MINERAL APPRAISAL OF CERTAIN
ALASKA NATIONAL INTEREST LANDS,
PROPOSED LAKE CLARK NATIONAL PARK:
A SUMMARY REPORT

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FOREWORD

This is one of a series of summary reports that present the findings of reconnaissance-type mineral assessments of certain lands in Alaska. It is important to remember that Alaska has not been seriously prospected for minerals other than gold--except in a few relatively limited areas. These summary reports include data developed by both contract and Bureau studies; frequently a combination of both. As digests of more detailed reports that are still in preparation, these summaries omit the detailed findings that will be presented in the main reports, but the basic data and conclusions remain the same.

Assessing an area for its potential for buried mineral deposits is by far the most difficult of all natural resource assessments. This becomes more apparent when considering that no two deposits even of the same genesis and host rock conditions are identical. Moreover, judgments prior to drilling, the ultimate test, frequently vary among evaluators and continue to change as more detailed studies add to the understanding.

Included in these reports are estimates of the relative favorability for discovering metallic and related nonmetallic mineral deposits similar to those mined elsewhere. Favorability is estimated by evaluation of visible outcrops, and analyses of sampling data, including mineralogic characteristics and associated elements, in combination with an evaluation of the processes that have formed the rocks in which they occur. Essentially, it is a comparison of a related series of prospects and the environment in which they occur with the mineral deposits and environments in well-known mining districts. Recognition of a characteristic environment allows not only the delineation of a trend but also a rough estimate of the favorability of conditions in the trend for the formation of minable concentrations of mineral materials. This is a technique long used in the mineral industry to select areas for mineral exploration. Qualifying a trend or area as "highly favorable" for the discovery of mineral deposits indicates that the combination of outcrop samples, mineralogic data and geologic conditions that have been observed essentially duplicate the conditions in a recognized mining district elsewhere.

TABLE OF CONTENTS

ILLUSTRATIONS

MINERAL APPRAISAL OF CERTAIN ALASKA NATIONAL INTERST LANDS, PROPOSED LAKE CLARK NATIONAL PARK: A SUMMARY REPORT

by

Robert H. Lambeth 1/

ABSTRACT

The Bureau of Mines made a reconnaissance examination of the Lake Clark region in 1976 and 1977 to identify and evaluate mineral deposits and mineralized areas. The southeast part of the region except for a narrow strip along Cook Inlet seems relatively lacking in metallic mineral deposits although this may reflect only a lack of prospecting due to the rugged terrain. The northern half of the region has three areas favorable for (1) tin and uranium deposits and copper-lead-zinc deposits; (2) porphyry copper-molybdenum deposits with associated lead-zinc-silver-gold deposits; and (3) molybdenum or molybdenum-tungsten porphyry deposits. The west central part of the region and a strip along Cook Inlet are favorable for (1) copper-zinc and zinc-lead stratiform deposits. The west central part also is favorable for (2) copper molybdenum and gold in prophyry deposits. The extreme north end of the region may contain (1) contact type lead-zinc-copper deposits; (2) vein deposits of antimony, lead, zinc, copper and gold; and (3) porphyry copper-gold deposits. Industrial minerals in the region include cement-grade limestones, pumice and zeolites. Four active volcanos indicate that geothermal development may be practical. The southeast margins are in the Cook Inlet petroleum province.

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INTRODUCTION

The Bureau of Mines was requested by the Joint Federal-State Land Use Planning Commission to evaluate the mineral potential of certain lands in Alaska. One area was the proposed Lake Clark National Park in Southwest Alaska (figures 1 and 2). Funding was by a special Congressional appropriation. The investigation began in 1976 with the compilation of all data available from the Geological Survey, the State of Alaska, and private industry. Additional data were purchased from a consulting firm that had worked in the area. In 1977, a Bureau of Mines field party studied the known occurrences and significant anomalies and made reconnaissance sample surveys. Several significant occurrences, some of which merit more study, were discovered during the program.

The mineralized areas are defined by the occurrence of mineral deposits, by the presence of rock-units favorable for mineralization, by stream sediment samples, and by any other sampling data that could be obtained. Data on the more significant occurrences and anomalies indicated on figure 3 are tabulated in the Appendix.

This is a summary report; a more comprehensive report is being prepared.

ACKNOWLEDGMENTS

Numerous people provided useful information and suggestions. Especially helpful were Bruce Reed, a Geological Survey geologist who worked in the southern Alaska Range for several years and T. C. Mowatt of the Bureau of Mines who made petrographic studies of samples from the area. Robert Fankhauser of Resource Associates of Alaska, and James McDougall of St. Eugene Mining Company provided much useful data.

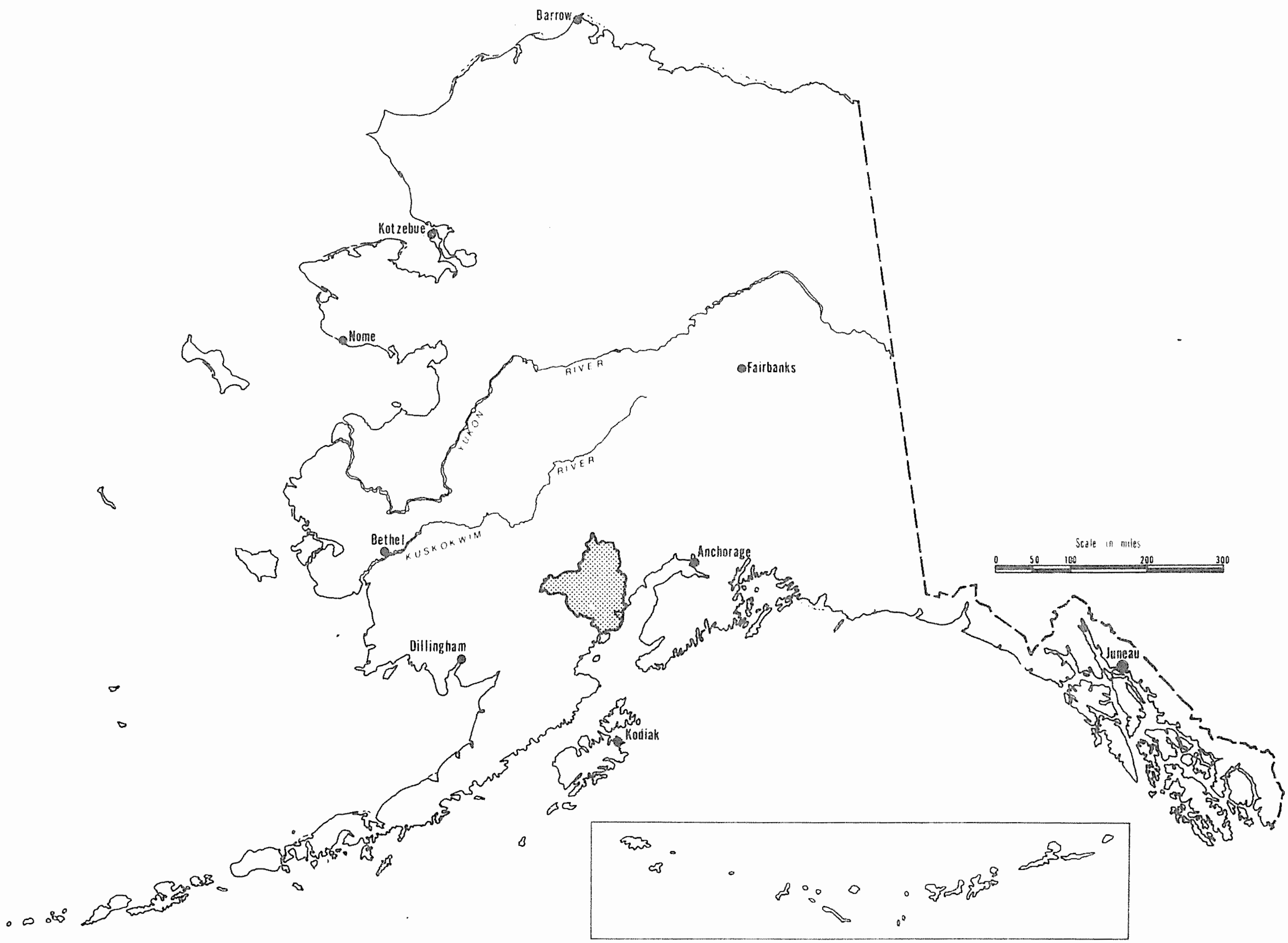

FIGURE 1.- Index map of the proposed Lake Clark National Park

MINERAL POTENTIAL

There have been three distinct epochs of granitic rock formation (Alaska-Aleutian Range Batholith) and one phase of marine sedimentation and volcanism recognized within the Lake Clark study region (figure 3 and 4). The known mineralization can be directly related to these rock units. The areas indicated to be favorable for metallic minerals (figure 5) are either related to or within the Tertiary age granitic intrustives or are within the sequence of rocks derived from marine sedimentation and volcanism. Recent surficial and Tertiary continental deposits seem to be unfavorable for metallic minerals but may contain industrial minerals and coal. The presently active volcanic area may be favorable for geothermal energy development.

Because of the complexity of the area, the mineral deposits in each group of rock types are described separately starting with the oldest rocks.

Jurassic Granites

The oldest rocks in the study region are Jurassic age granitic rocks, which represent the core of an ancient volcanic island-arc similar to the modern Aleutian or Japanese Islands. This core was subsequently uplifted and eroded. Little evidence of mineralization has been found where these rocks are exposed. However, this area is extremely rugged and poorly explored. A weak copper anomaly in stream sediments near Chinitna Bay, the contact-type iron-copper deposits at Tuxedni Bay, mineralization near Drift River, and copper deposits near Iniskin River indicate that there is at least some mineralization in the Jurassic intrusives.

Mesozoic-Paleozoic Volcanics and Sediments

"Volcanogenic" types of deposits originally formed by ejection of ore solutions onto the ocean floor may be found in the study region.

One probable volcanogenic base metal sulfide prospect, the Tak II (Occurrence 8, figure 3), has been drilled, but the data are unavailable. Occurrences 6, 8, and 9 (figure 3), as well as most anomalously high samples found within area 5 (figure 5) may be due to volcanogenic deposits.

During the early stages of the above mentioned deposition of interbedded volcanics and sediments, limestone deposits formed on the ocean floor. These are now exposed at several locations in Kamishak Bay. Sampling by the Geological Survey shows the limestone to be of adequate quality for cement manufacture.

During the latter stages of this sequence, most of the material deposited was sediment, some of which now contains petroleum as is illustrated by oil and gas seeps on the Iniskin Peninsula (figure 5). This is part of the Cook Inlet Mesozoic Province.

Tertiary-Cretaceous Granitic Rocks

The next major geologic event was the formation of the Tertiary-Cretaceous age granitic rocks adjacent to and northwest of the Jurassic granitics. Little is known about these rocks but they are considered to be more favorable for mineral deposition than the Jurassic granites. This is based on the discovery of thin sheets of copper ore (chalcopyrite) in fractures (Occurrence 7, figure 3); a moderate copper anomaly near Iliamna volcano (Anomaly 12, figure 3); and one major mineralized area (Occurrence 6, figure 3). There are probably others.

Tertiary Intrusives

Roughly 35 million years after formation of the Tertiary-Cretaceous granitics a complex highly mineralized sequence of Tertiary rocks were formed. These are intrusive rocks that have a chemical composition commonly associated with mineralization in other parts of the world (relatively high potassium and silicon content).

This Tertiary sequence has been divided into three parts on the basis of observed minerals: the Tired Pup batholith (Area 1, figure 5), the Mt. Estelle-Crystal Creek-Tordrillo sequence (Area 3, figure 5), and the Merrill Pass sequence (Area 4, figure 5).

The Tired Pup batholith has tin-uranium mineralization in the southern end and contact copper-lead-zinc deposits near the center and the fringes. Occurrence 2 (figure 3) is one of several small contact deposits from which individual samples assayed as high as 12 percent copper-lead-zinc combined. Anomaly 2 (figure 3) is a stream sediment sample which contained tin. Anomaly 1 (figure 3) is a relatively high amount of uranium found in a stream sediment. This area has not been examined adequately.

The Mt. Estelle-Crystal Creek-Tordrillo series (Area 3, figure 5) of the Tertiary intrusive system is a large, multiphase, granitic body in which have been found numerous mineral occurrences, including porphyry copper-molybdenum. One, the Chilligan (No. 4, figure 3) has been drilled by industry on a reconnaissance basis; others, particularly the Hayes Glacier prospect (no. 2, figure 3), are apparently large deposits. This area is moderately accessible via logging roads from Tyonek.

Area 4, (figure 5) the Merrill Pass sequence of the Tertiary system, contains numerous and consistent occurrences of coarse molybdenum and quartz in fractures, also some magnetite and quartz in thin veinlets. There is a general lack of intense alteration. However, there are areas of intense alteration with significant tungsten values.

During this period, the numerous relatively small intrusives (called stocks) such as the Kijik, Bonanza Hills, and Jimmy Lake prospects penetrated the older sediments and volcanic rocks. These may contain large low-grade porphyry copper-gold, and copper-molybdenum deposits with associated lead, zinc, and silver veins, and contact deposits of copper, lead, and zinc. The lode sources of the Bonanza Hills and Portage Creek placer gold mines (figure 3) are Tertiary stocks. Kijik (No. 6, figure 3 and Appendix) is a reputed copper-gold porphyry. Kasna Creek (No. 7, figure 3) and Millets Point (No. 10, figure 3) are reputed contact deposits. The Pass prospect appears related to a Tertiary stock. It is possible that undiscovered porphyry deposits occur within this area related to these or other Tertiary stocks.

Cretaceous Sediments

Area 2 (figure 5) is underlain by Cretaceous sediments. These are adjacent to and possibly in some cases overlie the previously mentioned Tertiary intrusives. Ore forming solutions derived from the Tertiary intrusives might form deposits in these sediments. One example is Occurrence 1 (figure 3), an antimony vein which is traceable for 550 feet. Other occurrences are known. It is likely that many other gold, gold-silver, mercury, and copper-lead-zinc-silver occurrences remain to be discovered. There is also a high probability for the discovery of contact deposits similar to Occurrence 2.

Volcanic Activity

Four active volcanos have developed in this area: Spurr, Redoubt, Iliamna, and Augustine. The most obvious resource associated with these is geothermal power. Two other resources are also related to the volcanoes--pumice, an industrial abrasive formed from volcanic effects near Mt. Spurr, and zeolite, and industrial sorbent and catalyst formed by alteration of volcanic glass, near Mt. Redoubt.

ON-GOING STUDIES

The Bureau of Mines is presently preparing a more comprehensive technical report on the Lake Clark area which will include a tabulation and evaluation of some 6000 samples. Minor additional field work is planned in 1978 or 1979 in those areas where available data cannot be evaluated without more evidence. No major programs are planned.

CONCLUSION

The favorability for mineral development was estimated on the basis of known rock type-mineral relationships, known occurrences, and anamolous samples. The estimates are necessarily speculative, particularly in the southeast half of the area because of the scanty evidence. Nevertheless, the data indicate that large parts of the Lake Clark region are highly mineralized. The portion of the study region southeast of Lake Clark Pass except for a narrow strip along Cook Inlet is composed of a rock type thought to be unfavorable for mineral deposition. However, this area is rugged, glaciated, and inaccessible. The geology is not well known. A few mineral occurrences are known. The lack of known mineral deposits may reflect lack of prospecting.

The north half of the study region may be divided into areas favorable for (1) tin-uranium mineralization of unknown type or extent, as well as contact-type copper-lead-zinc; (2) a zone favorable for porphyry copper-molybdenum deposits with associated lead-zinc-silver-gold veins; and (3) an area favorable for molybdenum or molybdenum-tungsten porphyry deposits.

The western portion of the study region is underlain by a marine volcanic-sediment sequence favorable for copper-zinc and zinc-lead stratiform deposits. Copper-gold or copper-molybdenum-gold porphyry deposits occur in this area within small Tertiary intrusives. The placer gold deposits in this area appear to have been derived from these deposits.

The extreme north end of the study region is underlain by sediments which may contain vein deposits of antimony, antimony-mercury, lead-zinc-silver and gold-quartz. Copper-gold bearing porphyry deposits similar to those in the western part of the study region may also occur in this area.

Industrial mineral deposits of possible value include cement-grade limestones, pumice, and zeolites.

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APPENDIX

TABULATION OF PROSPECTS, OCCURRENCES, AND ANOMALIES WITHIN AND NEAR THE PROPOSED LAKE CLARK NATIONAL PARK

Prospects

Number	Description
1	Jimmy Lake, stockwork Cu-Au in Tertiary quartz monzonite porphyry which intrudes Cretaceous sediments (18) 2/.
2	Hayes Glacier, stockwork Cu-Au-Mo in Tertiary quartz monzonite porphyry which intrudes Cretaceous sediments (18).
3	Crystal Creek, stockwork Cu-Mo in Tertiary quartz monzonite porphyry which intrudes an older Tertiary intrusive and a Jurassic volcanic roof pendant, abundant tourmaline (13).
4	Chilligan, stockwork porphyry copper, has been studied by limited diamond drilling (24).
5	Pass Prospect, Cu-Ag mineralization related to a breccia pipe in probable Tertiary volcanics (13).
6	Kijik, stockwork Cu-Au-Mo porphyry in Tertiary quartz monzonite porphyry intruding Jurassic volcanics (18).
7	Kasna Creek, contact-metamorphic Cu-Zn in limestone near a Tertiary intrusive, contains an estimated 30 million tons of ore blocked by drilling (32).
8	Tak II, probable volcanogenic Cu in Jurassic andesite, mineralized stratum is traceable for 2 miles, has had limited diamond drilling.
9	Tuxedni Bay, contact-metamorphic Fe-Cu deposits in limestone, has been drilled (15).
10	Millet Point, contact-metamorphic Cu deposit in limestone, has been drilled and trenched (28).
11	Dutton, stockwork Cu-Au-Mo porphyry in granodiorite porphyry which intrudes quartz diorite (18).

2/ Underlined numbers in parentheses refer to items in the selected bibliography preceding the appendix

Placer Deposits

Number	Description
1	Bonanza Hills, Au is related to a Tertiary intrusive, still active working

Occurrences

Number	Description
1	Stibnite in brecciated Cretaceous sediments, traceable for 550 feet
2	Sphalerite, galena, and chalcopyrite in small xenoliths of Cretaceous sediments, up to 12% Cu-Pb-Zn
3	Possibly Tetrahedrite in rhyolite
4	Coarse molybdenite, quartz veins and magnetite veinlets in quartz monzonite; not extensive alteration
5	Coarse molybdenite with tungsten in fracture in quartz monzonite
6	Several occurrences of chalcopyrite in roof pendant of interbedded limestone and andesite
7	Chalcopyrite in thin fractures in quartz diorite
8	Chalcopyrite in Jurassic andesite
9	Chalcopyrite in Jurassic andesite roof pendant

Anomalous Sediment Samples

Number	Description
1	U = 200 ppm, Be = 4 ppm, Sn = 70 ppm, W = 4 ppm, F = .062%, Cu = 20 ppm, Pb = 35 ppm, Zn = 145 ppm, Ag =<.2 ppm, Mo =<2ppm
2	Sn = 1000 ppm by semiquantitative spectrographic analysis, U = 90 ppm, Be = 5 ppm, Sn = 100 ppm (-80 mesh), W = 8ppm, F = .065%
3	Sn = 100 ppm (-80 mesh), U = 15 ppm, W = 6 ppm, F = .05%
4	U = 65 ppm, W = 8 ppm
5	U = 90 ppm, Mo = 40 ppm, Ag = 1.2 ppm
6	U - 120 ppm, Zn - 285 ppm
7	Mo = 31, 38, 63, 66, 75 and 200 ppm

Number	Description
8	Pb = 1000 ppm, Zn = 700 ppm, Ag = 5 by semiquantitative spectrographic analysis
9	Zn = 1000 ppm, Pb = 129 ppm
10	Zn = 460, 530, 510, and 370 ppm; Pb = 220, 185, and 120 ppm; Cu = 190, 340, 650, and 290 ppm
11	Mo = 52 and 57 ppm