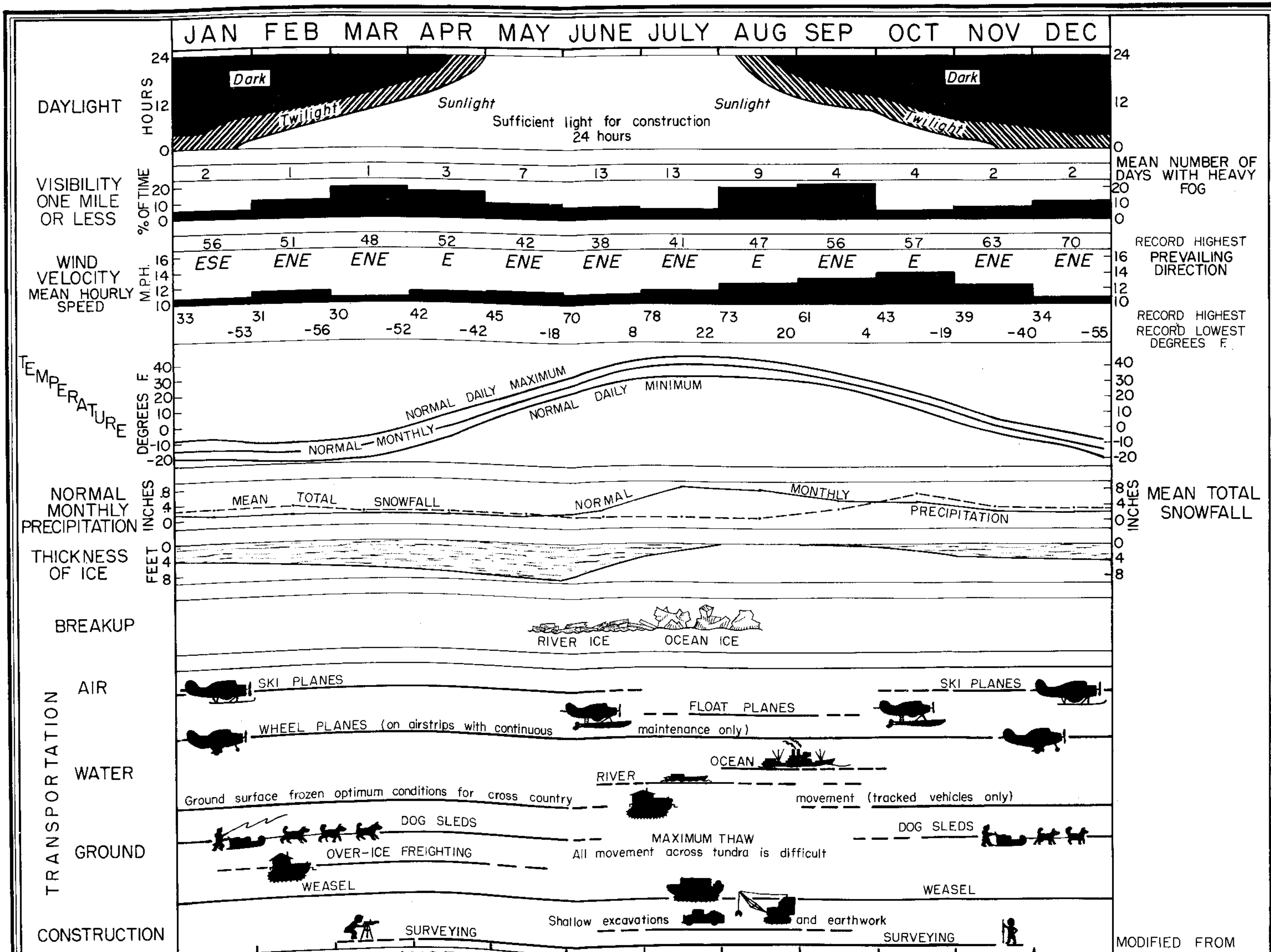


FIGURE 6 OUTDOOR WORK FEASIBILITY CHART, BARROW, ALASKA

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CHAPTER 3

TERRAIN ANALYSIS

Three primary physical characteristics, together with climate, determine the terrain development within each of the physiographic provinces of the Arctic Slope Region. They are bedrock geology including both the lithology of the bedrock units and configuration of the bedrock surface, surficial geology, and drainage pattern. A description of these three characteristics is given for each of the physiographic units within the individual provinces in the order indicated below, and the relationship of the resultant terrain development to cross-country movement, construction, and water supply within each province is discussed.

I. Arctic Coastal Plain Province.

II. Arctic Foothills Province.

III. Brooks Range Province.

Section I. ARCTIC COASTAL PLAIN PROVINCE
(consisting of Teshekpuk Lake Section and White Hills Section)

14. Teshekpuk Lake Section

a. General

The Teshekpuk Lake Section extends from the coast of the Chukchi Sea midway between Point Lay and Cape Lisburne to Camden Bay on the Beaufort Sea (see plate 1, Landforms and Physiographic Provinces Map). It is an area of very low relief and monotonous landscape characterized by numerous shallow elongated lakes comprising 60 percent of the surface area, with intervening areas of marshy tundra and meandering poorly integrated streams. Microrelief features consisting of tussocks, ice wedge polygons, frost mounds, and scattered pingos with elevations of up to 60 feet are intensely developed throughout the tundra. (See photograph 2.)

b. Geology

(1) Bedrock geology (see plate 2, Bedrock Geology Map). The bedrock underlying the Teshekpuk Lake Section is known only from scattered exposures along the beds of major rivers, a few isolated outcrops at the base of the coastal bluffs and from oil wells drilled in selected localities throughout the province. The rocks consist of very gently folded Cretaceous interbedded marine and continental sandstones, siltstones, and shales with scattered thin coal seams. Dip of the beds seldom exceeds 5°; however, the relief of the bedrock surface approaches 100 feet, due to pre-Pleistocene erosion.

(2) Surficial geology (see plate 3, Surficial Deposits Map). The bedrock surface is mantled by from 50 to 200 feet of the unconsolidated Pleistocene marine Gubik formation. The Gubik formation is composed of three members of variable thickness which were deposited in shallow seas during the Pleistocene submergence of the Arctic Coastal Plain Province. Many of the original depositional features, such as beach ridges, bars, etc., are preserved in the Gubik formation. The lowest member of the formation overlies the Cretaceous bedrock unconformably and consists of a sticky or greasy blue-black clay containing well-graded beds and lenses of silt, sand, and pebbles. The middle member uncomformably overlies the basal unit or in places, the Cretaceous bedrock. It consists of clean yellow or buff sand, generally poorly graded, composed predominantly of quartz and chert. The uppermost member of the Gubik formation is in part contemporaneous with and grades into the middle member and in part is younger than and overlies the middle member. It consists of well-graded to poorly graded intermixtures of clay, silt, and sand with scattered gravel lenses, and comprises complexly intercalated beach, distributary, deltaic, lagoonal, and lacustrine deposits.

A variety of thin modern surficial deposits overlie the Gubik formation in scattered localities throughout the area. These consist of alluvial channel and flood-plain deposits along the modern drainageways, colluvial fan deposits from calving banks of present-day streams and lakes, lacustrine deposits in the modern lakes, and eolian deposits in areas of active dune formation. The entire waterfree surface area of the Teshekpuk Lake Section is mantled by a thick (12- to 20-inch) tundra vegetation mat composed of matted low-graded peat topped by a living assemblage of dwarf heaths and sedges and mixed herbs and lichens. Dwarf willows appear along the drainageways.

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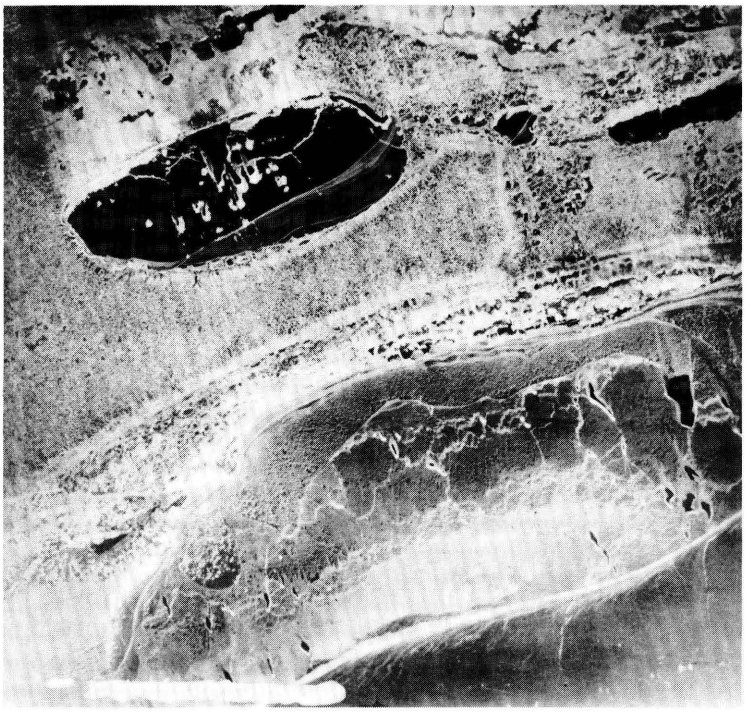

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Photograph 2. Oriented lake and ice-wedge polygons along the Arctic coast near Point Barrow. (U. S. Army Air Force, 7A-V-60 project 201.)

Both the Gubik formation and the overlying surficial deposits contain a very high percentage of frozen water occurring both as interstitial ice and as segregated clear ice masses in the form of wedges and lenses. It is not uncommon within the fine-grained sediments to find, in a given unit volume of the ground, a much higher percentage of ice than of mineral constituents.

15. White Hills Section

The White Hills Section lies south of the eastern portion of the Teshekpuk Lake Section, and extends from the flood plain of the Colville River eastward to the Canadian border. This section differs from the Teshekpuk Lake Section primarily in the composition of the underlying bedrock and in the morphology of the bedrock surface. The White Hills Section is underlain by the Tertiary Sagavanirktok formation which is composed of non-marine, poorly consolidated, weakly cemented siltstone, silty sandstone, and thin low-rank coal seams. The thin modern surficial deposits overlying the Sagavanirktok formation in the White Hills Section are similar to those found in the Teshekpuk Lake Section.

The differences in geological setting between the Teshekpuk Lake and White Hills Sections result in three differences in terrain development between the two units. They are:

(1) Relief in the White Hills Section is greater, up to several hundred feet, than in the Teshekpuk Lake Section.

(2) Average slopes in the White Hills Section are steeper, up to 12 percent, than in the Teshekpuk Lake Section.

(3) Because of the greater relief and steeper slopes, the drainage pattern is better integrated in the White Hills Section than in the Teshekpuk Lake Section, and a much smaller percentage of the surface area is covered by standing water.

None of these differences are of sufficient magnitude to change materially the military aspects of terrain. Consequently, the two sections will be considered jointly in the following discussions on cross-country movement, construction, and water supply of the entire Arctic Coastal Plain Province.

16. Cross-country movement

The absence of roads and the extreme difficulty involved in the construction of suitable roads in the Arctic Coastal Plain Province limit cross-country movement to unprepared routes across the natural terrain. Tracked vehicles are mandatory at all seasons.

Between May and December the major barriers to cross-country movement are the low bearing strength of the surface layer of the ground and the high percentage of open water (lakes and streams). These features limit cross-country movement at this time of the year to small tracked amphibious vehicles with ground pressures of not more than 2 pounds per square inch, such as the M 29C Weasel. (See photograph 1.)

During the spring breakup period high water and floating ice along the major rivers may render them temporarily impassable for periods of up to two weeks. Except during breakup, with judicious route-finding to avoid local steep stream cut-banks and steep calving lakeshores and with adequate air support to extend the normal operating range of the Weasel, it can travel anywhere throughout the Arctic Coastal Plain Province. Rough ground surface conditions can be expected to necessitate low average speed of vehicles and to decrease the service life and maintenance interval of vehicles.

The period from December to May presents optimum conditions for cross-country movement of heavy vehicles and equipment throughout the province. During that time swampy ground is frozen and microrelief is somewhat reduced by snow cover. As an index of the feasibility of this type of operation, the following summary of previous freighting in the area is given.

In 1947-52 Arctic Contractors was the agency responsible for logistic support of the extensive oil exploration and drilling program being conducted throughout the Arctic Coastal Plain Province and the Northern Foothills Section of the Arctic Foothills Province. During an average freighting season (for example, 1950-51), 15,000 tons were moved a total of 1,860,000 ton miles; 2,586 tons of fuel and supplies were delivered by air in direct support of the freighting operations. The only construction measures found necessary during this program were moderate surface grading and dragging of some of the rougher portions of the routes traversed and strengthening of the crossing points of some of the major rivers by the construction of ice bridges. Before any freighting was begun, all proposed trails were scouted from the air and then staked by Weasel parties.

Typical composition of each of the two tractor trains used in this heavy-duty freighting program was:

One Weasel (Train Foreman), equipped with plywood cab and gyro compass.
One D-8 tractor, equipped with Balderson cable-operated snow plow and Hyster towing winch.
Four "Bald Faced" D-8 tractors equipped with Hyster towing winches.
One D-8 tractor equipped with Le Tourneau cable dozer and Hyster towing winch.
One 16' x 24' trail-type sleeper wanigan mounted on No. 9 Michler freighting sled, containing 50-watt radio transmitter and receiver.
One 8' x 12' trail-type shop, mounted on Michler Go-devil, containing Hobart 300-amp. gasoline-engine welder; Witte 8-kw. 110/220-volt, 3, 60-cycle, diesel-electric generator set; Herman-Nelson heater; 2-h. p. electric centrifugal train fuel pump; miscellaneous tools, spare parts, and equipment.
One fuel tanker (4 T-6 Pontoons mounted on Michler No. 9 sled).
One 8' x 12' Michler Go-devil.
Thirteen Michler No. 9, 8' x 24' flat bed cargo sleds.
Two Michler No. 9, 8' x 36' cargo sleds.
One Michler No. 9, 8' x 24' box flat bed cargo sled.
One 18' x 36' trail drag.

Personnel make-up of a typical train crew was as follows: one foreman, six skinners, one mechanic, and one cook.

Two complete crews were carried with each train to allow operation 16 hours a day.

17. Construction

Extreme difficulties may be expected in all types of construction (foundations for structures, roads and airfields, etc.) throughout the Arctic Coastal Plain Province. The four primary geological conditions which result in these difficulties are:

(1) Shallow depth of seasonal thaw (thin active layer ½ to 4 feet) and the great thickness of the zone of permafrost (600 to 1,300 feet).

(2) General prevalence in the surficial mantle of fine-grained frost-susceptible materials with a high ice content.

(3) Absence of solid foundation sites (that is, general great depth to bedrock).

(4) Scarcity of sources of suitable coarse gravel and aggregate.

The intense permafrost conditions in the Arctic Coastal Plain require that only the passive method of construction, wherein sufficient permafrost is preserved to be used for maximum structural value, be employed. To this end great care must be taken during construction to insure that the thermal equilibrium is disturbed as little as possible. The tundra vegetation mat is particularly important as an insulation medium, and precautions must be exercised to insure that, during construction, the efficiency of this cover is not damaged irreparably by removal or excess compaction. In addition to destruction of the cover, changes in compaction of materials below the surface, disruption of local drainage, and the presence of heated structures or other artificial heat sources will adversely affect the thermal equilibrium; therefore adequate provisions for the rapid reestablishment of the preexisting or similar thermal regime must be made.

In many places near construction sites at Barrow, and in the neighborhood of the various oil wells, where repeated passes have been made by heavy tracked vehicles, the insulating vegetation mat has been broken and progressive degeneration of the subjacent permafrost has resulted. In the poorly drained permafrost areas standing water accumulates in these tracks and promotes accelerated melting and attendant slump and subsidence during the seasonal thaw period. Steep-sided water-filled ditches several feet deep and 6 to 7 feet wide are formed. Many such tracks initiated in 1945 and 1946 are still clearly visible from the air, and have become sufficiently enlarged to constitute an obstacle which seriously impedes access to certain localities by Weasel and other tracked vehicles. Once initiated, such thaw areas are self-enlarging and are very difficult to control; it is important that such thaw areas do not encroach on construction sites.

The great average thickness of surficial mantle throughout the Arctic Coastal Plain (60 to 200 feet) and the consequent depth to solid bedrock precludes the use of bedrock as a foundation medium in most localities.

Construction of the radar site at Barter Island serves as an excellent example of the methods that have been employed successfully in the Arctic Coastal Plain Province. During the winter when the ground was frozen, a gravel fill approximately 4½ feet thick was built across an undisturbed surface with great care being exercised to avoid disruption of the tundra vegetation mat. Coarse well-graded gravel was available from ice-shove deposits on an exposed spit on the northeast end of the island. Next, wooden pilings were driven through this gravel fill and firmly seated in the subjacent permafrost. Insulated buildings were then set on the pilings, with a free air space of approximately 6 feet between the floors of the buildings and the surface of the gravel fill. Great care was taken to discharge all waste and sewage lines through suspended, insulated utilidors at a sufficient distance from the installation to avoid the possibility of progressive thaw encroaching on the construction site. To date, except for minor heaving of a few of the pilings, which could be adjusted by the station personnel, this particular insulation has proved satisfactory.

18. Construction materials

The supply of coarse gravel and aggregate for construction purposes is very limited throughout the Arctic Coastal Plain Province. The average low gradient of rivers throughout the Arctic Coastal Plain results in deposition by these rivers of very fine-grained materials, which are generally unsuitable for construction purposes. Experience at Barrow indicates that sand and gravel deposits found on the Arctic beaches in general possess three characteristics which limit their usefulness as construction materials:

(1) They are extremely poorly graded which results in poor packing and consequent low bearing strength.

(2) They are highly rounded, which results in low bearing strength.

(3) They contain a high percentage of coal fragments and chert, both of which are considered deleterious ingredients for concrete aggregate.

Attempts to apply mechanical stabilization to the beach deposits at Barrow have to date proved unsuccessful.

The great average thickness of unconsolidated surficial mantle precludes the use of quarried bedrock as a source of crushed rock aggregate.

The primary source of construction gravel to date has been from deposits piled ashore by ice shove of the Arctic pack ice. Unfortunately these deposits are quickly removed by storm waves, and their occurrence is unpredictable.

19. Water supply

The extensive permafrost conditions throughout the Arctic Coastal Plain Province seriously limit the potential water supply of the entire area. To date all installations within the region have been forced to rely on surface water from deep lakes or from deep, ponded sections of major rivers.

In general, the bottom waters of lakes and of river sections greater than 8 feet deep and 2,000 feet wide remain unfrozen throughout the year and furnish a constant, though very small (about 1,500 gallons per day) supply. Since no winter recharge of such bodies can be expected, supply will be limited to the storage capacity of the natural reservoir.

The possibilities of finding potable ground water are poor. To date subpermafrost water encountered in drilled wells below the zero isotherm (about 1,000 feet) has been found to have a salinity of several thousand parts per million. A meager supply of ground water may be available in unfrozen pockets beneath some of the large lakes or beneath the flood plains of the major rivers. The winter recharge potential of these possible sources will be small.

The necessity of depending upon surface water supplies throughout the area, combined with the poor drainage and low annual temperature, which appreciably slow the natural reactions involved in water purification, create the necessity for extreme care in the location of waste disposal facilities to avoid contamination of natural water supplies.

Section II. ARCTIC FOOTHILLS PROVINCE
(consisting of Northern Foothills Section and Southern Foothills Section)

20. General

The Arctic Foothills Province forms a narrow elongate belt extending from Cape Lisburne on the Chukchi Sea to the Canadian border (see plate 1, Landforms and Physiographic Provinces Map). It is a transition zone between the level, flat-lying Arctic Coastal Plain Province to the north and the rugged, strongly dissected Brooks Range Province to the south. The Arctic Foothills are underlain by Mesozoic sandstones and shales, both of which are relatively weak. Throughout the provinces these rocks are folded into elongate, east-west, parallel anticlines and synclines which give the country a linear aspect similar to that of the Appalachian Mountains of the eastern United States. (See photographs 3 and 4.) In the Northern Foothills Section the folding is subdued, the beds lie nearly horizontal, and the resistant layers form steps on the hillsides or caps on the ridges. Hilltops average from 400 to 600 feet in elevation with slopes from 6 to 12 percent, and the surface is gently rolling. In the Southern Foothills Section the folding is more intense, with beds standing nearly vertical in places. Slopes are steeper (12 to 18 percent) and elevations range from 2,000 to 3,000 feet. The general characteristic of the belt is a gradual progression from north to south of increasing elevation, increasing slope angles, increasing dissection, and increasing stream gradients right up to the abrupt mountain front of the Brooks Range.

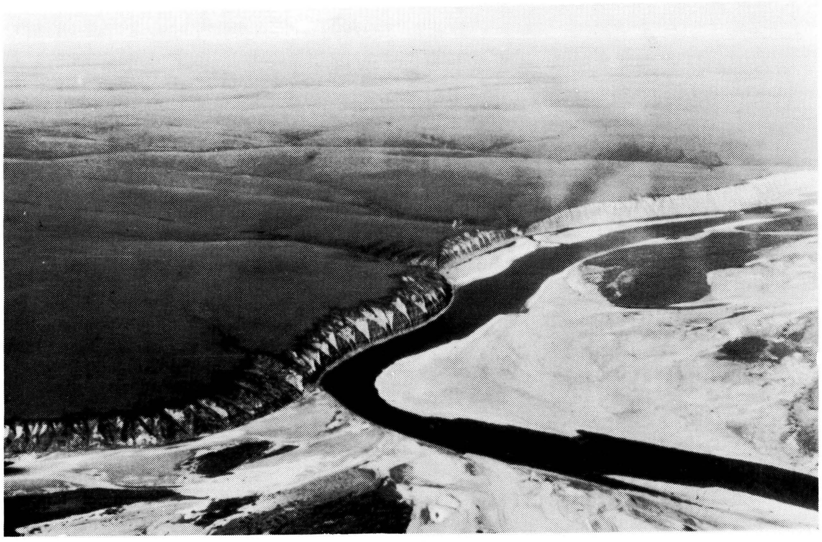
21. Geology

a. Bedrock geology (see plate 2, Bedrock Geology Map). The Northern Foothills Section is underlain primarily by Lower and Upper Cretaceous sandstones and shales of the Nanushuk and Colville groups which are gently folded to form relatively regular topography with persistent ridges, mesas, and hills, and with summits that approach accordance.

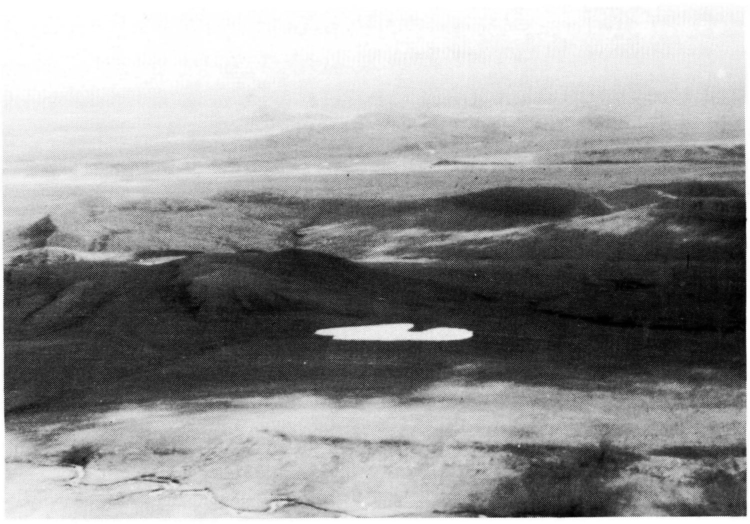
The Southern Foothills Section, on the other hand, is underlain primarily by Lower Cretaceous shales plus sandstones and conglomerates of early Mesozoic age and limestone of Paleozoic age. The differential resistance of these diverse rock types plus the more intense folding and structural complexity of the rocks account for the more rugged topography of the Southern Foothills where irregular isolated hills and ridges of sandstone, conglomerates, and limestone stand above low-lying shale areas of moderate relief.

b. Surficial geology (see plate 3, Surficial Deposits Map). The bedrock surface in the Northern Foothills Section and in portions of the Southern Foothills Section is mantled by a 2-foot to 20-foot section of eolian silt or loess. The loess is typically poorly graded, and contains a high percent of ice as interstitial crystals and as segregated masses. The loess has been removed along the courses of the major rivers by solifluction and normal stream erosion, and many of the rivers are incised in bedrock valleys across the structural ridges of the foothills belt. A complex of alluvial sands and gravels is being deposited along the modern flood plains.

In the more southerly portions of the Southern Foothills Section the loess mantle is absent. The upland bedrock surface is mantled by frost-shattered rubble, and glacial and glaciofluvial deposits of well-graded silt, sand, and gravel occur in the larger valleys.



Photograph 3. View north across the Northern Foothills Section of the Arctic Foothills Province toward the Arctic Coastal Plain Province. Flood plain of the Colville River near Umiat in the foreground. (U. S. Geological Survey, 1955.)



Photograph 4. View north across the Southern Foothills Section of the Arctic Foothills Province. Castle Mountain in foreground, Chandler River in the distance. (U. S. Geological Survey, 1955.)

Except along steep river cutbanks and on modern flood plains the ubiquitous thick tundra vegetation mat masks all but the most resistant ridge-forming outcrops throughout the province.

22. Cross-country movement

The same factors (absence of roads, difficulty of constructing them and low bearing strengths of the surface layer of the ground) which limit cross-country movement in the Arctic Coastal Plain Province apply with equal force throughout the Arctic Foorthills Province. Lakes are less numerous in the Arctic Foothills Province than in the Arctic Coastal Plain Province. Stream valleys, on the other hand, are more deeply incised, with the result that in general cross-country movement is more strongly channelized along interfluves in a north-south direction with tranverse routes somewhat restricted. This north-south topographic grain becomes progressively more strongly developed in the Southern Foothills Section. Near the Brooks Range mountain front traverse routes are almost totally restricted to the broad north-south interfluve areas.

As in the Arctic Coastal Plain Province, optimum conditions for cross-country movement in the Arctic Foothills Province occur from December to May, with summer operation limited to small tracked amphibious vehicles with low ground pressures.

The greater average relief and the more stringent requirements for the choice of suitable stream-crossing sites in the Arctic Foothills Province necessitate even more careful trail scouting and staking by location crews than are required in the Arctic Coastal Plain Province.

23. Construction

The geological conditions which impose serious restrictions on all types of construction in the Arctic Coastal Plain Province also pertain to the Arctic Foothills Province (refer to par. 17 & 18). The great thickness of permafrost and high ice content of the fine-grained surficial mantle necessitate the passive method of construction. In general, although bedrock outcrop areas are more numerous in the Foothills than in the Coastal Plain, the fact that their locale is either on steep hillsides or in narrow intrenched river valleys limits the utility of such areas as foundation sites.

24. Construction materials

The supply of coarse gravel aggregate for construction purposes is abundant and widespread within the modern floodplain deposits of the larger rivers. The airfield and camp area at Umiat are constructed on a gravel mat similar to that described for the radar site at Barter Island (refer to par. 17). Abundant supplies of coarse gravel are available from the flood plain of the Colville River near the installation.

25. Water supply

Permafrost conditions throughout the Arctic Foothills Province create water-supply problems similar to those encountered in the Arctic Coastal Plain Province. Since there are very few deep lakes in the Arctic

Foothills, as compared to the Arctic Coastal Plain, deep, ponded sections of the major rivers must be relied on for dependable year-round water supplies. To date all subpermafrost waters encountered in drilled wells throughout the province have been found to contain a salinity of several thousand parts per million, hence there is little promise of developing a supply of potable water from this source.

As in the Arctic Coastal Plain Province, extreme care must be taken to avoid contamination of natural water supplies by improper waste disposal procedures.

Section III. BROOKS RANGE PROVINCE

26. General

The Brooks Range Province extends from the headwaters of the Kukpuk and Kupowruk Rivers on the west to the Canadian border on the east (see plate 1, Landforms and Physiographic Provinces Map). It dominates northern Alaska, standing as a major divide that separates waters flowing southward into the Yukon and its tributaries or westward into Kotzebue Sound from those flowing northward into the Arctic Ocean. Although usually considered as a unit, the Brooks Range consists of many individual rugged mountain masses separated by steeply trenched or glacially widened valleys (see photograph 5). Compared with many mountain systems of comparable areal extent the Brooks Range is relatively low. The highest portions are found in the east, with maximum elevations of 9,000 feet. In the central portion average elevations are lower, with a maximum of about 8,000 feet. Average elevations are still lower at the western end with maximum in the neighborhood of 5,000 feet. Steep slopes greater than 24 percent characterize the mountains of the Brooks Range Province.

Erosion and glaciation of the major valleys across the Brooks Range have resulted in the development of a series of broad, low, open passes through the mountains. Eighteen passes with maximum elevations of 4,000 feet cross the range, and of these, 10 passes in the western portion of the range have maximum elevations of 3,000 feet or less. The utility of all of these passes as access routes to northern Alaska is limited by the rugged, steep-gradient canyons developed on the southern flanks of the mountains.

27. Geology

a. Bedrock geology (see plate 2, Bedrock Geology Map). The northern portion of the Brooks Range is formed of massive fault blocks of resistant sandstone, limestone and chert conglomerate. The regional trend of these blocks is easterly with a southerly dip component. The northern border of the mountain province corresponds generally with the Mesozoic-Paleozoic contact zone.

Resistant limestones and metamorphic rocks of early Paleozoic and possibly Precambrian age, also with an easterly trend, comprise the southern portion of the Brooks Range Province.

b. Surficial geology (see plate 3, Surficial Deposits Map). Distribution of surficial deposits in the Brooks Range Province is closely controlled by the slope angles throughout the various mountain morphologic units. Bare bedrock characterizes the steep cliff exposures of the upper peaks and axial portions of the range. Large blocky talus and fan accumulations characterize the transition slopes between the steep valley walls and the more gently sloping valley floors. The larger valleys are the loci of accumulations of a characteristic assemblage of glacial deposits. These include till and drift in the areas formerly covered by ice, and well-graded sand, silt, and gravel in the terrace remnants of former flood plains of glacial streams. In many of the larger valleys lacustrine sand, silt, and clay are being deposited in large moraine-dammed lakes. Except on active flood plains the tundra vegetation mat covers the valley floors and the gentler of the bordering transitional slopes up to an elevation of approximately 4,500 feet.

Photograph 5. View south across the Arctic Foothills Province towards the Brooks Range Province. (U. S. Geological Survey, 1955.)

28. Cross-country movement

South of the northern boundary of the Brooks Range Province all cross-country movement is rigidly confined to the major open valleys through the range. Within these valleys the same factors controlling cross-country movement in the Arctic Foothills and Coastal Plain Provinces apply. In many of the valleys large moraine-dammed lakes fill the valley floors from wall to wall, effectively blocking through traffic during the summer months except to amphibious vehicles.

Access to any portion of the Province outside of the major valleys is limited to highly trained and well-equipped mountain troops who can operate without mechanized logistical support.

29. Construction

In general construction problems are less extreme within the major valley systems of the Brooks Range Province than elsewhere throughout the Arctic Slope Region. The thick, permanently frozen surficial cover of frost-susceptible materials is generally absent or relatively thin within the mountainous area. Bedrock knolls or bosses which would serve as excellent foundation sites can be found along most portions of the major valleys. Beyond the limits of the valley systems the steep slopes create unfavorable conditions for all types of construction.

30. Construction materials

Poorly graded sand, gravel, and coarse rubble aggregate are abundant and widespread.

31. Water supply

Hot springs, which flow all winter, have been reported from the contact zone of the Lisburne limestone and the Sadlerochit sandstone at the eastern Brooks Range front along the Canning, Sadlerochit, Sagavanirktok, Shaviovik, and Okpilak Rivers. The Shublik springs on the Canning River are reported to have an estimated discharge of 1,000 gallons per minute and a summer temperature of 48 °F. Additional perennial springs may be present in comparable positions along the mountain front on other rivers heading in the Brooks Range. (See plate 1, Landforms and Physiographic Provinces Map.)

Aside from these springs the sole potential source for year-round water supply is the deeper portions of the large lakes in the major valley systems.

APPENDIX

I. BASE MAPS FOR THE AREA COVERED BY THIS EIS:

U. S. Air Force Pilotage Charts 62D, 63A, 63B, 64B, 64C, scale 1:500,000.

U. S. Geological Survey, Alaska Reconnaissance Topographic Series, scale 1:250,000.

II. AERIAL PHOTOGRAPHY USED IN PREPARATION OF THIS EIS:

U. S. Air Force Project 905A-3-342, 2-2011, and 7M112.

U. S. Geological Survey Photography Project TAL.

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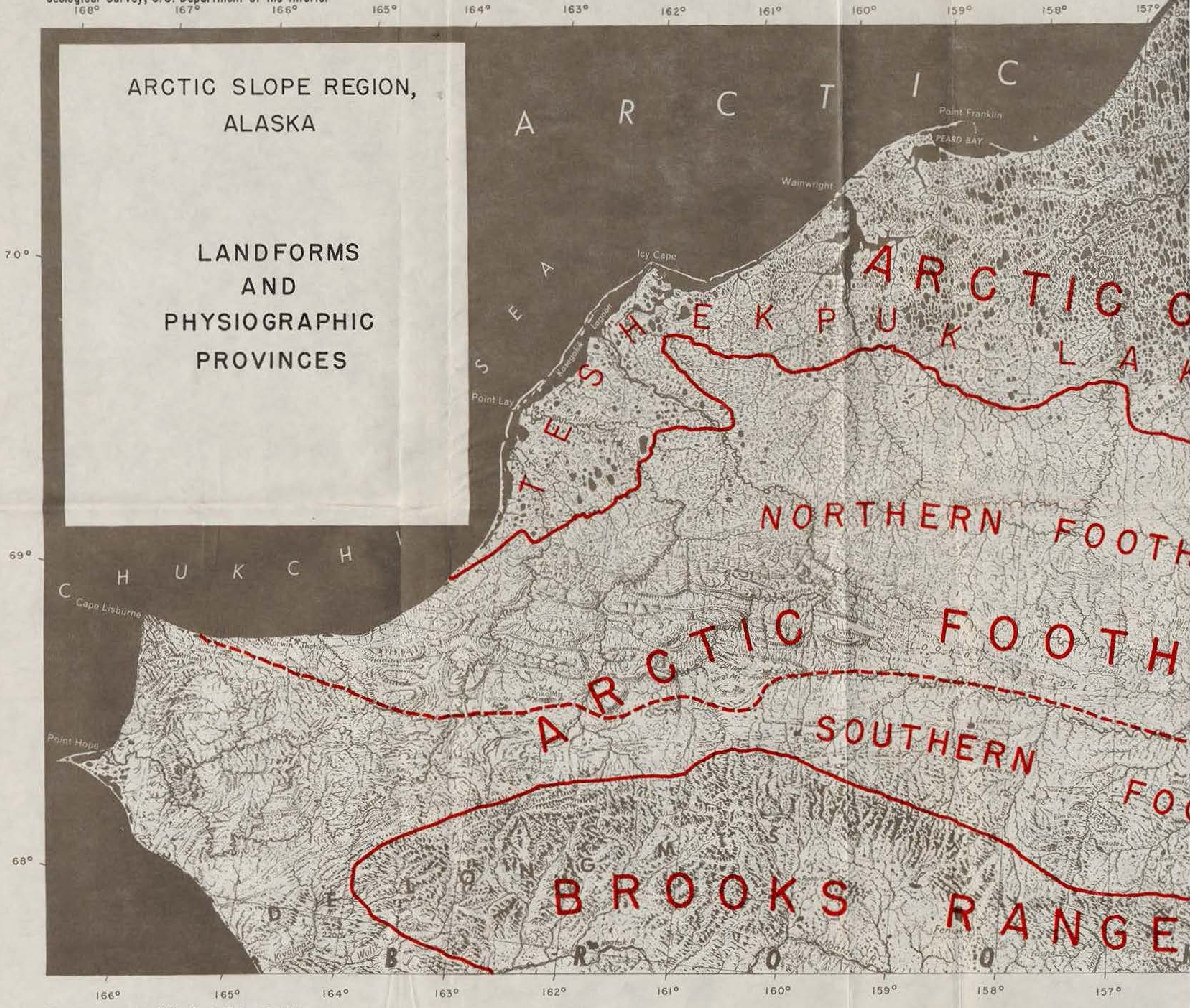
Map Pocket contains the Following:

Plate Number	
1	Landform and Physiographic Province
2	Bedrock Geologic Map
3	Surficial Deposit Map

Those files follow in this digital document as Plate 1a, Plate 1b, Plate 1c, Plate 2, and Plate 3.

Plate 1a

Prepared under the direction of the Chief of Engineers, Department of the Army, by Military Geology Branch, Geological Survey, U.S. Department of the Interior



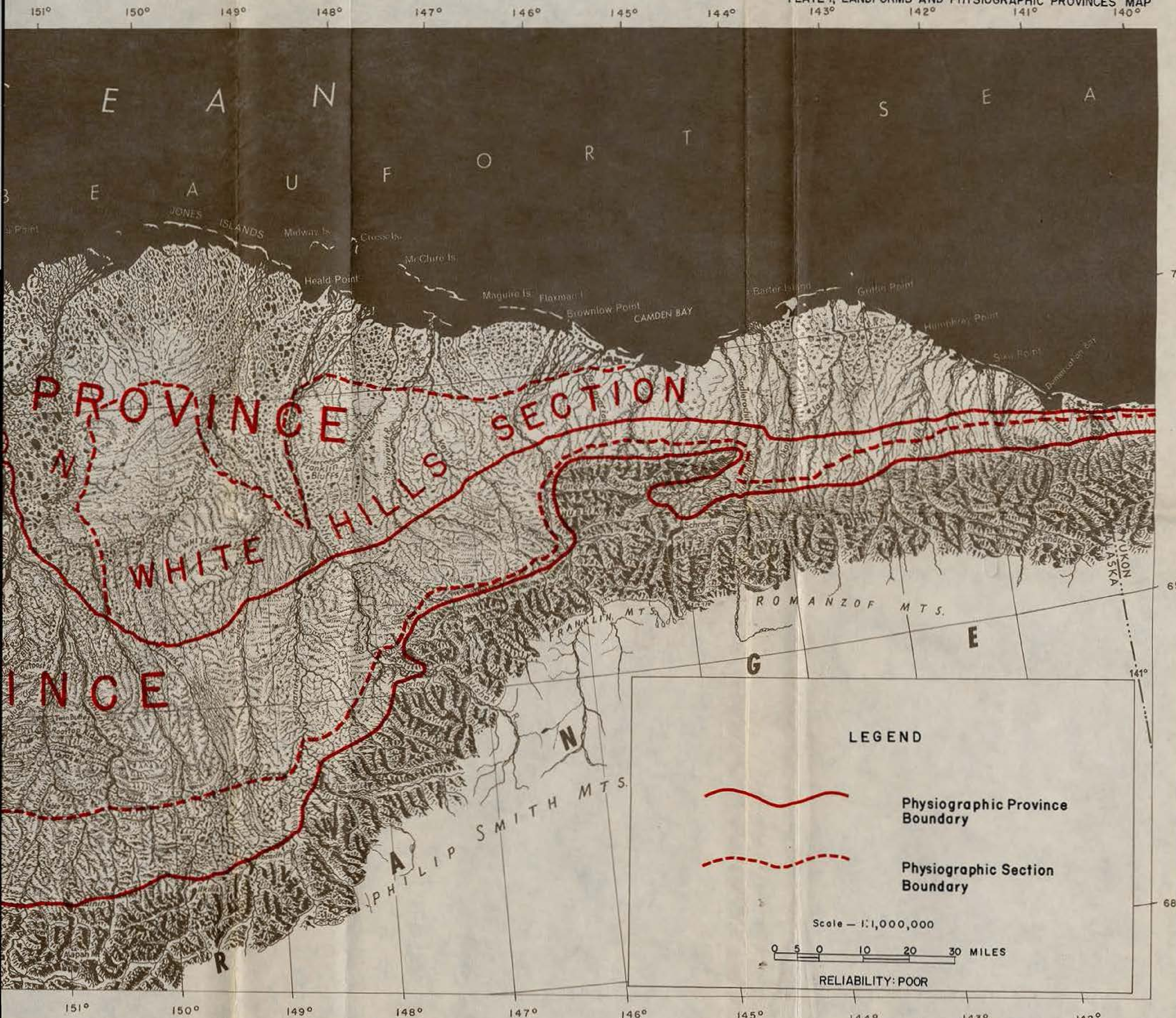
Base map: prepared by Erwin Raisz, Boston University, Physical Research Laboratories project.


ARCTIC OCEAN
BEAUFO
Point Barrow
Barrow
Point Franklin
PEARD BAY
Wainwright
Icy Cape
ADMIRALTY BAY
Cape Simpson
SMITH BAY
Cape Halkett
TESHEKPUK LAKE
JONES ISLANDS
Heald Point
ARCTIC COASTAL PLAIN PROVINCE
TESHEKPUK LAKE SECTION
WHITE HILLS SECTION
NORTHERN FOOTHILLS SECTION
ARCTIC FOOTHILLS PROVINCE
SOUTHERN FOOTHILLS SECTION
BROOKS RANGE PROVINCE
PHILIP SMITH
162° 161° 160° 159° 158° 157° 155° 154° 153° 152° 151° 150° 149° 148° 147°

Plate 1b

Plate 1c

EIS 191
Engineer Intelligence Study
TERRAIN ANALYSIS OF THE ARCTIC SLOPE REGION, ALASKA
PLATE I, LANDFORMS AND PHYSIOGRAPHIC PROVINCES MAP



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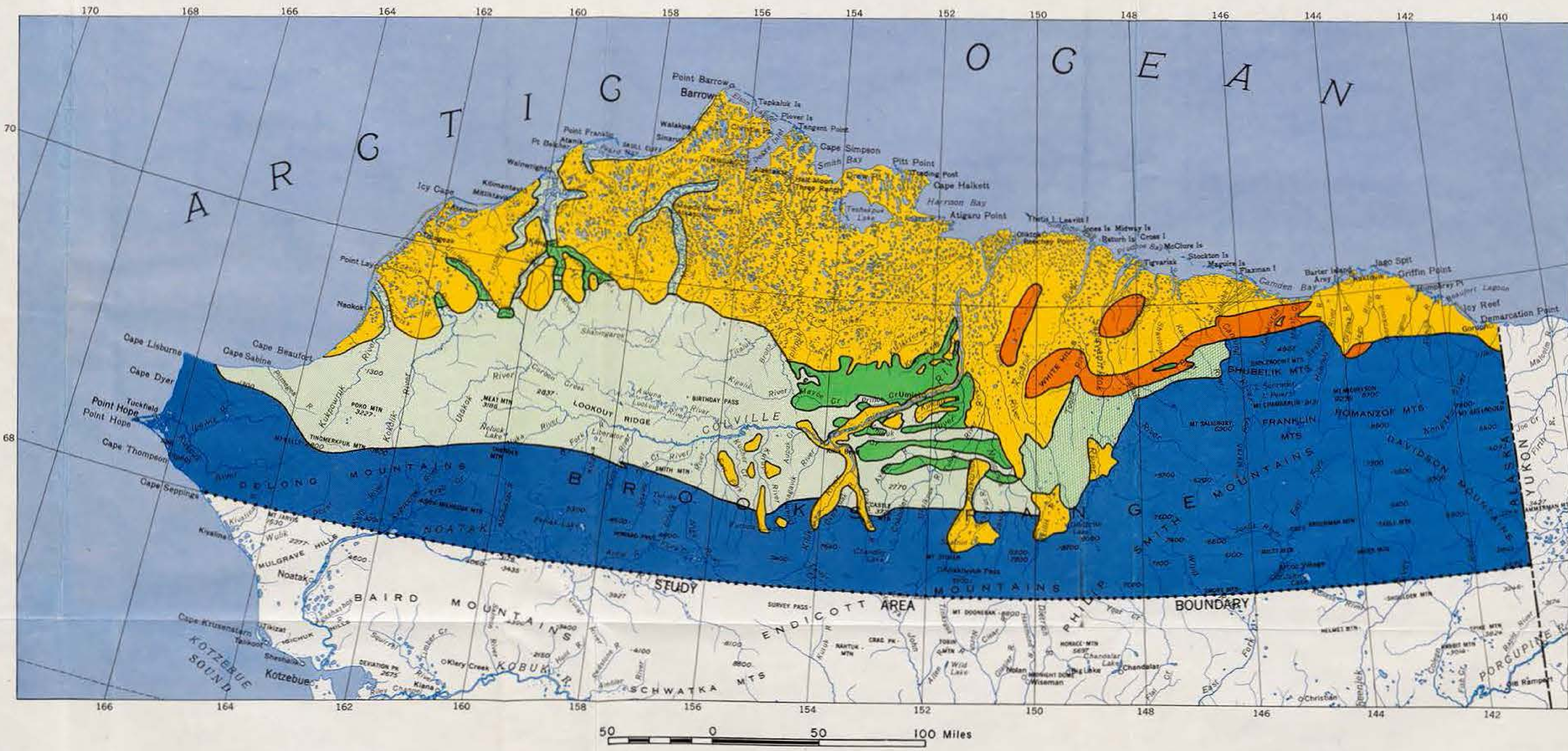
1958
(Data compiled 1955)



LEGEND

QUATERNARY	TERTIARY	UPPER CRETACEOUS	UNDIFFERENTIATED CRETACEOUS	LOWER CRETACEOUS	MESOZOIC & PALEOZOIC
Glacial deposits, river terrace and floodplain deposits; unconsolidated marine sand, silt, and gravel of the Gubik formation.	Nonmarine poorly consolidated conglomerate, sandstone, and siltstone of the Sagavanirkotok formation.	Light-colored marine sandstone with many bentonite and tuff beds of the Colville group and Ignek formation.	Combined rock types of units Lower and Upper Cretaceous	Dark-colored marine sandstone and mudstone of the Nanushuk group and Torok formation.	Structurally complex Brooks Range rocks; resistant limestone, sandstone, schist, and gneiss.

Reliability: Poor

Plate 2

Base map: Alaska Map E, scale 1:2,500,000
U.S. Geological Survey, 1954

ARCTIC SLOPE REGION, ALASKA
BEDROCK GEOLOGY

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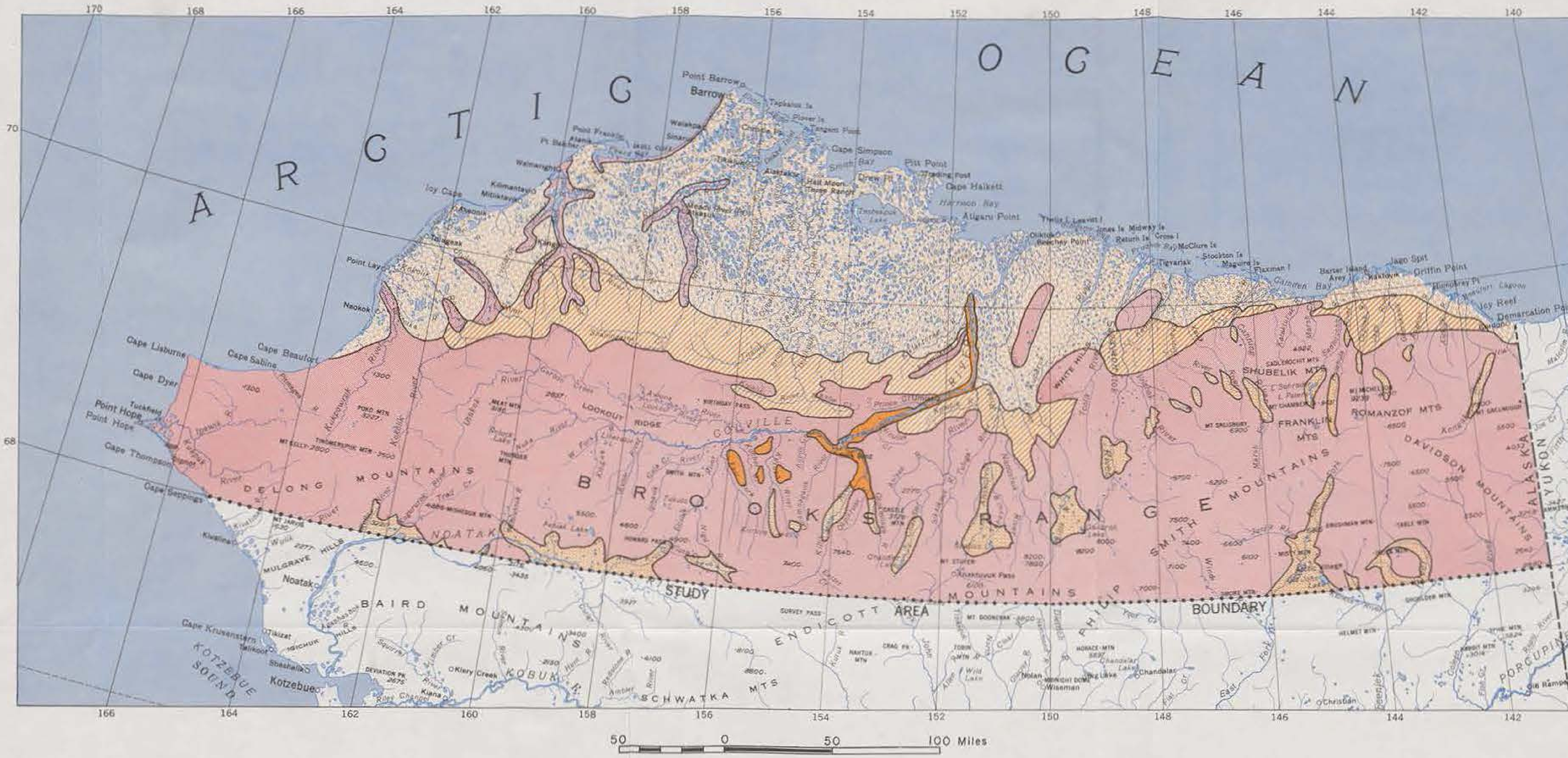
(Date compiled 1955)

Prepared under the direction of the Chief of Engineers, Department of the Army, by Military Geology Branch, Geological Survey, U. S. Department of the Interior

EIS 191
Engineer Intelligence Study
TERRAIN ANALYSIS OF THE ARCTIC SLOPE REGION, ALASKA
PLATE 3, SURFICIAL DEPOSITS MAP



ALLUVIAL DEPOSITS
Stratified gravel, sand and silt in floodplains and low terraces.

GLACIAL AND GLACIOFLUVIAL DEPOSITS
Till and drift deposited within glacial ice limits.

EOLIAN DEPOSITS
Silt covering upland surfaces and interfluves.

COASTAL PLAIN DEPOSITS
Unconsolidated, marine, gravel, sand and silt. (Gubik formation)

BEDROCK

Arctic Slope Region, Alaska

Surfical Deposits

Reliability: Poor

Plate 3

Base map: Alaska Map E, Scale1:2,500,000
US Geological Survey, 1954

1958
(Data Compiled 1955)