UNITED STATES DEPARTMENT OF THE INTERIOR

GEOLOGICAL SURVEY

THE STATUS OF MINERAL RESOURCE INFORMATION ON THE MAJOR LAND WITHDRAWALS OF THE ALASKA NATIVE CLAIMS SETTLEMENT ACT OF 1971

Compiled by Alaskan Geology Branch
June, 1972

An appraisal of existing mineral resource data including preliminary potential evaluations where warranted.

This report is preliminary and has not been edited or reviewed for conformity with U.S. Geological Survey standards and nomenclature.

Open-file report

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THE STATUS OF MINERAL RESOURCE INFORMATION ON THE MAJOR LAND WITHDRAWALS OF THE ALASKA NATIVE CLAIM SETTLEMENT ACT OF 1971

INTRODUCTION

This report is an analysis of the adequacy of the present level of geologic knowledge for making mineral resource potential evaluations of 126 federal land withdrawals made under the Alaska Native Claims Settlement Act. The withdrawals considered are Native village and regional deficiency areas (Sec. 11.A.3, ANCSA), classification and national interest study areas for possible inclusion in the four national systems (Sec. 17.d.2) and classification and public interest areas (Sec. 17.d.1). Neither prior withdrawals, utility corridors, state selections, open lands, or Indian Reserves are included. Native village withdrawals are also not included because they were the subject of an earlier report (Cobb, E. H., and Trollman, W. T., 1971).

The present report consists of two sections. The introduction explains the method of preparation and presents a summary table and some general remarks on the mineral potential of Alaska. The second part, the discussion of withdrawals, contains listings of the investigations that have been made and analyses of their adequacy in view of what needs to be known about the withdrawals.

The withdrawal-by-withdrawal analysis of geologic information levels was prepared during the last weeks of May by the Alaskan Mineral Resources Branch of the U.S. Geological Survey. In this analysis, Alaska, except the southeastern part where there are no withdrawals of the types considered, is subdivided into 14 numbered subregions (fig. 1) which are outlined on a 1:2,500,000-scale cadastral map (U.S. Department of the Interior, 1972). Since each withdrawal within a subregion is designated by a letter, any withdrawal is uniquely specified by the combination of the subregion number and withdrawal letter: 12-A, for example. The subregions and withdrawals are shown on figure 1.

Each withdrawal in each of the 14 subregions is described and analyzed by a geologist having many years of field experience in the area. The uniform format used includes (1) location, (2) present knowledge, and (3) adequacy. Under the heading "present knowledge" are the major studies of the geology and mineral resources in or near the withdrawal area. Under the heading "adequacy" is an analysis weighing what is presently known of the geology and mineral resources against what should be known in order to prepare a qualitative evaluation of the mineral resource potential of the withdrawal.

A tabular summary of the analysis of the 126 withdrawals is contained in table 1. Listed for each withdrawal are its classification, area, and some expression of its potential for metal, petroleum, or coal resources.

A major outcome of the withdrawal-by-withdrawal analysis is the realization that in most cases the geologic information level is too low to determine the resource potential of specific areas. This is in sharpest focus in large 17.d.2 withdrawals in the Central and Western Brooks Range (withdrawals 1-I, 2-B_1, and 2-B_2), in the Central and Southern Alaska Range (withdrawals 9-B, 9-I, and 12-N), and in the Chugach-Wrangell Mountains (withdrawals 11-E and 14-B_2). Metal production has occurred in some of these withdrawals and numerous occurrences of mineralization are known in all of them. But in all of the areas, the present level of geologic mapping and geochemical sampling is inadequate to completely define the parcels that could be mineral exploration targets in years to come.

The general dimensions of possible resource potentials in these areas are probably best illustrated within and along the length of the Alaska Range. Recent work on the eastern portion shows the presence of a major porphyry copper belt similar to the known and producing porphyry copper belts of the Canadian Cordillera and the southwestern United States. A conservative estimate of the resource potential of the eastern Alaska Range is 4 to 10 billion dollars. Work in the central and southern Alaska Range also shows enormous potential for porphyry-copper-type mineralization, massive replacement and fissure-filling lead-silver veins, and gold deposits. A conservative estimate of the resource potential of this area is 8 to 14 billion dollars.

Adequate base data to guide land-use decisions do not exist for Alaska. To date there is no complete geologic map of the state and only about half of Alaska has been mapped at the reconnaissance scale of 1:250,000. Less than 2 percent of the land has been examined by geochemical sampling programs that would identify a major ore body and there has been virtually no exploration for the more unusual types of deposits such as stratabound copper-lead-zinc, Topaz Mountain-type beryllium or Carlin-type gold deposits.

Alaska probably has a metal resource potential in excess of 100 billion dollars, but as the analyses in the pages that follow clearly show, where this potential lies is not known with high precision.

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SUBREGION 1 (NORTHWESTERN ALASKA)

Subregion 1 consists of the western parts of the northern Alaska petroleum province (Brosgé and Tailleur, 1971) and the Brooks Range mountain system. From north to south it is subdivided into the arctic coastal plain, the northern and southern sections of the arctic foothills and the De Long, Endicott, Baird, and Schwatka sections of the arctic mountains (Wahrhaftig, 1965, pl. 1). The total area is approximately 55 thousand square miles, 23 thousand of which is in Naval Petroleum Reserve No. 4, 6,800 in 11.A.3 lands, and 17,000 in 17.d.2 lands.

The geologic elements of northwestern Alaska are a structural basin filled with an older and a younger series of sedimentary rocks and a companion arch of complexly deformed sedimentary and subordinate igneous rocks. From Silurian through Jurassic time, sediments were laid down in a broad sea adjoining a land mass on the north. An arch formed in the southern part of the basin by the intrusion of igneous rocks during the Jurassic and by uplift during the Cretaceous. Through large-scale dislocation, folding and metamorphism, the arch eventually evolved into the mountains and foothills of the Brooks Range. Deposition of debris from the growing mountains buried the earlier series of sedimentary rocks and progressively shifted the shoreline northward nearly to the edge of the continent (Brosgé and Tailleur, 1970; Tailleur and Brosgé, 1970).

Resources in subregion 1 are known and prospective fossil fuels in the basin and potential mineral deposits in the mountains. Extensive coal fields occur near the surface of the coastal plain and are exposed in the northern foothills. Prospects are good for oil or gas accumulations in the rocks associated with the coal as well as in some of the older deeply buried strata. The mineral resource potential of the mountains is unknown, although a few occurrences of metallic minerals have been found. The geologic setting, especially in the Baird and Schwatka Mountains, is similar to some mineralized areas elsewhere in North America. The mineral resource potential may be especially difficult to evaluate because the surficial effects of permafrost tend to complicate the interpretation of data obtained through geochemical sampling.

Withdrawal 1-A (11.A.3)

Location--Withdrawal 1-A (11.A.3) consists of approximately 216 square miles adjoining NPR-4 on the coastal plain east of Point Lay.

Present knowledge--A 1:125,000-scale geologic map (Chapman and Sable, 1960), prepared from traverses of the two rivers that cross the area and by photo-interpretation, shows the area completely covered by unconsolidated deposits. A dry, shallow test well is located about 40 miles to the east. Proprietary geophysical surveys reportedly cross the area.

Adequacy--Projection of known geology into the area suggests broad synclines of coal-bearing sandstone near the surface and south-dipping potential hydrocarbon reservoir beds at depths of 2 or more miles. Substantial amounts of coal are indicated by the nearly 350 feet aggregate thickness of subbituminous coal in the upper 3,000 feet of the test well, but the amount and quality of the coal has not been determined by systematic drilling. Geophysical studies, particularly seismic surveys, will be required for adequate evaluation of the petroleum potential of the withdrawal.

Withdrawal 1-B (11.A.3)

Location--Withdrawal 1-B (11.A.3) consists of approximately 5,904 square miles in the coastal plain and the northern and southern foothills of the Brooks Range. It is bounded by the Lisburne Hills, the seacoast, NPR-4 and the western De Long Mountains.

Present knowledge--The coastal plain and northern foothills (north of 68°45'N. latitude) have been mapped at a scale of 1:125,000 (Chapman and Sable, 1960) and the southern foothills have been mapped at 1:63,360 or larger scales (Sable, Dutro, and Tailleur, unpublished). Proprietary geophysical surveys reportedly cover much of the coastal plain and northern foothills and extend into the southern foothills.

Adequacy--Cutbanks on the rivers in the coastal plain expose gently folded coal-bearing rocks. Cutbanks and hills in the northern foothills expose the thick, coal-bearing sandstones of the Corwin Formation and marine sandstones of the underlying Kukpowruk Formation. The strata are folded into long, broad synclines separated by narrow, relatively sharp-crested anticlines. The folds do not persist to great depths. The coal-bearing beds have been eroded from the structural highs and are preserved in the generally shallow-dipping troughs of the synclines. Beds believed prospective for petroleum are inclined southward at depths of 2 to as much as 5 miles. Their structure near the southern edge of the northern foothills is complicated by faulting and poorly known at present.

The southern foothills consist of complexly folded sedimentary rocks that contain thin, discontinuous layers of oil shale.

Although bituminous coal reserves of 6,400 million tons have been estimated from scant data from the coastal plain and northern foothills, detailed information is available for only a few localities. Total strippable coal resources of nearly 20 million tons (Callahan and others, 1969) underlie about 9 square miles of a syncline where it crosses the Kukpowruk

River (T. 1 S., R. 44 W.). Approximately 8 square miles in another syncline south of Cape Beaufort (T. 6 S., R. 51 W.) contain 5 million tons of strippable coal and 245 million tons of minable coal (Callahan, 1971). Coking qualities have been noted in core samples from a 20-foot bed of bituminous coal in the Kukpowruk River section and from the coal east of Cape Beaufort (Warfield and others, 1966; Warfield and Boley, 1969).

In the northern foothills, adequate preliminary estimates of coal resources can be based on the mapped extent of the Corwin Formation. In the coastal plain, however, seismic profiles will be required to interpret the extent of the coal horizons. Petroleum and gas prospects in the withdrawal cannot be adequately evaluated without deep drilling in the foothills and seismic surveys in the coastal plain.

Withdrawal 1-C (11.A.3)

Location--Withdrawal 1-C (11.A.3) consists of about 576 square miles in the central Lisburne Hills east of Point Hope.

Present knowledge--The area has been mapped at 1:63,360 and larger scales (Tailleur, unpublished) by means of river, seacliff and foot traverses supplemented by helicopter reconnaissance and photointerpretation.

Adequacy--The Lisburne Hills are composed largely of broad sheets of Paleozoic carbonate and subordinate clastic rocks that have been thrust over one another and later folded. The thrust complex is bordered on the west by deformed, presumably older clastic rocks and on the east by deformed younger clastic rocks.

The known potential resources of withdrawal 1-C are beds of low-volatile bituminous coal in a clastic unit along the west flank of the Hills and vast amounts of limestone at and near tidewater. Thirteen coal seams more than 2 1/2 feet thick aggregate about 70 feet in thickness in a section measured in cliffs near the middle of the west coast (Tailleur, 1965). The enclosing beds are locally so strongly deformed that detailed prospecting will be needed to determine the extent and amount of coal. The existing maps, however, adequately show the regional distribution of the rock unit that contains the coal.

Withdrawal 1-D (11.A.3)

Location--Withdrawal 1-D (11.A.3) consists of approximately 180 square miles of vegetation-covered uplands on the mainland north of the village of Kotzebue.

Present knowledge--The area is covered by a generalized geologic map at a scale of 1:250,000 (Barnes and Tailleur, 1970). Proprietary and unpublished reconnaissance aeromagnetic profiles cross the area and a gravity traverse has been completed along the Noatak River.

Adequacy--Most of the withdrawal area is covered by vegetation. Rocks in the bordering Igichuk Hills are Paleozoic carbonates believed to be allochthonous. South of the Hills are small outcrops of metamorphic and mafic igneous rocks.

No occurrences of mineralization are known in the withdrawal. Numerous occurrences of copper have been found in the same rocks to the northeast and a mineral prospect has been reported near the northeast corner of the withdrawal. Present data from the withdrawal block are not adequate for a preliminary mineral resource potential evaluation.

Withdrawal 1-E (17.d.1)

Location--Withdrawal 1-E consists of approximately 90 square miles adjoining Cape Seppings on the southwest coast.

Present knowledge--All of the area except the hills in the southeast corner has been geologically mapped (Tailleur, unpublished). The hills in the southeast corner are known only from scattered helicopter landings.

Adequacy--The withdrawal is underlain by strongly deformed younger sedimentary rocks comparable to those mapped in detail to the northwest (Campbell, 1967). The hills in the southeast corner of the withdrawal appear to be composed of deformed, perhaps allochthonous older sedimentary rocks.

Most of the area is adequately mapped. No mineral occurrences are known in the withdrawal and the regional geology suggests a low resource potential.

Withdrawal 1-F (17.d.2)

Location--Withdrawal 1-F consists of approximately 99 square miles on the northwest coast south of Point Lay. The area is mostly coastal plain but the southeast corner extends into the uplands of the northern foothills.

Present knowledge--The area has been mapped photogeologically at a scale of 1:125,000 (Chapman and Sable, 1960).

Adequacy--By interpretation and projection, the northern part of the area is underlain by the northwestward extension of the Kasegaluk syncline and the southern part by the parallel extension of the Archimedes Ridge anticline. At least 13 square miles in the northern part of the withdrawal are underlain by the coal-bearing Corwin Formation and coal beds are exposed where the Kukpowruk River cuts across the Kasegaluk syncline (Chapman and Sable, 1960, p. 158). Like the adjoining areas, withdrawal 1-F appears to have substantial potential for coal and probably for hydrocarbon resources.

Withdrawal 1-G (17.d.2)

Location--Withdrawal 1-G (17.d.2) consists of approximately 144 square miles inland of Cape Lisburne and includes the north end of the Lisburne Hills.

Present knowledge--The area has been mapped at 1:63,360 and larger scales (Tailleur, unpublished).

Adequacy--The northern Lisburne Hills are composed largely of Paleozoic carbonate and subordinate clastic rocks deformed into asymmetric, faulted folds. Bordering on the east are deformed younger, mainly clastic, rocks. The existing data are adequate to show that the withdrawal has low potential for mineral resources.

Withdrawal 1-H (17.d.2)

Location--Withdrawal 1-H (17.d.2) consists of approximately 126 square miles adjoining and inland from the A.E.C. project Chariot site at the south end of the Lisburne Hills.

Present knowledge--The area has been geologically mapped at a scale of 1:63,360 (Campbell, 1967).

Adequacy--The southern Lisburne Hills are underlain largely by sheets of Paleozoic carbonate rocks thrust over one another and then folded. They are bordered on the west by deformed, presumably older, clastic rocks and on the east by a broad tract of deformed younger clastic rocks. The data are adequate to show that the mineral resource potential is low.

Withdrawal 1-I (17.d.2)

Location--Most of the central and western parts of the Brooks Range are included in a single withdrawal, the largest made under the Settlement Act. This large withdrawal is arbitrarily subdivided in this analysis: the portion west of 156° is termed withdrawal 1-I and is discussed in the following paragraphs; the portions east of 156° are termed withdrawals 2-B_1 and 2-B_2 and are discussed in a later section of this report.

Withdrawal 1-I consists of about 16,500 square miles and includes much of the drainage of the Noatak River and large parts of the De Long, Endicott, Baird and Schwatka Mountains.

Present knowledge--Reconnaissance by helicopter and scattered foot and river traverses have provided an understanding of the gross geologic framework for the region (Tailleur and others, 1967; Brosgé and others, 1967). Geochemical sampling in the withdrawal comprises fewer than 100 samples (Brosgé and others, 1967). Reconnaissance gravity studies have been made along the Noatak and Kobuk Rivers and adequate reconnaissance aeromagnetic data are available for about 20 percent of the area.

Adequacy--The general geologic setting, scattered metallic mineral occurrences and several geochemical anomalies suggest that the withdrawal may have moderate to high resource potential. Additional studies, however, will be necessary for an adequate evaluation of the area.

The Baird and Schwatka Mountains appear to have the best metallic resource potential (Clark and others, 1972) because they are underlain by strongly deformed, altered sedimentary rocks intruded by small granitic masses. The De Long and Endicott Mountains appear to have lower potential for metallic minerals. The De Long Mountains are underlain by a series of folded and faulted thrust sheets consisting mainly of sedimentary rocks. In the southern De Long Mountains, however, the uppermost thrust sheet contains layered ultramafic rocks. Layers of chromite occur in the ultramafic body at Avan Mountain and one intrusive has been prospected for platinum. Mafic and ultramafic rocks at the west end of the Baird Mountains (Barnes and Tailleur, 1970) are the southern equivalents of the rocks in the De Long Mountains. The southern Endicott Mountains are composed of folded and faulted clastic rocks of Paleozoic age. Copper mineralization occurs in weakly metamorphosed phases of these rocks along the Noatak River (T. 31 N., R. 3 W.), and a remote prospect north of the upper Noatak has attracted intermittent attention since World War II.

Occurrences of mineralized rock are known in the withdrawal and reconnaissance sampling has discovered several geochemical anomalies (Brosgé and others, 1967). Placer gold has been produced sporadically from Klery Creek (T. 21 N., R. 8 W.) and a copper prospect (T. 24 N., R. 10 W.) has been drilled. Large, well explored copper deposits are just east of the withdrawal (Heiner and others, 1968), and potential copper resources may occur in the southern part of the withdrawal because the belt of mineralized marble and pelitic schist that forms the southern margin of the Brooks Range trends westward through the area (Clark and others, 1972).

Although the geologic setting of the area appears generally favorable for the occurrence of metallic mineral deposits, the existing data are inadequate to identify the areas in which significant mineral deposits might be found.

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SUBREGION 2 (CENTRAL NORTHERN ALASKA)

Subregion 2 (fig. 1) extends across the metamorphic, granitic and upper Paleozoic sedimentary rocks exposed in the Brooks Range geanticline, and across the Mesozoic and Tertiary sedimentary rocks of the Colville geosyncline exposed in the Arctic foothills and Coastal Plain. Beneath the Mesozoic rocks of the Arctic coast is the Arctic Platform, a buried uplift of Paleozoic sedimentary rocks which is the site of large oil accumulations.

Petroleum is the major resource; it occurs within the Colville geosyncline, and at least 20 billion barrels (Alaska Scouting Service, 1970) occur in giant fields on the Arctic Platform. Coal resources inferred to be 2.5 billion tons at depths of less than 1,000 feet occur in the Cretaceous rocks of the foothills and Coastal Plain, and coal probably also occurs in the Tertiary rocks. Phosphate occurs in the Mississippian rocks at the front of the Brooks Range. Gold, antimony, and probably copper and silver, occur in the metamorphic rocks of the southern Brooks Range.

Withdrawal 2-A (11.A.3)

Location--The area consists of approximately 7,200 square miles in the Chandler-Toolik Rivers region.

Present knowledge--The northeastern third of the area (2,300 square miles) is underlain by poorly exposed Upper Cretaceous and Tertiary rocks, and has been geologically mapped at a scale of 1:1,000,000 (Lathram, 1965). The rest of the area has been mapped at 1:125,000 scale (Detterman and others, 1963; Patton and Tailleur, 1964) except for about 300 square miles in the Brooks Range in the southwest corner of the withdrawal. In this area the mapping is mostly air photo interpretation at a scale of 1:96,000 (Brosgé and others, 1960.

Seismic traverses by the U.S. Navy cross the area from east to west and north to south (Woolson and others, 1962). Exploratory wells by the U.S. Navy and oil companies give valuable stratigraphic data (Robinson, 1958a, b).

The Mississippian phosphate beds at two localities have been sampled for chemical analyses (Patton and Matzko, 1959). No other systematic geochemical sampling has been done.

Adequacy--The known resources in withdrawal block 2-A are gas, oil, coal, phosphate rock and oil shale. The existing observations show that there are probably no metallic mineral resources in the area.

The withdrawal includes the Gubik gas field (reserves - 300 billion cubic feet) in Upper Cretaceous rocks, the East Umiat gas well in Upper or Lower Cretaceous rocks, and probably the edge of the Umiat oil field (reserves - 70 million barrels) in Lower Cretaceous rocks. Despite several dry holes, the northeastern part of the area may contain additional small fields in shallow Cretaceous rocks. The northeastern part of the area may also include the Carboniferous and Triassic reservoir rocks in the southern margin of the Arctic Platform at depths of about 20,000 feet.

The surface geological mapping in this area is inadequate to define closed shallow structures, and seismic mapping would be required to determine the presence and depth of the possible deeper traps in the Carboniferous and Triassic. Elsewhere in the northern foothills the existing geological mapping is adequate to define favorable structures and facies trends in the Cretaceous rocks. It is possible that structures like those of the

Alberta foothills underlie the southern foothills near the Brooks Range and that the Permian clastic rocks of the Nuka Formation may be present to serve as a reservoir.

Coal resources of about 1.5 billion tons at depths of less than 1,000 feet have been inferred from data at 11 localities in Lower and Upper Cretaceous rocks in the mapped portion of the northern foothills (Barnes, 1967). The coal data there can be considered adequate but could be improved by detailed mapping and drilling. Data on Cretaceous and Tertiary coal in the unmapped foothills and Coastal Plain in the northeast are inadequate.

Phosphate rock occurs in the Brooks Range and in the adjacent foothills in the southwest corner of the area. Detailed analyses show 9 feet of beds with P_2O_5 content more than 18 percent in a section at the west edge of the withdrawal area, and about 4 1/2 feet of these beds in a section 25 miles to the east. The phosphatic member is present over about 30 square miles in the withdrawal area, but the photogeologic mapping and the sampling is inadequate for reserve estimates.

Small lenses or boudins of oil shale occur in Jurassic shale and chert close to the Brooks Range but the occurrences are probably too small to be considered resources either for oil or for the associated disseminated metals.

Withdrawal 2-B$_1$ (17.d.2)

Location--To facilitate discussion, withdrawal 2-B, which is continuous with withdrawal 1-I, is subdivided into a northern and southern part (fig. 1). Withdrawal 2-B$_1$, the northern part, consists of about 8,200 square miles in the Kurupa-Okokmilaga Rivers area and upper Nanushuk River area.

Present knowledge--The entire area has been mapped at scales of 1:250,000 or larger, partly by photogeologic methods.

All of the area west of withdrawal 2-A and north of latitude 68° N. has been mapped at 1:125,000 or 1:96,000 scale (Brosgé and others, 1960; Detterman and others, 1963; Chapman and others, 1964; Patton and Tailleur, 1964). The northwest quarter of the area east of withdrawal 2-A has been mapped at 1:125,000 (Patton and Tailleur, 1964) in the foothills, and at 1:63,360 (Bowsher and Dutro, 1957) in the Brooks Range. The part of the area in the Brooks Range south of latitude 68° N. has been mapped at 1:250,000 scale. Neither coal mapping nor geochemical sampling has been done.

Adequacy--The potential mineral resources are oil and gas, coal, and phosphate.

The northeast corner of the area is on the flank of the Umiat oil field (reserves - 70 million barrels) in Lower Cretaceous rocks, and about 20 miles west of the Gubik gas field (reserves - 300 billion cubic feet) in Upper Cretaceous rocks. The north-central part includes the Aupuk gas seep. The geologic mapping is adequate to show that petroleum potential in the Cretaceous rocks is small except in the northern 800 square miles of the withdrawal area. Elsewhere, because of regional north dip and east plunge, the Upper Cretaceous rocks are absent and the Lower Cretaceous productive horizon is breached on most of the structures. In addition, the Lower Cretaceous reservoir facies (Grandstand Formation) is absent except in the northeast. One dry hole has been drilled by an oil company in this area.

The geologic mapping of the lowest Cretaceous to Mississippian sedimentary and Jurassic(?) mafic rocks exposed in the southern foothills is inadequate to determine the probability of favorable structures and reservoir rocks in folded thrust sheets in front of the Brooks Range.

Coal resources of about 1 billion tons at depths of less than 1,000 feet have been inferred from data at 26 localities in the Lower Cretaceous rocks in the northern third of the area (Barnes, 1967). These coal data can be considered adequate for preliminary analysis.

Phosphatic rocks are present across at least the eastern half of the area. Although the photogeologic mapping and sampling are not adequate for resource estimates, the few data suggest that the strata contain only low concentrations of P_2O_5.

Most of the mapping of the Devonian clastic rocks that form the Brooks Range divide has been by photogeologic methods. Although these rocks probably have no mineral potential, their geologic history bears on the petroleum potential in the upper Paleozoic-lower Mesozoic rocks beneath the foothills. The existing mapping is inadequate for this purpose.

The existing field observations, although not supported by geochemical sampling, are adequate to show that there probably are no metallic mineral resources in the area.

Withdrawal 2-B_2 (17.d.2)

Location--Withdrawal 2-B_2 is the southern part of withdrawal 2-B and consists of about 8,100 square miles in the south-central Brooks Range.

Present knowledge--The eastern three-fourths of the area in the Brooks Range has been mapped at 1:250,000 scale (Brosgé and Reiser, 1971) as has the dogleg in the Koyukuk Basin at the southwest corner of the withdrawal (Patton and Miller, 1966). In the western quarter, about 1,000 square miles along the Brooks Range divide has been mapped by photogeologic methods (unpublished). The remainder, in the area of granite and metamorphic rocks around the State selection, has been mapped by photogeologic methods at 1:250,000 scale, and has also been mapped at 1:63,360 scale by the Alaska Geological Survey (Fritts, unpublished).

A reconnaissance geochemical sample traverse crosses the east end of the area from north to south (Brosgé and Reiser, 1972). In the west, samples have been collected around mineralized rhyolite in the southwestern dogleg into the Koyukuk Basin (Miller, 1969), and the area in the Brooks Range has been mapped by the State in 1971 and sampled in detail (Fritts, unpublished).

Adequacy--The available mapping, including the photogeology, is adequate to show that most of the area has high mineral potential, but is not generally adequate to show whether or not mineral resources really exist.

The southern half of the area in the Brooks Range is mostly schist, phyllite, quartzite, and Devonian marble intruded by two large granite plutons in the western part of the area, by a small pluton at the center of the area, and probably by a pluton at depth just east of the area. Stibnite and gold occur in the schist and phyllite just east of the area, where more than 200,000 ounces of placer gold were mined at Wiseman. A belt of small gold placers extends west from Wiseman but lies mostly outside the withdrawal. Just west of the withdrawal, in the reentrant of State lands, a large group of claims held by Bear Creek Mining Co. is evidence of additional mineralization in the schist. In addition, the Devonian marble, which contains many small copper shows and is mineralized near a pluton 25 miles east of the withdrawal, is correlative with the reefs that host a major copper deposit 25 miles west of the withdrawal. However, except in the area mapped by the State, the geochemical sampling is inadequate to show whether mineralization occurs in the metamorphic rocks in the withdrawal.

Mineralization in other rocks in the withdrawal is indicated by copper, lead, zinc and gold in pyritized rhyolite dikes in the southwest corner of the area, by tin anomalies in the granite in the western part of the area, and by very large zinc anomalies in lower Paleozoic slate in the northeastern part of the area.

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SUBREGION 3 (NORTHEASTERN ALASKA)

Subregion 3 extends across the Arctic Coastal Plain (underlain by the Arctic Platform and Colville Basin) then across the Brooks Range geanticline to the Yukon Flats. Within this area three distinct fault-separated stratigraphic sequences are exposed.

The most extensive is comprised of low-grade metamorphosed Precambrian sediments, exposed in the core of the geanticline, flanked on the north and south by Paleozoic sediments and on the north by Mesozoic and Cenozoic sediments that filled Colville Basin. Both Paleozoic and Mesozoic granites intrude the sequence. A second sequence, possibly allochthonous, crops out on the Porcupine Plateau. It consists of thin Paleozoic and Mesozoic sediments and an extensive mafic igneous complex. A third sequence cropping out south of the Porcupine-Yukon lineament consists of unmetamorphosed Precambrian sediments overlain by Paleozoic and Mesozoic sedimentary rocks and Cenozoic volcanics. Paleozoic granite intrudes this sequence.

Gas and oil are the major potential resources of the area. Estimated petroleum reserves for the entire North Slope reach 40 or 50 billion or more barrels (Gryc and others, 1969; U.S. Department of the Interior, 1972) and the extrapolated reserves of Northeastern Alaska could be several billions of barrels. Phosphate-rich sediments and native copper associated with the volcanics occur along the north front of the range.

Placer gold amounting to 300,000 ounces has been recovered in and near the south flanks of the Brooks Range. Related to this gold-producing area is the only active gold lode mine in the Brooks Range. Occurrences of copper, arsenic, zinc, antimony, nickel, molybdenum, silver, and lead are known from the same area (Brosgé, 1960; Brosgé and Reiser, 1972; Cobb, 1967). High mineral resource potential exists for the region primarily because of its geologic continuity with, and similarity to, the host rocks of the Bornite-Ruby Creek copper deposits. Since the fall of 1969, 279 lode claims have been staked.

Withdrawal 3-A (11.A.3)

Location--The withdrawal area, consisting of approximately 2,500 square miles, lies within the Sagavanirktok and Philip Smith Mountains quadrangles along the eastern boundary of the pipeline corridor.

Present knowledge--The area has been mapped at 1:250,000 (Brosgé and others, 1960), and at 1:1,000,000 scale (Lathram, 1965) largely on the basis of photogeology. The northern and eastern portion including the mountain front and adjoining foothills has been mapped at 1:125,000 scale (Keller and others, 1961). The southern and eastern portions have not been mapped. No geochemical studies have been made.

Adequacy--The strong northeast-trending Brooks Range mountain front is due to a progressive plunge of an east-west *en echelon* folding. It results in the Paleozoic limestones and sandstones of the range being buried under the terrigenous clastic rocks of Mesozoic and Cenozoic age. Except for minor coal there are no known mineral resources. Despite its proximity to the North Slope petroleum province, withdrawal 3-A has a low petroleum potential because of high structural elevation, breaching of Paleozoic rocks and general lack of Mesozoic sediments (Keller and others, 1961). However, recoverable petroleum may be trapped in the sediments underlying the northeastern townships.

The Triassic Shublik Formation crops out all along the mountain front. Samples taken from phosphate-rich beds within the Shublik 45 miles to the east have yielded up to 35 percent phosphate (Patton and Matzko, 1959; Detterman, 1970). Thin minor beds of coal, with few seams up to two feet thick, occur in the mapped Tertiary rocks exposed over an area of approximately 60 square miles. At present, the sampling is inadequate for reserve estimates.

A small mafic sill is the only igneous rock known in the area.

The mineral resources of withdrawal 3-A cannot be adequately assessed because of the lack of field geologic mapping of about half of the area and the absence of geochemical sampling over all of the area.

Withdrawal 3-B (11.A.3)

Location--Area 3-B, consisting of about 500 square miles, is located just west of the Canning River utility corridor in the Mount Michelson quadrangle.

Present knowledge--The area has been mapped at 1:1,000,000 (Lathram, 1965) and 1:250,000 (Reiser and others, 1971), but except for three stream-sediment samples, no geochemical sampling has been done.

Adequacy--The area is underlain by Paleozoic and Mesozoic sediments and no igneous rocks are known. Present geologic knowledge indicates little mineral resource potential.

The Triassic Shublik Formation crops out along the mountain front and in a structural low within the range for a total surface exposure of about 1 square mile. Phosphate-rich beds occur in the Shublik. Small anthracite coal occurrences at the base of the Mississippian formation have little potential value.

Withdrawal 3-C (11.A.3)

Location--Area 3-C, approximately 900 square miles in area, is located along the east boundary of the TAPS utility corridor in the Chandalar quadrangle.

Present knowledge--The area has been mapped at 1:250,000 scale (Brosgé and Reiser, 1964). The areas to the east and west have been geochemically sampled at a density of one sample in 2 to 15 square miles. Geochemical sampling within the withdrawal area is at a density of one sample in 75 to 100 square miles.

Adequacy--The existing mapping and sampling is adequate for the purposes of the preliminary resource appraisal presented in the following paragraphs.

A belt of Paleozoic, predominantly pelitic, greenschist facies rocks crops out across the withdrawal area along the south flank of the Brooks Range. It is paralleled on the north by a less metamorphosed belt of Devonian carbonates and clastics, and on the south by a belt of Paleozoic and Mesozoic phyllite, volcanic and clastic rocks. Mafic igneous rocks, in part volcanic, occur in all three belts. Mesozoic granitic rocks have intruded and altered rocks of both the schist and carbonate belts, and both belts are locally mineralized (Brosgé, 1960; Brosgé and Reiser, 1972; Runnells, 1969; Patton and others, 1968; Brosgé and Reiser, 1970a, b). This area has been only a minor contributor to the 300,000 ounces of placer gold recovered from the district despite its location between the main production areas of Wiseman and Chandalar. Geochemical sampling, primarily in the areas adjoining the withdrawal, show anomalous concentrations of base metals, including lead, zinc, antimony, copper, arsenic, and molybdenum usually associated with the anomalous gold and silver concentrations of the schist belt (Brosgé and Reiser, 1972). The persistence of the placer gold into the withdrawal area suggest both base and precious metal mineralization in the schist. Additionally, geochemical sampling within the less metamorphosed, predominantly carbonate belt shows anomalous concentrations of copper, nickel, silver, and lead.

In the Chandalar area 24 miles to the east anomalous amounts of gold, silver and base metals are concentrated along northwest-trending shear zones in the schist. A lode mining operation employing a 100-ton-per-day capacity mill has recently been initiated (Alaska Division of Geological Survey, 1972).

Indications of high mineral resource potential in this area are: (1) granite intrusions with accompanying hornfels in two different belts of rock; (2) northwest-trending shear zones known highly mineralized a short distance to the east may persist into the area; (3) nuggets of copper up to 7 pounds as well as silver and gold reported in Mule Creek in the northern edge of the area; (4) a sample of galena from a prospect northeast of the withdrawal assayed 360 ppm silver and 6.5 ppm gold; (5) the continuation of the carbonate and schist belt rocks of the withdrawal into the Ruby Creek-Bornite copper deposits (W. P. Brosgé, unpublished report). The geologic similarity between the withdrawal area and Bornite is very strong, and extends even to the occurrence of cymrite, a relatively rare barium silicate, in both areas. The Bornite deposits are described as medium-tonnage, high-grade ore deposits (Allen Clark, personal communication). Recent staking of copper claims along the north edge of the area substantiates the high mineral resource potential present.

Withdrawal 3-D (11.A.3)

Location--Withdrawal 3-D, somewhat less than 300 square miles in area, is located in the northeastern portion of the Christian quadrangle, west of the East Fork of the Chandalar but east of the North Fork of the East Fork of the Chandalar.

Present knowledge--The area has been mapped at reconnaissance scale (Brosgé and Reiser, 1962), but no geochemical sampling has been done.

Adequacy--The area is underlain by a structurally complex sequence of Devonian carbonate rocks and calcareous and noncalcareous clastic rocks. The sequence is unmetamorphosed except for partial recrystallization of the Skajit Limestone. This area is the eastern terminus of a belt of similar rocks that extends westward along the entire south flank of the Brooks Range.

Small mafic dikes cut the carbonate units but no mineral resources or potential are known to exist in this area. Eventually the area should be sampled for geochemical analysis because equivalent rocks host the Bornite copper deposits in the west.

Withdrawal 3-E and 3-F (11.A.3)

Location--Withdrawals 3-E, 72 square miles, and 3-F, 108 square miles in area, border the east side of the Venetie Indian Reservation in the Arctic and Christian quadrangles.

Present knowledge--Both areas are mapped at reconnaissance 1:250,000 scale (Brosgé and Reiser, 1962, 1965). No geochemical sampling has been done.

Adequacy--No mineral resources are known in area E and the only mineral resource known in withdrawal 3-F is tasmanite, an oil shale (Tailleur and others, 1967), occurring in small amounts in a chert and mafic rock sequence. The resource potential of the tasmanite is very low although it may be useful as a local source of fuel.

(Withdrawal 3-G (11.A.3)

Location--Withdrawl 3-G, 2,400 square miles in area, is adjacent to the Canadian border in the Black River and Coleen quadrangles.

Present knowledge--Preliminary geologic mapping at 1:250,000 is completed (Brosgé and Reiser, 1969; Brabb, 1970). Except for one stream sediment and one rock sample, no geochemical sampling has been done.

Adequacy--The withdrawal is underlain by complexly folded and faulted Precambrian to Mesozoic sedimentary rocks overlain by minor Cenozoic volcanic rocks in the northern part of the area. A small patch of Paleozoic(?) volcanics occur along the Black River-Charley River quadrangle boundary. No mineral resources are known within the area.

Withdrawal 3-H (17.d.1)

Location--Located in the central portion of the subregion, withdrawal 3-H extends over portions of the Chandalar, Philip Smith, Arctic and Christian quadrangles. It includes 5,700 square miles.

Present knowledge--Geologic mapping at 1:250,000 scale (Brosgé and others, 1960; Brosgé and Reiser, 1962, 1964, 1965) exists for all the area. A compilation of metallic mineral resources in Chandalar quadrangle (Cobb, 1967) and a geochemical study of the Wiseman and Chandalar districts Brosgé and Reiser, 1970a, b; 1972) includes areas of this withdrawal that lie within the Chandalar quadrangle.

Adequacy--This withdrawal area straddles the eastern end of the belts of Paleozoic metamorphic and sedimentary rocks that underlie the south flank of the Brooks Range. In general, mineralization in the Brooks Range occurs where this group of rocks is associated with Mesozoic and Paleozoic(?) mafic igneous rocks and Mesozoic granitic intrusions. Known mineral resources are untested lode occurrences of copper, silver, lead and gold in the North Fork of the Chandalar River and 40 recently filed (fall, 1971) copper lode claims between the Middle Fork of the Chandalar and the Wind Rivers.

Tasmanite (oil shale) has been reported within the area of this withdrawal in the Christian quadrangle and two occurrences of tasmanite are known adjoining the withdrawal area. The tasmanite occurs in layered clay slate, is extremely restricted and of low resource potential.

The present geologic mapping is adequate to divide withdrawal 3-H into three categories:

1. Having high mineral resource potential--that portion in the Chandalar, Philip Smith and western Christian quadrangles.
2. Having medium mineral resource potential--that portion in the western Arctic quadrangle.
3. Having low mineral resource potential--that portion in the central and southeastern Arctic quadrangles and in the Christian quadrangle. Mapping in the southern Philip Smith quadrangle is largely photogeologic and inadequate as a reliable basis for classification.

Withdrawal 3-I (17.d.1)

Location--Almost entirely in the western and northern Beaver quadrangle, 3-I extends into the Bettles quadrangle and is approximately 2,000 square miles in area.

Present knowledge--There is 1:250,000-scale geologic mapping for the parts of the withdrawal in the Chandalar (Brosgé and Reiser, 1964) and in Bettles quadrangles (Patton and Miller, unpublished). Other existing mapping is largely based on photogeologic interpretation and is unpublished.

Adequacy--The withdrawal area constitutes the Hodzana Highlands which are underlain by complexly folded and faulted Paleozoic pelitic schists, minor carbonates, phyllites, Mesozoic mafic intrusives and volcanics and extensive Mesozoic granites. Ultramafics are known about 25 miles to the southwest and may extend into the area.

Mineral occurrences within the withdrawal are an untested lode occurrence of molybdenum and zinc on Trout Creek (Smith, 1942), occurrences of placer gold at Trout Creek (Berg and Cobb, 1967) and an unconfirmed report of placer gold on Trail Creek (V. Knorr, personal communication). Based on the geology of the area and the mineralization to the west and southwest (tin, lead and zinc lode deposits; Patton and Miller, 1970), the withdrawal is considered to have high mineral resource potential.

The existing geological and geochemical studies are inadequate.

Withdrawal 3-J (17.d.2)

Location--Withdrawal 3-J, approximately 800 square miles in area, is located in the Table Mountain quadrangle south of the Arctic National Wildlife Refuge.

Present knowledge--The area is mapped at 1:1,000,000 (Lathram, 1965) and there is unpublished 1:250,000 scale mapping of approximately 50 percent of the area

Adequacy--The area is crossed by a major northeasterly trending fault. West of the fault early Paleozoic(?) schistose rocks are overlain by Paleozoic sedimentary rocks; east of the fault only the Paleozoic sedimentary rocks are exposed. Twelve miles north of the withdrawal the lower part of the sequence is intruded by Mesozoic granites. Anomalous concentrations of tin, beryllium, lead, zinc, tungsten, copper and molybdenum are associated with the granite there (Brosgé and Reiser, 1968).

No mineral occurrences are known within the area but because of the proximity of known granite intrusions accompanied by mineralization, the area is considered to have moderate mineral resource potential.

The geologic mapping of the area is inadequate and geochemical sampling is needed.

Withdrawal 3-K (17.d.2)

Location--Withdrawal 3-K consists of about 13,500 square miles in the lower third of subregion 3.

The withdrawal lies predominantly within the Cenozoic basin of the Yukon Flats section, but also includes areas of the Kokrine-Hodzana Highlands, Yukon-Tanana Upland, Porcupine Plateau and Brooks Range.

The following discussion treats the basin, the highlands surrounding the basin and the intervening marginal upland separately.

Present knowledge of basin--Although there has been little geologic mapping in the Cenozoic basin of the Yukon Flats, it has been regarded as a potential petroleum province (Miller and others, 1959). Favoring the petroleum potential are gravity data (Barnes, 1970) that define two pronounced lows in the basin that may represent troughs filled with Tertiary sediments. Not favoring the petroleum potential are magnetic anomalies resulting from concealed volcanic rocks (Brosgé and others, 1970).

Adequacy of basin information--The available data are inadequate to assess the petroleum potential of the Cenozoic basin of the Yukon Flats. Geologic mapping and seismic exploration are required.

Present knowledge of the marginal uplands--The marginal upland areas in withdrawal 3-K have been geologically mapped at a scale of 1:500,000 (Williams, 1962) and the upland portions in the Christian quadrangle have been mapped at 1:250,000 (Brosgé and Reiser, 1962).

Adequacy of knowledge of marginal uplands--The present level of geologic information is inadequate to assess the mineral resource potential of the marginal upland portions of withdrawal 3-K.

The uplands are underlain partly by Cenozoic sedimentary and volcanic rocks that contain sub-bituminous to lignitic coal (Mendenhall, 1902; Williams, 1962) of unknown thickness and extent. Poorly known older rocks included in the uplands comprise Mesozoic sedimentary, intrusive and volcanic rocks, Paleozoic metamorphic and sedimentary rocks, and unmetamorphosed Precambrian rocks.

Present knowledge of the highlands--There is little geologic mapping in the highlands portions of withdrawal 3-K. Parts of the Coleen (Brosgé and Reiser, 1969), Christian (Brosgé and Reiser, 1968) and Livengood quadrangles are mapped at a scale of 1:250,000.

Adequacy of highlands information--There is inadequate information to assess the mineral resource potential of the highlands in even the most preliminary fashion.

Withdrawal 3-L (17.d.2)

Location--Withdrawal 3-L, located between the two utility corridors, straddles the crest of the Brooks Range, and is about 2,100 square miles in area.

Present knowledge--The area within the Philip Smith and Sagavanirktok quadrangles is mapped at 1:1,000,000 (Lathram, 1965). The area within the Arctic quadrangle is mapped at 1:250,000 (Brosgé and Reiser, 1965). About 60 percent of the mapping is photogeologic interpretation.

Adequacy--The withdrawal area is underlain by highly deformed Mesozoic and Paleozoic sedimentary rocks dominated by the Mississippian Lisburne Group. The Mesozoic rocks occur in two structurally low areas--one at Wahoo Lake in the Mount Michelson quadrangle, the other at Porcupine Lake in the Arctic quadrangle. Folding is tight isoclinal and usually overturned to the north. Imbricate thrusting occurs throughout the area.

Igneous rocks comprise a small mafic intrusion located near the Ivishak River (Keller and others, 1961) and a reported mafic body near the top of the Mesozoic sequence at Porcupine Lake.

Known mineral occurrences are restricted to two localities: (1) Pyrite in the carbonate rocks at the contact with the mafic intrusion in the Ivishak area, and; (2) a block of 20 lode claims believed to be for copper (Allen Clark, verbal communication) located on the Wind River in the Philip Smith quadrangle. Twenty similar claims in two groups are located just south of the withdrawal area in the same region. These lodes are on trend with known mineralization in the south flank of the Brooks Range and probably reflect a northeastward extension of the association of anomalies (copper, silver, zinc and lead) found in the carbonate terrane at the north margin of the granitic rock on the North Fork of the Chandalar (Brosgé and Reiser, 1972).

Withdrawal 3-L probably has moderate mineral resource potential but information presently available is inadequate for preliminary appraisal, except in the southwest corner of the area. The seven southernmost townships of the southwestern corner of the area appear to have high mineral resource potential because they are underlain by the same carbonates that trend along the north boundary of the Chandalar granite in the North Fork of the Chandalar River, 3 miles to the southwest. There these carbonates are locally highly mineralized (Brosgé and Reiser, 1972). Further west silver and copper nuggets occur in the gold placers of Mule Creek. Anomalous amounts of lead, zinc and copper are associated with the gold in Mule Creek and with rock samples from nearby carbonate rocks.

Withdrawal 3-M (17.d.2)

Location--Withdrawal 3-M, on the Canning River drainage east of the gas pipeline utility corridor, abuts the Arctic National Wildlife Refuge and is approximately 200 square miles in area.

Present knowledge--The area is mapped at 1:250,000 scale in the Mount Michelson (Reiser and others, 1971) and Arctic quadrangles (Brosgé and Reiser, 1965).

Adequacy--The area is underlain by highly deformed Devonian, Carboniferous and Permian sedimentary rocks unconformably overlying more intensely deformed older Paleozoic rocks which include small amounts of mafic volcanics as well as sediments. No mineral occurrences are known within the area although native copper is associated with Paleozoic volcanics 42 miles to the north.

The part of the area within the Mount Michelson quadrangle is adequately mapped, but the part in the Arctic quadrangle has been mapped by photogeologic methods only. No geochemical sampling has been done, but the restricted occurrence of minerals in the withdrawal suggests that the area has low mineral potential.

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SUBREGION 4 (SEWARD PENINSULA)

Subregion 4 includes all of the Seward Peninsula and small portions of surrounding provinces with a total area of about 20,000 square miles. The Seward Peninsula is a thrust-faulted province of sedimentary and metamorphic rocks of Precambrian to mid-Paleozoic age intruded by a variety of Mesozoic plutons. It is bounded on the east by the Yukon-Koyukuk volcanogenic province of Mesozoic age.

The subregion has a high mineral resource potential based on existing knowledge. It has produced about 150 million dollars worth of metals, about 98 percent of which was placer gold, with tin, lode gold, and minor amounts of silver, copper, lead, antimony, tungsten, and graphite constituting the remainder (Harris, 1968; Cobb, 1972). A large deposit of fluorite and tin with byproduct tungsten and perhaps beryllium is currently in the development stage at Lost River with a potential value of several hundred million dollars (Northern Miner, April 13, 1972). Other known deposits of lead, silver, barite, tin, molybdenum and antimony occur in the subregion (Berg and Cobb, 1967). A recent geostatistical analysis by Harris (1968) estimated that the Seward Peninsula had about 2.6 billion dollars of potential metallic mineral resources.

Petroleum potential on-shore is low except possibly for the extreme northern part of the Peninsula.

Withdrawal 4-A (11.A.3)

Location--Western Teller quadrangle, western Seward Peninsula.

Present knowledge--Complete 1:250,000-scale geologic mapping (Sainsbury, 1970), 1:63,360-scale geologic mapping for most of the block.

(Sainsbury, 1969). Geochemical sampling of stream sediments, rocks, soil, and plants is complete for much of the block.

Adequacy--Present information is adequate for preliminary mineral resource potential appraisal.

The southern two-thirds of the block has a very high mineral resource potential because deposits of fluorite and tin with by-product tungsten and perhaps beryllium are presently being developed in the Lost River area (Sainsbury, 1969; Berg and Cobb, 1967). The Lost River mine appears to have a 20-year supply of ore with an estimated total value of 400-600 million dollars (Northern Miner, April 23, 1972). The deposits are related to biotite granite stocks and the ore shoots occur in pre-Ordovician and Ordovician carbonate rocks localized along thrust faults where the faults are cut by dikes.

Withdrawal 4-B (11.A.3)

Location--Southwestern Nome quadrangle, southwestern Seward Peninsula.

Present knowledge--Reconnaissance geologic mapping at 1:63,360 scale (Sainsbury and others, 1972a). No geochemical surveys.

Adequacy--The geologic mapping is adequate but minor amounts of geochemical stream sampling are needed.

The mineral resource potential is probably low to moderate in the part of the block (~65 percent) not covered by coastal and morainal deposits. The bedrock in the block is strongly faulted Paleozoic marble and Precambrian schist intruded by lamprophyre and altered granitic dikes. The only mineral production has been a small quantity of placer gold (Cobb, 1972). The alteration and recrystallization of the marble together with the abundant dikes may indicate a buried pluton with which mineral deposits might be associated.

Withdrawal 4-C (11.A.3)

Location--Baldwin Peninsula, Kotzebue and Selawik quadrangles

Present information--1:250,000-scale geologic mapping (Patton and Miller, 1968)

Adequacy--The present geologic information is adequate since the block is composed entirely of Quaternary surficial deposits. Geophysical studies would be necessary to adequately assess the petroleum potential.

The metallic mineral potential is low since the entire block is covered by a thick section of unconsolidated Quaternary silts and glacial outwash deposits. There may be some petroleum potential, however, since the Tertiary deposits that have been found at scattered localities along the southern part of the Kobuk-Selawik Lowland and the northern Seward Peninsula suggest the possibility of a Tertiary sedimentary basin underlying the area.

Withdrawal 4-D (17.d.1)

Location--Central Seward Peninsula including parts of the Candle, Solomon, Bendeleben, and Teller quadrangles.

Present knowledge--Complete 1:250,000-scale mapping and reconnaissance 1:63,360-scale mapping for about half of the block (Miller, in prep.;

Sainsbury, in prep.; Sainsbury and others, 1969, 1970). Geochemical mapping including rock and stream sediment sampling for about half of the block (Miller and others, 1971; Asher, 1970; Miller and others, in prep.; Sainsbury and others, 1969; Herreid, 1965).

Adequacy--The geologic map coverage is adequate but some additional geochemical mapping would be necessary in the central Bendeleben Mountains.

The block has medium to high mineral resource potential. It includes major parts of the Council, Kougarok, and Fairhaven placer gold mining districts which have a past production of about \$2-\$3 million (Cobb, 1972). Small amounts of argentiferous galena have been mined at two localities and known prospects of lead, silver, molybdenum, and gold occur in the block (Berg and Cobb, 1967; Miller and others, 1971; Sainsbury and others, 1969, 1970). The geology of the block is varied and includes both low- and high-grade metamorphic rocks, carbonates, and granitic intrusives. The structure is complex and dominated by thrust and normal faulting. Harris' (1968) geostatistical study of the southern edge of this block suggests a total resource estimate of over a billion dollars.

Withdrawal 4-E (17.d.1)

Location--Western Solomon quadrangle.

Present knowledge--Complete reconnaissance geologic mapping at 1:63,360 scale (Sainsbury and others, 1972b, 1972c). The past history of placer (Cobb, 1972) and lode (Berg and Cobb, 1967) gold production has been recorded.

Adequacy--Geologic map coverage is adequate. There is no stream-sediment sampling coverage available but block has been actively prospected for 50 years.

The block has low to moderate mineral potential (Sainsbury and others, 1972b, 1972c). It includes a few small placer gold-mining districts (Cobb, 1972) and the Big Hurrah lode gold mine, the largest lode gold mine on the Seward Peninsula (Berg and Cobb, 1967). This mine produced about 10,000 oz. of gold from 1900 to 1940 but is presently inactive. Other lode gold prospects occur in the immediate area. Most of the block is underlain by thrust-faulted schists and carbonates with mineralization concentrated in a graphitic schist.

Withdrawal 4-F (17.d.2)

Location--Kobuk-Selawik Lowland

Present knowledge--Complete 1:250,000-scale geologic mapping (Patton and Miller, 1968).

Adequacy--The geologic map coverage is adequate and stream-sediment sampling is not necessary since most of the area is covered by Quaternary unconsolidated sediments. An aeromagnetic survey would be required for estimating petroleum potential.

The block has low metallic mineral potential although the possibility of buried alkaline complexes with associated rare-earth deposits cannot be totally dismissed (Miller and Anderson, 1969). The area does have low to moderate petroleum potential since the Kobuk-Selawik Lowland may be underlain by a basin of Tertiary sedimentary rocks (Patton, 1971).

Withdrawal 4-G (17.d.2)

Location--Northern Seward Peninsula

Present knowledge--Reconnaissance 1:250,000-scale geologic mapping south of 66° N. (Sainsbury, 1970); only a broad reconnaissance 1:500,000-scale compilation (Hopkins, unpublished) is available for areas north of 66° N. which constitutes most of the block.

Adequacy--Geologic mapping has not been completed for much of the block but past work indicates that most of the block is underlain by Quaternary basalts and unconsolidated sediments. Geologic mapping and mineral deposits studies have been done in the area around Ear Mountain and south. Present knowledge is probably sufficient to adequately classify the block in regard to metallic minerals but a mapping program in the Kotzebue and Shishmaref quadrangles would be necessary to estimate the petroleum and coal potential.

The block has low metallic mineral resource potential; the Ear Mountain area has been actively explored for tin by surface prospecting, drilling, and drifting (Berg and Cobb, 1967). Some tin mineralization has been found and a beryllium geochemical anomaly surrounds the biotite granite of the Ear Mountain stock which intrudes limestone and slate (Sainsbury, 1963). For most of the block, the cover of Quaternary sediments and basalts suggests a low metallic potential; there is a possibility of petroleum and coal, however, in the northern part.

Withdrawal 4-H (17.d.2)

Location--Imuruk Lake area, central Seward Peninsula.

Present knowledge--Geologic mapping at 1:125,000 scale (Hopkins, 1963).

Adequacy--The geologic mapping is adequate and no geochemical sampling is necessary because of the geology of the block.

The area has a low mineral resource potential. Most of the block is underlain by a thick pile of Quaternary basalt; only along the southern and eastern edges are granite and other crystalline rocks found. The only reported mineral deposits are beds of diatomite which range in thickness from 4 to 10 feet and have a surface area of about 70 acres (Hopkins, 1963).

Withdrawal 4-I (17.d.2)

Location--Southwestern Seward Peninsula.

Present knowledge--Complete reconnaissance 1:250,000-scale geologic mapping (Sainsbury, 1970); Sainsbury and others, in prep.), some 1:63,360 mapping (Hummel, 1962; Sainsbury and others, 1969).

Adequacy--The geologic map coverage is sufficient but additional geochemical sampling is needed in some areas.

The mineral resource potential of this block is high, with numerous reported prospects of lode gold, iron, tungsten, lead, zinc, silver, copper, and antimony (Berg and Cobb, 1967) and small production of lode gold, scheelite, and graphite. A barite-fluorite deposit has been found immediately south of the block (Brobst and others, 1971). The block includes part of the Nome placer gold district which had a production of more than 100 million dollars (Cobb, 1972; Lu and others, 1968). The withdrawal is underlain by faulted carbonate and metamorphic rocks cut by small granitic bosses and dikes with widespread mineralization. Harris' (1968) geostatistical study gave an estimated value of over 500 million dollars for the area.

Withdrawal 4-J (17.d.2)

Location--South-central Seward Peninsula.

Present knowledge--Complete reconnaissance 1:63,360 scale geologic mapping (Sainsbury and others, 1972b) and records of past production and prospecting (Cobb, 1972).

Adequacy--The present knowledge is adequate for a preliminary mineral resource potential appraisal.

The withdrawal block has a low to moderate mineral resource potential. It is underlain by thrust-faulted carbonates and schists of Precambrian and Paleozoic age. Past mineral production has been chiefly placer gold with a total value of less than a million dollars (Cobb, 1972; Lu and others, 1968).

Withdrawal 4-K (17.d.2)

Location--Southeastern Seward Peninsula.

Present knowledge--Complete 1:250,000-scale geological and geochemical mapping (Miller, in prep.).

Adequacy--The present knowledge is adequate for preliminary mineral resource potential appraisal.

The mineral potential of the block is low. The withdrawal is underlain chiefly by Cretaceous granitic rocks intruding Precambrian metamorphic rocks. There has been no past mineral production and recent geologic and geochemical mapping has not disclosed any areas with anomalous metals.

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SUBREGION 5 (YUKON-KOYUKUK PROVINCE)

The Yukon-Koyukuk Province is a broad triangular-shaped depression of Cretaceous sedimentary and volcanic rocks bordered on three sides by a metamorphic complex of Paleozoic age. About half of the province is underlain by Quaternary alluvium in three separate lowland areas; the Koyukuk Flats, the Kanuti Flats, and the Kobuk-Selawik Lowlands. Parts of the province are of interest for their petroleum possibilities, particularly the alluviated lowlands and the coastal areas bordering Kotzebue and Norton Sounds (Patton, 1971). In addition, parts of the province and adjoining borderlands are considered to have high potential for base and precious metal deposits. These include the Cretaceous volcanic and intrusive complex of the Hogatza trend where notable amounts of gold have been mined (Cobb, 1968a), and the metamorphic complex of the Kaiyuh Mountains (Cobb, 1968b) and Ruby district (Cobb, 1968c) where gold and small amounts of lead and silver have been produced.

Subregion 5 contains 15 individual withdrawal blocks; eight under 11.A.3, four under 17.d.1, and three under 17.d.2. The total area withdrawn under these categories is 24,000 square miles.

Withdrawal 5-A (17.d.1)

Location--A 6,085-square-mile block extending along the Norton Sound-Koyukuk divide from the Kobuk-Selawik Lowlands southward to the Nulato River. Includes parts of the Selawik, Shungnak, Candle, Kateel River, Norton Bay, and Nulato quadrangles.

Present knowledge--Modern 1:250,000 scale geologic mapping covers the entire block (Patton and Miller, 1968; Patton and others, 1968; Patton, 1966, 1967; Bickel and Patton, 1957; Patton and Bickel, 1956; Patton, unpublished). Geochemical investigations are confined to a 250-square-mile area in the Selawik Hills (Elliott and Miller, 1969).

Adequacy--The northern half of this block covers the Hogatza trend, a plutonic-volcanic complex which offers favorable prospects for finding metallic minerals. The southern half is underlain almost entirely by Cretaceous graywacke and mudstone and is considered to have a low mineral resource potential.

Additional geochemical sampling in Selawik Hills, southwestern Shungnak quadrangle and northwestern Kateel River quadrangle is required for preliminary mineral resource evaluation of the Hogatza trend.

Withdrawal 5-B (17.d.2)

Location--This block of 5,290 square miles in the northern and central part of the Koyukuk Flats includes parts of the Kateel River, Melozitna, and Nulato quadrangles.

Present knowledge--A 250,000 scale geologic map is complete in Kateel River quadrangle (Patton, 1966), but mapping is not complete in the Melozitna and Nulato quadrangles. No geochemical data available for any of the block.

Adequacy--Most of the block lies within the Koyukuk Flats, a broad lowland mantled by thick deposits of Quaternary alluvium. Along the eastern and western margins, the block laps onto uplands composed of Cretaceous and Tertiary sedimentary and volcanic rocks.

The Koyukuk Flats have long been regarded as a possible petroleum province (Miller and others, 1959). Scattered aeromagnetic profiles flown across the Flats by the U.S.G.S. suggest that at least part of the Flats are underlain at shallow depth by Cretaceous volcanic rocks and thus are unpromising for petroleum (Zietz and others, 1959; Patton, 1971). However, until complete aeromagnetic coverage is available no final evaluation of the petroleum potential of this large area can be made.

The uplands along the western margin of the block are made up largely of Cretaceous sedimentary and volcaniclastic rocks which appear to have low mineral potential. The uplands along the eastern margin include a wide variety of intensely deformed volcanic, sedimentary, and intrusive rocks of Cretaceous and Tertiary age which are poorly known and largely unmapped. The general structural and lithologic character of these rocks suggests that they may have a high base and precious metal resource potential.

Geological and geochemical mapping are needed in the Melozitna quadrangle along the eastern margin of the block and complete aeromagnetic coverage is required to appraise the petroleum potential of the Koyukuk Flats.

Withdrawal 5-C (11.A.3)

Location--The 1,500 square miles of withdrawal 5-C are along the northern border of the Koyukuk Flats including parts of the Purcell Mountains, Zane Hills, and Isahultila Mountains.

Present knowledge--This withdrawal is completely covered by modern 1:250,000 scale geologic maps (Patton and Miller, 1966; Patton, 1966; Patton and others, 1968; Patton and Miller, unpublished). Most of the area is also covered by geochemical sampling (Miller and Ferrians, 1968; Miller, 1969).

Adequacy--The bedrock is chiefly of Cretaceous volcanic and granitic rocks although the southern edge of the block includes alluviated lowlands of the Koyukuk Flats. The withdrawal contains the Hog River gold placer mine. Geochemical sampling indicates several areas favorable for prospecting (Miller and Ferrians, 1968): (1) lead, copper, and silver near Sun Mountain, (2) uranium and thorium at Caribou Mountain, (3) gold on Clear Creek, and (4) lead and silver on the south side of Purcell Mountains.

Overall, the block is considered to have a very high potential for both base and precious metals. The existing geologic and geochemical information is considered adequate for preliminary mineral resource potential evaluations.

Withdrawal 5-D (11.A.3)

Location--Withdrawal 5-D consists of about 650 square miles in a narrow north-trending block extending from the Indian Mountains near Hughes northward across the Koyukuk and Alatna valleys to the Alatna Hills.

Present knowledge--The block is completely covered by modern 1:250,000 scale geologic mapping (Patton and Miller, 1966), and some geochemical sampling has been done in the Indian Mountains along the southern edge of the block

(Miller, 1969).

Adequacy--Bedrock consists chiefly of graywacke and mudstone of Cretaceous age. South of the Koyukuk River these rocks are intruded by two small quartz monzonite plutons and by swarms of small felsic dikes. The southern edge of the block borders the Indian Mountain quartz monzonite plutons.

The portion of the block south of the Koyukuk River appears to have a high mineral potential because of: (1) the widespread occurrance of plutonic and hypabyssal intrusive rocks (Patton and Miller, 1966), and (2) the occurrence of placer gold and base metal sulfides nearby at Utopia Creek (Cobb, 1968a; Miller and Ferrians, 1968).

The portion of the block north of the Koyukuk River is regarded as having low mineral potential.

Additional geochemical mapping will be required in order to make an adequate appraisal of the mineral potential of the part of the block lying south of the Koyukuk River.

Withdrawal 5-E (17.d.1)

Location--A 1,010 square-mile block in the southern Wiseman and northern Bettles quadrangles.

Present knowledge--The withdrawal is covered by modern 1:250,000 scale mapping (Brosgé and Reiser, 1971; Patton and Miller, in preparation, a). No geochemical mapping is available.

Adequacy--The southern two-thirds of the block is underlain by Cretaceous graywacke and mudstone with low mineral resource potential. The northern one-third is underlain by a Paleozoic metamorphic and volcanic complex which may have mineral resource potential.

Geochemical sampling is needed for preliminary mineral resource evaluation of the northern one-third of the block.

Withdrawal 5-F (11.A.3)

Location--About 430 square miles along the Koyukuk River valley south of Bettles.

Present knowledge--Block is completely covered by modern 1:250,000 scale mapping (Patton and Miller, in preparation, a). No geochemical mapping has been done.

Adequacy--The block is underlain chiefly by glacial and alluvial deposits. There are a few exposures of Cretaceous graywacke and mudstone in the western part of the Permo-Triassic volcanic rocks in the eastern part.

The area appears to have low mineral resource potential based on present, probably adequate data.

Withdrawal 5-G (17.d.2)

Location--Withdrawal 5-G is in the Kanuti Flats in the central part of the Bettles quadrangle and comprises about 1,115 square miles in area.

Present knowledge--There is 1:250,000 scale geologic mapping for the entire block (Patton and Miller, in preparation, a) and the uplands along the eastern margin of the block are covered by geochemical mapping (Patton and Miller, 1970; Patton and Miller, in preparation, b).

Adequacy--The western part of the block covers the heavily alluviated lowlands of the Kanuti Flats. If the Cretaceous sedimentary rocks which border the Flats on the west and southwest extend beneath the alluvium, the Flats could offer petroleum possibilities. The eastern part of the block laps onto the Kokrines-Hodzana Highlands, a complex geologic terrane that includes Paleozoic pelitic schist, Permo-Triassic mafic and ultramafic rocks, Cretaceous granite, and Tertiary volcanic rocks. Geochemical and geological mapping indicates that this part of the block has a high potential for metallic minerals.

In order to evaluate the petroleum possibilities of the Kanuti Flats, approximately 1,500 square miles of aeromagnetic mapping are required. Present geological and geochemical mapping are adequate for a preliminary mineral resource appraisal of the eastern part of the block in the Kokrines-Hodzana Highlands.

Withdrawal 5-H (11.A.3)

Location--About 860 square miles in Kanuti River drainage, including parts of the Kanuti Flats and the Kokrines-Hodzana Highlands.

Present knowledge--Block is covered by 1:250,000 scale geologic mapping (Patton and Miller, in preparation, a; Chapman and Yeend, unpublished), and the part in the Kokrines-Hodzana Highlands is covered by geochemical mapping (Patton and Miller, 1970; Patton and Miller, in preparation, b).

Adequacy--The block straddles the southeastern boundary of the Yukon-Koyukuk province. The western part consists chiefly of Cretaceous graywacke and mudstone and is considered to have a low mineral potential. The eastern part, which includes Paleozoic schist, Permo-Triassic mafic and ultramafic intrusives, and Cretaceous granitic intrusives, appears to have a high potential (Patton and Miller, 1970).

Present geological and geochemical data are adequate for preliminary mineral resource potential evaluation.

Withdrawal 5-I (17.d.1)

Location--Withdrawal 5-I consists of 935 square miles in the southwestern Melozitna quadrangle.

Present knowledge--1:250,000 scale mapping is incomplete and no geochemical data is available.

Adequacy--The block is underlain by complexly deformed Cretaceous graywacke and mudstone, Cretaceous granitic rocks, and Cretaceous and Tertiary volcanic rocks. The mineral potential of this block is unknown because there has been no geochemical sampling of any kind and only broad reconnaissance geologic mapping.

A mineral resource appraisal will require complete regional 1:250,000 scale mapping of the entire block, reconnaissance geochemical sampling of the entire block and detailed sampling around the granitic intrusive bodies.

Withdrawal 5-J (11.A.3)

Location--Withdrawal 5-J consists of about 470 square miles in the Nulato Hills west of the Koyukuk River.

Present knowledge--The block is completely covered by 1:250,000 scale geologic mapping (Patton, 1966), but no geochemical data are available.

Adequacy--Bedrock in the withdrawal is composed entirely of Cretaceous sandstone, conglomerate, and shale. The mineral resource potential is regarded as low. No additional geological mapping is needed.

Withdrawal 5-K (11.A.3)

Location--About 215 square miles in the Nulato Hills west of Nulato village.

Present knowledge--Geological mapping at 1:250,000 scale is complete (Bickel and Patton, 1957; Patton, unpublished). No geochemical data are available.

Adequacy--The withdrawal is underlain by highly deformed Cretaceous graywacke and mudstone. The mineral resource potential appears low, based on presently available adequate data.

Withdrawal 5-L (17.d.2)

Location--The withdrawal consists of 755 square miles in the southern part of the Koyukuk Flats and the adjoining Kaiyuh Mountains.

Present knowledge--Geologic mapping of this block is incomplete (Patton, unpublished), and no geochemical data are available.

Adequacy--The Koyukuk Flats are covered by Quaternary alluvium. Gravity data indicate that this part of the Flats is underlain by a thick wedge of Cenozoic sediments and thus may have petroleum possibilities (Patton, 1971). Kaiyuh Mountains consist of Paleozoic schist and limestone, Cretaceous granite, and Permo-Triassic mafic volcanic and intrusive rocks. Multivariate geostatistical analysis by Harris (1969) suggest that this part of the Kaiyuh Mountains has very high potential for base and precious metals--valued between $25,000 and $1,000,000 per square mile. Small amounts of lead, silver, and placer gold have been produced from this area (Cobb, 1968b).

Geological mapping and geochemical sampling are needed in the Kaiyuh Mountains for appraisal of base and precious metal resource potential. Complete aeromagnetic coverage is needed for evaluation of petroleum possibilities of the Koyukuk Flats.

Withdrawal 5-M (17.d.1)

Location--The withdrawal is a block of 2,180 square miles in the Norton Bay and Unalakleet quadrangles.

Present knowledge--Geological mapping at 1:250,000 scale is complete for the entire block (Patton, unpublished; Bickel and Patton, 1957; Patton and Bickel, 1956). No geochemical mapping is available.

Adequacy--Most of the block is underlain by Cretaceous graywacke and mudstone and appears to have a low mineral potential. However, two small areas of granitic and volcanic rocks offer prospects for base and precious metal deposits. One area, located on the lower Ungalik River near Christmas Mountain, has produced small amounts of placer gold (Cobb, 1968b). The other area, located in the northern Unalakleet quadrangle, has not had any recorded production of minerals but appears to offer attractive possibilities because of the widespread occurrence of Cretaceous and Tertiary felsic plutons and hypabyssal intrusives.

Geochemical sampling and detailed geologic mapping is needed in the Christmas Mountain area and in the part of the withdrawal block that lies south of the Unalakleet River.

Withdrawal 5-N (11.A.3)

Location--The withdrawal consists of about 2,170 square miles in a narrow strip along the Yukon River between Kaltag and Grayling.

Present knowledge--Geologic mapping at 1:250,000 scale has been completed in the northern part of the block in the Norton Bay and Nulato quadrangles (Patton, unpublished). Mapping is incomplete in the southern part of the block in the Unalakleet and Ophir quadrangles. No geochemical mapping is available in any of the block.

Adequacy--The geologic terrane is made up of Cretaceous sedimentary and Cretaceous and Tertiary volcanic and hypabyssal intrusive rocks. A small granitic pluton occurs in the Blackburn Hills. Known mineral deposits include Cretaceous coal deposits (Barnes, 1967) and a quartz-molybdenum prospect (Cobb, 1968b). The coal deposits appear generally too thin and too complex structurally to support large-scale mining. The prospects for finding base and precious metals appear to be generally favorable except in the extreme northern part of the block.

Geologic mapping and geochemical sampling in the Unalakleet and Ophir quadrangles are needed to provide data for preliminary appraisal of the mineral resource potential.

Withdrawal 5-0 (11.A.3)

Location--Withdrawal 5-0 includes about 290 square miles along the Yukon River near Kokrines.

Present knowledge--No modern geologic or geochemical maps are available.

Adequacy-- The portion of the block south of the Yukon River is underlain by alluvial fill and appears to have low mineral resource potential. The portion north of the river includes a mixed terrane of Paleozoic metamorphic and Cretaceous granitic rocks. Although little is known about these rocks, the fact that they lie on strike with the gold-tin placer deposits of the Ruby district (Cobb, 1968c) suggests that they may have a high mineral resource potential.

Both geological and geochemical mapping are needed to evaluate the resource potential of the area north of the Yukon River.

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SUBREGION 6 (EAST-CENTRAL ALASKA)

Subregion 6 is an area of regionally metamorphosed rocks primarily of Paleozoic age flanked on the north and northwest by unmetamorphosed sedimentary rocks of Precambrian to Tertiary age. Granitic plutons occur throughout the area and are especially large and abundant in the eastern part. Mafic and ultramafic rocks, both metamorphosed and unmetamorphosed, also occur. The northwesterly-trending Tintina fault zone crosses the northeastern part of the area, and several major northwesterly-trending faults are known in the northwestern part of the area.

Subregion 6 includes several gold placer areas of major significance in the past, and some placer gold is still being produced with the potential for continued and possibly increased production. The potential exists for finding other metals in economically feasible amounts although there is no production at present. Asbestos and coal are known in the area, and the finding of petroleum is a possibility.

Withdrawal 6-A (11.A.3)

Location--Mountainous area in the central part of the Tanacross quadrangle, Yukon-Tanana Upland.

Present knowledge--Published geologic map at 1:250,000 (Foster, 1970b). Not mapped or sampled geochemically. Covered by aeromagnetic map.

Adequacy--The area consists of fairly high-grade metamorphic rocks cut by Mesozoic granitic intrusions and felsic dikes and small intrusive masses of probably Tertiary age. There are also mafic and felsic volcanic rocks of probable Tertiary age. There are no presently known mineral occurrences, but some aspects of the geology are favorable. Geologic mapping of the area is probably adequate for present purposes but geochemical sampling is not. Reconnaissance type stream-sediment sampling, coupled with some bedrock geochemical sampling, is needed.

Withdrawal 6-B (11.A.3)

Location--Mountainous area in the north-central part of the Eagle quadrangle and south-central Charley River quadrangle.

Present knowledge--Preliminary geological maps at 1:63,360 available for part of the area (Clark and Foster, 1969a; Foster and Keith, 1968), and 1:250,000 geologic mapping available for all of the area (Brabb and Churkin, 1969(1970); Foster, 1972). Geochemical data available for two-thirds of the area (Eagle quadrangle) (Clark and Foster, 1969b; Foster, 1969b, 1970a, 1971b; Foster and Yount, 1971). Geomagnetic data may become available.

Adequacy--This geologically complex area includes the Tintina fault zone. Serpentinized ultramafic rocks and a wide variety of other igneous rocks occur. Placer gold has been mined and geochemical sampling indicates higher than normal background amounts of several metals. Information in the Eagle quadrangle is probably adequate for a preliminary mineral resource potential appraisal, but additional geochemical data is needed in the Charley River A-3 quadrangle. Stream-sediment sampling along with bedrock sampling and additional study of greenstone and ultramafic bodies is needed in the Charley River A-3 quadrangle.

Withdrawal 6-C (11.A.3)

Location--Withdrawal 6-C is located in the northeastern part of the

Charley River quadrangle and includes the Kandik Basin.

Present knowledge--The area is mapped geologically at a scale of 1:250,000 (Brabb and Churkin, 1969(1970)), but no geochemical sampling has been done.

Adequacy--The area consists primarily of folded and faulted sedimentary rocks ranging in age from Precambrian to Tertiary. Some small igneous intrusions occur. Locally there is possible petroleum potential, particularly in the area between the Kandik and Nation Rivers. The possibility of stratiform copper deposits and other mineralization needs to be considered. Geologic mapping is probably adequate for most purposes, but geochemical sampling and mineral evaluation is needed.

Withdrawal 6-D (17.d.1)

Location--Withdrawal 6-D includes the eastern part of the Tanacross quadrangle, much of the Eagle quadrangle, and the eastern Big Delta quadrangle.

Present knowledge--The Tanacross and Eagle quadrangles are mapped geologically at 1:250,000 (Foster, 1970b, 1972), and some areas are mapped at 1:63,360 (Clark and Foster, 1969a; Foster, 1969a; Foster and Keith, 1968). The Big Delta quadrangle is not mapped. The Eagle quadrangle has been geochemically sampled (Clark and Foster, 1969b; Foster, 1969a, 1970a, 1971a; Foster and Clark, 1969; Foster and Yount, 1971) but the Tanacross and Big Delta quadrangles have not. An aeromagnetic map is available for the Tanacross quadrangle.

Adequacy--This is an area of poorly exposed, fairly high grade metamorphic rocks complexly intruded by Mesozoic and Tertiary granitic rocks.

Also included are large areas of volcanic rocks. Recent exploration in the Tanacross quadrangle has indicated a possibility of porphyry copper deposits. Placer gold has been mined in the eastern Big Delta and Eagle quadrangles and is still mined at several places in the Eagle quadrangle. There are indications of other metals of possible commercial significance, including silver, antimony, molybdenum, lead, zinc, and tungsten. Asbestos and coal occur. Geologic and geochemical information is inadequate in the Big Delta quadrangle (and a small adjacent part of the Mt. Hayes quadrangle) and geochemical information inadequate in the Tanacross quadrangle. Geologic mapping at a minimum scale of 1:250,000 is needed in the Big Delta quadrangle, and reconnaissance-type geochemical sampling is needed in all parts of the area except the Eagle quadrangle.

Withdrawal 6-E (17.d.1)

Location--This area is mostly in the Circle quadrangle but includes some of the northeastern part of the Livengood quadrangle and a small part of the western Charley River quadrangle.

Present knowledge--Little information is available on the geology and mineral potential of the Circle and Big Delta quadrangles, but the Livengood and Charley River quadrangles are mapped geologically at 1:250,000 scale (Brabb and Churkin, 1969(1970); Chapman and others, 1971; Foster and Chapman, 1967). Geochemical data are lacking for most of the area.

Adequacy--The geology of the Circle quadrangle is complex and poorly known, although it includes previously important gold placer mining areas. Much of the area is a metamorphic terrane cut by Mesozoic and(or) Tertiary granitic intrusions, although there are some small complex areas of little metamorphosed sedimentary rocks. In order to prepare a mineral resource potential apprnisal, geologic mapping and geochemical sampling would be required for the Circle quadrangle and additional geochemical data would be required for the Livengood quadrangle.

Withdrawal 6-F (17.d.2)

Location--The area includes the Yukon River and adjacent areas, the remote northwestern part of the Eagle quadrangle, the southwestern part of the Charley River quadrangle, and small parts of the Big Delta and Circle quadrangles.

Present knowledge--The Charley River and Eagle quadrangles are mapped geologically at 1:250,000 scale (Brabb and Churkin, 1969(1970); Foster, 1972), and the Eagle quadrangle has been geochemically sampled (Clark and Foster, 1969b; Foster, 1969a, 1970a, 1971b; Foster and Clark, 1969; Foster and Yount, 1971). The Charley River map area has not been geochemically sampled or fully evaluated for mineral resource potential. The small part of the Big Delta quadrangle that is included has not been mapped geologically or geochemically.

Adequacy--The Tintina fault zone cuts the area into two very different geological provinces: to the north of the fault zone are folded and faulted sedimentary rocks of Precambrian to Tertiary age; south of the fault zone is a complex metamorphic terrane that has been intruded by several kinds and ages of igneous rocks. The fault zone has long been suspected to be a major factor in the mineralization of the area, but it has not been studied in detail.

The area includes gold placer mines and prospects for other metals such as copper. Good quality limestone and clay deposits occur. Geochemical information is inadequate for much of this area and geologic information is inadequate for a small part of the area.

The part of withdrawal 6-F included in the Charley River quadrangle has had mineral production and has potential for future mineral production. Placer gold has been mined from at least five locations: Woodchopper Creek, Coal Creek, Sam Creek, Fourth of July Creek, and Ruby Creek (Cobb, 1967). The future gold potential for this area has not been fully assessed but may be significant. Areas of Precambrian rock containing iron ore of possible future economic significance are also included. Subbituminous coal occurs in a district that roughly parallels the Yukon River on the south side and bituminous coal has been mined near the mouth of the Nation River.

Geologic and geochemical data are needed for the eastern Big Delta quadrangle and geochemical and other mineral resource data are needed for the Charley River quadrangle. Reconnaissance geochemical sampling is recommended for all but the Eagle quadrangle, and a competent assessment of the gold and other mineral potential of the area in the Charley River quadrangle should be carried out.

Withdrawal 6-G (17.d.2)

Location--This area is in the northern part of the Livengood quadrangle.

Present knowledge--The area is geologically mapped at a scale of 1:250,000 (Chapman and others, 1971) but geochemical data are not available.

Adequacy--The geologic mapping is probably adequate although more geochemical work is desirable. No mineral deposits are known in this withdrawal area.

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SUBREGION 7 (CENTRAL ALASKA)

Subregion 7 embraces about 15,000 square miles near the geographic center of Alaska. About 20 percent of it in the basin of the Yukon-Tanana Rivers consists of thickly vegetated swampy lowlands underlain by alluvial, colluvial, and eolian unconsolidated deposits that are largely perennially frozen. Many of the lower bedrock hills are also heavily mantled with colluvium, loess, and vegetation.

The oldest bedrock unit, which forms the core of the Yukon-Tanana Upland, includes schists, quartzites, slates, and phyllites of lower Paleozoic (possibly in part Precambrian) age. This unit is flanked on the north and west by lower Paleozoic sedimentary and mafic igneous rocks that are more or less metamorphosed. The Rampart Group (Permian) mafic volcanics, cherts, tuffs, and argillites, and the associated basalt-diabase-gabbro Triassic intrusives lie in the northern part of the area. Cretaceous or Jura-Cretaceous clastic rocks, all at least slightly metamorphosed, lie in a northeast-trending belt in the central eastern part of the area, and probably extend into the southwestern portion of the area. Small patches of Tertiary clastic rocks, including minor amounts of lignitic coal, occur along the Yukon River. There are several small- to moderate-size granite and quartz monzonite plutons of Cretaceous-Tertiary age in the northern half of the area, and some poorly mapped granitic plutons in the southwestern part of the area.

Approximately 545,000 oz. of placer gold (about 3 percent of the State's total) has been produced. The Manley Hot Springs-Tofty and the Rampart districts account for nearly all of this. Cassiterite is associated with some of the placer deposits, and in the former district several hundred tons of concentrates were produced as a by-product. A few lode deposits and prospects of antimony, lead, mercury, gold, silver, manganese, chromium, and nickel are known; most are small prospects, and the only known production is a few hundred tons of high-grade stibnite ore from the deposit on Sawtooth Mountain.

The future mineral resource potential of this subregion is low to moderate based on present knowledge and mapping. However, favorable structural settings for lode deposits are known or inferred, parts of the subregion have scarcely been prospected, and complete geologic mapping and exploration by aeromagnetic, geochemical, and drilling methods are warranted.

Withdrawal 7-A (11.A.3)

Location--About 500 square miles in the southwest quarter of the Livengood quadrangle.

Present knowledge--Geologic map on 1:250,000 scale (Chapman, Weber, and Taber, 1971). Some reconnaissance geochemical sampling of bedrock and stream sediment, plotted on 1:250,000 scale map, has been done (Chapman and Weber, 1972).

Adequacy--The basic geologic mapping of this block is adequate for land use decisions; the data are complete enough to compile 1:63,360 scale maps of most of this area. Seven bedrock units are differentiated and past production of small amounts of placer gold and lode antimony are known. Additional geochemical sampling in the zones of hornfels and dike intrusions around 4 granitic plutons should be done in order to better evaluate indications of possibly anomalous amounts of copper, lead, silver, and tin that are shown by reconnaissance geochemical coverage. The serpentinite and mafic rock unit on Cascaden Ridge is a potential source of nickel, chromium, and platinum.

Owing to structural complexity and to many covered intervals, several faults and a complex anticline, the full lateral extent of several rock units are only generally indicated. Detailed aeromagnetic coverage, prior to additional field work, would be very helpful. A private aeromagnetic survey has been made over part of the block, and this may eventually be available.

In summary, at least half of this block can be regarded as favorable for mineral exploration on the basis of present knowledge.

Withdrawal 7-B (11.A.3)

Location--About 144 square miles, in 2 parcels, forming a N-S strip 20 miles east of Tanana and extending from the Tanana River to just north of the Yukon River.

Present knowledge--Existing published maps are inadequate or partly in error. Reports on placer tin areas by Wayland (1961), and Chapman, Coats, and Payne (1963) include some borderline portions of this area and are useful for supplementary data. Field work for reconnaissance 1:250,000 scale mapping of the northern 40 square miles was completed in 1971, and the remainder of the area will be covered in June 1972. Only a few geochemical samples have been collected in this area.

Adequacy--The known bedrock in the area is schist, quartzite, phyllite, and slate with minor amounts of limestone and greenstone. Possibly small belts of serpentinite and Tertiary clastic rocks are included. About half of the area is covered by alluvium, and the rest is partly concealed by soil and vegetation. Some placer gold and tin deposits may be concealed, but no significant metallization is known in the bedrock. In view of the small size of this block, the additional information that will be in hand in 1972 should be adequate for land use decisions. The mineral deposit potential is believed to be low.

Withdrawal 7-C (11.A.3)

Location--About 760 square miles roughly along the Yukon River in the Tanana, Melozitna, and Ruby quadrangles.

Present knowledge--Published geologic maps are generalized and incomplete. Reconnaissance field work for a 1:250,000 scale map of 250 square miles of this area that is in the Tanana quadrangle was completed in 1971 and will be compiled in 1972. About 45 square miles of the block is covered in a placer tin deposits report (Chapman, Coats, and Payne, 1963). The Melozitna and Ruby 1:250,000 scale maps (Cass, 1959a, 1959b) are compiled from old maps and supplemented with photogeology.

Adequacy--Present information is not adequate for a preliminary mineral resource potential appraisal. Bedrock includes a unit of schist, quartzite, phyllite, and slate with minor amounts of limestone and greenstone, the Rampart Group, a granitic pluton , and unit of gneiss-hornfels. Possibly small patches of Tertiary clastic rocks are present. The structure is complex, and a segment of the Kaltag Fault is included. About 25 percent of the area is covered by alluvial deposits, and at least one-third of the bedrock is masked by colluvium and vegetation.

The known mineral deposits are placer gold with minor amounts of tin associated. Gold production has been small and marginally profitable. Too few geochemical samples were collected in 1971 to warrant any conclusions, but a limited amount of panning and prospecting in earlier years revealed little promise of deposits other than the small gold placers in the Grant Dome portion of the area.

In view of the geologic setting, the gold and tin deposits, and the lack of adequate mapping and sampling, this area should be regarded as having some potential for mineral deposits.

Withdrawal 7-D (17.d.1)

Location--About 2,125 square miles in the southeastern part of the Ruby quadrangle and the central-western portion of the Kantishna River quadrangle.

Present knowledge--Geologic knowledge of this block is based on sketchy 1:250,000 scale maps from early-day pack train traverses by Eakin (1918) and Mertie and Harrington (1924). The 1:250,000 Ruby quadrangle (Cass, 1959b) is based on this mapping plus some photogeologic interpretation. No geochemical sampling has been done.

Adequacy--Mapping is inadequate for preliminary mineral resource potential evaluations. Apparently some or all of the lower Paleozoic sedimentary and metamorphic rocks, and the Cretaceous clastic rocks of the Livengood and Fairbanks quadrangles are present. Greenstones of probable lower Paleozoic age, rhyolitic and andesitic volcanic rocks of uncertain age, and several granitic plutons are approximately outlined. A considerable portion of the block is covered by surficial deposits and vegetation, and rock exposures and accessibility are poor.

The structure is complex and details are unknown. Certainly some major faults are present, and an alinement of several isolated placer gold deposits suggests an unrecognized significant fault that is parallel to the Iditarod-Nixon Fork Fault.

Although the only reported mineral deposits are 2 placer gold occurrences on the south-central edge of the block, the geological setting is potentially favorable for mineralization.

Withdrawal 7-E (17.d.2)

Location--About 2,500 square miles in the northern part of the Kantishna River quadrangle, the northern and central part of the Ruby quadrangle, and small portions in the south-central part of the Tanana quadrangle and in the southeastern corner of the Melozitna quadrangle.

Present knowledge--Geologic knowledge of this block is limited to sketchy 1:250,000 scale maps from pack train traverses by Eakin (1918) and Mertie and Harrington (1924). The Ruby quadrangle 1:250,000 (Cass, 1959b) is based on this mapping plus some photogeologic interpretation. A small part of the area adjacent to the Yukon River is shown on an open-file strip map 1:250,000 scale (Robinson, 1959), and mapping of surficial deposits is based largely on aerial and photogeologic interpretation. The small portion in the Tanana quadrangle is covered by Mertie's (1937) 1:500,000 scale map, and it will be remapped during June 1972 as part of the 1:250,000 scale Tanana quadrangle.

Adequacy--Mapping is inadequate for mineral resource potential evaluation. About 70 percent of the block is covered by alluvial and eolian surficial deposits and is largely swampy vegetation-covered ground with very few bedrock exposures. Some Tertiary clastic and coaly rocks are included in this part of the area, but exposures are small and rare and the extent and thickness of these rocks is unknown. Bedrock includes lower Paleozoic sedimentary and metamorphic rocks and a small belt of Cretaceous clastic rocks similar to those in the Tanana, Livengood, and Fairbanks quadrangles. There are some greenstones of probable lower Paleozoic age, one granite pluton of unknown age and size in the southwest corner of the block, and a small belt of serpentinite is present in the northernmost section of the withdrawal. Most of the bedrock is concealed by soil and vegetation.

The only mineral deposits are placer gold deposits, including some tin, in the small segment of this block in the Tanana quadrangle. The Tertiary lignitic coal probably has no economic value. Based on very little information, it appears that only about 10 percent of this block may have a potential that would encourage exploration. However, the structure is undoubtedly complex, there may be several significant concealed faults, including a segment of the Kaltag Fault, and other intrusives may be present; thus favorable sites for mineral deposits may exist beneath surficial deposits of unknown, but not necessarily economically prohibitive, thicknesses.

Withdrawal 7-F (17.d.2)

Location--About 750 square miles in the eastern part of the Kantishna River quadrangle.

Present knowledge--No geologic or geochemical mapping or other studies are published.

Adequacy--Mapping is inadequate for any proper evaluation of this block, but field mapping within the block will not contribute much to a knowledge of other than surficial deposits. Possibly some bedrock or rubble could be found on the low hills in the southern part of the block, and presumably would be lower Paleozoic sedimentary and metamorphic rocks similar to those in the lower part of the section in the Fairbanks quadrangle. Possibly some Tertiary clastic rocks are present. The Iditarod-Nixon Fork Fault might extend through the southern part of the block.

No mineral deposits are known or reported; there is no basis for speculating on the potential.

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SUBREGION 8 (SOUTHWEST ALASKA)

Rocks in subregion 8 consist of gneisses and schists of early Paleozoic and Precambrian(?) ages, carbonates of early and middle Paleozoic age, wackes, tuffs, cherts, lavas and minor limestone of late Paleozoic and early Mesozoic ages, graywacke and siltstone of late Mesozoic age, and intermediate and mafic lavas of Cenozoic age. Except for the late Cenozoic lavas, the rocks are generally tightly folded and broken by many faults. They are intruded by more than 100 stocks of granitic rock of Mesozoic age, thousands of mafic, intermediate, and siliceous dikes and several ultramafic bodies.

The subregion contains our chief domestic platinum source and has been the source of appreciable gold and mercury production.

Petroleum potential for most of the subregion, where bedrock is exposed, is low because the rocks are highly deformed, well-indurated and nonporous. However, the delta region and adjoining continental shelf probably has a higher petroleum potential. Reconnaissance aeromagnetic data indicate that deep sedimentary basins are present beneath the alluvium. A wildcat well drilled 35 miles west of Bethel bottomed in Cretaceous sediments at 15,000 feet. Private sources reported that the strata are only slightly deformed and that the well penetrated about 30 feet of porous rock which contained some indication of oil.

Detailed geophysical data which show the size, shape, and depth of the sedimentary basins would provide a useful tool in evaluating the petroleum potential. Commercial aeromagnetic data in the delta area is presently available.

Withdrawal 8-A (11.A.3)

Location--Yukon-Kuskokwim delta region (2 areas).

Present knowledge--The northern area has been geologically mapped at a scale of 1:250,000 (Hoare and Condon, 1966, 1967); the southern at 1:500,000 (Coonrad, 1957). No geochemical data are available.

Adequacy--The northern block is probably partly underlain by granodiorite. The southern block is underlain chiefly by unconsolidated deposits and late Cenozoic basalt.

The existing data are inadequate to assess the petroleum potential of the withdrawal. Geophysical data, including seismic, aeromagnetic and gravity, are required.

Withdrawal 8-B (11.A.3)

Location--East-west block north of central Kuskokwim River.

Present knowledge--Most of the withdrawal has been geologically mapped at 1:300,000 scale (Cady, Wallace, Hoare, and Webber, 1955). No geochemical data are available.

Adequacy--Bedrock consists chiefly of Cretaceous graywacke and slate with Jura-Cretaceous volcanics at the west end. These rocks are locally intruded by monzonitic, rhyolitic, or diabasic stocks and dikes. The block appears to have moderate gold and high mercury potential but present knowledge is inadequate for a preliminary mineral resource potential evaluation.

Withdrawal 8-C (17.d.2)

Location--Withdrawal 8-C is east of the Yukon River, in the Kaiyuh Hills, at the latitude of Norton Sound.

Present knowledge--The west edge of block has been mapped at 1:250,000 scale (Hoare and Patton, unpub.). No geochemical data are available.

Adequacy--The block is largely covered by brush and alluvium. Bedrock is probably chiefly Paleozoic schists to the east and mixed Paleozoic schists and Mesozoic sediments and volcanics to the west. No mineralization is known in the block but because similar rocks in the adjoining block contain lead-zinc and molybdenite prospects, mineralization, including gold, may also occur in withdrawal 8-C. A preliminary mineral resource potential of the block will require geologic mapping and geochemical sampling.

Withdrawal 8-D (17.d.2)

Location--Withdrawal block 8-D is located on the southeast side of Norton Sound.

Present knowledge--The block is included in a 1:250,000-scale geologic map (Hoare and Patton, unpub.), but no geochemical studies have been undertaken.

Adequacy--Bedrock in the withdrawal comprises late Cenozoic basalts overlying folded Cretaceous sediments. The mineral resource potential is low based on existing, probably adequate, data.

Withdrawal 8-E (17.d.2)

Location--This irregular block north and south of the lower Yukon River includes a small parcel south of the Kuskokwim River.

Present knowledge--The withdrawal has been geologically mapped at a scale of 1:250,000 (Hoare, 1959a, 1959b; Hoare and Condon, 1966, 1971a), but no geochemical or geophysical data are available.

Adequacy--About one-half of the withdrawal is covered by unconsolidated deposits. To the north are folded Cretaceous sediments intruded by large acidic sills. Deformed Paleozoic and Mesozoic sediments and volcanics intruded by granitic stocks occur in the east. One small gold placer is known and zinc has been reported in Kusilvak Mts.

Withdrawal 8-F (17.d.2)

Location--The withdrawal is north of Bristol Bay and extends as far east as the Tikchik Lakes (159°00 longitude).

Present knowledge--Knowledge of the region is limited to poor 1:250,000 scale geologic mapping (Hoare, 1961a, 1961b, unpub.) on a very poor topographic base. No geochemical data are available. Complete aeromagnetic coverage has been recently prepared by the State of Alaska.

Adequacy--The bedrock consists of tightly folded rocks of late Paleozoic and Mesozoic age cut by many faults and intruded by a wide variety of igneous rocks. The withdrawal includes four old unoperating gold placer mines, other gold prospects and minor platinum occurrences. Lead, zinc, and copper mineralization are known and the withdrawal probably contains mercury. The southernmost extension of withdrawal 8-F, the Nushagak Peninsula, is covered by unconsolidated deposits which may overlie petroleum prospective strata of Tertiary and Cretaceous ages.

Although the geologic knowledge of this region is inadequate for the purposes of preliminary mineral resource potential evaluations, there seems a good chance that portions of the withdrawal contain valuable minerals. New topographic mapping, complete geologic mapping and geochemical sampling are required.

Withdrawal 8-G (17.d.1)

Location--This northeast-trending block is east of Kuskokwim Bay and the lower Kuskokwim River.

Present knowledge--Understanding of the area is limited to 1:250,000 scale geologic mapping (Hoare, 1959a, 1959b, 1961b) on a poor topographic base. No geochemical data are available.

Adequacy--The bedrock consists of folded and faulted Cretaceous and Jurassic sediments and volcanics intruded by granitic and rhyolitic stocks and many diabase dikes. Some rocks of Paleozoic and probable Precambrian age are included in the southern end of the withdrawal. The area contains one operating gold placer, one old unoperating gold-cinnabar placer, a cinnabar prospect, and a large area with high gold potential in rocks identical to those at Nyac.

Available data are inadequate for preliminary mineral resource potential evaluations. Better 1:250,000 scale geologic mapping supplemented by regional and detailed geochemical sampling are needed.

Withdrawal 8-H (17.d.1)

Location--The withdrawal is located north of Nushagak and Kvichak Bays.

Present knowledge--No modern geologic mapping or geochemical data are available. There is partial commercial aeromagnetic coverage.

Adequacy--The bedrock is mostly Mesozoic sedimentary rocks with minor late Paleozoic sedimentary rocks intruded by several granitic stocks. The area is mostly covered by moraine and outwash. No mineralization is known except for magnetite-rich pyroxenite near the north of the withdrawal. There may be potential for gold and mercury resources.

The data presently available are inadequate for preliminary mineral resource potential evaluation.

Withdrawal 8-I (17.d.1)

Location--Hagemeister Island.

Present knowledge--The withdrawal is covered by 1:250,000 scale geologic mapping (Hoare, 1961a), but no geochemical data are available.

Adequacy--The bedrock consists of Mesozoic sediments and volcanics intruded by two granitic stocks and numerous diabase dikes. Gold has been reported in beach sands at the north end of the island.

Although there may be some potential for small gold placer deposits, the existing data generally suggest a low resource potential in the withdrawal.

Withdrawal 8-J (17.d.1)

Location--Withdrawal 8-J is located on the southern side of Norton Sound.

Present knowledge--The region is covered by 1:250,000 scale geologic mapping (Hoare and Condon, 1971b), but no geochemical or geophysical data are available.

Adequacy--Bedrock, which is largely obscured by alluvium, consists of Cretaceous sedimentary rocks and minor late Cenozoic lava. No mineralization is known in the withdrawal and the existing data appear adequate to suggest a low mineral resource potential.

Withdrawal 8-K (17.d.2)

Location--The withdrawal is a small block located east of the mouth of Kuskokwim River.

Present knowledge--Most of the area has been mapped geologically at 1:250,000 scale (Hoare, 1959b), but no geochemical or geophysical data are available.

Adequacy--The withdrawal is entirely underlain by thick unconsolidated deposits; the bedrock is unknown. The probable mineral potential is low but geophysical data will be needed to adequately evaluate the possible petroleum potential.

Withdrawal 8-L (11.A.3)

Location--Withdrawal 8-L is situated in the great bend of the Yukon River west of Holy Cross village.

Present knowledge--The area has been mapped at a scale of 1:250,000 (Hoare, unpublished), but no geochemical or geophysical data are available.

Adequacy--The withdrawal area is brush-covered and underlain by Tertiary and Cretaceous(?) volcanic rocks that probably overlie Cretaceous sediments. No mineral occurrences are known and the area probably has little potential.

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SUBREGION 9 (CENTRAL AND SOUTHERN ALASKA RANGE)

The dominant physiographic features of subregion 9 are the central and southern portions of the Alaska Range. The central and southern portions of the Alaska Range are composed chiefly of Mesozoic and Cenozoic granitic rocks intruded into and flanked by Middle and Upper Devonian limestone and basalt, Mississippian(?) basalts and argillites, and Permian basalts, calcareous tuffs, limestone and subordinate shale. Unconformably overlying these rocks are Upper Triassic limestone and shale, Upper Jurassic and Lower Cretaceous shale, argillite, sandstone and conglomerate, and Upper Cretaceous terrestial deposits. In the northwest portion of subregion 9, north of the crest of the Alaska Range, are strongly metamorphosed rocks of uncertain, probably Paleozoic age.

The structure of the Alaska Range and surrounding rocks is complex. Most of the rocks are strongly folded and fractured. The predominant structural feature is the Denali fault which is a major strike-slip structure that roughly parallels the crest of the Range. The Denali fault and associated subparallel faults are the major structural control for the emplacement of plutons and occurrences of ore deposits in the Alaska Range.

Mineral occurrences with subregion 9 are of three main types: lode vein and replacement deposits, disseminated deposits, and placer deposits.

Deposits of the types mentioned have produced over one million dollars from three districts within subregion 9: the Upper Chulitna district (Hawley and Clark, 1968), the Yentna district, and the Innoko district. In addition, significant reserves of antimony-silver are known in the Kantishna district.

At present it is impossible to evaluate the total potential of subregion 9, however, in any preliminary economic evaluation several factors must be stressed:

1. Recent studies by Hawley and Clark (1968), Hawley and others (1969), Elliott and Reed (1968), and Reed and Elliott (1968a, b, 1969) have shown that wherever geologic mapping and geochemical sampling have been carried out in subregion 9, significant occurrences of mineral resources have been discovered.

2. The known geology of subregion 9 is identical to the geologic setting of known porphyry copper districts of the southwestern United States and South America.

3. Numerous incompletely evaluated porphyry copper type deposits are known in subregion 9 and throughout the Alaska Range.

The economic significance of defining subregion 9 as a porphyry copper-bearing area with numerous associated base metal deposits is best summarized by Jerome (1966, p. 79-80).

> "...it may be appropriate to summarize some of the main characteristics of the porphyry copper ore body. It is a large, low-grade ore body dominated by primary and secondary copper minerals in disseminated grains, stockwork veinlets, and breccia pipe and vein fillings superimposed on an intermediate to salic intrusive rock and its wall rocks...The size of the combined ore bodies in terms of today's economics ranges from 20 million to over 4 billion tons, with the value of several of the largest districts exceeding $4 billion; continued exploration and development and more economic methods of mining and milling will expand these figures...Also it should not be forgotten that the central ore bodies often are surrounded by satellites of copper, magnetite, lead, and zinc, some with precious metal values. These latter ore bodies, although greatly overshadowed by their big brothers, contribute substantially to the tonnage of metal and the dollar value of such districts."

In summary, the mineral potential of subregion 9 is inadequately evaluated but probably very large (in excess of one billion dollars).

Withdrawal 9-A (11.A.3)

Location--Withdrawal area 9-A comprises approximately 3,200 square miles located in the Kuskokwim Mountains physiographic province (Wahrhaftig, 1965).

Present knowledge--All existing geological mapping is peripheral to the area. No geochemical sampling has been done within or peripheral to the area.

Adequacy--No existing information.

Withdrawal 9-B (17.d.2)

Location--Withdrawal area 9-B comprises approximately 8,500 square miles, exclusive of Mt. McKinley National Park, located in the central Alaska Range physiographic province (Wahrhaftig, 1965).

Present knowledge--Existing geologic mapping within the withdrawal area (scale 1:250,000) covers approximately 3,100 square miles northeast and southwest of Mt. McKinley National Park (Reed and Lanphere, 1972, in press). Larger scale mapping (scale approximately 1:63,360) covers approximately 900 square miles in the areas of the Upper Chulitna district (Hawley and Clark, 1968, 1969), the Yentna district (Clark and Hawley, 1969), and the Kantishna district (Wells, 1933; White, 1942).

Reconnaissance geochemical sampling has covered approximately 1,000 square miles, including approximately 800 square miles southwest of Mt. McKinley National Park (Reed and Elliott, 1968b) and approximately 200 square miles in the Yentna district (Clark and Hawley, 1968).

Lode and placer deposits have been studied in detail in the Kantishna district (Wells, 1933; White, 1942) and the Yentna district (Clark and Hawley, 1968).

Adequacy--Recent studies have shown the existence of a major mineral belt, the Chulitna-Yentna mineral belt (Hawley and Clark, in press), which extends the entire length of the southeastern border of the withdrawal area. The results of this study show an area of very high mineral potential in copper, gold, silver, molybdenum, lead, and zinc. In addition, minor occurrences of tin, tungsten, and chromite were noted.

Potential mineral deposits of the area are copper-molybdenum-porphyries, gold-copper-molybdenum-lead zinc breccia pipes, copper-lead-zinc massive sulfides and copper-gold disseminated sulfides in volcanic hosts.

In presently partially explored areas within and immediately adjacent to the withdrawal area, there is a known potential of 19 million dollars (17 million dollars in the Upper Chulitna district and 2 million dollars in the Yentna district) and a probable resource potential of 360 million dollars.

Preliminary reconnaissance evaluation of approximately 800 square miles southwest of Mt. McKinley National Park (Reed and Elliott, 1968a) defined several areas of anomalous copper, molybdenum, silver, zinc, and lead. The anomalous concentrations are believed to be related to porphyry copper type mineralization and to smaller massive lead-silver sulfide replacement bodies similar to those discovered by Reed and Elliott (1968a).

The area of withdrawal 9-B south of Mt. McKinley National Park is considered to have a very high economic potential, although less than one-fourth of the area has been evaluated.

The Kantishna district, north of Mt. McKinley National Park, has produced gold, silver, lead, zinc, and antimony and presently has proven reserves of at least 12,000 tons of stibnite ore averaging more than 6 percent antimony and an unknown amount of gold and silver. The potential of the district is unproven but large.

The area of withdrawal 9-B, north of Mt. McKinley National Park, has a high potential for mineral resources, however less than one-fifth of the area has ever been studied.

The entire area, with the exception of the Yentna district and a small part southwest of Mt. McKinley National Park studied by Reed and Elliott (1968b), requires geologic mapping and geochemical sampling. In areas of cover or high relief, detailed geophysical studies, including gravity and aeromagnetics, should be undertaken.

Detailed mapping and sampling is needed in areas of known mineralization to estimate the true economic potential of the area. This is particularly true of the Kantishna district.

Withdrawal 9-C (17.d.1)

Location--Withdrawal area 9-C comprises approximately 4,800 square miles in part of the Tanana-Kuskokwim lowlands and in the Nushagak-Big River Hills physiographic provinces (Wahrhaftig, 1965).

Present knowledge--There is no known geologic mapping or geochemical sampling within the area. Geological and geochemical studies peripheral to the area have demonstrated the presence of quicksilver deposits (Sainsbury and McKevett, 1965) and lead-silver deposits (Reed and Elliott, 1968a, b).

Adequacy--No existing information. The entire area will require a reconnaissance geologic and geochemical study. Because of the large areas of covered bedrock, geophysical studies will also be required.

Withdrawal 9-D (17.d.1)

Location--Withdrawal area 9-D comprises approximately 250 square miles located in part in the Kuskokwim Mountains and in part in the Nushagak-Big River Hills physiographic provinces (Wahrhaftig, 1965).

Present knowledge--There is no known geologic mapping or geochemical sampling within withdrawal area 9-D. The nearest geologic mapping is approximately 50 miles to the southwest (Cady and others, 1955).

Adequacy--No existing information. The entire area will require a reconnaissance geologic and geochemical study. Because of the large areas of covered bedrock, geophysical studies will also be required.

Withdrawal 9-E (17.d.2)

Location--Withdrawal area 9-E (17.d.2) comprises approximately 700 square miles located in part in the Kuskokwim Mountains and in part in the Nushagak-Big River Hills physiographic provinces (Wahrhaftig, 1965).

Present knowledge--There is no known geologic mapping or geochemical sampling within the withdrawal area. The nearest geologic mapping (Cady and others, 1955) is peripheral to the area on the southwest.

Adequacy--No existing information. The entire area will require a reconnaissance geologic and geochemical study. Because of the large areas of covered bedrock, geophysical studies will also be required.

Withdrawal 9-F (11.A.3)

Location--Withdrawal area 9-F (11.A.3) comprises approximately 1,900 square miles located in the southern Alaska Range physiographic province (Wahrhaftig, 1965).

Present knowledge--The area has been mapped in reconnaissance (Capps, 1935; Reed and Lanphere, 1969, scale 1:250,000). No geochemical sampling has been undertaken.

Adequacy--Reconnaissance studies by Capps (1935) showed that the general geology of the region is similar to that of the remainder of subregion 9 with one exception. The area has a history of volcanism from Eocene to recent (Capps, 1935, p. 70) associated with the Mount Spurr area. Eruptions from Mount Spurr have resulted in the accumulation of a thick pile of tuffs, breccias and lava flows.

Little is known of the economic potential of the area except that porphyry molybdenum and copper mineralization was reported near Hayes glacier in the northeastern portion of the area in a highly altered granitic stock 3-4 miles in length and approximately 1 mile wide. In addition, copper-bearing float samples have been noted by M. B. Estlund (personal communication) along the western portion of the study area near Chackachamna Lake.

Available information suggests the potential of large porphyry type deposits of copper-molybdenum. There is, however, insufficient information to adequately evaluate this potential. Thus the entire area requires a reconnaissance mapping and geochemical sampling program to assess its economic potential.

Withdrawal 9-G (17.d.1)

Location--Withdrawal area 9-G comprises approximately 288 square miles located in the Nushagak-Big River Hills physiographic province (Wahrhaftig, 1965).

Present knowledge--No geologic or geochemical mapping is known in the area.

Adequacy--No existing information. The entire area requires a reconnaissance mapping and geochemical sampling program.

Withdrawal 9-H (17.d.1)

Location--Withdrawal area 9-H comprises approximately 540 square miles located in the Kuskokwim Mountains physiographic province (Wahrhaftig, 1965).

Present knowledge--With the exception of the area of the Innoko mining district (Mertie, 1936, p. 174-192) located in the western portion of the area, the area is mapped only in reconnaissance. No known geochemical sampling has been undertaken.

Adequacy--The area is geologically similar to the general geology of subregion 9. The western portion of the area has produced considerable placer gold and lode deposits of stibnite, cinnabar and gold are known. The total potential of the area is unknown but does not appear to be large.

Reconnaissance geologic mapping and geochemical sampling should be undertaken for all the area. In addition, detailed geology and geochemical studies should be conducted within the Ophir area to determine the potential of the area.

Withdrawal 9-I (17.d.2)

Location--Withdrawal area 9-I comprises approximately 5,000 square miles located in the southern Alaska Range physiographic province (Wahrhaftig, 1965).

Present knowledge--The entire withdrawal area has been mapped in reconnaissance (scale 1:250,000) by Capps (1935) and Reed and Lanphere (1969). No geochemical sampling has been done within the study area, however regional geochemical studies were conducted north of withdrawal area (Reed and Elliott, 1970).

Adequacy--The general geology of the area as described by Capps (1935) is similar to the general regional geology of subregion 9. The primary difference is that the east-southeast portion of the area is overlain by Tertiary and Quarternary basaltic, andesitic, and dacite flows and tuffs. Within the area, copper, gold, silver, lead, zinc, and molybdenum replacement, vein, and disseminated deposits occur in sedimentary rocks, in propylitized andesitic and dacitic volcanic rocks, and in complex hypabyssal intrusive centers.

Recent exploration in the area has proven the existence of at least one medium tonnage copper deposit southeast of Lake Clark which has an expected resource value of at least 200 million dollars. In addition, active exploration is presently underway on at least two other porphyry type deposits. Work by Reed and Elliott (1970) north of the study area showed the presence of argentiferous galena-sphalerite and sphalerite-pyrrhotite fracture fillings in igneous breccias. The similarity in geology and geographic proximity to area 9-F strongly indicates the potential for similar types of deposits.

The overall geologic environment consisting of multiple igneous intrusions of varying age with associated andesitic volcanics and the presence of known porphyry type mineralization makes this area very similar to the porphyry copper areas of the southwest United States and strongly suggests a comparable potential. If comparable potential exists, the area may well have a resource value in excess of one billion dollars.

The entire area requires semi-reconnaissance (scale 1:100,000) mapping and a geochemical sampling program to assess its economic potential. Selected areas will need to be studied geophysically for similarity with known porphyry copper deposits.

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SUBREGION 10 (CENTRAL ALASKA RANGE)

Subregion 10 is located in south-central Alaska and is approximately bounded by the Alaska Railroad on the west and by the Richardson Highway on the east and north. The southern boundary lies just north of latitude 62°N.

The northernmost portion of subregion 10 is underlain by the Tanana River lowlands, the central part by the rugged Alaska Range, and most of the southern portion by the Talkeetna Mountains. The Copper River lowlands extend into the southeast corner of the subregion.

The geologic backbone of subregion 10 is the east-west trending Denali fault system, separating two geologically dissimilar terranes. The area north of the Denali system consists chiefly of Precambrian to upper Paleozoic metamorphic and sedimentary rocks, lesser Tertiary marine and non-marine deposits, and a number of small intrusive bodies ranging in composition from felsic to mafic. South of the fault system the terrane is dominated by large granitic plutons and by a variety of volcanic and sedimentary rocks, all of late Paleozoic and Mesozoic age. Quaternary surficial deposits are widespread in both terranes.

Lode mineralizations of gold, silver, lesser copper, and some antimony and molybdenum, generally near the borders of felsic intrusives, are common throughout the subregion. However, as the lodes are small or of low grade, only small amounts of gold with subordinate silver and some antimony have been produced (Berg and Cobb, 1967). Considerable placer gold was mined along the northern foothills of the Alaska Range and around Denali (Cobb, 1972). Substantial placer gold reserves (approximately 480,000 fine ounces) remain near Denali in withdrawal block 10-C according to Smith (1970b). Extensive deposits of subbituminous coal along the northern flank of the Alaska Range are the most important mineral resources in subregion 10 (Wahrhaftig and others, 1951; Barnes, 1967). Until 1964 a total of 9.6 million tons of coal was produced from the Nenana field (Barnes, 1967).

Evaluation of the mineral resource potential of subregion 10 is greatly hindered by the paucity of geologic information. On the basis of the information available, no withdrawal block boundary changes are proposed.

Withdrawal 10-A (11.A.3)

Location--In the Fairbanks 1:250,000 quadrangle just west of the Wood River, about 30 miles southwest of Fairbanks, the withdrawal block underlies an area of approximately 350 square miles within the Tanana River lowlands.

Present knowledge--The entire block is covered by up-to-date geologic mapping at 1:250,000 scale (Péwé and others, 1967). However, geochemical information is lacking.

Adequacy--The withdrawal block is underlain solely by Quaternary glacial outwash deposits and alluvium. No economic placer deposits are known to occur in the withdrawal block or in adjacent areas of similar geologic composition. The probability of substantial placer deposits appears to be small, although the lack of geochemical data does not permit a definitive evaluation.

Withdrawal 10-B (11.A.3)

Location--In the Healy 1:250,000 quadrangle along the southern flank of the Alaska Range near the headwaters of the Nenana River, the withdrawal block has an approximate area of 400 square miles.

Present knowledge--Modern geologic map coverage, as well as geochemical information, are lacking. Available geologic maps consist of an early-day 1:250,000 reconnaissance map by Moffit and Pogue (1915) and subsequent regional compilation and aerial photo interpretation maps at 1:250,000 scale (Capps, 1940; Wahrhaftig, 1958). Aeromagnetic maps at 1:63,360 scale prepared by the Alaska Geological Survey are available for the southern half of the withdrawal block.

Adequacy--Intensely deformed upper Paleozoic to Upper Cretaceous(?) sedimentary rocks intruded by granitic plutons comprise the exposed bedrock. Quaternary morainal deposits and alluvium cover almost half of the withdrawal block. The McKinley strand of the Denali fault system cuts across the withdrawal block at its northern tip. Although no mineral deposits are known to occur within the withdrawal block, its mineral potential cannot be evaluated on the basis of present geologic information. A program of geochemical sampling, both bedrock and stream sediments, and some geologic mapping at a scale 1:125,000 is needed.

Withdrawal block 10-C (11.A.3)

Location--This area of approximately 1,250 square miles is located in the Healy, Mount Hayes, and Gulkana 1:250,000 quadrangles, mostly around the upper MacLaren River.

Present knowledge--Much of this large withdrawal block is covered only by early-day exploratory geologic mapping at 1:250,000 scale (Chapin, 1918). Portions of the area have never been geologically mapped. In contrast, up-to-date geologic and geochemical maps at an approximate scale 1:150,000 cover the westernmost part of the withdrawal block around Denali (Smith, 1970a). Aeromagnetic survey maps by the Alaska Geological Survey at the scale of 1:63,360 are available for the northern portion of the block and an aeromagnetic map at a scale of 1:125,000 covers the southern portion (Andreasen and others, 1958). The placer gold deposits around Denali have been investigated by Smith (1970b).

Adequacy--Except for the westernmost areas, the geology of the withdrawal block is inadequately known. Dominant rock types comprise a sequence of andesitic metavolcanics and clastic metasediments of late Paleozoic age, overlain by Mesozoic mafic volcanic and volcaniclastic rocks. Small granitic intrusive bodies are common. A large portion of the withdrawal block is underlain by Quaternary glacial deposits and alluvium. Considerable placer gold was mined from Pleistocene alluvial gravels near Denali, and Smith (1970b) calculates the remaining potential gold reserves to be more than 480,000 fine ounces (over $18 million at $38 per ounce). None of the lode mineralizations around Denali are economic. The mineral resource potential of the remainder of the withdrawal block is unknown.

Withdrawal block 10D (11.A.3)

Location--Withdrawal 10-D consists of about 420 square miles in the Talkeetna Mountains and Gulkana 1:250,000 quadrangles, around the Tyone River along the western edge of the Copper River lowlands.

Present knowledge--Available geologic information is limited to early-day exploratory investigations shown on 1:250,000 geologic maps (Chapin, 1918). The withdrawal block is covered by an aeromagnetic map at the scale of 1:125,000 (Andreasen and others, 1958).

Adequacy--Most of the withdrawal block is underlain by Quaternary glacial deposits and alluvium. Mesozoic basic lavas and upper Paleozoic clastic sediments crop out in a few small areas. The mineral potential of the withdrawal block cannot be evaluated on the basis of present geologic information. A program of geochemical sampling and geologic mapping of bedrock areas at the scale of 1:125,000 is needed.

Withdrawal block 10-E (17.d.1)

Location--The withdrawal block underlies approximately 3,400 square miles in the northern Talkeetna Mountains.

Present knowledge--Over half of the withdrawal block has never been geologically mapped, not even by early-day exploratory surveys. Thus this block constitutes one of the least known areas not only in subregion 10 but in the State of Alaska as well. What geologic information there is is shown on a 1:250,000 reconnaissance geologic map by Capps (1940).

Adequacy--The withdrawal block is underlain by a variety of metavolcanic and sedimentary rocks of late Paleozoic and Mesozoic age intruded by numerous Late Mesozoic granitic plutons. A few lode mineralizations of gold, silver, and minor copper occur in the withdrawal block (Berg and Cobb, 1967) but none appear to be economic. Available geologic information is inadequate to assess the mineral resource potential of this withdrawal block. An extensive program of reconnaissance geologic mapping at a scale of 1:125,000 and geochemical sampling is needed.

Withdrawal block 10-F (17.d.2)

Location--Withdrawal 10-F consists of approximately 820 square miles in the Gulkana 1:250,000 quadrangle, within the Copper River lowlands.

Present knowledge--Map coverage consists of an exploratory geologic map of 1:250,000 scale by Chapin (1918) and of an aeromagnetic survey map of 1:125,000 scale by Andreasen and others (1958).

Adequacy--Except for some low hills along its northern edge, the withdrawal block is underlain entirely by Quaternary glacial deposits and alluvium. The hills along the northern edge are comprised of late Paleozoic mafic metavolcanic rocks. There are no known mineral deposits within the withdrawal block, and the probability of finding some in the future appears to be small.

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SUBREGION 11 (EASTERN ALASKA RANGE AND WRANGELL MOUNTAINS)

Subregion 11 includes the Nabesna and McCarthy quadrangles and parts of the adjacent Tanacross, Mount Hayes, Gulkana, and Valdez quadrangles. Physiographically, the southern half of the subregion is characterized by the high and rugged Wrangell and Chugach Mountains and the northern half by the eastern part of the Alaska Range and its subsidiary mountains. The mountainous regions are separated by locally extensive lowlands that are largely mantled by Quaternary surficial deposits. The physiography of the subregion strongly reflects glaciation and glacier-related erosional and depositional processes.

The subregion is divisible into three distinct geologic terranes that are separated by faults. The southernmost terrane is entirely within the Chugach Mountains and is bounded on the north by a northwest-striking fault that extends across the southwestern part of the McCarthy quadrangle into the Valdez quadrangle. A thick sequence of Mesozoic flysch-type graywacke and argillite dominates the geology south of the fault. The intermediate terrane is bounded by the aforementioned fault and by the Denali Fault, which extends northwestward across the northern part of the Nabesna quadrangle into the Tanacross and Mount Hayes quadrangles. Basement rocks of the intermediate terrane comprise generally metamorphosed late Paleozoic submarine volcanic and volcaniclastic rocks that are associated with subordinate sedimentary rocks, gabbro, and local alpine-type ultramafics. Diverse Mesozoic sedimentary and volcanic assemblages overlie the basement rocks. Quaternary subaerial volcanic rocks cover parts of the Wrangells and constitute the youngest bedrock. The terrane north of the Denali Fault consists mainly of greenschist facies metamorphic rocks. Granitic plutons are sporadically distributed throughout all three terranes and, in a few places, attain batholithic dimensions. The subregion's lowlands and many of its intermontane valleys are largely covered by surficial deposits. Structural trends throughout most of the subregion are northwestward.

The intermediate terrane has a high mineral resource potential, but the potential of the northernmost and southernmost terranes is minimal. Production from the intermediate terrane is dominated by the Kennecott mines whose output of copper valued in excess of $500,000,000 and about $9,000,000 worth of byproduct silver far exceeds the amounts of gold, copper, and silver recovered from the few other mines in the subregion. In addition, the intermediate terrane contains numerous promising prospects and large scantily explored tracts that are geologically favorable for mineral deposits. Several large low-grade porphyry type copper-molybdenum deposits are associated with Cretaceous granitic plutons along the northern flanks of the Wrangells in the Nabesna quadrangle. These deposits were mainly discovered during the past 10 years and are mostly still in the exploration stage. Preliminary evaluations indicate that these deposits contain about 2 billion tons of material averaging 0.3 percent copper and a substantial quantity of potential byproduct molybdenum. Besides copper, gold, silver, and molybdenum the intermediate terrane contains a few other mineral commodities of potential economic significance, notably nickel and antimony.

The southernmost terrane has produced small amounts of gold. Except for the likelihood that it contains additional small gold-bearing vein and placer deposits its mineral potential is regarded as poor. Likewise the northernmost terrane has a low mineral resource potential. This terrane contains an antimony deposit, scattered small placer gold deposits, and local magnesitic marble. However, production has been insignificant, and the possibility of important new discoveries in the northernmost terrane is considered poor.

Withdrawal 11-A (17.d.2)

Location--Withdrawal 11-A includes approximately 108 square miles in the Valdez quadrangle between the Richardson Highway and the Chitina River.

Present knowledge--For practical purposes withdrawal 11-A is unmapped geologically, although Moffit's (1938) 1:250,000 reconnaissance map covers a small part of the area.

Adequacy--The fault that separates the southernmost terrane from the intermediate terrane projects through the area. The approximately one-third of the withdrawal that lies north of the projected fault probably is largely underlain by a late Paleozoic complex of metamorphic rocks, gabbro, and ultramafics. Ultramafic rocks have been mapped by Barry Hoffman (University of Alaska) during his thesis study in an area about 10 miles north of the withdrawal, and similar ultramafics and mafics occur at Spirit Mountain, about 10 miles east of the withdrawal. The region north of the projected fault has some mineral potential because nickel-copper deposits are associated with the ultramafic-mafic complex at Spirit Mountain (Kingston and Miller, 1945; Herreid, 1970), and because the ultramafic rocks are possible hosts for chromite and platinum. Chromite, along with traces of nickel and platinum, occurs in a dunite sill about 10 miles north of the withdrawal, but the deposits probably are too lean and too small to be exploited at present. The region south of the fault is probably largely underlain by Valdez Group graywacke and argillite and except for gold has a low mineral potential. Gold lodes clustered near Tonsina Lake, several miles west of the withdrawal, are localized in Valdez Group rocks near small granitic plutons. They have yielded only a small production.

An adequate mineral resource potential evaluation of withdrawal 11-A would require reconnaissance geologic mapping and concomitant geochemical sampling of the entire area and would be abetted by aeromagnetic and gravity geophysical studies.

Withdrawal 11-B (11.A.3)

Location--Withdrawal 11-B includes 1,300 square miles in the Nabesna quadrangle, 504 square miles in the Gulkana quadrangle, 432 square miles in the Valdez quadrangle, and 108 square miles in the McCarthy quadrangle.

Present knowledge--Except for its northeasternmost 4 townships, which are in the Nabesna quadrangle north of the Denali Fault, the entire area of withdrawal 11-B is in the intermediate terrane as defined in the general statement on this subregion. The withdrawal area is covered by Moffit's (1938, 1954) 1:250,000 reconnaissance geologic maps, which, despite their general usefulness, are not adequate for modern mineral resource potential evaluations. In addition, a 1:62,500 geologic map by Moffit and Mertie (1923) includes a few square miles near the southeastern part of the withdrawal in the McCarthy quadrangle, and about one-third of the withdrawal in the Nabesna quadrangle is covered by 1:63,360 maps by Richter (1971a) and by Matson and Richter (1971a, 1971b). Surficial deposits in that part of the Copper River basin within the withdrawal have been investigated by several U.S. Geological Survey geologists. Richter's and Matson's studies and those in the Copper River basin are considered adequate for the present evaluations.

Adequacy--The geology and resource appraisal for the withdrawal are summarized on a quadrangle basis.

Nabesna quadrangle:

The four townships in the withdrawal that lie north of the Denali Fault contain scattered low hills of Paleozoic schist that are surrounded by lowlands mantled by Quaternary surficial deposits. No mineral deposits are known in these townships, and the potential for significant deposits in them is poor.

The remaining 32 townships in the Nabesna quadrangle part of the withdrawal are characterized by three northwest-trending geologic belts. The northernmost belt consists of a thick Upper Jurassic-Lower Cretaceous graywacke-argillite-siltstone-conglomerate sequence; the medial belt contains diverse Paleozoic and Triassic sedimentary and volcanic rocks and scattered Cretaceous granitic plutons; the southernmost belt is dominated by the Quaternary Wrangell Lava.

The medial belt has the best mineral potential of the three belts. It contains the Nabesna mine near White Mountain, a contact-metamorphic deposit with production (mainly gold) valued at $1,870,000, and a few gold or copper propsects. Parts of the medial belt offer geologically favorable targets for mineral exploration. Both the northern and southern belts have small mineral resource potentials; however, they cannot conclusively be regarded as lacking potential.

Gulkana quadrangle:

The part of the Gulkana quadrangle in the withdrawal includes some of the spectacular volcanic peaks of the Wrangells. It is largely underlain by Wrangell Lava, but it contains some shallow Tertiary plutons that are affiliated with the lava, and a few windows of Mesozoic and Permian rocks.

Errors

p. 116 Withdrawal 11-A is erroneously listed as withdrawn under section 11.A.3. It is actually withdrawn under section 17.d.2 and should be considered as part of withdrawal 11-E (17.d.2).

The mineral potential of this area is considered low, but, in places, granitic plutons associated with Wrangell Lava are mineralized and are possible exploration targets.

McCarthy quadrangle:

Three townships near the northwest corner of the McCarthy quadrangle are included in the withdrawal. They are underlain by Wrangell Lava and by Permian and Mesozoic rocks, chiefly volcanics.

Several copper prospects are reported from the Kluvesna River drainage in this part of the withdrawal (Moffit and Mertie, 1923, p. 112-115). These prospects, which also contain minor amounts of silver and gold, are in the Nikolai Greenstone or Permian volcanics. None have produced. The Permian and Mesozoic rocks have the best promise as hosts for mineral deposits, but the Wrangell Lava terrane is considered to have a poor potential.

Valdez quadrangle:

That part of the withdrawal in the northeastern part of the Valdez quadrangle is largely underlain by Wrangell Lava. It also contains Tertiary plutons, some inliers of Mesozoic and late Paleozoic rocks, and Quaternary surficial deposits. The region contains one prospect, which explored a copper-bearing vein in the Nikolai Greenstone. The older rocks and the plutons have the best mineral potential, but the withdrawal area within the quadrangle is largely covered by Wrangell Lava, and its overall potential is low.

An adequate mineral resource potential evaluation of withdrawal 11-B would require geological mapping and geochemical sampling of all bedrock areas in the withdrawal except those in the Nabesna B-4, C-4 and C-5 quadrangles.

Withdrawal 11-C (11.A.3)

Location--Withdrawal 11-C includes about 828 square miles in the southeastern part of the Mount Hayes quadrangle and in the northeastern part of the Gulkana quadrangle.

Present knowledge--Except for half a township in its extreme northeastern corner that lies north of the Denali Fault, the withdrawal is within the intermediate terrane of the subregion.

The withdrawal area is covered by Moffit's (1954) 1:250,000 reconnaissance map and locally by reports stressing the surficial deposits.

Adequacy--None of the withdrawal's bedrock regions are considered to be adequately mapped for mineral potential evaluations.

The withdrawal includes bedrock terrane of the southern flank of the Alaska Range and lowlands of the Copper River basin that are covered by surficial deposits. The small part of the withdrawal north of the Denali Fault is underlain by schists of Devonian and older(?) age. The remaining much larger part of the withdrawal is underlain by late Paleozoic volcanic and sedimentary rocks, diverse plutonic rocks, and Quaternary surficial deposits.

The withdrawal contains placer gold deposits, but no lodes are reported from within its confines. Probably less than half of the $3,000,000 placer gold production from the Chistochina district was recovered from the withdrawal. The area is considered to have some potential for additional placer gold production and for lode gold deposits. Several nearby areas that have been studied in detail contain base metal-silver lodes and good exploration targets, although none of the areas have yielded significant production. These areas include the Slana district (Richter, 1966), the Upper Slana-Mentasta Pass area (Richter, 1967), the Upper Chistochina River area (Rose, 1967), and the Eureka Creek and Rainy Creek areas (Rose, 1966).

The bedrock tracts of the withdrawal need mapping and geochemical sampling for an adequate evaluation.

Withdrawal 11-D (17.d.1)

Location--Withdrawal 11-D includes large parts of the Nabesna and McCarthy quadrangles and contains most of the Wrangell Mountains and a few subsidiary mountains of the eastern Alaska Range.

Present knowledge--Most of the withdrawal has been mapped at 1:250,000 by Moffit (1938, 1954). Several geologists have investigated mines, prospects, and specific geologic topics within the withdrawal, and their publications are useful, but, like Moffit's maps, they are not entirely adequate for the objectives of this study. Modern mapping and related investigations that are considered satisfactory for the present objectives in the Nabesna quadrangle part of withdrawal 11-D covers the Nabesna A-1, A-2, A-3, A-4, and B-4 quadrangles (Richter, 1971a, b; Matson and Richter, 1971c, 1972 (in press)). Similarly adequate investigations in the McCarthy quadrangle by MacKevett and coworkers cover the McCarthy B-4, B-5, B-6, C-4, C-5, C-6, and C-8 quadrangles. Recent investigations, as yet unpublished, in the McCarthy B-7 and parts of the C-7 quadrangles provide a basis for appraising these quadrangles.

Adequacy--The small part of the withdrawal north of the Denali Fault is characterized by widespread Cenozoic surficial deposits that surround hills composed of Paleozoic schist and phyllite with subordinate granitic and gabbroic plutons. The vast part of the withdrawal south of the Denali Fault includes most of the Wrangell Mountains and is underlain by a generally well-exposed sequence that ranges from late Paleozoic to Quaternary in age. This region contains a basement complex of typically weakly metamorphosed mafic lavas, volcaniclastic rocks, and gabbro that is overlain by Permian marine sedimentary rocks and by extensive Mesozoic rocks. The layered Mesozoic rocks consist of abundant Middle(?) and Late Triassic rocks including widespread subaerial basalts and marine shelf deposits, in part carbonates, and in the southern Wrangells by local Jurassic rocks that mainly consist of diverse clastic assemblages of shallow marine genesis. Cretaceous rocks in the southern Wrangells consist of epiclastic shallow marine sedimentary types that generally are separated from older rocks by a marked unconformity. North of the Wrangells the Late Jurassic and Early Cretaceous are represented by a turbidite sequence of graywacke and argillite that is overlain locally by andesitic volcanics. Cenozoic rocks in the withdrawal include the voluminous Wrangell Lava that caps most of the Wrangells, local subaerial sedimentary rocks that are subjacent to or partly coeval with older Wrangell Lava, and diverse surficial deposits that are mainly of glaciofluvial origin. Plutonic rocks are widely distributed throughout the withdrawal and formed during several intervals. They comprise gabbro and less abundant granitic rocks of Permian age, local Jurassic granitic rocks, mid-Cretaceous granodiorite, and shallow-seated granitic and subvolcanic types interpreted as genetic affiliates of the Wrangell Lava. The dominant structural trends are northwestward and are reflected by outcrop trends, localization of plutons, and by faults, including numerous thrust faults in the southern Wrangells and many of the steep faults. Some of the faults, such as the Totschunda, are of regional tectonic significance.

Withdrawal 11-D has the best mineral resource potential of all the withdrawals in subregion 11. It contains the major mines that have dominated the subregion's mineral production, numerous prospects including some with large reserves, large resources, and an excellent mineral resource potential.

Production from the withdrawal is dominated by the Kennecott mines with an output of copper valued in excess of $500,000,000, and of silver valued at about $9,000,000. Other production from the withdrawal comprises small amounts of copper and byproduct silver, about 143,500 ounces of placer gold from the Nizina district, and 44,760 ounces of placer gold from the Chisana district. The area has the potential to again attain its status as one of the nation's foremost copper producers. It contains several types of copper deposits in various geologic settings. Porphyry copper deposits, mainly recently discovered, along the north flanks of the Wrangells contain large resources and reserves estimated at about two billion tons containing 0.3 percent copper and probably byproduct molybdenum and silver. The Kennecott mines, which are best described by Bateman and McLaughlin (1920), exploited large chalcocite-rich lodes localized in lower strata of the Triassic Chitistone Limestone. They still contain some reserves. Other Kennecott-type copper lodes are known in the subregion, and some may develop into important producers. Copper deposits and occurrences are widespread in the area's mafic lavas, and, although production from these deposits has been scant, they still afford worthwhile exploration targets. The region contains many attractive exploration targets for copper deposits, and some of them are scheduled for exploration. An additional small production of placer gold from the area is likely, but the probability of significant lode gold production is small. In addition to copper and gold, the withdrawal contains small known deposits of molybdenum, antimony, iron, and silver, and occurrences of a few other commodities. Some of the Triassic carbonate rocks constitute a possible source of cement, but their utilization, at least in the near future, is unlikely.

An adequate evaluation of withdrawal 11-D requires geologic mapping and geochemical sampling of parts of the withdrawal that have not been investigated by modern methods. Some geophysical work, particularly local resistivity surveys of favorable areas, would be helpful.

Withdrawal 11-E (17.d.2)

Location--Withdrawal 11-E consists of large tracts in the southern parts of the McCarthy and Valdez quadrangles. It includes the northern flanks of the Chugach Mountains, parts of the Chitina Valley, and the southeastern extensions of the Wrangell Mountains.

Present knowledge--About two-thirds of the withdrawal is covered by Moffit's (1938) 1:250,000 reconnaissance map. The few other geologic studies in the withdrawal consist mainly of brief prospect examinations. Miller and MacColl (1964) mapped the northern part of the McCarthy A-4 quadrangle in sufficient detail for the present evaluation, and that part of the McCarthy B-4 quadrangle in the withdrawal has also been adequately studied (MacKevett and Smith, 1972; MacKevett, 1970c).

Adequacy--Withdrawal 11-E includes parts of the southernmost and intermediate terranes. The southernmost terrane consists largely of Valdez Group graywacke and argillite. It contains fairly abundant small gold-bearing quartz veins and stringers, but except for a small production from lodes near Golconda Creek, none have been mined. This terrane has the potential for an additional small production of lode and placer gold.

The intermediate terrane part of the withdrawal is largely underlain by metamorphosed late Paleozoic volcanic and sedimentary rocks that are associated locally with gabbro and ultramafics. These basement rocks are cut by diverse granitic rocks including some in the eastern part of the withdrawal that attain batholithic proportions. Shallow marine clastic Cretaceous sedimentary rocks overlap the basement in and adjacent to the Chitina Valley, and, in turn, are covered by Quaternary surficial deposits throughout much of the valley. The Nikolai Greenstone and Triassic carbonates and shales extend into the scantily explored part of the area north of the upper reaches of the Chitina River. This part of the withdrawal also contains fairly abundant granitic plutons.

The intermediate terrane contains a few known mineral deposits, but except for small amounts of placer gold from north-flowing tributaries of the Chitina, none have produced. Copper is associated with other base metals in veins north of the headwaters of the Chitina River, and several small copper-bearing deposits or occurrences are localized in Nikolai Greenstone in the general vicinity. Molybdenite-bearing quartz veins cut granitic rocks in the high mountains west of University Peak, but they have not been thoroughly explored. Small magnetite-rich skarns are developed adjacent to some granitic plutons in the eastern part of the withdrawal. Ultramafic and mafic rocks near the southern margin of the intermediate terrane are possible hosts for nickel, copper, chromite, and platinum, but they have not been thoroughly prospected.

Much of withdrawal 11-E has a high mineral potential. The relative scarcity of known deposits is partly attributable to the lack of exploration. Much of the remote area of difficult access north of the Chitina River has, at best, been cursorily prospected. This area contains several rock types that are favorable ore hosts elsewhere in the Wrangells, which, coupled with its abundant granitic rocks, should provide favorable exploration sites, particularly for copper and molybdenum.

Withdrawal 11-F (17.d.2)

Location--Withdrawal 11-F includes about 486 square miles near the northeastern corner of the Nabesna quadrangle.

Present knowledge--No substantial geological investigations have been made in this withdrawal.

Adequacy--Reconnaissance along the Alaska Highway and projections of mapping from the nearby Tanacross quadrangle (Foster, 1970) indicate that the region is largely underlain by Paleozoic quartz-muscovite schist with subordinate Mesozoic and Tertiary granitic rocks. Unconsolidated subaerial deposits mantle much of the area's extensive lowlands. No mineral deposits are reported from the area. The potential for economic deposits is poor, although the area probably contains some small gold-bearing lodes and placers.

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SUBREGION 12 (ALASKA PENINSULA)

The Alaska Peninsula is part of the Aleutian Island arc system that contains many active or recently active volcanos. It contains also a thick sequence of bedded sedimentary and volcanic rocks of Mesozoic and Tertiary age. The bedded rocks have been intruded in numerous places by granitic rocks ranging from small stocks and plugs to large batholiths. The intrusions range in age from Jurassic to Quaternary, and mineralization is common near some of them.

The region has great potential for petroleum and mineral resources. The few wells drilled to date have produced little oil but the potential is largely untested. The area has about 2,800 square miles of possible petroleum land with an estimated 1,500,000,000 bbls of oil.

The subregion is known to contain gold, silver, copper, lead, iron, and molybdenum. Some gold has been produced on Unga Island, but the main potential is still largely unknown. Using the Harris probabilistic approach, a potential value of about $500,000,000 can be set on the mineral potential of this subregion.

Withdrawal 12-A (11.A.3)

Location--Withdrawal 12-A is on the Pacific side of the Alaska Peninsula, between the southwest end of Wide Bay and the northeast side of Puale Bay.

Present knowledge--The area has been mapped at the scale of 1:250,000 by Smith and Baker (1924). Other 1:250,000-scale mapping includes the ten townships at the southwest end (Burk, 1965) and the north edge (Mather, 1925). There are no geochemical studies in the area but there has been some aeromagnetic work (Andreasen and others, 1963).

Adequacy--The area is underlain primarily by Middle and Upper Jurassic sedimentary rocks folded into several large anticlines and a dome. Large oil seeps are known and the area has been of interest to petroleum companies for years. Although drilling to date has produced little oil, the withdrawal has considerable petroleum potential. About 540 square miles of potential oil-bearing coarse clastic rocks occur in the withdrawal and probably average about 5,800 feet in thickness. Assuming a petroleum potential of 50,000 bbls/mile^3, there would be 30,000,000 bbls of oil in withdrawal 12-A.

The potential of the area for metallic resources is unknown although several geochemically untested intrusives are known. In a statistical study, Harris (1968) found a probability between .9 and 1.0 that the region contains between $100,000 and $1,000,000 in base and precious metals.

Withdrawal 12-B (11.A.3)

Location--The withdrawal is situated on the Pacific side of the Alaska Peninsula between Dorenoi and Clark Bays.

Present knowledge--The most recent geologic mapping (1:250,000) is that of Burk (1965); earlier mapping is by Atwood (1911) at 1:250,000. No geochemical sampling or aeromagnetic surveys have been made.

Adequacy--Burk's work is probably adequate for generalizations on the petroleum potential, but certainly not for the metallic mineral potential. This withdrawal block may have some petroleum potential in the thick Tertiary and Mesozoic section present over a major anticline. The potential may be reduced by numerous small intrusives, but field work will be needed to determine the amount of alteration. The area of the block is small, so it would probably contain no more than 3 to 5,000,000 bbl of petroleum.

Surface exposures are mainly Paleocene to Oligocene sediments and volcanics intruded by numerous small Tertiary plugs and stocks. The mineral potential is good near all the small intrusives and gold has been reported near the head of Port Moller. Potential for copper and silver may also exist. The Harris report (1968) rates it as having .9 to 1.0 probability of containing $1,000,000 to $10,000,000 in minerals.

Withdrawal 12-C (11.A.3)

Location--Withdrawal 12-C is on the Pacific coast of the Alaska Peninsula between the head of Canoe Bay and Balboa Bay.

Present knowledge--The area was studied by Burk (1965) and in part by Atwood (1911) at a scale of 1:250,000. No geochemical sampling data is available.

Adequacy--The present mapping is probably sufficient to evaluate the petroleum potential of the area around Canoe Bay. The Canoe Bay anticline has been of considerable interest to the petroleum industry and several wells have been drilled. Although no production has been reported, the area still has considerable potential. About 5,000 feet of coarse clastic late Mesozoic sediments underlie about 150 square miles of this block, suggesting a potential of approximately 7,500,000 bbl of oil.

There is no available work on possible mineral resources of the block. Copper has been found on the north shore of Balboa Bay, and the conditions are good that minerals will be found near the small stocks around Mount Dana and Hoodoo Mountain. Harris (1968) rates this area as having a .9 to 1.0 potential of having a $1,000,000 to $10,000,000 resource potential.

Withdrawal 12-D (11.A.3)

Location--Outer Shumagin Islands.

Present knowledge--Grantz (1963) visited the island briefly and Burk (1965) included the islands in his 1:250,000 mapping.

Adequacy--The islands are part of the oceanic crust composed of turbidites, shales and argillites of Early Cretaceous age intruded by early Tertiary granitic rocks. The outermost islands consist entirely of intrusive rocks. Although the present knowledge is adequate, the area has little potential for either oil or metallic minerals.

Withdrawal 12-E (11.A.3)

Location--Withdrawal 12-E is a small area near the tip of the Alaska Peninsula between Mount Emmons and Mount Hague, and includes Ukolnoi, Wosnesenski, and Poperechnoi Islands.

Present knowledge--The part of the block on the Alaska Peninsula was mapped by Kennedy and Waldron (1955) at a scale of 1:100,000, and the entire area was mapped by Burk (1965) at a scale of 1:250,000. There has been no geochemical mapping.

Adequacy--The area of this block is underlain by Tertiary and Quaternary volcanic rocks that are cut by small intrusive dikes and plugs. The geologic mapping is adequate, but no geochemical sampling has been done. Both gold and copper have been found by prospectors (Kennedy and Waldron, 1955). Extensive copper mineralization was reported by Kennedy and Waldron (1955) where the Belkofski Tuff is cut by quartz diorite stocks, and minor mineralization occurs near plugs, necks, and dikes of basalt and andesite. Mineral deposits valued between $1,000,000 and $10,000,000 have a probability between 0.9 and 1.0 of occurring in this area (Harris, 1968).

Withdrawal 12-F (11.A.3)

Location--Withdrawal 12-F is the tip of the Alaska Peninsula between Morzhovoi and Cold Bays, including a small area on the west shore of Morzhovoi Bay.

Present knowledge--The part on the west shore of Morzhovoi Bay has never been mapped; the rest of the area was mapped at 1:250,000 scale by Waldron (1961), and Burk (1965).

Adequacy--This block is underlain by late Tertiary and Quaternary volcanic rocks with a few Pliocene sedimentary rocks and volcanic plugs locally. Mineralization has not been reported and there probably is not much potential. The mapping should be adequate except for unmapped part.

Withdrawal 12-G (11.A.3)

Location--The withdrawal comprises the Krenitzin Island group including Akum, Akutan, and Tigalda Islands.

Present knowledge--There is no geologic or geochemical data available for these islands.

Adequacy--The area should be mapped and sampled because Unalaska Island just to the west contains considerable mineralization. The potential of these islands is completely unknown, but their proximity to the mineralized eastern end of Unalaska Island suggests that they may also be mineralized. Based on what is known of the adjacent islands, these islands are probably underlain by Tertiary and Quaternary volcanic and intrusive rocks.

Withdrawal 12-H (11.A.3)

Location--Unalaska and Sedanka Islands, Aleutian Island system.

Present knowledge--Geologic mapping at 1:250,000 scale is available (Drewes and others, 1961), as is some geochemical work on a zinc deposit (Webber and others, 1946).

Adequacy--Unalaska Island is formed primarily of late Tertiary and Quaternary volcanic and intrusive rocks. The intrusives include both granodiorite and gabbro which have locally altered and mineralized the volcanic rocks. Because of these intrusions, Unalaska and Sedanka Islands probably have the highest mineral potential of any of the Aleutian Islands. Many occurrences of gold, copper, zinc, iron, and sulfur were noted during the geologic mapping, but little or no regional geochemical work was done.

Analyses by the Bureau of Mines of samples from an area 240 feet long and 60 feet wide indicates the Sedanka Island zinc deposit to average 9.1 percent zinc, 0.25 percent lead, 0.45 copper and 1/2 oz. gold and 1.4 oz. silver per ton (Webber and others, 1946). The ore is readily amenable to flotation with 95 percent recovery of zinc.

Geochemical studies will be necessary to properly evaluate the mineral potential of the withdrawal.

Withdrawal 12-I (11.A.3)

Location--Withdrawal 12-I consists of Umnak Island.

Present knowledge--Geologic maps at 1:63,360 and 1:96,000 scale cover the entire area of this withdrawal block (Byers, 1959).

Adequacy--Umnak is primarily underlain by late Tertiary and Quaternary volcanic and volcaniclastic rocks. The southwest end of the island contains an albitized sedimentary and igneous complex of middle Tertiary age. The mapping of most of the island is adequate to show that Umnak Island probably does not have great potential for mineralization.

Withdrawal 12-J (17.d.1)

Location--This withdrawal includes the northwest corner of the Iliamna quadrangle and the southwest corner of the Lake Clark quadrangle.

Present knowledge--The Iliamna quadrangle has been geologically mapped at a scale of 1:50,000 and the data is on open file at 1:200,000 (Detterman and Reed, 1967, 1968). Geochemical sampling is complete. No mapping has been done in the Lake Clark quadrangle.

Adequacy--The area mapped is underlain by Tertiary volcanic rocks which probably extend northward into the Lake Clark quadrangle. There are no known mineral occurrences within the known part of this block, and there probably are none in the northern part. The area also has no petroleum potential.

Withdrawal 12-K (17.d.1)

Location--Withdrawal 12-K is in the Naknek quadrangle just west of Katmai National Monument.

Present knowledge--The only data on this area concerns the surficial deposits and are in unpublished military documents.

Adequacy--The entire area of this withdrawal block is covered by glacial deposits that obscure the bedrock. Granitic rocks of the Aleutian Range batholith are exposed to the east and probably underlie the withdrawal. There is no need for further study in this block.

Withdrawal 12-L (17.d.1)

Location--The area extends south from the south side of Becharof Lake to Amber Bay on the Pacific side of the Alaska Peninsula, then west nearly across the peninsula. It includes Sutwik Island.

Present knowledge--Most of the area is mapped at the scale of 1:250,000 (Burk, 1965; Smith and Baker, 1924).

Adequacy--The area contains a thick section of clastic sedimentary rocks of Jurassic, Cretaceous, and Tertiary ages. Numerous Tertiary plugs and stocks associated with volcanic rocks intrude the sedimentary rocks, mostly near the Pacific coast of the block.

The withdrawal has good potential for both petroleum and minerals. The western part of the area has a thick sedimentary section with known structures. The rocks are about 10,000 feet thick and underlie about 800 square miles of the block. Using a conservative estimate of 50,000 bbl/per mile^3 there is a potential of at least 80,000,000 to 100,000,000 bbls of petroleum in this block.

In the mountainous areas near the coast numerous small stocks and plugs intrude the sedimentary section. No known prospecting or geochemical sampling has been done in the area, but the potential for mineralization should be high. Harris (1968) rates this coastal area as having a 0.9 to 1.0 probability of mineral deposits worth $1,000,000 to $10,000,000.

Withdrawal 12-M (17.d.1)

Location--Withdrawal 12-M extends from Kujulik Bay and Cape Kumliun on the Pacific side of the Alaska Peninsula west and south to Black Lake.

Present knowledge--All of the withdrawal is geologically mapped at a scale of 1:250,000 (Burk, 1965; Smith and Baker, 1924).

Adequacy--Withdrawal 12-M includes the large Chignik Bay anticline in which sedimentary rocks of Jurassic and Cretaceous age are exposed. Approximately 5,000 feet of potential reservoir rock are present in the anticline and could contain from 20,000,000 to 25,000,000 bbls of petroleum.

Gold, silver, lead and zinc occur just east of Black Lake outside the withdrawal. The host rocks for this mineralization extend into the withdrawal but whether they are mineralized is unknown.

Coal has been produced at Chignik Bay and a coal bed 3 feet thick occurs near Hook Bay. The extent and tonnage of the coal reserves are unknown.

Withdrawal 12-N (17.d.2)

Location--This withdrawal block includes most of the subregion north of the Katmai National Monument.

Present knowledge--Much of the area of this withdrawal block has been mapped at scales ranging from 1:50,000 to 1:250,000 (Martin and Katz, 1912; Mather, 1925; Moffit, 1927; Kirschner and Minard, 1949; Keller and Reiser, 1959; Detterman and Hartsock, 1966; Detterman and Reed, 1964, 1965, 1966, 1967, 1968; Detterman and Lanphere, 1965; Detterman, Reed, and Rubin, 1965; Jones and Detterman, 1966; Detterman, 1968). In addition, there are numerous reports on geochemical sampling (Detterman and Reed, 1965; Reed and Detterman, 1965; Reed, 1966; Detterman, 1969; Detterman and Cobb, 1969). Aeromagnetic surveys have been made of parts of the area (Henderson and others, 1963; Grantz and others, 1963). Parts of the area in the Lake Clark, Naknek, and Dillingham quadrangles are unmapped.

Adequacy--The present state of knowledge is adequate for most of the block except the unmapped parts of Lake Clark, Dillingham, and Naknek quadrangles. Additionally, the area south of Nonvianuk Lake should be sampled geochemically as a mineralized area was recently found there.

The geology of the area is very complex and includes metamorphic, sedimentary, volcanic, and intrusive rocks of late Paleozoic to Recent age. The major Bruin Bay fault bisects the eastern part of the area. There are many areas of known mineralization including copper, iron, gold, silver, and molybdenum. In addition, the Iniskin Peninsula has numerous oil seeps and considerable petroleum potential.

There are known mineral deposits in this withdrawal block and mineralization is suspected in other areas that contain the same geologic setting as the known mineral areas. Areas of copper mineralization are present near the head of Cottonwood, Iliamna, Iniskin, and Chinitna Bays, and near Pilot Lake. Gold and silver are present north of Battle Lake. Large deposits of magnetite are present near Crevice Creek, in Chenik Mountain, in the mountains east of the Lake Fork of Paint River, and near Iliamna Bay.

The oil seeps on Iniskin Peninsula were the first known in Alaska and although there has been sporadic drilling for 70 years, the potential is still untested. The prospective area is small but could contain about 10,000,000 bbls of oil.

Withdrawal 12-O (17.d.2)

Location--This withdrawal is an irregularly shaped block adjoining the Katmai National Monument on the south and west sides.

Present knowledge--Most of the area was mapped by Keller and Reiser (1959) at 1:250,000 scale.

Adequacy--The area is mainly underlain by Upper Jurassic clastic rocks, Middle Jurassic intrusive rocks and minor Quaternary volcanics. Occurrences of copper, lead, and molybdenum are reported from the area around Mount Kubugakli near Shelikof Strait. This block has minor mineralization that should be checked, but the potential is not great. Most of the mapping is adequate for evaluation

Withdrawal 12-P (17.d.2)

Location--North of the west end of Becharof Lake.

Present knowledge--There are no geologic reports covering this area, but some aeromagnetic coverage exists (Andreasen and others, 1963).

Adequacy--Most of this block is covered by glacial deposits and presumably has low potential. A minor amount of granitic rock occurs in the southeastern corner.

Withdrawal 12-Q (17.d.2)

Location--The withdrawal is located on the Pacific coast of the Alaska Peninsula and includes Cape Kumlik and Amber Bay.

Present knowledge--The area has been geologically mapped at the scale of 1:250,000 (Burk, 1965).

Adequacy--Withdrawal 12-Q is underlain by Late Jurassic and Cretaceous clastic sedimentary rocks unconformably overlain by Eocene to Oligocene volcaniclastic rocks. The west end of the block contains the large caldera of Aniakchak volcano and is covered by Quaternary volcanics.

There are no known mineral deposits, but no geochemical sampling has been done around the small Tertiary and Quaternary intrusives. Harris (1968) considers the area has an 0.8 to 0.9 chance of have a deposit of $1,000,000 value.

The petroleum possibilities are good, as there are several anticlines with possible closure and coarse clastic rocks at depth. Included in the withdrawal are about 360 square miles with 5,000 to 7,000 feet of potential petroleum producing sediments. Petroleum resources could be from 20,000,000 to 30,000,000 bbls.

Withdrawal 12-R (17.d.2)

Location--This withdrawal is northeast of Port Moller along the west side of the mountains in the interior of the Alaska Peninsula.

Present knowledge--The area has been geologically mapped at 1:250,000 (Burk, 1965).

Adequacy--The withdrawal is underlain by late Tertiary and Quaternary volcanic rocks intruded by small Tertiary and Quaternary stocks and plugs. The northern part of the block is covered by Quaternary volcaniclastic deposits from Veniaminof volcano and probably lacks mineral deposits. The potential of the southern part of the withdrawal is unknown.

Withdrawal 12-S (17.d.2)

Location--Withdrawal 12-S is a strip across the Alaska Peninsula that includes the Pavlof volcanos, Pavlof Bay, Canoe Bay and Herendeen Bay.

Present knowledge--The most recent mapping in the area is by Burk (1965) but parts of the area are mapped by Atwood (1911), and by Kennedy and Waldron (1955).

Adequacy--This block must be considered as having considerable potential for petroleum, coal, gold, and copper, but more fieldwork is needed to properly evaluate this potential.

The withdrawal contains a thick sequence of late Mesozoic sedimentary rocks unconformably overlain by Paleocene to Oligocene sedimentary and volcanic rock. Small plugs and stocks of late Tertiary to Quarternary age cut the sediments at numerous localities and gold and copper are reported from altered tuffs adjacent to intrusives.

The area near Canoe Bay is of considerable interest to oil companies and although several wells have been drilled, the potential is still largely untested. About 400 square miles are underlain by 5,000 to 7,000 feet of sediments with petroleum potential possible reservoir characteristics; the area could contain from 20,000,000 to 30,000,000 bbls of oil.

The Mesozoic section at Herendeen Bay and Oligocene section at Coal Bay contain significant deposits of coal. At Herendeen Bay 30 to 40 feet of coal occurs in beds 1 foot to 8 feet thick.

Withdrawal 12-T (17.d.2)

Location--Outer Shumagin Islands.

Present knowledge--Withdrawal 12-T has been geologically mapped at the scale of 1:1,000,000 (Grantz, 1963), and 1:250,000 (Burk, 1965).

Adequacy--Area is entirely underlain by biotite granodiorite of early Tertiary age. No metallic minerals are reported and probably none are present.

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SUBREGION 13 (SOUTH-CENTRAL ALASKA)

Most of the withdrawal areas in subregion 13 are in the Kenai-Chugach Mountains, an arcuate range of high rugged mountains bordering the Gulf of Alaska. One withdrawal area (13-A) and a small part of another (13-B) are in the southern Talkeetna Mountains. Small parts of area 13-B and 13-C, respectively, are in the Upper Matanuska Valley and the Copper River Lowlands. The subregion is in an active orogenic area with a high incidence of earthquakes. Bedrock in the Kenai-Chugach Mountains is predominantly weakly metamorphosed but strongly deformed Mesozoic eugeosynclinal bedded deposits of metagraywacke, slate and argillite. Mafic volcanic and volcaniclastic sequences are exposed in the Prince William Sound area near the north and west Kenai-Chugach Range front and in the Talkeetna Mountains. Ultramafic and related rocks crop out locally in an arcuate belt near the north and west Kenai-Chugach Range front and in one area on Prince William Sound near Seward. Tertiary intrusive bodies, generally of small size, cut the bedded rocks of the Kenai-Chugach Range. A Mesozoic batholithic complex is widely exposed in the southern Talkeetna Mountains and smaller Mesozoic plutons crop out near the north flank of the Chugach Mountains.

The metallic mineral deposits of the western Kenai-Chugach Mountains can be crudely grouped into three arcuate, concentric zones that conform generally to the arcuate trend of the range. The innermost zone includes copper and gold deposits around Prince William Sound. Most of the deposits are in or near greenstone. Almost 214 million pounds of copper has been produced from this area, most of which was from the Ellamar and Latouche deposits (Berg and Cobb, 1967). Gold was produced from lode mines and as a byproduct of the copper mining. The recorded production was 137,600 ounces (Berg and Cobb, 1967).

An intermediate zone contains mostly gold deposits in a belt roughly parallel to the central part of the range north and west of the high interior mountains. Gold has been produced chiefly from small lode and placer deposits in the Hope, Girdwood, and Moose Pass areas. The gold deposits are probably related to Tertiary intrusive activity. Recorded production from the Kenai Peninsula district, which includes most of the deposits from 1895 through 1959, was 120,375 ounces (Koschmann and Bergendahl, 1968).

The outermost belt in the Chugach-Kenai Mountains includes the chromite associated with ultramafic bodies near the west and north flank of the range. Chromite production consists of about 30,000 tons of ore from deposits at Red Mountain and Claim Point near the southwestern tip of the Kenai Peninsula (Berg and Cobb, 1967). Chromite has also been reported from ultramafic bodies near Eklutna (Rose, 1966) and the headwaters of Wolverine Creek (Clark, 1972).

In the part of the Talkeetna Mountains included in the subregion, gold has been produced from vein deposits, mostly at the southern border of the Talkeetna batholith, and from placers. Total production was about 404,425 fine ounces of gold from lode mines and about 204,000 fine ounces of gold from placers (Berg and Cobb, 1967). A small number of copper prospects exist in the southern Talkeetna Mountains and the northern Chugach Mountains, but none have been productive.

The metallic mineral resource potential of the subregion can be evaluated only on the basis of existing inadequate knowledge of the geologically favorable settings and known mineral occurrences. The potential of the innermost zone of the Kenai-Chugach Mountains is considered moderately high for massive sulfide deposits because of past production and the large extent of geologically favorable greenstone terrane. The potential of the intermediate zone of the Kenai-Chugach Mountains is considered moderate for small deposits of precious metals but low for large deposits. Much of this area has not been mapped or intensively prospected, however, and the potential is unknown. The potential of the outermost belt is considered moderately high for chromite and possibly copper, nickel, iron, titanium, platinum, and cobalt in the area of known ultramafic bodies, as well as unexplored areas on trend with the known bodies. In addition, a potential for gold and copper mineralization associated with the Mesozoic intrusive bodies exists. Although past production from this zone is small, the variety of potentially favorable geologic settings, combined with the relative inaccessibility of much of the northern portion of the belt, make this a zone of moderately high potential. The Willow Creek district and vicinity must be considered geologically favorable for mineral deposits on the basis of past production. Because of lack of indication of significant mineralization other than gold and probable intensive past exploration in the area, the probability of future production is considered only moderate.

Withdrawal 13-A (11.A.3)

Location--Withdrawal 13-A consists of about 540 square miles in the southern Talkeetna Mountains north of Palmer.

Present knowledge--Present knowledge of the area is primarily from maps at a scale of 1:250,000 by Paige and Knopf (1907) and Capps (1940). A small part of the area was mapped by Barnes (1962) at a scale of 1:63,360.

Adequacy--The bedrock is predominantly granitic rocks (mostly quartz diorite) of the Talkeetna batholith. Part of the area in T. 20 N., R. 3 W. is underlain by sedimentary rocks of the non-marine Arkose Ridge Formation and the marine Matanuska Formation and is cut by the Castle Mountain fault (Barnes, 1962). The Willow Creek district, an area of productive lode and placer deposits (Ray, 1954), is adjacent to the south border of the withdrawal area. However, no prospects are known within the withdrawal area. The area has been adequately studied for purposes of a preliminary mineral resources potential appraisal.

Withdrawal 13-B (11.A.3)

Location--Withdrawal 13-B consists of about 1,470 square miles mostly in high rugged parts of the Chugach Mountains northeast of Anchorage.

Present knowledge--Early geologic mapping in the area was mainly by Landes (1927), at a scale of approximately 1 inch to 5 miles, Capps (1927 , scale 1:62,500; 1940, scale 1:250,000), Waring (1936, scale 1:62,500), and Martin and Katz (1912, scale 1:62,500). Most of this work is in the Matanuska Valley and covers only the north edge of the withdrawal area.

Existing modern geological and geochemical mapping in the area consists of a study at a scale of 1:63,360 on an ultramafic body near the headwaters of Wolverine Creek (Clark, 1972), unpublished reconnaissance geologic mapping and geochemical sampling at a scale of 1:63,360 from parts of the Anchorage C-5, C-4, B-5, and A-5 quadrangles by S. H. B. Clark, Ernest Dobrovolny, and H. R. Schmoll, and geologic mapping at a scale of 1:48,000 of the Anchorage D-2 quadrangle (Grantz, 1961a). Part of the map area on the north flank of the Chugach Mountains was mapped by Barnes (1962) at a scale of 1:63,360.

Adequacy--Existing mapping and extension of knowledge of adjacent areas indicate that the withdrawal area includes portions of three distinctly different terranes. Bedrock in the southern half to three-quarters of the area is predominantly strongly deformed late Mesozoic metagraywacke, argillite, slate, and minor amounts of weakly metamorphosed volcanic rocks. North of a line from near Jim Creek to near the Metal Creek Glacier, bedrock is a late Paleozoic to Early Jurassic terrane of mafic volcanic and volcaniclastic and ultramafic rocks intruded by plutons. Much of this terrane is complexly deformed and metamorphosed. In the area near the Matanuska River valley, Cretaceous sandstones and siltstones overlie rocks of the late Paleozoic to Early Jurassic terrane.

Two copper occurrences have been reported from the area; one near the head of Jim Creek (Landes, 1927), and one near the head of the Glacier Fork of the Knik River (Richter, 1967). Placer gold has been mined intermittently on a small scale along lower Metal Creek (Richter, 1967). Some platinum may have been recovered in the gold placers (Richter, 1967).

The withdrawal area is adjacent to Tertiary coal deposits of the Matanuska Valley but does not include any known coal deposits or Tertiary beds that might be coal bearing.

The existing data are not adequate to prepare a preliminary mineral resources potential assessment.

Withdrawal 13-C (11.A.3)

Location--Withdrawal area 13-C consists of about 3,580 square miles mostly in the rugged center part of the Chugach Mountains west of the Richardson Highway and north of Valdez. On the north, the area includes part of the Copper River Basin and the upper Matanuska Valley.

Present knowledge--Geologic mapping is available for parts of the withdrawal area at a scale of 1:250,000 by Chapin (1918) and Moffit (1938, 1954). More recent geologic mapping at a scale of 1:48,000 by Grantz (1960, 1961a,b) and at a scale of 1:96,000 by Coulter and Coulter (1962) covers small portions of the area only. The northern part of the withdrawal area is included in aeromagnetic and gravity surveys of the Copper River Basin (Andreason and others, 1964).

Adequacy--Bedrock in the southern part of the withdrawal area is predominantly folded and metamorphosed graywacke and slate of Mesozoic age. Bedrock in the Chugach Mountains in the northern part of the withdrawal area is predominantly strongly deformed early Mesozoic or late Paleozoic metamorphic rocks and Jurassic volcanic and sedimentary rocks intruded by small plutons. Mapping in adjacent areas suggests that the two terranes are probably in fault contact. Much of the central part of the withdrawal area has not been mapped.

The part of the withdrawal area in the Talkeetna Mountains and upper Matanuska Valley is underlain mainly by Early Jurassic volcanic and sedimentary rocks overlain by marine sedimentary rocks of Jurassic and Cretaceous age. Both units are folded and faulted.

In the part of the area within the Copper River Basin, the marine Jurassic to Cretaceous units are overlain by Tertiary continental sedimentary rocks. Most of the bedrock in this area is covered by Quaternary alluvial and glacial deposits.

The withdrawal area includes mineral occurrences in the Shoup Bay area, near upper Mineral Creek, between Tonsina Lake and the Richardson Highway, and near Sheep Mountain. In the Shoup Bay and Mineral Creek areas near Valdez, occurrences are mainly free gold in vein and fissure deposits (Brooks, 1912; Johnson, 1915). Gold production is recorded from some of the properties. Associated metals include lead, copper, silver, and zinc.

In the area between Tonsina Lake and the Richardson Highway, two placer gold deposits (Moxham and Nelson, 1952; Moffit, 1918) and one lode copper-gold-lead prospect (Moffit, 1918) with no recorded production are included within the withdrawal area.

Two copper prospects (Martin and Mertie, 1914; Jasper, 1965) and a gypsum occurrence (Eckhart, 1953) are included in the withdrawal area near Sheep Mountain.

Much of the area has not been mapped geologically. The only modern geologic mapping is in the Anchorage D-1 and D-2 quadrangles. In the remainder of the withdrawal area geologic mapping is inadequate and no geochemical sampling is available.

Withdrawal 13-D (11.A.3)

Location--Withdrawal 13-D consists of about 740 square miles bordering the Gulf of Alaska southwest of Seward.

Present knowledge--Geologic mapping of the withdrawal area is limited to mapping of shorelines at a scale of 1:250,000 by U. S. Grant and D. F. Higgins (Martin, Johnson, and Grant, 1915).

Adequacy--Bedrock was described as highly folded graywacke and slate intruded by granitic rocks. The only mineral occurrences known in the area are some small gold prospects near Two Arm Bay. Little work was done on these prospects (Berg and Cobb, 1967). Because of the absence of modern geologic or geochemical studies, the information level is inadequate for mineral resource potential analysis of the area.

Withdrawal 13-E (11.A.3)

Location--Withdrawal area 13-E comprises about 140 square miles in the Kenai Mountains of the south-central Kenai Peninsula, about 20 miles east of Homer.

Present knowledge--A small part of the withdrawal area that borders the North Arm and East Arm of Nuka Bay was mapped by Martin, Johnson, and Grant at a scale of 1:250,000 (1915).

Adequacy--In the area mapped, bedrock is highly folded graywacke and slate. The remainder of the area has not been mapped geologically. No mineral deposits are known but the present level of knowledge is inadequate for purposes of mineral resource potential analysis.

Withdrawal 13-F (17.d.1)

Location--Withdrawal area 13-F comprises about 290 square miles in the Kenai Mountains west of Nuka Bay on the Kenai Peninsula about 20 miles east-southeast of Homer.

Present knowledge-- The area along the shoreline of the North and West Arms of Nuka Bay was mapped at a scale of 1:63,360 and geochemically sampled by Richter (1970). The only mapping in other parts of the area is mapping along the shoreline at a scale of 1:250,000 by Martin, Johnson, and Grant (1915).

Adequacy--In the mapped areas the bedrock is mainly folded sequences of interbedded graywacke and slate. Gold-bearing quartz veins were discovered in the Nuka Bay area in 1918. Several small mines operated between 1920 and 1940 with a total production of about $166,000. Richter (1970) concluded that the Nuka Bay area appears to warrant further investigation as a potential producer of small amounts of gold. With the exception of the area described by Richter (1970), the data are inadequate for purposes of a preliminary mineral resource appraisal.

Withdrawal 13-G (17.d.1)

Location--Withdrawal area 13-G includes about 600 square miles in south-central Chugach Mountains east of Anchorage and north of Prince William Sound.

Present knowledge--The parts of withdrawal area 13-G that are accessible from fiords and inlets were mapped by Moffit (1954) at a scale of 1:250,000. Much of the northern part of the area is covered by icefields and glaciers and is unstudied.

Adequacy--In the area mapped by Moffit (1954), the bedrock is interbedded slate and graywacke of Cretaceous(?) age. This is probably the predominant bedrock for the rest of the area also.

Several small prospects have been described in the Harriman Fiord-Barry Arm area (Cobb and Matson, 1969) but none have been productive. The withdrawal area is near the border of the Prince William Sound district, which had a considerable production of copper and gold. Most of the known deposits from the district were in or near greenstone. No greenstone is known to occur in the withdrawal area.

Because of the absence of modern geologic or geochemical studies for any of the withdrawal area, the presently available information is inadequate.

Withdrawal 13-H (17.d.1)

Location--Withdrawal area 13-H comprises about 130 square miles in the Kenai Mountains of the south-central Kenai Peninsula about 25 miles east-northeast of Homer.

Present knowledge--No geological or geochemical investigations have been made of the area.

Adequacy--Geologic investigation with mapping at a scale of 1:250,000 in surrounding areas (Martin, Johnson, and Grant, 1915) show that bedrock in surrounding areas is predominantly graywacke and slate intruded by granitic plutons. No mineral occurrences are known in the withdrawal area but the information is clearly inadequate for the purposes of a preliminary mineral resource potential appraisal.

Withdrawal 13-I (17.d.2)

Location--Withdrawal 13-I consists of about 120 square miles adjacent to the Chugach National Forest and Kenai National Moose Range northwest of Seward.

Present knowledge--No geologic investigations of the withdrawal area are available.

Adequacy--Moffit, Johnson, and Grant (1915) mapped graywackes and slates in adjacent areas at a scale of 1:250,000. They showed symbols for a "gold lode mine or prospect" on Placer Creek and Redman Creek in the withdrawal area. The mineral occurrences were not described and there is no other information available to verify the existence of these properties. Adequate knowledge is not available for any of the area.

Withdrawal 13-J (17.d.2)

Location--Withdrawal 13-J comprises approximately 460 square miles in the eastern Kenai Mountains east of Seward.

Present knowledge--Gordon Herreid (1965) made a geologic and geochemical traverse along the southern part of the Nellie Juan River. The map at a scale of 1:63,360 and description of the geology along the traverse are the only reports available on this area.

Adequacy--Herreid (1965) described the bedrock as graywacke and slate cut by some dikes and quartz veins. Similar rocks were mapped by other workers in adjacent areas. No mineral occurrences are known in the area.

Herreid (1965) reported slightly anomalous amounts of metals in only three samples. With the exception of the vicinity of the south part of the Nellie Juan River, the existing information is insufficient.

Withdrawal 13-K (17.d.2)

Location--The withdrawal areas consist of six townships (216 square miles) which include the islands at the ends of two peninsulas in the Gulf of Alaska southwest of Seward.

Present knowledge--Both areas were mapped at a scale of 1:250,000 by Martin, Johnson, and Grant (1915).

Adequacy--The bedrock is predominantly granitic intrusive rocks. No mineral occurrences are known from the islands. Because of the absence of modern geologic or geochemical studies, information about the islands is inadequate for purposes of a preliminary mineral resources appraisal.

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SUBREGION 14 (SOUTHERN ALASKA)

Withdrawal 14-A (11.A.3)

Location--Approximately 600 square miles in the Chugach Mountains between the Copper River on the east, Prince William Sound on the west, Chugach National Forest on the south and the Lowe River-Tiekel River valleys on the north. The area is uninhabited and has no land transportation routes.

Present knowledge--No geological or geochemical mapping is available for any of this area. Approximately 2 days of helicopter-supported reconnaissance was spent in the southern part of the area during 1971. Brief descriptions of the geology and mineralization at the abandoned Midas Mine in the extreme western corner of the area are the only published geologic information (Moffit and Fellows, 1950; Rose, 1965).

Adequacy--Bedrock in area consists of a complexly deformed, thick, bedded sequence of Mesozoic and early Tertiary metamorphosed siltites, graywackes, conglomerates, impure limestone, and mafic volcanic rocks. Metamorphic grade ranges from zeolite to probable epidote-amphibolite facies. Bedded rocks are intruded by granodioritic stocks, aplite to mafic dikes, and quartz veins of probable early Tertiary age. Gold-and-silver bearing copper sulfides were mined in the early part of the century from mineralized shear zones in black slates and related rocks at the Midas Mine near the western apex of the block. Comparable geologic conditions potentially suitable for mineralization appear to exist throughout much or all of this block but available data are inadequate for preliminary mineral resource potential evaluation.

An adequate resource appraisal will require geological and geochemical mapping of the entire block at scale of 1:250,000 supplemented by gravity and ground and airborne magnetometer surveys in selected areas.

Withdrawal 14-B (17.d.2)

Location--Withdrawal 14-B comprises parts of the Chugach-Saint Elias Mountains and the bordering foothills and coastal lowlands along the Gulf of Alaska between Tongass National Forest on the east and Chugach National Forest on the west. The area is uninhabited and has no roads.

Present knowledge--The southern half of the block (designated B_1 on fig. 1) has been mapped at scales ranging from 1:96,000 to 1:500,000 (Miller, 1961a,b,c, 1971; Plafker, 1967); the northern half of the block (B_2) is unmapped except for a narrow north-south traverse that crosses the Chugach Mountains (Brabb and Miller, 1962). Geochemical sampling has been completed on reconnaissance basis over bedrock areas in the southern half of the block and in coastal areas with placer deposit potential (Plafker and MacKevett, 1970).

Adequacy--Information in the southern half of the block (B_1), which is underlain mainly by Tertiary sedimentary rocks and Quaternary unconsolidated deposits, is adequate for mineral resource potential evaluations. Accessible parts of the area, and adjacent withdrawn blocks to the south, have been unsuccessfully explored for petroleum during the past 19 years and all onshore prospects have probably been adequately tested. Beach placer gold deposits along the coast are too small and low-grade to be of immediate economic significance (Thomas and Berryhill, 1962). Geochemical sampling in the bedrock areas did not reveal any significant anomalous concentrations of metals, and there are no known mines or prospects within the area.

Information on the northern half of the block (B_2) is totally inadequate for mineral resource potential evaluation. This part of the block is underlain by a diverse sequence of slaty, schistose, and gneissic metasedimentary and metavolcanic rocks of Mesozoic and Paleozoic age that are cut by granitic plutons of Mesozoic and probable Cenozoic age. No mines or prospects are known to occur within this part of the block although geologically comparable contiguous areas to the north and east host copper, gold, nickel, and chromium mineralization.

An adequate mineral resource potential appraisal will require geological and geochemical mapping of the entire northern half of the block (approximately 4,000 square miles) at a scale of 1:250,000, supplemented by geophysical detailing where warranted.

AUGGS

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TABLE 1.--SUMMARY OF MINERAL RESOURCE INFORMATION IN THE MAJOR LANDS WITHDRAWN UNDER THE ALASKA NATIVE CLAIMS SETTLEMENT ACT OF 1971

SUBREGION	WITHDRAWAL	TYPE OF WITHDRAWAL	APPROX. AREA MILES^2	PERCENT GEOLOGIC RECONNAISSANCE COMPLETED	CAPSULE APPRAISAL OF MINERAL RESOURCE POTENTIAL[1/] METALS	PETROLEUM	COAL
NORTHWESTERN ALASKA (1)	1-A	A3	216	100	LOW	MODERATE	"SUBSTANTIAL"
	1-B	A3	5904	100	LOW	MODERATE	HIGH
	1-C	A3	576	100	LOW		MODERATE
	1-D	A3	180	0	UNKNOWN		
	1-E	D1	90	100	LOW		
	1-F	D2	99	0	LOW	"SIGNIFICANT"	HIGH
	1-G	D2	144	100	"LOW"		
	1-H	D2	126	100	"LOW"		
	1-I[2/]	D2	16524	0	POSSIBLY HIGH IN SOUTH AND NORTH		
CENTRAL NORTHERN ALASKA (2)	2-A	A3	7200	59	LOW	HIGH	HIGH
	2-B1[2/]	D2	8172	51	LOW	HIGH	HIGH
	2-B2[2/]	D2	7920	86	PROBABLY HIGH		
NORTHEASTERN ALASKA (3)	3-A	A3	2232	29	"NO KNOWN"	"LOW"	OCCURRENCES

	3-B	A3	522	100	"LITTLE MINERAL RE- SOURCE POTENTIAL"		OCCURRENCES
	3-C	A3	828	78	HIGH		
	3-D	A3	252	100	"NO KNOWN"		
	3-E	A3	72	100	"NO KNOWN"	LOW-OIL SHALE	
	3-F	A3	108	100	"NO KNOWN"		
NORTHEASTERN ALASKA (3) (Cont'd)	3-G 2/	A3	2376	15	"NO KNOWN"		
	3-H	D1	5823	84	HIGH IN PHILIP SMITH & CHRISTIAN QUADRANGLES	LOW-OIL SHALE	
	3-I	D1	2196	32	"HIGH"		
	3-J	D2	828	39	"MODERATE"		
						FLATS	
	3-K	D2	13554	27	INADEQUATE DATA	POSSIBLE IN YUKON	OCCURRENCES
	3-L	D2	2376	0	"MODERATE" OVERALL		
	3-M	D2	216	0	"NO MINERAL OCCURRENCES"		
	4-A	A3	414	100	"VERY HIGH"		
	4-B	A3	216	100	"PROBABLY LOW"		
	4-C	A3	144	100	"LOW"	"SOME"	
	4-D	D1	6660	100	"MEDIUM TO HIGH"		
SEWARD PENINSULA (4)	4-E	D1	360	100	"LOW TO MODERATE"		
	4-F	D2	864	100	"LOW"	"LOW TO MODERATE"	
	4-G	D2	2880	100	"LOW";TIN AT EAR MT	"POSSIBILITY"	"POSSIBILITY"
	4-H	D2	540	100	"LOW"		
	4-I	D2	1116	100	"HIGH"		
	4-J	D2	288	100	"LOW TO MODERATE"		
	4-K	D2	216	100	"LOW"		
	5-A	D1	6084	71	"FAVORABLE" NORTH; "LOW" SOUTH		
	5-B	D2	5292	0	"HIGH"		
	5-C	A3	1512	100	"VERY HIGH"		
	5-D	A3	666	70	"HIGH"SO.;"LOW" NO.		
YUKON-KOYUKUK PROVINCE (5)	5-E	D1	972	70	SOUTH 2/3 "LOW"; NORTHERN PART MAY HAVE MINERAL RESOURCE POTENTIAL		
	5-F	A3	432	100	"LOW"		
	5-G	D2	1188	18	"HIGH" EASTERN PART	POSSIBLE-KANUTI FLATS	
	5-H	A3	846	100	"LOW"WEST;HIGH"EAST		
	5-I	D1	1008	0	"UNKNOWN"		
	5-J	A3	468	100	"LOW"		
	5-K	A3	216	100	"LOW"		
	5-L	D2	756	0	"VERY HIGH-KAIYUH MOUNTAINS"	POSSIBLE-KOYUKUK FLATS	
	5-M	D1	2106	61	"LOW"EXCEPT FOR TWO		

YUKON-KOYUKUK PROVINCE (5) (Cont'd)	5-N	A3	1872	17	SMALL AREAS "GENERALLY FAVOR-ABLE"		COAL TOO THIN
	5-O	A3	288	75	UNKNOWN, POSSIBLY HIGH		
EAST CENTRAL ALASKA (6)	6-A	A3	900	0	"SOME ASPECTS FAVORABLE"		
	6-B	A3	540	60	UNKNOWN		
	6-C 2/	A3	2952	0	"POSSIBLY NEEDS TO BE CONSIDERED"	"POSSIBLE"-KANDIK	
	6-D	D1	9162	47	"INDICATIONS"		OCCURRENCES
	6-E	D1	5760	0	UNKNOWN-"PREVIOUSLY ...PLACER"		
	6-F	D2	3888	34	"HAS POTENTIAL"		
	6-G	D2	216	0	"NO...KNOWN"-INADE-QUATE DATA		
CENTRAL ALASKA (7)	7-A	A3	504	0	"HALF...FAVORABLE FOR MINERAL EXPLOR-ATION"		
	7-B	A3	144	0	"LOW"		
	7-C	A3	972	0	"INADEQUATE DATA-SOME POTENTIAL"		
	7-D	D1	2124	0	"INTERESTING"		OCCURRENCES NO ECONOMIC VALUE
	7-E	D2	2448	4	10% OF BLOCK MAY HAVE POTENTIAL		
	7-F	D2	756	0	NO DATA		
SOUTHWEST ALASKA (8)	8-A	A3	2574	0	UNKNOWN		
	8-B	A3	2268	0	"MODERATE AU, HIGH HG"		
	8-C	D2	5796	0	UNKNOWN, MAYBE AU		
	8-D	D2	360	100	"LOW"		
	8-E	D2	9234	0	UNKNOWN		
	8-F	D2	4716	0	"GOOD CHANCE"		
	8-G	D1	4896	0	"HIGH AU POTENTIAL"		
	8-H	D1	1980	0	UNKNOWN		
	8-I	D1	126	0	"LOW"		
	8-J	D1	216	0	"LOW"		
	8-K	D2	126	0	"LOW"		
	8-L	A3	144	0	"PROBABLY LITTLE POTENTIAL"		
CENTRAL AND SOUTHERN ALASKA RANGE (9)	9-A	A3	2988	0	UNKNOWN		
	9-B	D2	8820	8	"VERY HIGH"		
	9-C	D1	3231	0	UNKNOWN		

CENTRAL AND SOUTHERN ALASKA RANGE (9) (Cont'd)	9-D	D1	252	0	UNKNOWN		
	9-E	D2	738	0	UNKNOWN		
	9-F	A3	1926	0	POSSIBLY HIGH		
	9-G	D1	216	0	UNKNOWN		
	9-H	D1	540	0	MODERATE		
	9-I[2/]	D2	5184	0	POSSIBLY VERY HIGH		
CENTRAL ALASKA RANGE (10)	10-A	A3	342	0	PROBABLY LOW		
	10-B	A3	396	0	UNKNOWN		
	10-C	A3	1188	24	$18 MILLION GOLD RESERVES,LODES UN-KNOWN		
	10-D	A3	405	0	UNKNOWN		
	10-E	D1	3564	6	UNKNOWN		
	10-F	D2	792	0	"PROBABILITY SMALL"		
EASTERN ALASKA RANGE & WRANGELL MOUNTAINS (11)	11-A[2/]	D2	108	0	"SOME" IN NORTH; "LOW" IN SOUTH		
	11-B	A3	3078	29	MODERATE IN CENTRAL BELT, LOW ELSEWHERE		
	11-C	A3	828	0	"SOME" PLACER AND LODE POTENTIAL		
	11-D	D1	6840	38	"BEST" IN SUBREGION		
	11-E	D2	3861	4	"FAVORABLE" NORTH OF CHITINA RIVER, LOW ELSEWHERE		
	11-F	D2	531	0	"POOR"		
ALASKA PENINSULA (12)	12-A	A3	1188	21	UNKNOWN	"CONSIDERABLE"	
	12-B	A3	144	0	"GOOD"	"SOME"	
	12-C	A3	234	0	UNKNOWN	"CONSIDERABLE"	
	12-D	A3	108	0	"LITTLE"	"LITTLE"	
	12-E	A3	144	0	MODERATE		
	12-F	A3	126	100	"PROBABLY NOT MUCH"		
	12-G	A3	324	0	UNKNOWN		
	12-H	A3	1800	0	"HIGHEST OF ALEUTIAN ISLANDS"		
	12-I	A3	900	0	LOW		
	12-J	D1	324	78	"PROBABLY NONE"	"PROBABLY NONE"	
	12-K	D1	252	100	"NO MINERAL POTENTIAL"		
	12-L	D1	1728	0	"GOOD"	"GOOD"	
	12-M	D1	612	0	UNKNOWN	MODERATE	OCCURS,RESERVES UNKNOWN
	12-N[2/]	D2	5328	51	MODERATE TO HIGH	LOW TO MODERATE	
	12-O	D2	432	100	"NOT GREAT"		
	12-P	D2	360	0	"LOW"		
	12-Q	D2	522	0	UNKNOWN	GOOD	

ALASKA PENINSULA (12) (Cont'd)	12-R	D2	324	100	LOW NORTH, UNKNOWN SOUTH		
	12-S	D2	864	0	"CONSIDERABLE"	"CONSIDERABLE"	"SIGNIFICANT"
	12-T	D2	36	0	LOW		
SOUTH CENTRAL ALASKA RANGE (13)	13-A	A3	540	0	LOW		
	13-B	A3	1476	51	UNKNOWN		
	13-C	A3	3582	0	UNKNOWN		
	13-D	A3	612	0	UNKNOWN		
	13-E	A3	135	0	UNKNOWN		
	13-F	A3	216	0	GOLD AT NUKA BAY, REST UNKNOWN		
	13-G	D1	612	0	UNKNOWN		
	13-H	D1	126	0	UNKNOWN		
	13-I	D2	120	0	UNKNOWN		
	13-J	D2	396	0	UNKNOWN		
	13-K	D2	51	0	UNKNOWN		
SOUTHERN ALASKA (14)	14-A	A3	504	0	UNKNOWN		
	14-B1 2/	D2	5382	0	LOW	LOW	
	14-B2 2/	D2	5571	0	UNKNOWN		

FOOTNOTES TO TABLE

1/ THE ABBREVIATED SUMMARIES OF MINERAL RESOURCE POTENTIAL ARE QUOTED (WHERE POSSIBLE) FROM THE DISCUSSIONS OF THE WITHDRAWALS IN THE MAIN BODY OF THIS REPORT. THE SUMMARIES ARE REMOVED FROM THE CONTEXT INTENDED FOR THEM AND SHOULD THEREFORE BE EMPLOYED CONSERVATIVELY. MOREOVER, THE ANALYSES FROM WHICH THE SUMMARIES ARE DRAWN WERE MADE FOR SUBREGIONS THAT ARE KNOWN IN VARYING DEGREES OF COMPLETNESS BY INDIVIDUALS WHOSE CONCEPTS OF RESOURCE POTENTIAL DIFFER GREATLY.

2/ SUBDIVISIONS OF A SINGLE LARGE WITHDRAWAL.

UNITED STATES GEOLOGICAL SURVEY

ADDENDUM TO

THE STATUS OF MINERAL RESOURCE INFORMATION ON THE MAJOR LAND WITHDRAWALS OF THE ALASKA NATIVE CLAIMS SETTLEMENT ACT OF 1971

CONCERNING

THE STATUS OF MINERAL RESOURCE INFORMATION ON THE SOUTHEASTERN ALASKA LAND WITHDRAWALS OF THE ALASKA NATIVE CLAIMS SETTLEMENT ACT OF 1971

Preliminary Draft

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[illegible]

Contents

Illustration

Introduction

In June 1972 the Alaskan Branch of the U.S. Geological Survey prepared a report on the status of mineral resource information on the major land withdrawals of the Alaska Native Claims Settlement Act of 1971 (U.S. Geol. Survey, 1972). The withdrawals considered were Native village and regional deficiency areas (sec. 11.a.3, ANCSA), classification and national interest study areas for possible inclusion in the four national systems (sec. 17.d.2) and classification and public interest areas (sec. 17.d.1). The information in the report was used by the Department of Interior and the Joint Federal-State Land Use Planning Commission for Alaska in arriving at the final configuration of withdrawn lands announced in September 1972 (U.S. Bureau of Land Management, 1972).

The final configuration of 11.a.3, 17.d.2, and 17.d.1 lands included many minor and some major boundary changes from those used in the June 1972 study, but the actual lands involved remained the same with two exceptions. Those exceptions are two withdrawals (here designated d2-38 and d2-39 using the ALUPC system) in southeastern Alaska which were not included in the earlier withdrawals but which were included in the 17.d.2 category of the September 1972 withdrawals.

This brief report summarizes the status of mineral resource information for those two late withdrawals in the same way that the June 1972 report summarized the other withdrawn areas.

WITHDRAWAL d2-38

Location

Withdrawal d2-38 (fig. 1) lies adjacent to the International Boundary in the Meade Glacier and Juneau Icefield parts of the Boundary Ranges subdivision of the Coast Mountains (Wahrhaftig, 1965, pl. 1). The total area is estimated to be about 736 square miles (471,040 acres).

General Geology

The Coast Mountains are in general a crystalline complex of schists, gneisses, and granitic rocks. The schists and some gneisses are probably derived from detrital clastic and volcanic rocks of Mesozoic age, but some may be derived from older rocks. Structures in the schists indicate complex and repeated deformation. Large bodies of orthogneiss derived from granitic rocks of Mesozoic age occur with the schists and paragneisses. Granitic rocks of Late Mesozoic and Cenozoic age intrude the older rocks; although their extent is poorly known, it is likely that they underlie most of the Coast Mountains. The ratio of Late Mesozoic granitics to Cenozoic is not known.

The Coast Mountains' crystalline rocks are bordered on the southwest by progressively metamorphosed rocks of original Late Paleozoic to Middle or Late Mesozoic age. In this several-mile-wide belt the rocks range from greenschist facies on the southwest to amphibolite facies on the northeast and contain intermediate pressure facies series mineral assemblages. To the northeast the crystalline complex adjoins low pressure facies series metamorphic rocks of original Late Paleozoic to Middle or Late Mesozoic age. Hornblende hornfels facies assemblages commonly occur adjacent to the granitic bodies.

Across the International Boundary in British Columbia there are scattered areas of Early to Middle Tertiary volcanic breccias and tuffs that were apparently erupted from discrete centers at about the same time that the Cenozoic granitic rocks were being emplaced. Few outcrops of these rocks are known on the U.S. side of the boundary.

The withdrawal includes part of the Juneau Icefield (one of the largest in North America), the Meade Glacier Icefield, and a series of steep-sided glacial valleys. The Juneau Icefield terrane is characterized by broad undulating glaciers at elevations of 3,000 to 6,000 feet separating abrupt-sided bedrock nunataks that reach 8,500 feet. The Meade Glacier Icefield consists of interconnected glaciers at 3,000 to 6,000 feet that join together to form the Meade Glacier which descends gradually to within a few hundred feet above tidewater. The area of steep-sided valleys between the Meade Glacier and the Juneau Icefields contains valley glaciers that are fed by steep icefalls from the icefields.

Present Knowledge

There are no published geologic maps covering the withdrawal. Reconnaissance geologic maps cover the adjacent areas east of the International Boundary (Christie, 1957; Souther, 1971) and a [illegible] part of the Juneau Icefield was mapped by Forbes (1959). D. A. Brew [illegible] A. B. [illegible] have mapped the bedrock geology of most of the Icefield ([illegible]).

Adequacy

The lack of any kind of geologic information for most of the withdrawal makes evaluation of mineral resource information difficult. Cobb (1972) shows no mineral deposits in the withdrawn area. [illegible] far to the west and southwest are the many gold, silver, lead, [illegible] prospects and mines of the Juneau Gold Belt (Cobb, 1972), to the southeast is a recently discovered molybdenum-silver occurrence (Brew and Ford, 1969), and to the east and southeast are the copper, gold, silver, lead, zinc, and antimony deposits associated with the country rocks northeast of the crystalline complex (Christie, 1957; Souther, 1971). The map pattern in British Columbia suggests strongly that some of the rocks containing metallic mineral deposits east of the International Boundary may extend across into the U.S. in the area of the withdrawal.

Clark and others (1972) do not consider the area to lie within any of the metallogenic provinces that they recognize; nevertheless the area is considered here to have some potential for gold, silver, molybdenum, and copper. The existing geologic and geochemical information is inadequate for mineral resource potential evaluation.

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Souther, J. G., Geology and mineral deposits of the Tulsequah map-area, British Columbia: Geol. Survey Canada Mem. 362, 84 p.

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WITHDRAWAL d2-39

Location

Withdrawal d2-39 (fig. 1) lies adjacent to the International Boundary in the vicinity of the Sawyer, Dawes, Baird, Patterson, and LeConte Glaciers north of the Stikine River. The area is in the Boundary Ranges subdivision of the Coast Mountains (Wahrhaftig, 1965, pl. 1). The total area is estimated to be about 634 square miles (405,760 acres).

General Geology

The Coast Mountains are in general a crystalline complex of schists, gneisses, and granitic rocks. The schists and some gneisses are probably derived from detrital clastic and volcanic rocks of Mesozoic age, but some may be derived from older rocks. Structures in the schists indicate complex and repeated deformation. Large bodies of orthogneiss derived from granitic rocks of Mesozoic age occur with the schists and paragneisses. Granitic rocks of Late Mesozoic and Cenozoic age intrude the older rocks; although [illegible] is poorly known, it is likely that they underlie most of the Co[illegible]. The [illegible] of Late Mesozoic granitics to Cenozoic [illegible].

[illegible] rocks are bordered on the southwest by [illegible] rocks of original Late Paleozoic to Middle or Late [illegible] wide belt the rocks range from [illegible] amphibolite facies on the northeast [illegible] series mineral assemblages. To [illegible] low pressure facies series [illegible] to Middle or Late Mesozoic age. [illegible] commonly occur adjacent to the [illegible].

Across the International Boundary in British Columbia there are scattered areas of Early to Middle Tertiary volcanic breccias and tuffs that were apparently erupted from discrete centers at about the same time that the Cenozoic granitic rocks were being emplaced. Few outcrops of these rocks are known on the U.S. side of the boundary.

The withdrawal includes the highest parts of a connected series of glaciers that flow generally westward to tidewater. High bedrock ridges separate the individual glaciers and their tributaries and no single very large icefield is present. Glaciers in the area are at elevations of 3,000 to 6,000 feet and the highest peak is above 10,000 feet.

Present Knowledge

There is no published modern geologic mapping in the withdrawal. Old reconnaissance mapping by Kerr (1931) covers a small part and modern reconnaissance studies by Souther (1959) cover the area immediately east of the International Boundary along most of the withdrawal. Recent work immediately to the west of the withdrawal (Clark and others, 1970) included reconnaissance geologic mapping that is unpublished.

Adequacy

The lack of geologic and geochemical map coverage makes it impossible to evaluate the mineral resource potential of the withdrawal. Based on what little is known, the area probably includes large screens of metamorphic rock separated by granitic bodies of different types and perhaps different ages. The presence of copper occurrences immediately west of the withdrawal (Clark and others, 1970) and molybdenum prospects to the east in British Columbia (Souther, 1959) suggest that there may be some potential for those elements. Cobb (1972a, b, c) shows the location of known metallic mineral occurrences in the general area of the withdrawal. Most of those shown are related to the metamorphic rocks of the Juneau Gold Belt (and its extension to the southeast) and therefore probably have little bearing on the potential of the withdrawal itself.

Clark and others (1972) did not show any metallogenic province covering the withdrawal, although the boundary of a large copper-lead-zinc-gold-silver province lies not far to the west. Nevertheless, the area is here considered to have some potential for copper and molybdenum.

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MT ST ELIAS
YAKUTAT
Yakutat Bay
SKAGWAY
Skagway
WHITEHORSE
ATLIN
Atlin
Watson Lake
CASSIAR MOUNTAINS
MT FAIRWEATHER
Icy Point
Cross Sound
JUNEAU
Hoonah
TAKU RIVER
d2-28
CANADA
UNITED STATES
SITKA
Admiralty Island
SUMDUM
d2-33
HOTAILUH RANGE
PORT ALEXANDER
Cape Ommaney
Kupreanof
Petersburg
PETERSBURG
Wrangell
BRADFIELD CANAL
Prince of Wales Island
CRAIG
KETCHIKAN
Cape Chacon
DIXON ENTRANCE
Prince Rupert
Port Clements
Queen Charlotte
Amlia I
Atka I
SEGUAM
ISLANDS