United States Department of the Interior

BUREAU OF MINES
P.O. Box 550
Juneau, Alaska 99802

September 14, 1978

MEMORANDUM

To: Chief, Office of Mineral Information, Washington, D.C.

From: Chief, Alaska Field Operations Center, Juneau, Alaska

Subject: Open File Report 103-78, "Mineral Studies of the Western Brooks Range performed under contract to the U.S. Bureau of Mines, Contract #J0155089"

Subject report has been placed on open file in the Department of the Interior Library, the office of Environmental Coordination, and in Bureau of Mines offices in Anchorage, Fairbanks, and Juneau, Alaska. The State Geologist in Anchorage, Alaska, has also received a copy of the report.

John J. Mulligan

cc: Chief, Environmental Coordination
State Geologist, Anchorage, Alaska
AFOC: Anchorage, Fairbanks, Juneau
Dept. of Interior Library, Washington, D.C.

MINERAL STUDIES OF THE WESTERN BROOKS RANGE PERFORMED UNDER CONTRACT TO THE U.S. BUREAU OF MINES, CONTRACT # J0155089

VOLUME 1

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MAY 3, 1978
ANCHORAGE, ALASKA

WGM Inc.,
CONSULTING GEOLOGISTS AND ENGINEERS

This report contains mineral studies of known deposits in the general area of the Western Brooks Range which were initiated under contract in early 1975 under Secretary Morton to the WGM INC., Geologists and Engineers. These studies examined 19.2 million acres identified in four of Secretary Morton's 17(d)(2) proposals under the previous Administration including proposed Gates of the Arctic National Park, Kobuk Valley National Monument, Selawik National Wildlife Refuge, and Noatak National Arctic Range. Although there are areas of overlapping boundaries, the Morton proposals do not reflect the current Administration's proposals for the Western Brooks Range area. In particular, the proposals, study areas, and boundaries for Secretary Morton's proposals examined in this report differ substantially from Secretary Andrus' proposals for Noatak National Ecological Preserve and Selawik National Wildlife Refuge. Because this report does not reflect the current Administration proposals and was performed under contract, it should not be construed as representing official endorsement of the findings and conclusions contained therein.

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1. ABSTRACT

The known mineralized areas within an area of 19.2 million acres were studied during the 1975 and 1976 field seasons. A national park, a national monument, a national wildlife refuge and a national Arctic range are proposed for the 19.2 million acres.

The field work was directed mainly by an extensive literature search. The total program was limited to a $300,000 budget and so the field work was restricted to examination of previously reported mineral indications.

The Red Dog prospect, while previously noted, was identified as an extensive lead-zinc and barite occurrence with high grade zones of mineralization. Very preliminary work indicates a potential for 750,000 tons per vertical foot with impressive lead-zinc-silver-barite values.

The Omar and Frost occurrences were confirmed as promising base metal targets which warrant further work. Several other specific targets were pinpointed which individually, or as representative of a larger area, warrant further work.

While insufficient work was completed to quantify the mineral potential, the results do allow classification of

several important geologic units as hypothetical or speculative resources (principally base metals) in accordance with the United States Geological Survey classification. Some of these rock units have sufficient potential, on the basis of widespread examinations and limited geochemical surveys, to warrant detailed exploration for base metals. Other rock units warrant regional exploration efforts.

The resources identified within these units may be compared favorably with properties in northern Canada at a similar stage of development, and which are now being successfully mined in equally difficult and remote locations.

Further definition of these mineral resources is dependent on more detailed geological mapping and mineral exploration which will cost in the order of $1.00 per acre (McOuat, J.F. pers. comm.).

2. CONCLUSIONS AND OBSERVATIONS

1. Although the Red Dog lead-zinc-barite occurrence had been noted in earlier work, one of the principal results of the present program was its recognition as an extensive lead-zinc-barite prospect of outstanding merit. Both as to possible grade, with combined lead-zinc up to 44.6%, and as to size, with mineralization identified in an area of 9,000 feet by 3,500 feet, this must be termed a mineral resource with great potential.

2. Two other promising base metal and/or barite occurrences (Omar and Frost) were confirmed.

3. At several other locations (including some previously unknown) base metal mineralization was located in favorable geological environments.

4. Placer gold deposits, although generally small, have been known and some worked in the area for many years. Placer gold deposits were not evaluated for their ore reserves during this study.

5. Intensive exploration for copper and zinc, costing millions of dollars, is being conducted on nearby open

lands within rock units known to be present in the study area which, where examined, contain copper and zinc geochemical anomalies.

6. The presence of these deposits or occurrences within rock units which occur in extensive areas within the study area allows a projection of significant hypothetical resources in the area in accordance with the United States Geological Survey classification.

7. Certain other rock types (ultramafics, granitic rocks) examined contain mineral occurrences currently too small or too low-grade to be of individual interest, but which offer sufficient evidence to warrant regional investigations and designation as speculative resources.

8. At least some of the showings (Red Dog, Omar, Frost and Kav) and their host environments are of a type which are being intensively explored elsewhere in Alaska and Canada and which, in Canada, have been developed into successful mines in equally remote and severe climates.

9. Insufficient work (including this program, previous governmental surveys and private exploration programs) has been done to complete an overall mineral inventory of the 19.2 million-acre study area.

The current program was restricted to an examination of reported mineral occurrences because 1.6¢ per acre was available for the study. Elsewhere in Alaska, in an area of the same magnitude, which is more accessible and better known geologically, industry is spending 50¢ to 60¢ per acre to obtain a minerals inventory prior to detailed (drilling, etc.) prospect investigations (WGM Inc., private data).

10. The current program has established that, in those portions of the 19,200,000 acres examined, major mineral potential exists.

11. A number of case histories of northern mines has been included to illustrate the time, persistence and money required, and warranted to reach a comprehensive mineral inventory.

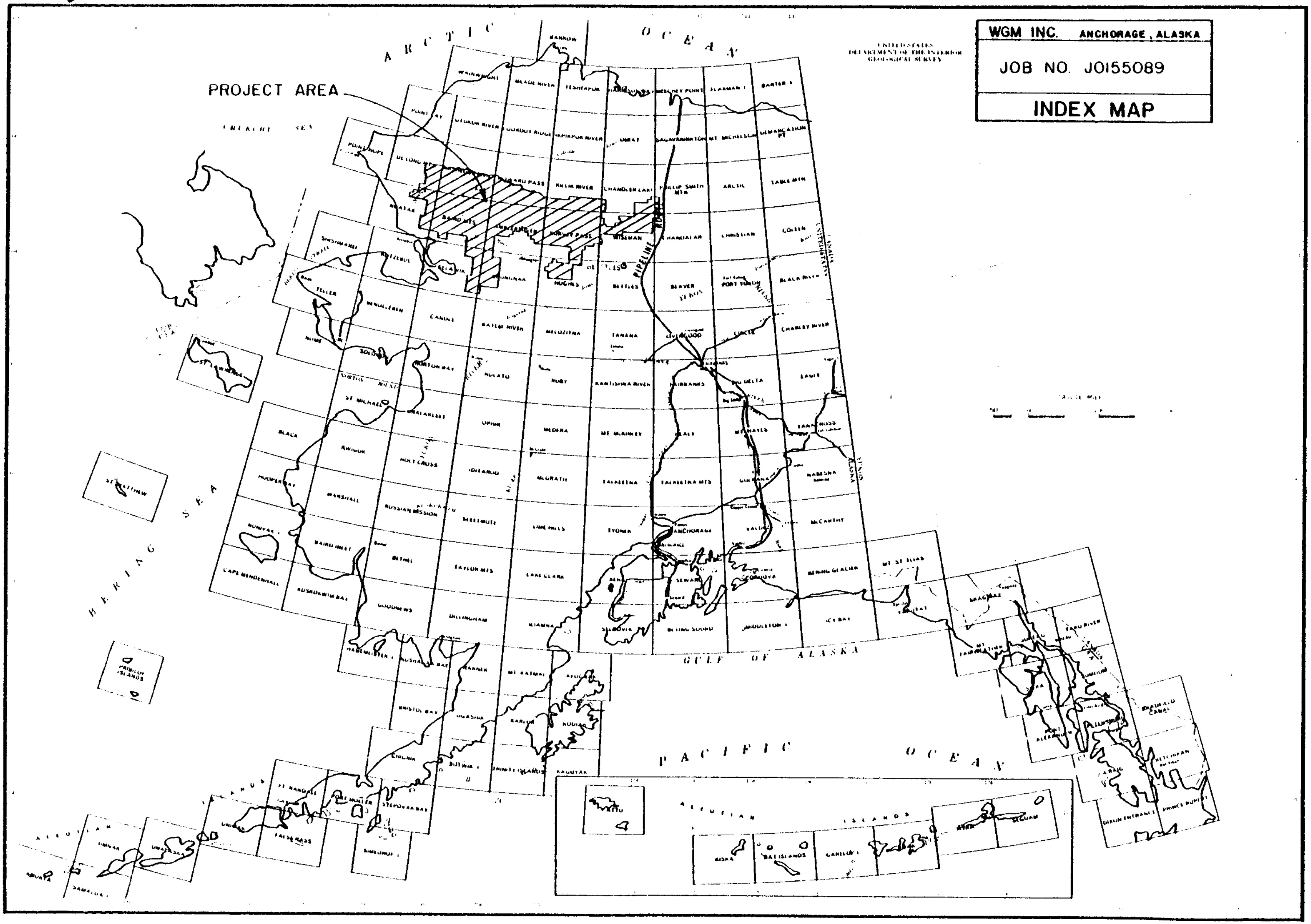
12. Until reconnaissance geological mapping at a scale of 1:250,000 is completed, meaningful evaluation of the area will not be possible. Extensive mineral exploration, appropriate to the various geologic environments, will then allow further definition of the mineral resources.

3. INTRODUCTION

3.1 GENERAL

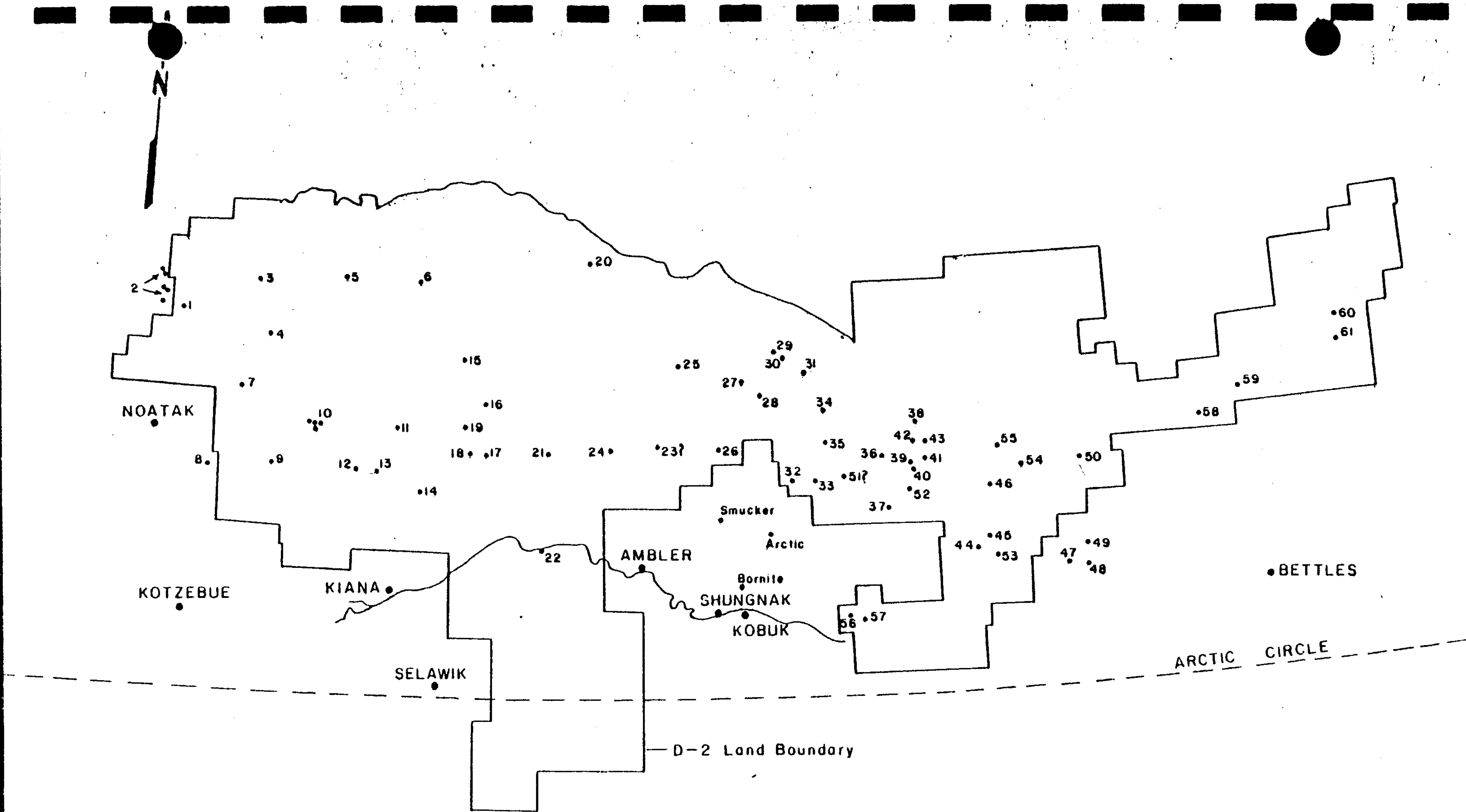
The Congress of the United States acknowledged the rights of Alaska Natives to land ownership in Alaska in 1884. Legislation conveying title was not enacted until December 18, 1971 when Congress passed the Alaska Native Claims Settlement Act (ANCSA, PL92-203). This act provides that Alaska Natives will receive 40 million acres of land in Alaska and $962,500,000 as settlement for extinguishing all aboriginal land claims. Another major provision of the Act directed the Secretary of the Interior to withdraw up to 80 million acres of land in Alaska for possible future national parks, forests, wildlife refuges, and wild and scenic river systems.

Acting under this congressional mandate, the Secretary set aside approximately 83.5 million acres of land for possible inclusion into the four national systems which includes 19.2 million acres of land in and adjacent to the Brooks Range of Alaska. The outline of this land is shown on Figure 3 and is designated as follows:



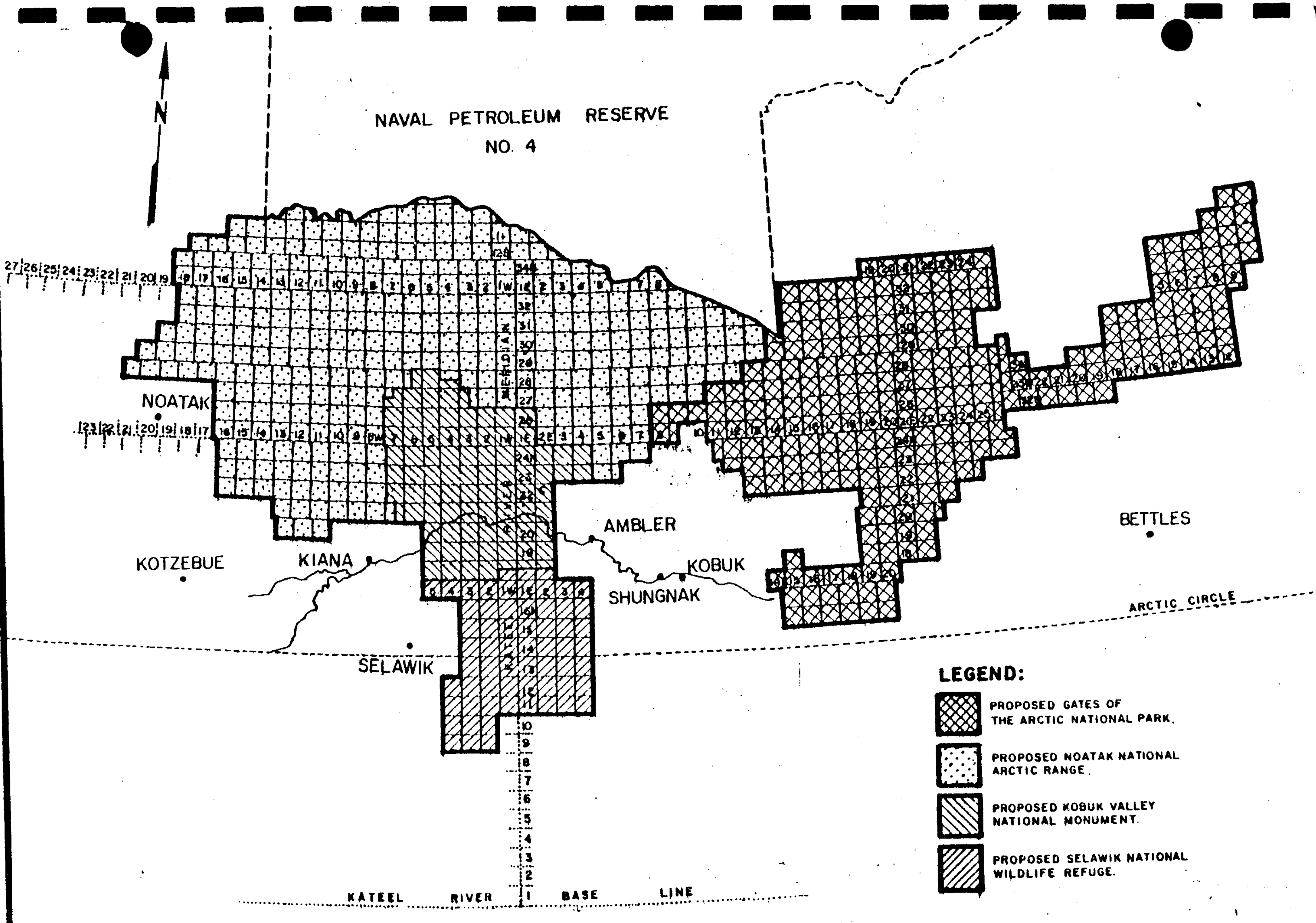
WGM INC. MINING & GEOLOGICAL CONSULTANTS ANCHORAGE, ALASKA

Scale: AS SHOWN		INDEX MAP PROJECT AREA, ALASKA	BM100 FIG. 1
Data By: U.S.G.S.	Date: 1976		



Numbers refer to section 7 of report.

WGM INC	MINING & GEOLOGICAL CONSULTANTS ANCHORAGE, ALASKA	DWN BY: JMP	REVISED	INDEX MAP	FIGURE 2
SCALE: 1" = Approximately 40mi		DATA BY: C D		MINERAL OCCURENCES	
		DATE: 3/78			BM 145



WGM INC	MINING & GEOLOGICAL CONSULTANTS ANCHORAGE, ALASKA	DWN BY: M H DATA BY: C D DATE: 8/76	REVISED	INDEX MAP PROJECT AREA, TOWNSHIP AND RANGE DESIGNATION	FIGURE 3

SCALE: approximately [illegible]

		Acres
1.	Proposed Gates of the Arctic National Park	8,360,000
2.	Proposed Kobuk Valley National Monument	1,850,000
3.	Proposed Selawik National Wildlife Refuge	1,400,000
4.	Proposed Noatak National Arctic Range	7,590,000
	TOTAL	19,200,000

In early 1975, the United States Bureau of Mines (U.S.B.M.) requested proposals from organizations having the capability to appraise the mineral potential of the 19.2 million acres of land in and adjacent to the Brooks Range. The terms of reference provided by the U.S.B.M. indicated that the purpose of the study was threefold:

1. To satisfy a congressional directive to appraise the "economic and subeconomic mineral potential" of areas proposed for withdrawal under terms of ANCSA.

2. To provide input into ongoing Alaska transportation corridor studies.

3. To complete mineral supply information for inclusion in the U.S.B.M. Minerals Availability System.

Within the general guidelines described above, the work was to be broken into three phases as follows:

> <u>Phase 1</u> - "... compile and summarize all pertinent published and unpublished data on the area ... The product of this phase shall be an annotated biblio--graphy and a summary of recommended fieldwork.

> <u>Phase 2</u> - "... select areas to conduct field sampling and mapping, utilizing engineering techniques appropriate to the occurrences. These studies shall concentrate on areas primarily where company confidential data cannot be released. The procedures used shall be the same as those used by mining companies to outline reserve potential ... Sampling and analytical work shall be commensurate with the detail required to document mineral reserves in anticipation of development when legal conditions permit. Scheduling of fieldwork shall be sufficiently flexible to enable changes to be made in study areas depending upon results encountered."

> <u>Phase 3</u> - "... The Contractor shall correlate field results with previously published and unpublished information. The findings will be presented in a report accompanied by appropriate tabulations and maps.

Mineral deposits, zones, and areas shall be delineated showing estimated size and grade of economic and sub-economicreserves."

In response to this request, WGM submitted a proposal and in early May 1975 was awarded a contract to conduct the work.

3.2 PROGRAM

Phase 1

Several meetings between representatives of WGM Inc., the U.S.B.M. and members of other concerned Federal and State of Alaska agencies were held in May 1975. Present at one of the meetings, the following were in attendance:

U.S. Bureau of Mines	State of Alaska	WGM Inc.
J. Mulligan	R. Schaff	C. Bigelow
A. Service	M. Wilste	J. McOuat
D. Banister	G. Pessel	C. Degenhart
T. Mowatt	M. Henning	

As a result of these meetings, priority work areas were established, permission was obtained from the Bureau of Land Management (B.L.M.) to conduct the work, and coordination procedures were established with the Federal and State geologic agencies.

Prior to commencement of field work, a literature search was carried out. This was based on available public documents, including those of the United States Geological Survey, the Alaska Division of Geology and Geophysical Surveys, and the United States Bureau of Mines.

Companies and individuals known to have examined parts of the area prior to closure of the study lands, or which had studied nearby lands, were solicited in writing for assistance. It was hoped that some guidelines might be obtained concerning the geological environments in which mineral occurrences were known. One of the principal sources of data were WGM personnel who had worked in the area prior to ANCSA.

Of the companies approached, General Crude Oil Company extended the only significant cooperation to WGM. This company had acquired, because of its regional interest in the Brooks Range, the results of a regional geological and geochemical program mounted in 1969 by a minerals exploration syndicate known as Alvenco. This work covered large areas of both open and closed land in the Brooks Range. General Crude gave WGM access to this data as well as its data on adjacent open to mineral entry lands.

Bear Creek Mining Company was for years the principal mineral explorer in the Brooks Range. WGM was able, through its own sources, to include in its compilation and field inspection the more important of the Bear Creek discoveries - details, however, are lacking - for example the mapping, sampling and drilling at the Omar prospect.

It is believed that the information provided by General Crude would represent exploration work of a value of at least $300,000 in 1975/1976 dollars.

As a result of these efforts, 61 mineral occurrences, prospects or geochemical anomalies were tabulated, as shown in Section 7.

Forty-five of these areas received field inspection based upon the criteria discussed in the Principles and Techniques section. Each of the sites was discussed with U.S.B.M. representatives, either prior to the field work or during the field season. Certain areas selected for examination, such as reported mining claims, were not locatable in the field. Several areas were added to the tentative examination list based on field observations.

Phase 2

It was obvious that the limited funds allocated ($300,000) were insufficient to complete a comprehensive evaluation of the entire 19.2 million acres. Therefore, a decision was made in conjunction with the U.S.B.M. to restrict the field investigations to an appraisal of a selection of the reported mineral occurrences with no regional exploration. It was agreed that within the limited budget, case studies on the apparently better prospects would provide at least some appreciation of the overall potential of the study area. The inherent weakness in this approach is that the earlier, very limited, exploration work by individuals and companies was directed towards discovery of gold and very high grade deposits, and most governmental investigations were of a scientific rather than economic orientation.

Upon approval from the B.L.M. to conduct geological work in the d-2 lands, the WGM field crew mobilized to the field on June 18, 1975.

Field work commenced June 19, 1975 in the western part of the project area in the DeLong Mountains and ended in late August 1975 at Walker Lake. Approximately three weeks of field work were carried out during 1976 in order to complete the program.

The length of the 1975 field season, from original mobilization to final demobilization, was 71 days while the length of the 1976 field season was 29 days. Four camp sites were occupied during 1975 and two camp sites were used during 1976. These were as follows:

From	To	Camp Location
June 18, 1975	July 13, 1975	Kelly River
July 14, 1975	July 30, 1975	Omar Prospect
July 31, 1975	Aug. 18, 1975	Matcharak Lake
Aug. 19, 1975	Aug. 27, 1975	Walker Lake
June 23, 1976	July 5, 1976	Sixtymile River
July 6, 1976	July 21, 1976	Kogoluktuk River

A total of 24 field days were totally lost to inclement weather. High winds, low visibility, and rain and snow hampered efficient field work during other periods.

Generally at each location the procedure followed was to try to locate the occurrences, and if successful, make a preliminary geological sketch map of the showing, take character and/or chip samples, conduct limited geochemical sampling of the streams or soil in the immediate area and try to gain some preliminary appreciation of the regional geological setting in which the showings were located. Samples obtained at the Red Dog, Omar and Avan prospects were subjected to additional studies such as microscopic examination.

A total of 1,386 rock, soil and stream silt samples were collected for analysis and an additional 240 samples were collected for reference and/or laboratory study.

Forty-five prospects, reported mineral occurrences and geochemical anomalies were examined. More time and effort were alloted to areas displaying significant mineralization than to weakly mineralized areas or to areas displaying geochemical stream silt anomalies.

Phase 3

Following the field season, all field data was studied and interpreted. A limited amount of petrographic work was carried out on selected rock types from three of the prospects examined during the field season. Wherever possible, results from previous investigations in the area are incorporated into the present study.

3.3 LOCATION

The location of the four study areas is shown on Figures 1, 2 and 3. A brief description of each of the areas follows.

The proposed Gates of the Arctic National Park (G.A.N.P.) contains about 9.69 million acres of land (Final Environmental Statement). The U.S.B.M. requested that 8.36 million acres of the park area be included in the present study. The G.A.N.P. is located between latitudes 66°30' and 69°15' north and longitudes 149° and 146°30' west, all north of the Arctic Circle. The proposed park is 200 miles by 200 miles at its maximum dimensions.

The proposed Kobuk Valley National Monument (K.V.N.M.) includes about 1.85 million acres of land and is generally bounded by latitudes 66°45' and 68°00' north, longitudes 160°30' and 157°00' west. The area extends about 56 miles in an east-west direction and a maximum of 64 miles in a north-south direction.

The proposed Selawik National Wildlife Refuge (S.N.W.R.) consists of about 1.4 million acres of land bounded roughly by latitudes 66°07' to 66°56' north and longitudes 157°55' to 159°50' west. The maximum dimensions of the S.N.W.R.

are 115 miles in a north-south direction and 105 miles in an east-west direction.

The proposed Noatak National Arctic Range (N.N.A.R.) includes about 7.59 million acres of land and extends from about latitude 67°05' to 68°37' north and from longitude 155°45' to 165°35' west. The maximum east-west distance across the N.N.A.R. is about 410 miles, while the maximum north-south dimension is approximately 120 miles.

The four areas extend from the DeLong Mountains in the far west Brooks Range to the Endicott Mountains in the central portion of the Brooks Range.

3.4 ACCESS

Access to the project area is restricted primarily to air and river traffic. There are no roads or railroads within the area, although the haul road for the Alyeska pipeline passes near the eastern edge of the proposed G.A.N.P.

During the summer months, barges may be utilized on the Noatak and Kobuk Rivers. The village of Noatak, located about 12 miles outside the western edge of the project area, is served by barges originating in Kotzebue. The villages of Kiana, Ambler, Shungnak and Kobuk, located near the Kobuk River, are also served by barges from Kotzebue. Kobuk is the easternmost point served by barge along the Kobuk River. The river is navigable after spring breakup, at least as far east as Kiana, and periodically an additional 100 miles farther up river to Kobuk. The Kobuk River passes through the K.V.N.M. between Ambler and Kiana.

Numerous airstrips are located near the project area, but only one or two very crude small bush plane airstrips are known to be present within the project area. The following summary lists airstrips located near the project region, which may be used as staging points for entry into the area. The location of each airstrip is shown on Figure 4.

Summary of Fixed-Wing Aircraft Facilities Near Project Region

Location of Airstrip	Runway Length, in Feet
Kotzebue	5,900
Bettles	5,200
Anaktuvuk Pass	4,400
Kiana	4,000
Dahl Creek	3,900
Wiseman	3,000
Kobuk	2,800
Noatak	2,400
Noorvik	2,000
Ambler	1,700
Selawik	1,400
Shungnak	1,400
Arctic Strip (private)	1,700(?)
Bornite (private)	-----
Crevice Creek (private)	1,700

Small fixed-wing aircraft can land on certain river gravel bars within the project region. Small aircraft equipped with floats can also land on certain lakes and rivers in or adjacent to the study area.

During the course of the 1975 and 1976 field programs, a combination of methods were used to transport personnel and supplies to and from Anchorage and within the program area. Among these methods are:

Commercial jet service
Otter - wheels
Otter - amphibious
Beaver - floats
Widgen - amphibious
Cessna 206 - wheels
Helicourier - wheels
Cessna 185 - floats
Super Cub - floats

Hughs 500C helicopter
Hiller SL-3 helicopter
Hiller J-3 helicopter

River barge

Logistical arrangements varied according to camp location, availability of aircraft, cost and weather conditions.

It is common while working in remote areas to have freight arrive on a commercial jet liner to a center such as Kotzebue, then transfer to bush plane and be transported to a small airstrip, and finally be transported to the campsite with a helicopter.

Fixed-wing aircraft support for the WGM field party was furnished mainly by:

Baker Aviation of Kotzebue
Bernhardt Air Service of Kobuk
Frontier Flying Service of Bettles

Helicopter support was contracted from Woods Air Service of Palmer and Temsco Helicopters of Ketchikan.

3.5 EXPLANATION OF REFERENCES

Topographic Quadrangles

The project area is covered by topographic maps at a scale of 1:250,000, published by the United States Geological Survey. These maps generally cover three degrees of longitude by one degree of latitude. These quadrangles are given geographic names such as Survey Pass quadrangle or Ambler River quadrangle.

The 1:250,000 quadrangles are subdivided into 24 (+ or -) quadrangles at a scale of 1:63,360 which cover an area of 30 minutes of longitude by 15 minutes of latitude. These quadrangles are designated by the letters A, B, C and D followed by the numbers 1 through 6 (occasionally 7 or 8).

The quadrangles designated by the letter A are the southernmost row of quadrangles, while the D designation marks the northern row. Number 1 designates the easternmost column of quadrangles, while 6 marks the western column.

For example, the Survey Pass A-1 quadrangle is located in the southeast corner of the 1:250,000 scale Survey Pass quadrangle, while the Survey Pass D-6 quadrangle is located in the northwest corner of the 1:250,000 scale quadrangle.

Despite the fact that not all topographic maps for the 1:63,360 scale quadrangles have been published, we have referenced locations to these quadrangles.

Government Reports

The United States Geological Survey (U.S.G.S.); the Division of Geological and Geophysical Surveys, Department of Natural Resources, State of Alaska (D.G.G.S.) and; the United States Bureau of Mines (U.S.B.M.) have published open-file reports.

We have referred to U.S.G.S. open-file reports as OFR, D.G.G.S. open-file reports as AOF, and U.S.B.M. open-file reports as BM-OFR.

Sample Designation

All samples collected by WGM for this project are designated by the prefix BM followed by a number. The numbers begin at one (BM 1) and continue up to four digit numbers.

4. HISTORY AND PREVIOUS WORK

Any discussion of the history of geological investigations and exploration activity of the study area must be described as part of the entire Brooks Range.

The tempo and extent of investigation has been greatly affected by a number of world political events, some internal U.S. policies, and always by location and access.

Prior to the Second World War, very few geological investigations or reports of any kind had been undertaken by governmental agencies, and private enterprise activity consisted principally of the prospecting for and subsequent working of a number of gold placers on a very small scale. A modest amount of effort was expended upon the investigation and limited development of lode gold properties. Other efforts were towards jade and asbestos mining activities in the west Brooks Range, and a brief examination by the U.S. Geological Survey in 1910 (Smith, P.S., 1913).

Obviously during this period isolation was a tremendous factor and bush flying was still in its early development. Radio communications were virtually non-existent and it was only the hardiest and most optimistic of souls who ventured into the interior of Alaska to prospect for minerals.

In the immediate post-war period, a trickle of prospectors began to enter the area again, principally to search for uranium and, of course, the "old timers" continued to prospect for and/or produce from gold placers. Some sporadic work continued on lode gold prospects in the central Brooks Range.

The seeds of the modern era of mineral exploration in the Brooks Range were sown mainly by Mr. Rhinehart Berg in the late 1940's, who, in the course of prospecting for uranium, "rediscovered" possibly significant copper mineralization in massive carbonate rocks south of the study area near Kobuk.

In 1956, the Kennecott Copper Corporation through its subsidiary exploration company, Bear Creek Mining Company, optioned the Ruby Creek Property which had been rediscovered by Mr. Berg.

To the best of our knowledge, this was the first significant effort by a well-financed and technically competent group, to explore for "hard minerals" in the Brooks Range. In addition to the work on the Ruby Creek deposit and the immediately adjacent lands in the Cosmos Hills also outside the current study area, Bear Creek personnel in the late 1950's, made a few helicopter supported probes outward from the Cosmos Hills.

The first systematic reconnaissance exploration was initiated by Bear Creek in 1960 and 1961. We understand their principal objectives were to determine if other deposits similar to Ruby Creek occur in the west Brooks Range and to determine if any potential for porphyry copper exists. It should perhaps be noted that Bear Creek's principal objective was to discover a porphyry type, i.e. large tonnage copper deposit.

This regional effort led to the discovery and staking of the Omar and Frost base metal-barite prospects in carbonate rocks, some 100 miles west from Ruby Creek. These prospects are within the current study area. The Omar and Frost discoveries were in a state of dormancy until the middle of the 1960's when Bear Creek returned to the area and staked claims at the properties.

In 1963, Kennecott formed the Ruby Creek division for the purpose of executing underground investigation of the Ruby Creek deposit.

In the period 1960 to 1965, Bear Creek's exploration activities in the Brooks Range continued but until 1965 these efforts were confined mainly to appraisals of previously located prospects in the Cosmos Hills (outside the current study area) and at the Omar and Frost prospects. It is believed that the first drill holes were put down at Omar in 1966.

Bear Creek personnel resumed exploration in 1965 in the west Brooks Range (Bigelow, C.G. pers. comm.).

With the discovery in 1965 of the Arctic deposit, a large high grade copper-zinc deposit approximately 15 miles east-northeast from Bornite, Kennecott embarked upon a detailed investigation of this area and several new occurrences were found and staked. Several of these remain under investigation to this date. These include the Dead Creek, Sunshine Creek, Picnic Creek, Horse Creek and certain lesser known deposits.

The discovery of the Arctic deposit established that at least two major geological environments were host to potentially economic copper and zinc deposits in the Ambler River area. These are:

1. To the south - carbonate shelf deposits along or near the south edge of the Devonian Brooks Range, sea, and

2. To the north - interlayered acidic volcanic-sedimentary deposits located along an acid volcanic area within or near the southern side of the Devonian Brooks Range sea.

During the latter part of the 1960's, Kennecott was joined from time-to-time in local areas, by various competitors. Newmont was active for a time in the Kelly River area in the far west Brooks Range. Alvenco, Texasgulf Sulphur, and Placid Oil among others are reported to have appeared in the central and west Central Brooks Range. Other companies appeared briefly but none, to our knowledge, with the possible exception of Placid Oil, stayed on with determined programs.

In 1969, the Alvenco Syndicate mounted a regional exploration program in the Brooks Range with the objective of finding the other "Ruby Creek" type deposits. The president of Alvenco was Mr. Clyde Wetherall, a very competent geologist. The sponsors consisted of financial backers from New York City. This program, with an emphasis on geochemical sampling and prospecting, covered in a preliminary fashion, an area extending from the Chandalar quadrangle in the east to the Ambler River quadrangle in the west and portions of the current study area. The results of this work for the current study area have been provided to WGM by General Crude Oil Company who purchased the data.

Prior to the land freeze in 1966 by the then Secretary of the Interior, Udall, the only active groups in the entire

Brooks Range were Alvenco and Bear Creek. The Bear Creek preliminary coverage extended intermittently from the Noatak River in the west, to the Chandalar District in the east, with a few reconnaissance probes extending eastward to the Canadian border.

With the exception of the Kelly River investigation by Newmont, Alvenco's reconnaissance activities and Bear Creek activities, no work of significance was undertaken in the current study area by industry up to the enactment of ANCSA in 1971. Obviously, since that date no work of any kind has been undertaken in the study area.

Beginning in the early 1970's, however, major exploration efforts by industry have been undertaken in the Brooks Range on land open to mineral entry. This has been concentrated particularly in the Ambler River area, where the Kennecott or Bear Creek deposits are located, but also encompasses other open-to-mineral-entry lands in the Brooks Range.

Companies or their subsidiaries, known to be active, include BP Alaska Inc., U.S. Steel, Anaconda Company, Sunshine Mining Company, General Crude Oil Company, Noranda Exploration, Inc., Cominco American, St. Joe American Corporation, Resource Associates of Alaska, New Jersey Zinc Company, and others.

The efforts of these companies are confined to relatively small enclaves of open lands in the Chandalar, Wiseman, Ambler River, DeLong Mountains and Philip Smith quadrangles.

Thousands of claims have been staked and millions of dollars spent on these open lands. It would appear that, considering the type of deposits and geologic environments located by the U.S.B.M. program, that a similar effort would result on the d-2 lands if they were re-opened to entry.

5. PRINCIPLES AND TECHNIQUES

In order to appraise the mineral potential of 19.2 million acres of land for $300,000 in an 18 month period, with only 6 months available for field work, setting priorities were essential. WGM, in conjunction with representatives of the U.S.B.M., established the following priorities and guidelines to direct the work program.

1. The program was not to be conducted as a regionally oriented geological or geochemical exploration appraisal. A definition of metallogenic belts on the basis of regional mapping and/or geochemical sampling was not to be attempted within the limited budget.

2. The field work was to consist of examinations of prospective mineral occurrences within the study areas. Areas selected for field work were determined following a review of published data, suggestions from the U.S. Geological Survey and State of Alaska D.G.G.S. personnel, data obtained from private companies, and past experience of WGM personnel within the areas.

3. A list of known or reported mineral occurrences was compiled from available data. The prospects were ranked, often in a very arbitrary manner, since the quality and extent of information available was variable. A selection was then made of prospects or occurrences to be examined in the field.

4. One of the directives established was to make one or more inspections of the "apparent best" mineral occurrences in different geologic environments along the several hundred miles of east-west regional geological strike within the study area. Again, it should be noted that the original information available concerning each mineral prospect to be examined was not uniform.

5. Less important criteria were visit to areas in which mining claims had been located regardless of the data available on them.

Large areas were eliminated from further consideration because of no known mineral occurrences, unfavorable geology, or extensive lowland areas covered by surficial deposits and/or bogs.

In general, the following environments were considered in the "favorable" category:

1. Quartzose schist;

2. Shelf carbonates, with magnesium-rich components;

3. Altered or pyritic plutons and intrusive rock contacts; and

4. Argillite-chert-barite-limestone sections.

The following environments were considered in the "unfavorable" category.

1. Monotonous quartzite, carbonate and basinal phyllite;

2. Fresh, monotonous greenstone dikes and sills;

3. Unconsolidated to poorly consolidated marine sediments; and

4. Fresh "monolithic" plutonic bodies.

The problem with the categories listed above relates to the paucity of data concerning the distribution patterns and composition of the rocks in much of the region. It was necessary to rely upon second- and, often, third-hand information.

The program was divided into three phases. Phase 1 consisted of data compilation, discussions with knowledgeable technical personnel, logistical arrangements and obtaining materials and supplies necessary to conduct the field work. Phase 2 was the field work. The third phase included evaluation of field data and report writing. The three phases were repeated during 1976, but to a lesser extent since the field season was only 29 days long.

The 1975 field party consisted of four geologists, a cook, a helicopter pilot and mechanic. During 1976, three geologists were employed with support personnel provided by another WGM field party. Credentials of The professional personnel were included with the initial bid to the Bureau, but some substitutution was necessary. All field work was helicopter-supported.

The normal day-to-day field procedure involved each of the geologists working individually (occasionally in pairs) at a selected area or prospect. The project supervisor and/or project geologist normally conducted an orientation survey of any new work area to determine the type and extent of work to be conducted. Field methods varied, contingent upon the type and extent of mineralization reported or observed, availability of published data for any given occurrence, and time available. A balance between the time allotted for each area and the amount of work accomplished was necessary in order to meet the overall objectives of the program. Field activities included: location in the field of a reported mineral occurrence; geological mapping; sampling of outcropping mineralization; stream silt and soil sampling in covered areas for geochemical analysis to further trace and define areas of mineralization; and foot traverses and prospecting away from mineralized showings in an attempt to discover additional areas of interest, and to gain a preliminary appreciation of the local geological environment.

Each day the party members reported their work on daily progress reports, and recorded details of sample locations and geological information on various forms.

The field crew made every attempt to comply with all Federal and State laws or regulations pertaining to fire, sanitation, conservation, water pollution and fish and game which govern all minerals exploration activities within the State of Alaska. Additional restrictions on the field activities were imposed by the Bureau of Land Management (B.L.M.), the most inhibiting being the prohibition of explosives or making excavations or cuts which would result in a visible scar. It should be emphasized that failure to excavate is not an indication of lack of need of same. The activites simply were not permitted. The examinations were very brief, and in many areas incomplete due to the various constraints imposed upon the workers.

At the request of Fish and Wildlife personnel, certain areas were excluded from field work for various periods during the summer. Excluded areas included caribou calving grounds and nesting habitats of Peregrine falcons.

6. REGIONAL GEOLOGY AND MINERALIZATION

This section summarizes the regional geology and mineral potential of the study area and adjacent lands. The geologic summary is based on a study of the limited number of available publications and on the writers' collective experience. Conclusions concerning mineral potential are based on the studies of known occurrences discussed in later sections of this report, the authors' knowledge of mineral deposits on the open lands adjacent to the study area, and on extrapolations from known worldwide geologic associations. Due to the paucity of published detailed geological information and the almost total lack of definitive mineral exploration within the study area, many of the conclusions stated here are tenuous.

The purpose of this section is to relate regional geology and mineral potential; accordingly, the known pertinent regional environments of the Brook Range are grouped into five "sequences" based on age, regional distribution, lithologic associations and potential mineralization. A brief summary of each sequence is presented below. More detailed descriptions are presented in subsequent sections.

Sequence 1 - includes the Devonian or older schists and carbonate sediments which outcrop along the southern flank the Brooks Range. The sequence is subdivided into the Cosmos Hills carbonate/schist belt and the Arctic Schist Belt.

Sequence 2 - includes Silurian and Devonian clastic and carbonate sediments which underlie the bulk of the central part of the study area.

Sequence 3 - a belt of Mississippian to Triassic shales, cherts and limestones, which outcrop in the northwest portion of the study area and along the north flank of the Brooks Range.

Sequence 4 - consists of Permian through Jurassic basaltic volcanics and mafic intrusives, which occur primarily in the western Brooks Range.

Sequence 5 - includes thick deposits of Jurassic-Cretaceous marine sediments and volcanics along the northern and southern edges of the study area.

The tentative distribution pattern of the various "sequences" is shown on Figure 4. It is likely that further work will show a much more complex pattern.

The following sections describe and interpret each sequence in greater detail and present a discussion of its mineral potential. The final section reviews geologic history and summarizes the mineral potential.

6.1 Sequence 1 - Devonian and Older Schists and Carbonates

The rocks grouped in Sequence 1 underlie an east-west trending belt 10 to 20 miles wide, which extends for nearly 200 miles along the southern flank of the Brooks Range (Fig. 4). The central portion of the belt is in an enclave of open-to-mineral-entry lands bounded on three sides by d-2 lands, and on the fourth side by Native Selection land. The portion of the belt located on open lands (hereafter referred to as the Ambler District) contains numerous mineral prospects, and is currently undergoing intensive exploration by private industry. Although located outside the project area, the geology and mineral deposits of Ambler District are described here in order to assist in appraising the potential of similar geologic environments located within the study area.

Sequence 1 is composed of two distinct, but possibly related lithologic belts; the Cosmos Hills carbonate-schist belt (subsequence A) and the Arctic Schist Belt (subsequence B). The following sections briefly describe the geology and some of the mineral deposits within the two subgroups of sequence 1 and finally present a hypothesis relating the two environments.

Non-referenced statements on the following pages are based on the writers' experience, principally C.G. Bigelow. Mr. Bigelow worked on the Ruby Creek prospect from 1959-1968. He was assistant manager of the project from 1961-1963 and manager from 1964-1968. During that time he conducted studies of the geology, stratigraphy, paleogeography, ore mineralogy, and petrology of Ruby Creek. Among other things this work entailed personally logging over 130,000 feet of diamond drill core. Other ideas presented in this section are credited to Mr. R.W.H. Chadwick and Mr. N.L. Lutz, both formerly of Bear Creek Mining Co. Mr. Chadwick examined the Ruby Creek prospect in 1956 and was the project manager there from 1957-1958. Mr. Lutz was assistant manager of the project under Chadwick and project manager from 1959-1963.

6.1.1 Sequence1: Subsequence A - Cosmos Hills Carbonate-Schist Belt

Geology

Rocks of subsequence A are best studied outside the project area in the Cosmos Hills. They occur within the d-2 study area along the south flank of the Brooks Range from 20 miles west of Bornite (Jade Mountains) to at least as far west as the Salmon River and possibly beyond (Fig. 4). Similar appearing strata, which may be subsequence A or its equivalent, are also exposed near Nutuvukti Lake in the Hughes quadrangle. These outcrops are within the study area and along the projected regional strike of the subsequence.

Subsequence A is made up of three principal lithologic units. The units were first defined by Bear Creek geologists Read and Lehner in 1959-1960 (cited in Runnells, 1969) and later refined by Fritts (1970).

The oldest unit or basement phyllite-schist is made up of carbonaceous phyllite and muscovite schist with interbedded lenses and layers of greenschist, thin bedded limestone and metagraywacke. There is also a prominent greenstone/greenschist member composed of intrusive metadiabase and metabasalt with subordinate limestone and schist.

The basement phyllite-schist unit is overlain by a thick sequence of dolomite, dolomitic limestone, and limestone with interbedded phyllite and local greenstone.

The carbonate unit reaches at least 2,000 feet in thickness, and consists predominately of weakly metamorphosed limestone, dolomite and dolomite breccia. Fine-grained light gray-green calcareous phyllite and dark carbonaceous calcareous phyllite occur as interbeds within the carbonate buildups. Sill-like bodies of medium-grained greenstone and greenschist are present locally.

The carbonate-calcareous phyllite unit includes intensive base metal-iron sulfide mineralization locally and, for this reason, has received the bulk of attention directed to subsequence A by mineral appraisers.

Fritts (1970) postulated a thrust fault between the underlying phyllite-schist units and the overlying carbonate-phyllite units. Bigelow (pers. comm., 1976) notes that calcareous phyllites and impure dolomite beds at the base of the carbonate-phyllite unit at Ruby Creek (Bornite) and Pardner Hill are gradational into and intertongue with the uppermost layers of the subadjacent carbonaceous quartzose phyllite-schist unit.

The uppermost part of the older phyllite-schist unit of subsequence B consists of black to dark gray pyritic carbonaceous phyllite with numerous pinching and swelling quartz veins. The basal portion of the overlying carbonate-phyllite unit consists of carbonaceous, pyritic, calcareous phyllite and impure bedded dolomite. None of the carbonate-phyllite units are quartzose.

The total thickness of the carbonate-calcareous phyllite unit is variable in the Cosmos Hills from a few hundred feet to 2,000 feet or more. The thickness is greatest in areas with extensive algal-coralline dolomite buildup. The major buildups exposed in the Cosmos Hills are located along the north side of the hills near Ruby Creek (Bornite) and Pardner Hill.

The regional trend of the carbonate buildups is approximately east-west near the Ruby Creek (Bornite)-Pardner Hill area in conformity with the regional strike of Paleozoic rocks in the west Brooks Range, and parallel to the trend of mountain-basin development.

The dominant aspect of the carbonate-calcareous phyllite unit in subsequence A is development of one or more Devonian reef complexes. Individual reefs are high relief bioherms, indicating rapid upward growth coincident with subsidence of the underlying platform. The reef at Ruby Creek grew to more than 2,000 feet in height.

It is to this reef that much of the remaining discussion in this section is directed, in consideration that the reef complex contains obvious strong mineral potential, which, by extrapolation, may be repeated on d-2 study area lands.

Individual bioherms within the complex locally display atoll-like form, but the regional pattern is indicative of a major barrier reef complex with an approximate east-west regional trend. It is not known if the complex parallels the entire south side of the Brooks Range Devonian marine basin, or is restricted to local platforms (islands) scattered along the south part of the basin.

The complex passes under younger rocks or alluvium at the north edge of the Cosmos Hills near the Kogoluktuk River, and under younger rocks in the lower Ambler River basin area to the west of Parnder Hill. The complex emerges to the west on the north side of the Jade Mountains, and is exposed farther to the west on south-trending ridge spurs to at least as far west as the Salmon River basin. The total strike length of the carbonate-calcareous phyllite unit and the reef complex it hosts is at least 70 miles, and open both to the east and west.

The only area that has been studied or prospected in any detail is the Cosmos Hills, and the Jade Mountains area to a lesser extent. The reef complex thins to the south away from the Brooks Range Devonian marine basin. The "reefy" section feathers out into a few layers less than 100 feet in thickness on the south side of the Cosmos Hills anticline, before dipping under younger rocks that mark the north edge of the Mesozoic Koyukuk Basin.

The reef complex pinches and swells along strike in an east-west direction, as noted above. The carbonate-calcareous phyllite unit is approximately co-extensive with the complex in areas of major algal-coralline biohermal development, but consists of thin bedded limestones and calcareous phyllites elsewhere.

Approach to areas of reef buildup is signaled by appearance of growing number of reef clasts in the bedded limestones and phyllites. The size of fragments increases, and they become increasingly angular as the reef is approached. Dolomitic rhombs (as distinct from the clasts of dense dolomite rock) increase relative to calcite rhombs in the non-reef calcareous units as the dolomite buildup is approached. Additional directive information is provided by an increase in grain size or recrystallized limestone as the shallow water reef environment is approached. This is not surprising, since the depositional grain size of the original calcarenite is probably coarsest in the high energy reef front environment.

At Ruby Creek, the Devonian reef appears to form an oval shaped four square mile complex, flanked on its outer margins by thick, steeply dipping aprons of dolomitic reef breccia. Typical-off-reef breccia-apron material consists of angular to subangular fragments of fine-grained dolomite in a matrix of fine-grained algal-coralline dolomite or calc-arenite. Back reef facies consists of impure coralline dolomite with bedded impure dolomite and calcareous phyllite. The reef front and near off-reef breccias include and intertongue with sparry limestone consisiting of calcite and dolomite rhombs. The limestone contains numerous dolomite reef clasts. The dolomite and limestone breccias intertongue outward with bedded, often phyllitic, limestones, and limey carbonaceous phyllites containing occasional isolated clasts of reefal dolomite or breccia. The clasts, which decrease rapidly in frequence away from the reef front, have been found a mile or more distant. The distant clasts are commonly rounded and less than an inch or two in diameter. Dolomite breccias similar to those at Ruby Creek are exposed on the west side of Pardner Hill at Aurora Mountain and at Lone Mountain. Metamorphic grade of the carbonates increases westward toward the Shungnak River where tremolite bearing marble predominates (Fritts, 1970).

The reefs at Bornite (Ruby Creek) were assigned a Middle Devonian age by Andrichuck (pers. comm. 1959), based on fossils found in drill core. According to Andrichuck, the reefs contain the same reef building organisms found in oil-bearing reefs in Alberta. He also noted that zinc sulfide has been encountered in Ruby Creek-type facies in Alberta oil well cores. The Devonian age assigned by Andrichuck was later confirmed by Patton, Miller and Tailleur (1968) and Fritts (1970).

The carbonate section is overlain by black non-calcareous, carbonaceous phyllite with numerous podiform, bull quartz veins. The hanging wall is identical in appearance to the footwall phyllite described above, and its presence apparently reflects a return to basinal conditions.

The quartzose carbonaceous phyllite is overlain by gray phyllite and light gray limestone, which in turn are capped by greenstone and meta-agglomerate. The cap rocks are exposed along the northeast flank of the Cosmos Hills. The lower contact of the gray phyllite and light gray limestone has been described as a thrust (Read & Lehner, 1959 and Fritts, 1970).

The structural geology of the Cosmos Hills was first studied in detail in 1959 by Bear Creek Mining Company geologists, Read and Lehner, and later by various workers. Their conclusion is that the Cosmos Hills represent a broad open east-west trending doubly plunging anticline with lower Paleozoic rocks of subsequence A exposed in its core, and Mesozoic sediments draped over the flanks and around the east and west ends of the fold. Fritts (1970) showed that the Mesozoic rocks are thrust over the older sequence and that the anticlinal fold is exposed as a window in the thrust sheet. The large scale structural elements are complicated by younger high angle faulting.

Summarily, the environment of deposition and geologic history of the subsequence A rocks in the Cosmos Hills are interpreted as follows.

The lower phyllite unit is composed of weakly metamorphosed pelitic sediments deposited in deep water contemporaneous with mafic volcanism and with local intrusion of small mafic igneous bodies (Read and Lehner, 1959, Fritts, 1969, 1970). Uplift or shoaling, of at least a portion of the basin, resulted in colonization by reef building organisms along an east-west trend, with the maximum known buildup occurring in the Bornite area. Abundant coralline and algal dolomite adjacent to coarse dolomitic calcarenite indicate a well aerated marine environment at or near wave base (Bigelow, pers. comm. with Andrichuck, 1959). The extensive coarse breccia deposits, which flank the reefs, are the result of destructive wave action on the seaward side of the reef crowns. The distribution of the reef buildups in the Cosmos Hills suggests they are part of a "barrier" reef complex that persists in an east-west trend for over 70 miles along the southern flank of the west Brooks Range. The circular pattern of the reefs at Ruby Creek suggests a modified atoll.

The north dipping breccia aprons at Ruby Creek and Pardner Hill intertongue to the north with carbonaceous, fine-grained, thin bedded carbonates and phyllites, and still farther to the north probably with quartzose carbonaceous phyllites, indicating euxinic basinal conditions in this direction.

The high relief of the reef complex is indicated by the presence of the breccia aprons, steep initial dips, over-riding and slump features, the unusually great thickness of the reef, and abrupt facies changes. Additional evidence of vigorous upward reef growth and consequent high depositional relief is provided by the apparently peculiar situation whereby the thickest portions of the reef rest in a depression in the underlying incompetent phyllite unit. Since it is not the nature of reefs to build in depressions, it appears likely that the reef settled into the basement during its growth due to its unusually great mass. The high vertical relief indicates that the basin was subsiding concurrently with reef buildup. The relationship between reef structure and subsidence is extensively documented in the literature. See, for example, Lowenstam (1957), Newell, et al., (1953), or more recently Wilson (1975).

The presence of greenstone bodies in the carbonate section indicates that mafic intrusion and volcanism may have been contemporaneous with carbonate deposition (Fritts, 1970). However, the carbonate rocks adjacent to intrusive rocks are barren of sulfide mineralization.

Reef building terminated at some time in the middle Devonian. The deep water deposition of pelitic and lesser carbonate sediments resumed in the Ruby Creek-Pardner Hill area. Finally, a surge of volcanic activity resulted in deposition of a thick sequence of basalt flows, tuffs and volcanic mudflows (Sequence 4) represented by the uppermost greenstone (Fritts, 1970, Read and Lehner, 1959). Fritts (1970) and Bear Creek geologists concluded that the source area for the basinal sediment probably lays to the north.

The only facies at Bornite (Ruby Creek) that appears to be atypical for a high relief Devonian reef complex consists of pale green to grayish green calcareous phyllite to phyllitic dolomite limestone. The composition is mainly albite-chlorite-sericite-calcite-dolomite. Occurrences are limited to the reef front. The unit pinches out into algal-coralline dolomite in the breccia apron position, and thickens toward the basin. It has not been found in association with reef core or back reef facies.

The pale green phyllite locally contains high grade base metal sulfide mineralization (>10% copper) in the form of bornite, chalcocite, chalcopyrite, locally tennantite, and minor galena and sphalerite.

The possible volcanogenic implications of the facies is discussed in Section 6.3. The geology of that part of Sequence 1 (subsequence B) located across the Ambler Lowland to the north of the Cosmos Hills (subsequence A) is discussed in Section 6.2.

Mineralization and Mineral Potential

The known base metal mineralization in rocks of the Cosmos Hills subsequence occurs on open lands south of the study area in the Cosmos Hills (Fig. 4). This is not to downgrade the potential for discovery of Cosmos Hills-type mineralization in the d-2 study area, since other prospective areas have not been appraised. Base metal mineralization at Omar (Section 8.6) and Frost (Section 8.7) are included in Sequence 2 rocks. Additional work may show that they should be placed in subsequence A of Sequence 1.

Carbonate-hosted copper mineralization is present at Bornite (Ruby Creek), Pardner Hill and Aurora Mountain in the Cosmos Hills.

Gold has been produced from placer deposits in valleys draining the Cosmos Hills. The placers appear to have their source in the Sequence 1 phyllite-schist unit, particularly the uppermost part near the contact with the carbonate-calcareous schist unit. The Klery Creek placers (Section 8.8) in the far west Brooks Range appear to orginate from the same unit. The carbonate rocks near Klery Creek have not been appraised for Cosmos Hills-type carbonate deposits.

It is beyond the scope and resources of this report to examine the Cosmos Hills copper deposits. Accordingly, no physical work was done in the area other than a short visit to Aurora Mountain, and a review of activities conducted by WGM on behalf of NANA. A description of the Cosmos Hills copper deposits is given here to serve as a basis for discussion of the mineral potential of Sequence 1 rocks on the d-2 lands study area.

Due to limitations of time, restrictions on physical work, in the d-2 study area, and the resources required to drill or trench, no examination of placer deposits was made either in or adjacent to the study area. Readers are referred to Fritts (1970) for an excellent summary of placer mining and potential in the Cosmos Hills area.

The best known copper deposits in the Cosmos Hills are those at Ruby Creek (Bornite) and Pardner Hill. Copper mineralization has been known since the late 1800's. Prior to 1940, the U.S. Geological Survey made several visits to the area (Smith and Eakin, 1911; Smith, 1913; Smith and Mertie, 1930). The area was examined for its uranium potential by both state and federal agencies following World War II after Mr. Rhinehart Berg discovered anomalous radioactivity at Ruby Creek (White, 1950; Saunders, 1953, 1955, 1956; Matzko and Freeman, 1963). Berg subsequently discovered and exposed extensive copper mineralization at the surface.

Bear Creek Mining Company optioned Berg's claims in 1957 and has since conducted detailed exploration-development activities at the property. Work to date includes at least 100 drill holes, 130,000 feet of diamond core drilling, surface trenching, an 1,100 foot shaft, 800 feet of lateral development, over 12,000 feet of underground diamond core drilling, plus construction of a mine plant and support buildings (Chadwick, 1960; Lutz, 1963, 1976).

Various grade and tonnage figures have been released for the Ruby Creek deposits. Lund (1961) cites 100 million tons at 1.2% copper. This figure apparently is the bulk tonnage potential as estimated on the basis of information available in 1961. The figure probably includes high grade bodies, such as the blocked out reserves cited by Lutz (1976). Lutz notes that 0.21 million tons of ore averaging 8% copper has actually been blocked out. Chadwick (1960) indicated that copper was the only credit in the ore. It has recently been noted that sphalerite mineralization to several percent zinc has been encountered over tens of feet. Bear Creek has not published figures on prospective grade/tonnage configurations between the figures cited as "blocked out" and the bulk tonnage figure.

The mineralization at Bornite occurs in middle Devonian reef facies of the Cosmos Hills carbonate-calcareous phyllite unit (subsequence A). Primary copper mineralization is mainly in the clastic dolomites, particularly the reef front and off-reef breccia aprons. Mineralization is generally absent in limestones and calcareous phyllite facies, except where they abut against dolomite or contain dolomite clasts

(Bigelow, pers. comm. 1976). Runnels (1964, 1966, 1969) reports that the primary metallic minerals are pyrite, chalcopyrite, bornite, tennantite, chalcocite, and sphalerite. Considerable pyrrhotite and galena are also present locally. Supergene mineralization consists of dolomite and calcite veins, with occasional veins or vugs of quartz, fluorite, siderite, and barite, plus supergene copper carbonates and sulfides, which occur in porous calcareous and dolomitic rocks to depths as great as 300 feet. The supergene mineralization is predominately confined to rocks above the highest "impermeable" calcareous phyllites in any single area, or to local fracture and solution zones beneath the phyllite barriers (Bigelow, pers. comm. 1976). The supergene sulfides are djurleite, covellite, digenite, chalcopyrite, and sooty chalcocite (Runnells, 1963, 1969).

The following types of occurrences for the base metal sulfides are recognized at Bornite:

- Massive replacements in dolomite breccia, and dolomitic calcarenite choked with dolomite reef clasts.
- Stringers around dolomite clasts, with replacement of clast rims, and in carbonate veinlets fillings within the dolomite.
- Stratabound chalcopyrite in dark biostromal dolomite and associated dolomitic phyllite layers.

- Disseminations, seams and replacements in albite-chlorite-sericite-calcite-dolomite-phyllite tongues within the algal reef front breccia zone.
- Minor thin seams in gouge and carbonate phyllite.
- Minor fillings in near-surface calcite and dolomite veinlets which also locally contain tiny quartz blebs; secondary coatings on surface rocks.
- Delicate replacement of algal structure.
- Small kernels in anthraxolite.

Pyrite and/or pyrrhotite occur with the base metal sulfides, and are far more widespread. Massive iron sulfides occur in dark coralline reef core facies away from the reef front. Chalcopyrite locally accompanies the iron sulfides in the core environment, but seldom exceeds three to four percent copper over widths of a few feet. Association of siderite with pyrite and pyrrhotite is a common feature, particularly in reef core facies.

Several workers have noted the presence of "framboidal" pyrite in the dark calcareous phyllite at Ruby Creek. Pyrite cubes are also present in the phyllitic units. The pyrite apparently is syngenetic (Runnells, 1969).

Not uncommonly, minor remobilization has resulted in several ages of sulfide deposition in areas of intense mineralization. Near-surface carbonate veinlets locally contain blebs of clear quartz and minor sulfides. Chalcopyrite has been observed as delicate encrustations on crystals in open veins near-surface (Bigelow, pers. comm. 1976).

Stylolitic seams are frequently mineralized. The sulfides form irregular masses which obliterate the host rock textures in the higher grade portions of the deposit. It is not uncommon to see knife edge contacts between massive sulfides and weakly mineralized dolomite. High grade mineralization occurs as sinuous bodies and pods within extensive lower grade envelopes.

Pyrite is common in the phyllites and carbonates throughout the Cosmos Hill Paleozoic section. Runnells (1966, 1969) shows that, based on sulfur isotopes and mineral textures, much of the pyrite was deposited prior to the copper minerals. The early pryite is mainly in the phyllites and commonly shows colliform and framboidal textures. Later pyrite occurs in carbonates as coalescing aggregates of anhedral grains and subhedral cubes and pyritohedrons (Runnells, 1969).

Runnells concludes that sulfur isotope studies indicate a probable sedimentary origin for the early pyrite and a low temperature hydrothermal origin for the later pyrite and the copper minerals. Considering the paucity of hydrothermal effects on the rocks, it is likely that depositional temperatures were very low. There is no evidence that the mineralizing solutions were derived from intrusive bodies in the general area.

The age of dolomitization and its relationship to copper mineralization at Bornite are particularly important to interpretation of the origin of the copper mineralization.

Bigelow marshaled considerable evidence in 1959 and 1960 indicating the dolomitization at Bornite was primary or early diagenetic:

- The presence of angular clasts of dolomitic reef material, sometimes entire coral or algal heads, in the dolomitic calcarenites and calcisiltites, which intertongue with the off-reef breccias. The conclusion is inescapable that the fragments were derived from pre-existing dolomites, or at least that a sufficient amount of magnesium was present prior to reef degradation to form solid dolomite rock.

- The dolomitic rocks occur as definite stratigraphic units. They do not exhibit cross cutting relationships commonly ascribed to secondary or hydrothermal dolomitization.

- Dolomite veinlets occur in dolomitic rocks and calcite veinlets occur in limestones. Calcite veinlets often continue into dolomite rock, but the converse is not true.

- Most of the dolomite is extremely fine-grained. Secondary dolomitization is commonly accompanied by recrystallization and increased grain size.

- Well preserved fossils are present in dolomitic rocks, and are commonly obliterated in non-dolomitic calcareous rocks. Dolomitization of the limestones could not lead to creation of a dolomite that contains fossils not present in the original limestone.

- Where the matrix of the breccias is recrystallized calcarenite with numerous dolomite rhombs, the borders of the dolomite clasts are commonly tattered, and many clasts contains calcite and dolomite veinlets. Replacement is outward into the dolomite from the veins, and inward into the clasts from the calcarenite contacts. All that remains of the original dolomite rock in many cases are ghost-like forms which preserve both the dolomite texture and algal-coralline mottling. Every gradation has been observed from insipient calcitization to total replacement by sucrosic calcite. Virtually no instances of dolomitic replacement of limestone have been observed.

Runnells (1969) states that the dolomitization at Bornite is not genetically related to copper mineralization. This contention is not as germane to the study of ore controls, as is the observation that the copper mineralization is related to particular dolomite facies of a reef complex. The most intense copper mineralization is in the reef front, mineralization with diminishing inward toward the reef core. Whether by coincidence or not, the copper sulfides occupy a similar position in the reef to that occupied by petroleum in some of the Alberta oil fields.

The magnesium in the reef almost certainly was there prior to wave fragmentation, since the clasts spalled from the reef and deposited up to a mile or more away are dolomite. The copper mineralization shows a marked preference for porous and permeable depositional sites, and whatever the mechanism for its transport into the reef the amount of copper deposited in the limestones that surround the dolomite facies is negligible. The bulk of the copper mineralization is in dolomitic rocks (Bigelow, pers. comm. 1976). Most of the mineralization is in clastic dolomitic rocks - chiefly dolomite breccia and adjacent off-reef breccia. Clearly the dolomite, especially clastic dolomitic, is one of the major ore controls. The remainder of the copper is mainly in dolomitic calcareous phyllitic units that intertongue with dolomitic facies, and dark biostroal dolomite layers.

Runnells' (1969) sulfur isotope data indicates a magmatic hydrothermal source for the copper sulfides, but the time of mineralization deposition is uncertain. According to Runnells, the copper minerals are definitely post-dolomitization and consequently are not syngentic in the strict sense.

Various sources have been proposed for the copper. Chadwick (1960) and Fritts (1970) suggested that the copper may have been derived from metamorphism of mafic igneous rocks in the area. In support of this, Brosgė (1960) has noted that small amounts of copper minerals are common in mafic rocks in the Brooks Range. This suggestion, however, is not supported by the sulfur isotope data according to Runnells (1969).

Fritts (1970) notes that the black phyllites underlying the Ruby Creek deposit and those interbedded with the fringes of the reef deposits have abnormally high copper content, and therefore could be a source for the copper. The sulfur isotope data does not rule this out. A mechanism such as that proposed by Jackson and Beales (1967) could be invoked to transport and deposit the copper.

Based on geologic and texture evidence, Lutz and Bigelow believe that the deposition of the copper mineralization occurred relatively early, perhaps during or shortly after completion of the reef building processes. Evidence cited is as follows:

- Chalcopyrite rims on dolomite fragments is completely enclosed in unmineralized limestone. The copper mineralization appears to be locked into a closed system with the host fragments. A striking relationship exists between copper mineralization and environments with high primary porosity and permeability. Later diagenesis, and/or recrystallization have eliminated any differences in the original porosity and permeability between limestone, massive dolomite and breccia facies. The chemical composition of the mineralized dolomite breccia hosts is the same as that of non-mineralized massive and bedded dolomite.

- The absence of channelways for the migration of hydrothermal fluids. The ore bodies are completely surrounded by highly reactive impermeable unmineralized limestones, calcareous phyllites, and back reef dolomitic facies.

- Lack of hydrothermal alteration. Delicate fossils and original textures are well preserved, with the exception of local incipient to pervasive calcitization, and local differential recrystallization.

- Absence of nearby intrusive rocks.

The conclusion is that the copper minerals were deposited at very low temperatures at a time prior to loss of the original porosity and permeability which characterized the reef front facies.

Lutz suggested that the copper might have been derived from a distant volcanic source (e.g. submarine fumaroles) and transported to the reefs as petroliferous complexes. The suggestion that petroleum was present is supported by the ubiquitous presence of anthraxolite in the Ruby Creek reef. Anthraxolite is a common constitutent of petroliferous reefs, and apparently is a petroleum residue. Bigelow reports finding kernels of chalcopyrite completely enclosed in rounded blebs of anthraxolite. He notes that the reefs have a strong petroliferous odor. Runnels (1965), however, feels that the anthraxolite was derived from indigenous organic matter in the dolomites.

While the exact origin of the Ruby Creek copper deposits is subject to debate, several characteristics stand out which are of importance to exploration:

- The deposits occur exclusively in carbonate rocks.
- The mineralization shows a marked preference for restricted facies within the carbonate section; especially dolomitic reef breccias, and more particularly reef breccias derived from degradation of reef front facies.
- The base metal mineralization is dominantly of the replacement and fracture filling type, with local stratabound and stratiform copper sulfide mineralization in calcareous-dolomitic phyllites that are spatially close to reef front facies.
- The weight of evidence favors mineralization prior to diagenetic sealing of depositional porosity and permeability, suggesting that appraisers should seek out breccia aprons in prospective carbonate terranes.
- The deposits are stratabound in that they occur in a specific strata - i.e., they are stratigraphically controlled.
- Igneous rocks are absent in the vicinity of the deposits, and exotic elements are virtually absent with the exception of minor supergene or secondary minerals.
- Peculiar albite-chlorite-sericite-calcite-dolomite phyllitic units with a pale greenish color pinch out into the reef front position, and thicken toward the adjacent basin. High grade copper

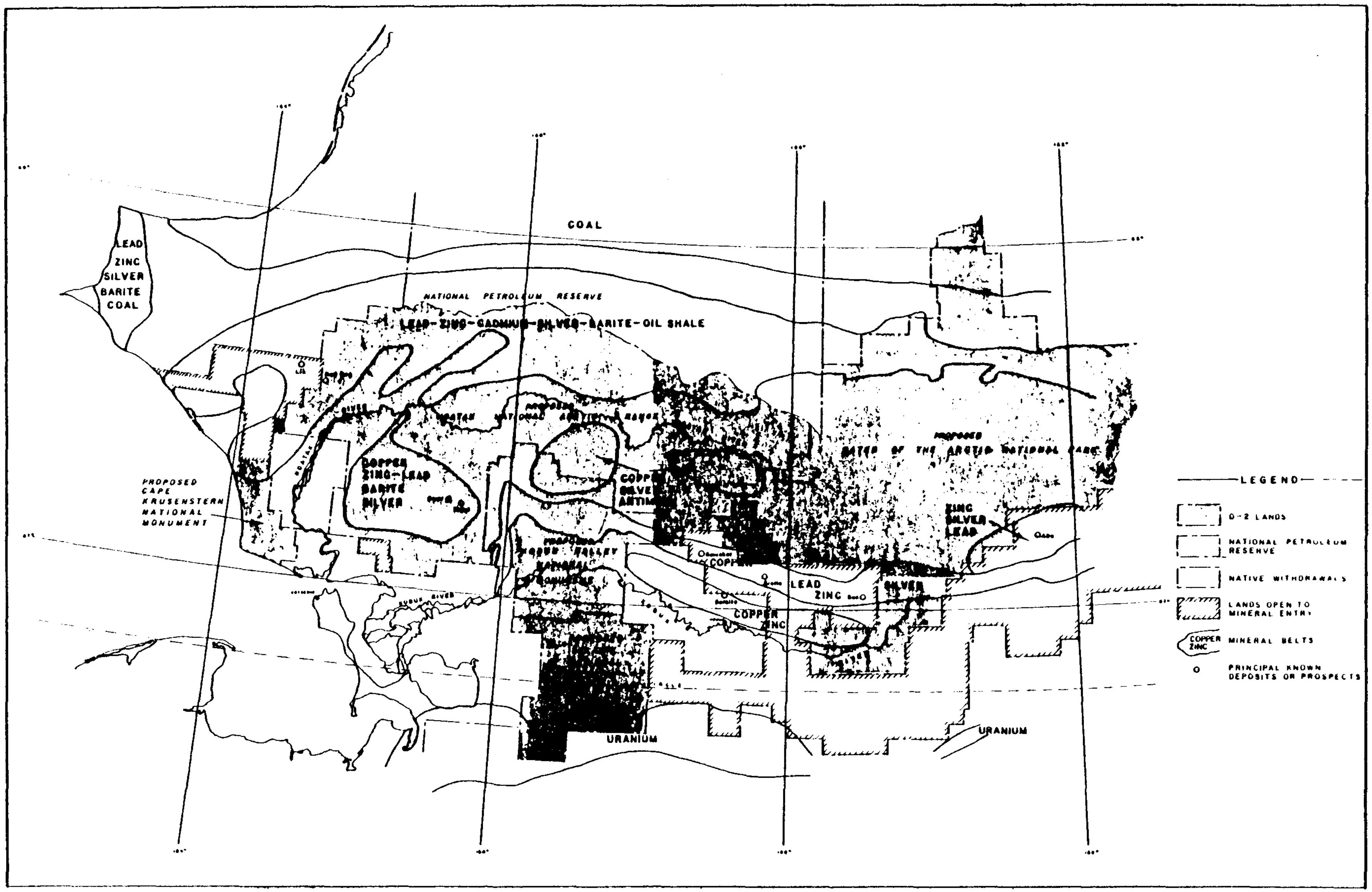
mineralization occurs within and adjacent to these facies.

- Copper is the obvious metal of greatest interest in the ore, but lead and zinc may occur in significant quantities.

Most of the above features, e.g. - host rocks, types of mineralization, stratigraphic control of ore, absence of igneous rocks, configuration of sulfide bodies, association with a positive magnesium-rich structure (in this case organic reefs), and low precious metal content - are characteristic of many Mississippi Valley-type deposits as defined by Bastin (1939), Ohle (1959), and Jackson and Beales (1967). Perhaps the most striking similarity to an individual deposit is with Pine Point in the Canadian northwest territories, where intense base metal mineralization is also confined to a Devonian biohermal reef complex (Skall, 1975). Ruby Creek differs from many Mississippi Valley-type deposits in that it occurs in a structurally complex area, and the principal metal is copper.

Prospective areas in which to seek additional mineralization of the Cosmos Hills Sequence 1 - subsequence A carbonate types are summarized in the following paragraphs (Fig. 4-A).

Based on known information, the carbonate-calcareous phyllite unit (subsequence A) has the strongest potential for



WGM INC	MINING & GEOLOGICAL CONSULTANTS ANCHORAGE, ALASKA	DWN BY: J.P. DATA BY: WGM DATE: 4/78	REVISED	**PRINCIPAL MINERAL BELTS of the WESTERN BROOKS RANGE**
SCALE: 25 0 50 MILES	1 : 3,000,000			FIGURE **4a**

discovery of additional base metal sulfide deposits to the west of the Cosmos Hills (Fig. 4). The exploration target area extends from the Jade Mountains to the Baird Mountains along the south side of the Brooks Range. The entire target area is on lands withdrawn from mineral entry.

The Omar and Frost dolomite-hosted base metal deposits are currently placed in Sequence 2.

Presence of limestone bluffs near Nutuvuki Lake suggests that the subsequence A carbonate-calcareous unit may re-appear from under younger volcanics of Sequence 4 approximately 60 miles to the east of Bornite. The area is part of the d-2 lands withdrawal. The area is worthy of examination to determine if copper or mixed base metal deposits are present.

The carbonate rocks which host the mineralization of Bornite, Pardner Hill, and Aurora Mountain dip northward beneath the Ambler Lowland as has been noted. The favorable strata, at least locally, comprise from several hundred feet to over 2,000 feet of carbonate section. The carbonate buildup apparently thins rapidly to the north, but may be present under part of the Ambler Lowland. The carbonates also thin southward across the Cosmos Hills, and appear to be pinching out under the north edge of the Cretaceous Koyukuk Basin. (Bigelow, pers. comm. 1976).

The known carbonate hosted deposits are small, high grade and, in the case of Ruby Creek, occur in a very restricted geologic environment. As such they are difficult exploration targets. Certainly, anywhere Devonian carbonate shelf sediments are present potential exists for the discovery of additional deposits.

Potential is recognized in subsequence A rocks for bulk-tonnage deposits (>50 million tons at one to two percent copper), with reasonable opportunities for smaller higher grade bodies containing up to several percent copper within the bulk tonnage target areas. The deposits are strata-bound, and the target environment consists of Devonian reef complex facies.

The placer gold potential of the Cosmos Hills sequence rocks can best be summarized by quoting Fritts (1970, pp. 58-59).

> "Gold reserves in the Cosmos Hills are considered low. Favorable placer gravels are rare and of limited extent. The best one, immediately upstream from the Dahl Creek canyon, already has been worked with the aid of modern heavy equipment. In general, stream gradients in the area are too steep and gravels are too young to constitute favorable environments for large concentrations

> of placer gold. Furthermore, no evidence has been found to indicate the presence of large quantities of lode gold. Although free gold in vein quartz has been reported in the past, none was observed during the recent mapping. Analyses of vein quartz collected by the U.S. Geological Survey near Shield Mountain yielded discouraging results (I.L. Tailleur, oral communications, 1968."

It is likely that the placer gold potential on d-2 study area lands in Sequence 1 rocks is very limited, although the reported placers were not drilled or excavated for appraisal during the more recent study. What limited potential there is confined to streams draining Sequence 1 rocks along the south margin of the Brooks Range between the Redstone, and Lower Squirrel River drainages in the Baird Mountains.

The lack of detailed systematic exploration by private industry in the parts of the study area underlain by Cosmos Hills-type rocks makes quantitative evaluation of the mineral potential difficult. We can infer, based on a knowledge of deposits on open lands, that there is potential for discovery of copper deposits in areas underlain by carbonate rocks. It is hoped that the general discussion presented above will assist in future regional appraisals of the study area.

The Sequence 4 volcanic rocks that overlie the Cosmos Hills subsequence A carbonate-calcareous unit are discussed in section 6.4.

Carbonate hosted copper mineralization occurs at two other locations in the Cosmos Hills; namely Pardner Hill and Aurora Mountain. The properties, which are controlled by Bear Creek Mining Company, are located approximately three to four miles west of Ruby Creek. Three types of occurrences have been found (Bigelow, pers. comm. 1976). C. Degenhart in the company of Uldis Jansons of the U.S.B.M. briefly visited the area in the course of the current study.

Copper sulfides exposed on the west side of Pardner Hill occur in a reef front environment similar to that described above for the Ruby Creek deposit at Bornite.

A nearby occurrence is worthy of note. Intense chalcocite-tennantite mineralization occurs at a shallow depth in dolomite resting on a gently dipping impermeable calcareous phyllite unit. The rock updip is highly oxidized and completely leached of sulfides. Fresh dolomite away from the effects of surface weathering, and downdip from the chalcocite-tennantite zone, contains disseminated chalcopyrite.

The intense sulfide mineralization has a "tabular" form. It remains at a relatively constant 50 to 70 feet beneath the surface, and follows the topography for a distance of 1,000 feet, or more. The information cited suggests the mineralization is an active supergene blanket that is slowly migrating downdip in the course of erosion.

The third type of mineralization at Pardner Hill consists of "gaudy" but apparently unimportant pockets of sulfide mineralization with grades to greater than 7% copper in back reef bedded dolomite facies on the east side of Pardner Hill. No more than a few tons of the material have been found. The sulfides consist of chalcopyrite, bornite, and pyrite. The host rock is dark with a rhythmic varve-like appearance to the bedding.

At Pardner Hill, small irregular masses of chalcopyrite and bornite are surrounded by halos of sparsely disseminated chalcopyrite, bornite and pyrite. The host rocks are apparently back reef sediments. At least 12 drill sites and evidence of trenching are visible at Pardner Hill.

The mineralization consists of chalcopyrite and bornite disseminated in thin bedded dolomite, limestone and dolomite breccia.

No samples were collected for analyses but grades are estimated to be less than 1% copper (Degenhart pers. comm., 1975).

Information on grade and tonnage configurations at Pardner Hill and Aurora Mountain are unavailable for this study.

The total area of exposed surface mineralization is up to a square mile. The area between Aurora Mountain and Pardner Hill is tundra-covered.

6.1.2 Sequence 1: Subsequence B - Arctic Schist Belt

The second group of rocks comprising Sequence 1 is known as the Arctic Schist Belt. The term "Schist Belt" was adopted in the early 1960's by Bear Creek Mining Company geologists and later used by Fritts (1971) and Pessel, et al. (1973).

The Arctic Schist Belt is an east-west trending belt of metasedimentary and metavolcanic rocks. The belt is 10 to 20 miles wide and extends at least from the Omar River in the Baird Mountains quadrangle eastward across the Ambler River, Survey Pass, northern Hughes and Wiseman quadrangles to the central Chandalar quadrangle (Fig. 4). Similar, and possibly correlative, rocks occur in the northeastern Wiseman quadrangle. Much of the belt, including the western 65 to 70 miles and parts of the central portion, lies within d-2 lands, as do the correlative rocks in the northeastern Wiseman quadrangle. The remainder of the belt is on d-1 or State selection lands, both of which are open to mineral exploration by private industry.

The westcentral portion of the Schist Belt, extending approximately 75 miles from west of Kalurivick Creek to the Reed River, is known as the Ambler Mineral District, or Ambler District. Several significant discoveries of volcanogenic massive sulfides have been made in the Ambler District during the late 1960's and the 1970's, and the area, which has remained open to mineral entry, is the scene of intensive exploration by private industry. In contrast, the d-2 areas underlain by Arctic Schist Belt rocks are poorly prospected, due largely to the fact that the area has been closed to mineral entry during the time of greatest interest on the part of private industry.

Geology

The Arctic Schist Belt is composed primarily of metamorphosed sedimentary and volcanic rocks. The principal lithologies are a younger unit of brown and dark gray phyllites, and an older sequence of quartz-muscovite schist, quartz-muscovite-chlorite schist and graphitic quartz-muscovite schist with lesser glaucophane-garnet greenstone and chlorite-amphibole schist, marble and calcite-quartz-muscovite-chlorite schist, quartzite, graphite-quartz schist, and felsic schists (quartz-potassium feldspar-muscovite schists) including porphyroblastic varieties.

Studies of the metamorphic petrology of the Schist Belt by Turner (1974) indicate two periods of metamorphism. Regional metamorphism occurred in Permo-Triassic time and a thermal overprint occurred in mid-Cretaceous time. The thermal event is related to mid-Cretaceous granitic plutonism.

Wiltse (1975, p. 5) concludes that the parent rocks for the Schist Belt are at least Devonian in age. This conclusion is based on: (1) 213 m.y.-old actinolite-paragonite isochron (Turner, 1974) and numerous Devonian(?) fossil localities in the Angayucham Mountains, Ambler Lowland and Brooks Range Schist Belt; and (2) the probable correlation of the Angayucham balsalts with the schist belt metamafics.

The major structural elements of the Schist Belt are the Kalurivick Arch and the Walker Lake Lineament. The Kalurivick Arch was first recognized in 1964 by T.A. Andrews (formerly of Bear Creek Mining Company, presently of WGM Inc.) and later by Pessel, et al. (1972). The arch has been suggested to be an anticlinorium (Andrews pers. comm., and Pessel, et al., 1972) or part of the folded root zone of a nappe (Forbes, et al., 1973). Tailleur (cited in Wiltse, 1975) suggests that the arch may be related to the emplacement of a Cretaceous pluton.

The Walker Lake Lineament separates the Schist Belt rocks from the predominantly carbonate strata in Sequence 3 to the north. The nature of the lineament is subject to considerable debate. It has been mapped as a regional scale thrust fault by Fritts (1971). Pessel, et al. (1972, 1973) map the lineament as a thrust fault near Walker Lake but not elsewhere. Forbes, et al. (1973) suggest that the projection of the lineament west of Walker Lake may be a metamorphic isograd. Pessel (pers. comm. cited in Wiltse, 1975) proposes that the lineament may be an unconformity between the schist belt and rocks of Sequence 3. Regardless of interpretation the Walker Lake structure separates terranes of distinctly different lithologies and structures.

In the Ambler District, the Schist Belt is bounded on the south by the Ambler Lowland. The structural nature of the lowland is essentially unknown. Fritts (1971) projected a questionable thrust fault through the area. Pessel, et al. (1973) mapped it as a synclinal trough. Wiltse (1975) cites aeromagnetic data which tentatively suggests the presence of a "linear discontinuity" in the lowland.

In the central Ambler River the Kalurivick Arch plunges gently westward. Between the Redstone River and Kalurivick Creek, schists of the Arctic Schist Belt plunge beneath overlying phyllite. West of this area, near the Jade Mountains, the schist belt rocks apparently merge with the trend of the Cosmos Hills structure. Little is known of the geology of Schist Belt rocks west of the Jade Mountains, but the schists may re-emerge between the Hunt and Salmon Rivers in the Baird Mountains quadrangle. The outcrop trend of the Arctic Schist Belt curves southward in the vicinity of the Salmon River in conformity with the regional southward curve of Brooks Range structural elements.

The origin of Schist Belt rocks has been studied by numerous geologists in private industry, the State of Alaska D.G.G.S. and the U.S. Geologic Survey. Published reports include Fritts (1971), Pessel, et al. (1972, 1973) and Wiltse (1975). In general the Schist Belt is interpreted to be a metamorphosed island arc assemblage. The calcareous, graphitic and carbonaceous schists represent psammittic and pelitic sediments. Marbles and quartzites were formerly limestones and cherts. The concordant greenstones represent metabasalts and locally, where dolomitic, may be metamorphosed tuffaceous or argillaceous dolomitic sediments. The discordant greenstone bodies indicate hypabyssal mafic intrusives. The button schists are generally thought to be metarhyolites, or acidic hypabyssal intrusives.

<u>Mineralization and Mineral Potential (Exploration History)</u>

Prior to the d-2 withdrawals under the Alaska Native Claims Settlement Act (1972) the areas underlain by the Arctic

Schist Belt were partially explored by Bear Creek Mining Company and Alvenco, an Alaskan-based joint venture.

Between 1965 and 1970 Bear Creek conducted first-pass reconnaissance of the Schist Belt ranged from the Chandalar area westward as far as the Noatak area. Follow-up efforts were concentrated in the Arctic area north of the Cosmos Hills and around the Alaska Pipeline Corridor in the Chandalar area. Little if any follow-up was done in other areas.

Alvenco explored the Brooks Range from Chandalar westward to the Reed River during 1968 and 1969. The Alvenco program was discontinued after loss of financial backing. No follow-up work was done.

The portion of the Schist Belt which lies on open lands in the Ambler District has been the scene of intensive exploration by private industry since 1973. Companies active in the area include Noranda, Sunshine, Anaconda, FalconBridge, General Crude Oil-Houston Oil & Minerals, and Bear Creek Mining Company. In the past few years over 7,000 claims have been staked.

There are no discovered prospects on the d-2 portions of the Schist Belt for the simple reason that the lands have been closed to mineral entry during the period of most intensive exploration. A discussion of the mineral potential of the Sequence 1B rocks in the study area must therefore be based on extrapolation from deposits on open lands.

In contrast with the Cosmos Hills, relatively little has been published on the mineral deposits of the Brooks Range Schist Belt. Wiltse (1975) mapped the bedrock geology at Bear Creek Mining Company's Arctic prospect for the Alaska D.G.G.S. N.L. Lutz (formerly of Bear Creek Mining Company), in a talk given at the Alaska Geological Society meeting in Anchorage, Alaska, gave grade and tonnage figures for the Arctic deposit (Lutz, 1976).

Except for the above papers the following sections are largely based on previous experience by members of the WGM staff, in particular C.G. Bigelow, J.F. Ruzicka, C.E. Degenhart and T.A. Andrews.

The Arctic deposit is at present the best prospect in the Schist Belt. The deposit was discovered in 1965 by J.F. Ruzicka and C.G. Bigelow for Bear Creek Mining Company. This discovery was followed in the succeeding years by the discovery and staking of the Dead Creek, Horse Creek, Charlie (Smucker) and Picnic Creek, among others. It is beyond the resources of this study to catalog and describe all of the prospects in the Ambler District. Brief descriptions of the above prospects will be given since members of the WGM staff have direct knowledge of them.

Lutz (1976) quoted the grade and tonnage of the Arctic deposit at approximately 35 million tons of plus 4% copper, plus 5% zinc and approximately 1% lead with appreciable credits in silver.

The deposit consists of tabular lenses of banded massive and semi-massive pyrite, chalcopyrite, bornite, chalcocite, sphalerite, galena and pyrrhotite. The sulfides make up from 30 to 90% of the rock generally consisting of granular sulfides in a maxtrix of quartz, talc and calcite. Pyrite is generally euhedral to subhedral with interstitial chalcopyrite, sphalerite and other sulfides. The sulfide textures are characteristic of metamorphosed sulfide ores (Vokes, 1968).

The sulfides are concordant with the foliation of the surrounding rocks. The lenses vary from a few feet to tens of feet in thickness and up to several tens of feet in length. The sulfide lenses aggregate up to several hundred feet thick in the center of the deposit and occur along about 5,000 feet of strike length.

The deposit occurs on the south flank of the Kalurivick Arch, in the upper portion of the Schist Belt section. Numerous lithologies are present in the vicinity of the mineralization, in contrast with the relative lithologic homogeneity of the rest of the section.

The following description of the petrology and stratigraphy of the Arctic prospect is based on Wiltse (1975) and discussions with J.F. Ruzicka and C.G. Bigelow.

The stratigraphic section exposed at the Arctic prospect consists of from 2,000 feet to over 5,500 feet of southwesterly dipping schists. The ore bearing talcose schist occurs more or less near the center of the section and appears to be a blanket-like lense enveloped in porphyroblastic chlorite-quartz-muscovite schist. The underlying porphyroblastic schist contains interbeds of graphitic and carbonaceous schist and is in turn underlain by albite, chlorite-quartz-muscovite schist and graphitic schist.

The hanging wall porphyroblastic schist is overlain by a distinctive blastoporphyritic microcline-biotite-muscovite schist (referred to as "button schist" by geologists working in the area). The button schist is in turn overlain by porphyroblastic quartz-muscovite schist and dark colored metamafic rocks with interbeds of marble and meta-argillite.

Wiltse (1975) and industry geologists working in the area interpret the button schist to be a meta-rhyolite porphry. The variable thickness of the blastoporphyritic unit is probably related to distance from paleovolcanic centers. The graphitic schists are metasediments which probably accumulated in areas of restricted circulation. The interbeds of carbonaceous schist indicate euxinic sedimentation taking place contemporeneously with felsic volcanism.

Wiltse (1975) concludes that the talc associated with the sulfide lenses is genetically related to the mineralization. He suggests that the talc may have formed by metamorphism of a parent material which was different in composition than the surrounding rocks. He further suggests "this local difference in composition may well have resulted from a pre-metamorphic rock alteration genetically associated with the sulfide emplacement," (Wiltse, 1975, p. 36). Magnesium metasomatism could provide such a mechanism. Alteration of this type does occur at sites of recent submarine volcanism (Bischoff and Dickson, 1975).

The Arctic prospect bears striking similarities to volcanogenic massive sulfide deposits in Canada (Sangster, 1972) and to the Besshi deposits of Japan (Kanehira and Tatsumi, 1970). Based on the above similarities and on interpretation of stratigraphy and oregenesis, Ruzicka and Bigelow suggested a submarine volcanogenic origin for the deposit as early as 1968. This conclusion was also reached by Wiltse (1975).

There are many other prospects in Sequence 1 rocks on open lands. The following are brief descriptions of the Dead Creek, Picnic Creek-Hot-Sun, Charlie-Smucker-Patti-Puzzle, and Horse Creek-Cliff-DH prospects. The descriptions are based on previous and present experience of members of the WGM staff in particular C.G. Bigelow, J.F. Ruzicka, C.E. Degenhart, T.E. Andrews, C. Hale, and G. Cleveland. Bigelow, Ruzicka and Degenhart did much of the original exploration in the Ambler District from 1965-70. Andrews was with Kennecott in the 1960's and Sunshine in 1972-73. Hale was with Sunshine in 1974 and is currently with WGM. Hale and Cleveland are conducting property evaluations in the district on behalf of General Crude Oil Company and Houston Oil and Minerals.

Bear Creek Mining Company's Dead Creek (Steptoe claims) prospect is located 4 miles northwest of Arctic. The prospect was discovered in 1965 by Bigelow and Ruzicka. Dead Creek, has perhaps the most spectacular, exposed mineralization in the district. Pyrite, chalcopyrite, bornite, sphalerite and minor Galena are present as coarse disseminated grains and semi-massive lenses in coarse-grained quartz muscovite schist which dips gently to the south. The mineralized schist is sandwiched between green-stone layers. A discordant greenstone cuts off the mineralization along strike to the east of the exposures.

Both the mineralized schist and the concordant greenstones pinch and swell along strike. Thin beds of quartzite (meta-chert?) are present locally in the greenstones. Some of the concordant greenstones are highly dolomitic. Bigelow, based on petrographic studies, suggested that at least some of the "greenstones" may be tuffaceous or argillaceous dolomites.

Bear Creek has drilled several diamond drill holes at Dead Creek but no results have been released.

The Picnic Creek (Bear Creek), Sun (Anaconda-Sunshine) and Hot (Noranda) prospects occur at the eastern end of the open lands (Fig. 4).

The properties adjoin one another and probably cover portions of the same deposit. The initial discovery was made in 1967 by Bear Creek Mining Company. The Hot claims were staked in 1974 and the Sun claims in 1974. Diamond drilling has been done on all of the claim groups. The claims cover a strong geochemical anomaly and several gossan exposures.

The rocks exposed at Picnic Creek-Sun-Hot are northeasterly dipping quartz-muscovite-chlorite schist with sparse greenstone lenses. A prominent unit of blastoporphyritic quartz-muscovite-feldspar schist occurs near the topographic base of the section. There is abundant evidence of thrust faulting so the stratigraphy is uncertain. The blastoporphyritic schist contains numerous interbeds of graphitic schist and greenstone. Some of the greenstone occurs as discordant plug-like bodies. Relic pillow structures are present in some tabular greenstones.

No mineralization is exposed. Gossan occurs in exposures of graphitic schist and associated blastoporphyritic schist. The favorable schist horizon is faulted off on the northeast. The horizon is also thinning to the northeast and thickening to the west and southwest suggesting a dome-like buildup.

At the western end of the open lands of the Ambler District are the Charlie (Bear Creek), Smucker (Anaconda-Sunshine), Patti (Noranda) and Puzzle (General Crude Oil-Houston Oil and Minerals) prospects (Fig. 4). These properties adjoin and may cover portions of the same deposit.

The properties are underlain mainly by dark gray, coarsely foliated, porphyroblastic muscovite-chlorite schist that is locally graphitic and biotitic. The rocks generally strike northerly and dip to the west and northwest. The prospects are on the western nose of the Kalurivick Arch. The schists are deformed into a complex subhorizontal overfold (nappe) which repeats the section several times.

Mineralization consists of pyrite, sphalerite and chalcopyrite with local tennantite and tetrahedrite. The sulfides are generally coarse-grained and occur as tabular lenses with a matrix of quartz and calcite. The host rocks are graphitic schists interbedded with porphyroblastic, quartz-feldspar-sericite schist and fine-grained massive siliceous rock (possible meta-rhyolite). The meta-rhyolites and graphitic schists are the most common host.

The Horse Creek (Bear Creek), Cliff (Anaconda-Sunshine) and DH (General Crude Oil-Houston Oil and Minerals) claims are between Charlie-Smucker-Patti-Puzzle and Arctic-Dead Creek. These prospects occur in steeply dipping folded rocks on the north flank of the Kalurivick Arch.

The section is composed of interbedded porphyroblastic, quartz-muscovite-calcite schist, graphitic schist, and greenstone, dominantly porphyroblastic schist. Some concordant greenstone lenses have definite pillow structures. Weakly metamorphosed semi-schistose graywacke forms one or more prominent members of the section.

Mineralization occurs in interbedded graywacke and porphyroblastic schist. Pyrite, chalcopyrite, bornite, galena and sphalerite are present as lenses, stringers, disseminations and, in places, massive pods.

The nature of the host rocks suggests a distal-volcanogenic environment.

In summary, there are several features of the mineralization in Schist Belt rocks which standout:

- The deposits are stratiform in shape.

- The mineralization is stratabound in character. In all locations the mineralization occurs in a restricted part of the stratigraphic section.

- The specific host rock is variable for prospect to prospect.

- Mineralization is usually associated with metamorphosed felsic volcanic rocks - blastoporphyritic schist, a unit of highly variable thickness.

- The mineralization occurs in a portion of the stratigraphic section characterized by abundant lithologic changes which probably represent primary facies changes.

- There is a near total lack of post-metamorphic mineralization.

Wiltse (1975, 1976) and industry geologists have concluded that the deposits in the Sequence 1B rocks are metamorphosed volcanogenic massive sulfide deposits. Wiltse (1975, p. 39) concludes: "it appears that the sulfide mineralization is preferentially located on the flanks or just off the edges of small pre-metamorphic felsic volcanic domes or volcaniclastic piles," Such an interpretation certainly would account for the variable thickness of the porphyroblastic schist and the abundant facies changes in the host rocks.

The ultimate economic potential of the deposits in the Ambler District has not been assessed. Wiltse and Henning (1976) suggest a range of value from $5 to $20 billion.

6.1.3 Sequence 1: Interpretation of the Relationship of the Cosmos Hills and Arctic Belts

Stratigraphic and Structural Relationships

Despite certain indications of structural complexity along the Ambler Lowland, it is believed that the Devonian Cosmos Hills schist-carbonate belt and the upper part of the Arctic Schist Belt occupy the same stratigraphic position. This conclusion rests partly on the appearance of both the Cosmos Hills and the Arctic schists from beneath similar graphitic phyllite which crop out on the north and south sides of the Ambler Lowland syncline. The occurrence of major concentrations of copper-rich base metal sulfide deposits in both units provides additional evidence. Correlation studies are complicated by lack of outcrop in the Ambler Lowland, rapid facies changes evident in surface exposures in both belts, and the general northward increase in metamorphic grade.

Structural dislocations along the Ambler Lowland, as long as they are not of major strike-slip or thrust magnitude, would only modify the shape of the original Devonian basin.

Correlation of the Cosmos Hills and Arctic belts permits a number of interpretations regarding sedimentation and depositional environments in the Devonian rocks. The emergence of a Devonian platform and reef-building in the Cosmos Hills would be approximately contemporaneous with development of an acidic volcanic island arc within the eugeosynclinal basin north of the shelf. Prior to development of the volcanic arc, the basin was the site of deposition of a thick section of flysch-type sediments interspersed with occasional outpourings of mafic lava. The overall tectonic setting is not clear, however the fore-arc basin/volcanic arc combination described by Mitchell and Bell (1973) and Dickinson (1974) is probably a good model.

Acidic volcanic activity was confined primarily to a short period of time within the Devonian and to a narrow east-west trending belt. Centers of acid volcanism are marked by plugs or domes of porphyritic rhyolite surrounded by aprons of volcanoclastic material. The largest volcanic center recognized to date is west of the Arctic deposit in the vicinity of VABM Riley (Wiltse, 1975). Shoaling of the volcanic areas resulted in deposition of a variety of lithologic units, including thin limestone beds and organic-rich muds within restricted basins, interbedded with normal clastic sediments, rhyolitic volcanics and volcanoclastics, and mafic volcanic lavas or sediments.

The trough between the volcanic arc and the carbonate shelf was characterized by lower-energy, deeper-water quartzose and carbonaceous clastic sediments.

Within the Cosmos Hills platform environment clean calcarenite and calcilutites, dolomite reefs, and intra-reef carbonate mud were deposited. The light greenish sericite-chlorite-albite-calcite-dolomite phyllite lenses which intertongue with the forereef breccia aprons, may represent metamorphosed tuffs or volcaniclastic sediments which had their source in the volcanic arc to the north. Similar light green micaceous phyllites occur in the Arctic section as well. The gross similarity of the rocks, their broad areal distribution and association with metavolcanic rocks suggest a possible volcanic origin even though relict volcanic textures are absent.

Age and Origin of Mineralization

The copper-zinc deposits of the Arctic Schist Belt are banded stratiform sulfide lenses associated with metamorphosed rhyolitic volcanic rocks interbedded in a eugeosynclinal marine sedimentary sequence. The deposits occur on the flanks of centers of rhyolitic volcanism (Wiltse, 1975). They, therefore, are metamorphosed examples of the "volcanogenic massive sulfide" class of ore deposits. Variations of this type of deposit are the Kuroko and Besshi deposits of Japan and the Noranda and Timmins districts of eastern Canada. The source of the metals was within or related to the original magmas which produced the volcanics. The metals made their way to the surface along volcanic channelways, where they were deposited on the sea bottom on the flanks of volcanic vents. Age of the mineralization is the same as that of the host rocks, probably Devonian (the basis for this age assignment is discussed in earlier sections and in Wiltse (1975)).

The Bornite copper-zinc deposit consists of sulfide mineralization hosted in permeable facies of a Devonian dolomite reef complex. The deposit is similar in most respects to the Mississippi Valley-type deposit, with the exception that most Mississippi Valley deposits contain zinc and lead but little copper. The origin of these deposits is generally thought to be due to the concentration of metal-rich brines along regional structural or stratigraphic trends, where various physio-chemical conditions cause precipitation of metallic sulfides in porous and permeable areas. Reef structures commonly provide excellent sites for deposition, as well as harboring fluids rich in reduced sulfur.

The proximity of the Arctic-type stratiform copper-zinc deposits to the Bornite carbonate-hosted copper-zinc deposits and the possible correlation of their enclosing host rock sequences, suggest a genetic relationship between the two types. It is suggested that metal-bearing solutions related to the volcanic activity, similar to the solutions responsible for deposition of the Arctic-type sulfide bodies, found their way into the dolomite reef environment shortly after deposition of the dolomites. The evidence for early deposition of copper minerals at Bornite is discussed in section 6.1.6. As such the deposits would be genetically as well as spatially related. This hypothesis was first proposed by C.G. Bigelow and N.L. Lutz in the late 1960's.

Implications to Appraisal of d-2 Lands

The significance of the discussion above, as it pertains to appraisal of the mineral potential on d-2 lands, is that resource evaluators and explorationists should be alert to the possibility that volcanogenic exhalative mineralization may be present if mineralization of the Cosmos Hills reef complex type if found, and vice versa. The lateral separation may be a few to several miles. Gross mineral trends in the two environments are very likely to be approximately parallel, although this certainly is not necessary.

The Cosmos Hills reef complexes trend to the north and northeast beneath Ambler Lowland phyllites. The favorable schist belt stratigraphy dips to the south beneath the phyllites (Fig. 4-A). It is conceivable that there may be deposits similar to carbonate or schist types under the lowland. As has been noted in previous sections, rocks of both the Arctic Schist Belt and Cosmos Hills belt enter d-2 lands east and west of the Ambler Mineral District. Since very large reserves of copper, zinc, and other metals have been located within the Ambler District and little exploration has been accomplished within similar rocks on the d-2 lands, the Schist Belt and Cosmos Hills rocks on the d-2 lands must be regarded as possessing the potential for additional discoveries of important metallic mineral resources.

6.2 SEQUENCE 2: SKAJIT-HUNT FORK-KANAYUT

6.2.1 Geology

The Arctic Schist Belt is succeeded to the north by Devonian to Silurian(?) age clastic and carbonate sedimentary and metasedimentary rocks. These rocks compose the bulk of the Brooks Range mountainous terrain and underlie a large portion of the d-2 lands within the study area.

Rocks of Sequence 2 increase in metamorphic grade from north to south, from relatively unmetamorphosed sediments through slates, quartzites, and phyllites to a variety of schists and calcareous rocks. Lithologies include marble, calcareous quartz-mica schist, quartzite, quartz-muscovite ± garnet schist, quartz-chlorite schist, garnet-amphibole greenstone, chlorite-feldspar greenschist, phyllite, slate, shale, sandstone and conglomerate. A number of predominantly north-dipping named and unnamed rock units comprise Sequence 2; the principal named units are, from oldest to youngest: the Skajit Limestone, Hunt Fork Shale, and Kanayut Conglomerate. Stratigraphic studies are hampered by large-scale thrust faulting, recumbent folding, metamorphism, and lack of geologic mapping. The top of Sequence 2 as defined for this report is placed at the Devonian-Mississippian boundary.

The massive cliff-forming Middle or Upper Devonian Skajit Limestone dominates the southern portion of Sequence 2. Massive to thin-bedded limestone and marble beds form prominent cliffs. Dolomite commonly occurs near the base and at the top of the formation. Biogenic carbonate buildup has been noted. Calcite-quartz-mica schist, quartz-mica schist, and quartz-chlorite schist are commonly interbedded with the carbonates. Rock units are typically lenticular, but many of the rocks are strongly folded suggesting possible transposition structures. Greenschist lenses and beds, probably of mixed volcanic-sedimentary origin, and both concordant and cross-cutting greenstones are found at all stratigraphic positions.

Regional mapping problems are compounded by rapid facies changes common to shallow depositional environments. In the western Survey Pass Quadrangle, where the belt of Skajit Limestone thins to an outcrop width of about four miles, it is overlain by a sequence of quartzite, micaceous quartzite, quartz-muscovite ± garnet schist, quartz-chlorite schist, quartz-biotite schist, and amphibole-garnet greenstone.

In the West Brooks Range limestones of the Devonian Baird Group are correlative with the Skajit Limestone and form a wide outcrop belt through the Baird Mountains. The rocks consist mainly of recrystallized normal shelf calcarenites and calcilutites. The calcarenites generally are recrystallized to a somewhat coarse grain size. Dolomite clasts in the limestones mark areas of nearby dolomite buildup.

The Late Devonian Hunt Fork Shale of the central Brooks Range overlies the Skajit Limestone and associated rock with apparent disconformity, however, geologic mapping is preliminary. The lower Hunt Fork consists of dark, partly calcareous phyllite and fine-grained schist, the metamorphosed equivalent of carbonaceous shale, gritstone, and impure carbonate. Common schist and phyllite types include quartz-muscovite-biotite schist, garnetiferous quartz-chlorite schist and calcareous schist. The rocks are commonly pyritic. The upper Hunt Fork consists of dark gray phyllite, slate, shale, and sandstone (Bowsher and Dutro, 1957; Porter, 1966).

The Late Devonian Kanayut Conglomerate and equivalent rocks form a thick wedge of conglomerate, sandstone, quartzite, and shale in the central Brooks Range. The unit is transitional to the Hunt Fork Shale and is overlain by Mississippian rocks. Pebbles in the conglomerate are mainly chert of various colors. The conglomerate sandstone and quartzite are resistant to weathering and form many of the peaks in the central Brooks Range (Porter, 1966). The sediments are predominantly of non-marine origin with a source from the north and northeast. Deposition of the Kanayut marks a Devonian orogenic pulse north of the present Brooks Range (Churkin, 1973).

West of the central Brooks Range, various named or unnamed units are probably in part equivalent to the Kanayut Conglomerate. The Noatak Formation, consisting of ferruginous sandstone and shale, is one of these.

Cretaceous granitic plutons intrude rocks of the lower part of Sequence 2. The intrusives are commonly porphyritic, with large euhedral phenocrysts of K-feldspar. Some of the intrusive rocks are foliated. Chilled pyritic borders are common. Contact effects, i.e., hornfelsing and formation of calc-silicate minerals, are widespread in the adjacent metasediments.

6.2.2 Mineralization and Mineral Potential

The major part of the Skajit-Hunt Fork-Kanayut belt is within the d-2 lands project area and, accordingly, has received little attention by mineral appraisers. Preliminary reconnaissance completed during the 1960s in selected portions of the Baird Mountains quadrangle resulted in in discovery of copper sulfide mineralization in massive dolomite at Omar and copper-lead-zinc mineralization associated with barite and massive dolomite at Frost. The two occurrences are described elsewhere in this report.

The Abo zinc-lead prospect is located in the Skajit section on open-to-mineral-entry lands in the Wiseman quadrangle near the d-2 boundary. In this area widespread stratabound(?) mineralization occurs in marble, dolomite, and associated quartzose rocks. Lead-zinc mineralization also occurs in schist and carbonate at the Buzz and Ann properties. In addition, copper mineralization has been found in schist in Sequence 2 areas at scattered localities on open lands in the Wiseman quadrangle.

Lead-zinc and copper sulfide mineralization have recently been found in schist and in schistose limestone within the Skajit environment near the West Fork of the Maneluk River at the north edge of the Ambler mineral district in the western Survey Pass quadrangle. Copper-silver mineralization has been discovered in Sequence 2 during the present appraisal on d-2 lands south of the Noatak River in the Ambler River quadrangle. Copper mineralization also occurs in phyllite of the Hunt Fork at Ningoyak Creek on the north side of the Noatak River.

Several copper occurrences have been the object of recent attention in the Skajit section 8 to 15 miles east of the pipeline corridor in the Chandalar quadrangle. The deposits are informally called the Chandalar "copper belt". The occurrences are in tactites and diorite and are northeast of Wiseman on Doyon regional selection lands and adjacent d-1 lands. The mineralization occurs as replacements(?) in garnetiferous, epidote-carbonate tactites and as disseminations and fracture fillings in diorite. The deposits, discovered during the late 1960s, are not on d-2 lands and, accordingly, were not re-examined during the course of the current study.

The known mineral discoveries on d-2 lands were made prior to the withdrawal of these lands. No recent exploration has been accomplished, with the exception of the present Bureau of Mines program, which was largely confined to reported mineral showings and geochemical anomalies. A major exploration effort would be required to determine the mineral potential of unappraised d-2 study lands underlain by the Skajit-Hunt Fork sequence. Detailed work is required in the carbonate environments due to limited geochemical dispersion of copper and zinc in that environment.

The Skajit and Hunt Fork units are considered to have the best mineral potential within Sequence 2. This conclusion is based on several factors, chiefly the number and type of mineral occurrences in the sequence both within and outside the study area and the association of mineral deposits in other parts of North America and the world with similar geologic settings. Environments of prospective interest include but are not restricted to the following:

1. Stratabound and non-stratabound copper and/or zinc and lead with possible silver credits in carbonate and clastic metasedimentary rock.

2. Porphyry and contact-related base metal deposits near plutonic contacts.

3. Volcanogenic base metal deposits in schist-greenstone environments.

4. Uranium and/or tungsten in areas of plutonic activity.

5. Vein antimony in Hunt Fork shale.

6. Placer gold.

It is likely that additional mineral environments would be delineated in the course of a systematic reconnaissance of favorable areas.

In summary it can be said that Sequence 2 rocks constitute a geologic environment which is permissive to the occurrence of a number of types of mineral deposits, and therefore the potential for the discovery of those deposits exists in areas underlain by Sequence 2 rocks. One cannot say conclusively, without careful detailed exploration by competent explorationists, where mineralization will be found or even if it will be found, only that the potential is there and in the judgement of the writers the potential is good.

6.3 SEQUENCE 3: LISBURNE-SIKSIKPUK-SHUBLIK

6.3.1 Geology

A section of unmetamorphosed marine sedimentary rocks consisting of shale, limestone, dolomite, chert, and sandstone ranging in age from Mississippian to Triassic are herein grouped into Sequence 3. The sequence includes some Jurassic and possibly Upper Devonian rocks in certain areas. Sequence 3 rocks occur along an east-west trending belt on the north flank of the Brooks Range, which turns southwestward in the far west Brooks Range. Within the d-2 lands the units crop out extensively in the DeLong Mountains in the following named quadrangles (Fig. 4):

DeLong Mountains
Noatak
Baird Mountains (NW corner only)
Misheguk Mountain
Howard Pass (north edge of the project region)

A number of named and unnamed units comprise Sequence 3 rocks, but stratigraphic relationships are frequently obscured by tectonic effects. The principal named units are the Lisburne Group (Mississippian), Siksikpuk Formation (Permian), and Shublik Formation (Triassic).

The Lisburne Group consists of limestone-dolomite, chert, and shale. The Lisburne has been divided into three formations in the DeLong Mountains, the Utukok, Kogruk, and Tupik (Sable and Dutro, 1961). The Utukok Formation consists of ferruginous sandy limestone, calcareous sandstone, and shale. The Kogruk Formation is composed of bluish to brownish to light gray thick-bedded cliff-forming limestone and minor chert. The Kogruk Limestone is fossiliferous, containing abundant corals, crinoids and other fossil remains. Rubble zones and fresh surfaces of Kogruk Limestone frequently emit a fetid odor. The Tupik Formation consists of thin, interbedded black or dark gray chert and carbonate beds which vary from limestone to dolomite to carbonate mudstone.

Lisburne Group rocks vary somewhat in lithologic character and age east and west of the DeLong Mountains in the central Brooks Range and Lisburne Peninsula, but carbonate lithologies predominate in all areas. Sabkha facies carbonates are reported in the upper part of the Lisburne Group in northeastern Alaska (Wood and Armstrong, 1975).

The Siksikpuk Formation of Permian age consists of a variegated sequence of greenish-gray and reddish-gray argillite, shale, siliceous shale, and chert. The unit is characterized by its varied colors and is apparently separated from underlying and overlying rocks by disconformities.

Arkosic sandstone, shale, and varicolored chert of the Nuka Formation (Late Mississippian to Permian) crop out north of the d-2 lands on Petroleum Reserve No. 4 (Tailleur and Sable, 1963). These rocks are in part correlative with portions of the Lisburne and Siksikpuk Formation.

Dark gray to black shale, limestone, and chert compose the Shublik Formation of Triassic age. Oil shale is known within this unit but apparently does not occur in the project area.

Stratigraphic studies suggest a northerly or northeasterly source area for most of the Sequence 3 clastic sediments (Churkin, 1973).

Complex faulting and folding has resulted in uplift and repetition of units in Sequence 3. According to Tailleur and Snelson (1966), large-scale thrust faulting of rocks as young as Cretaceous may aggregate "more than 75 miles, and may represent a type of tectonics that is characteristic of the entire western Brooks Range orogen". Tailleur and Snelson (1968) later suggested displacements up to 150 miles. On a smaller scale numerous folds and high to low angle faults disrupt the rocks.

6.3.2 Mineralization and Mineral Potential

Systematic mineral appraisals have not been conducted within the Sequence 3 rocks. In the course of reconnaissance mapping of the DeLong Mountains area Tailleur (1970) noted a stream sediment geochemical anomaly and lead-zinc-barite mineralization in chert at Red Dog Creek. Tailleur also noted several color anomalies in the surrounding area. Examination of the Red Dog area in the course of the present study showed the presence of extensive exposures of zinc and lead sulfides as well as barite as reported by Tailleur.

At least three companies have been active on d-1 lands west of the Red Dog prospect since the Bureau of Mines Press Release. These are General Crude Oil-Houston Oil and Minerals, St. Joe Minerals and Cominco American. A number of strong lead, zinc, and barium stream sediment anomalies are reported to occur on these lands. According to reports from company sources, most or all of these anomalies originate from areas of interbedded dark shales, chert, and limestone of uncertain age. Barite and sulfide-bearing horizons are reported to occur in shale and chert west of Red Dog.

The carbonate section of the Lisburne Group, the Kogruk and Tupik Formations are reportedly lacking in significant mineralization or geochemical anomalies on the d-1 lands. These formations may have potential for base metal deposits, however this potential is virtually unevaluated.

The Sequence 3 chert-shale section is considered to have strong potential for discovery of massive lead-zinc-barite stratabound deposits similar in many respects to recent discoveries in the Selwyn Basin of Canada (Templeman-Kluit, 1972, and Brock, 1976). Major reserves of these commodities occur in lithologically similar rocks of Cambrian to Mississippian age within the Selwyn Basin.

It is suspected that significant zinc-lead sulfide mineralization is present on d-2 lands near Red Dog and in Sequence 3 rocks on Petroleum Reserve No. 4, as well as on the d-1 lands west of Red Dog. Several published accounts list additional indications of base metal-barite potential in Sequence 3 rocks. These include shale with barite concretions reported in the Nuka Formation of Late Mississippian to Permian age in Petroleum Reserve No. 4 (Tailleur and Sable, 1963), and in the Siksikpuk Formation of Permian age near Anaktuvuk Pass (Porter, 1966). This indicates that the target environment may occur over a strike distance of up to several hundred miles in an east-west direction along the north side of the Brooks Range. The entire length is closed to mineral entry.

Minor barite has also been observed in Lisburne Group Limestone in the subsurface (Wood and Armstrong, 1975). Brosgé, et al. (1962), report a "richly pyritic siltstone, 10-20 feet thick" at the base of the Siksikpuk Formation in the eastcentral Brooks Range.

Phosphate rock, for the most part uraniferous, has been documented within black chert and shale in the upper Lisburne Group and in the Shublik Formation north and east of the d-2 lands by Patton and Matzko (1959).

It is unlikely that mining-oriented appraisers have investigated the base metal potential of any of the northern and far west Brooks Range region in significant detail aside from the restricted areas summarized in this report.

6.4 SEQUENCE 4: JURASSIC-PERMIAN MAFIC-ULTRAMAFIC ROCKS

6.4.1 Geology

Mafic volcanic and intrusive rocks of Permian to Jurassic age occur in a narrow band along the southern edge of the Brooks Range and in the far west Brooks Range, primarily along the Noatak and Wulik River drainages (Fig. 4). The sequence consists of pillow basalt, diabase, gabbro, chert, serpentized peridotite and dunite, and shale and slate. The volcanic and intrusive rocks are commonly altered to a mineral assemblage that includes chlorite, epidote, and sodic plagioclase. These rocks constitute a typical ophiolite suite (Patton, 1973; Roeder, 1976).

The band of mafic rocks along the southern edge of the Brooks Range crosses the d-2 study land in the Angayucham Mountains east of the Cosmos Hills. Mafic rocks also occur in the Cosmos Hills as described above in the Sequence 1 section. Sequence 4 reappears farther west along the south edge of the Brooks Range in the Hunt River area. Here the rocks consist predominantly of amygdaloidal and pillow basalt and andesite flows, diabase intrusives, varicolored radiolarian(?) chert, mudstone, and serpentine, and are often dynamically metamorphosed and altered (Patton and Miller, 1966; Patton, et al., 1968). The mafic rocks may constitute the exposed edge of oceanic crust which forms the basement rock for the extensive Cretaceous volcanics and sediments in the Koyukuk basin (Sequence 5) and is in contact with metamorphosed Paleozoic rocks of the Brooks Range proper. Alternatively, Wiltse (1975) lists evidence for the possible correlation of Angayucham Mountains and Ambler Lowland mafic rocks with metamafics within the Arctic Schist Belt and assigns a Devonian or older age to these rocks.

Mafic volcanics and ultramafic intrusives occur in large synclinal erosional remnants of a thrust sheet in the far west Brooks Range. The sheet is the uppermost of several north to northwest directed thrusts in the area. The mafic rocks, which overlie Paleozoic and Mesozoic sedimentary rocks, occur over extensive areas in the lower Wulik River-Kivalina River drainages and in the Noatak River drainage. Regionally the mafic remnants tend to occur near the northern and northwestern edge of the Brooks Range Devonian metasedimentary section (Sequence 2).

Rock types in the far west Brooks Range mafic sequence consist of pillow basalt flows, chert, dunite with chromite, and layered cumulate gabbro. Tailleur (1970) and Roeder (1976) report that the layered mafic and ultramafic rock appear to tectonically overlie the basaltic rocks.

Preliminary evaluation of the economic potential of three areas within the ultramafic rocks of the far west Brooks Range d-2 lands was accomplished in the present study. The reader is referred to the Avan River, Misheguk Mountain, and Maiyumerak Mountains sections of this report for discussions of local geology and geochemistry. The following discussion concerns a fourth such area.

Asik Mountain

The Asik Mountain ultramafic complex is located on native withdrawal land on the east side of the lower Noatak River 18 miles southeast of the village of Noatak. It is a part of the extensive mafic-ultramafic terrane in the lower Noatak Valley which extends onto d-2 lands. The area was briefly examined for mineral potential by WGM on behalf of the NANA Regional Corporation in 1974 (Degenhart and Bigelow, 1974). The following description of the Asik Mountain complex is given, with permission from NANA, to outline some of the salient geologic and conomic features of typical Brooks Range ultramafic bodies.

Asik Mountain is an ultramafic pluton which, by interpretation of regional aeromagnetic and gravity data, extends westward from an area of outcrop at Asik Mountain under the east side of the Noatak Valley where it is covered by Quaternary sediments. Complexly faulted carbonate and clastic sediments border the ultramafic complex on the east side of Asik Mountain.

The pluton has a poorly defined layering. From south to north, the general rock types observed consist of dunite-peridotite, quartz diorite interlayered with peridotite, gabbro, diorite, biotite-quartz monzonite, syenodiorite, and peridotite with pegmatite dike swarms. A chilled border phase consisting primarily of gabbroic rocks is present towards the northwest side of the exposed portion of the pluton.

The structure is complex, but generally it appears that the layered pluton has intruded carbonate rocks of possible Devonian age. The contact appears to be nearly conformable, indicating that the intrusive may be sill-like.

Geological and geochemical work indicates that chromium, copper, nickel, and platinum-group metals are present at Asik Mountain. A modest buildup of chromium and nickel occurs near the southwest part of Asik Mountain. Tan to brown weathered dunite is present in this area, and disseminations of chromite and magnetite are visible in the dunite. A lesser chromium buildup occurs at the peak of Asik Mountain, associated with a peridotite unit. These anomalous areas were outlined by soil samples. Values in the anomalous area are greater than 600 ppm chromium and greater than 450 ppm nickel versus backgrounds of less than 200 ppm chromium and less than 100 ppm nickel.

One sample of pyritic syenodiorite on the west side of Asik Mountain shows in excess of 500 ppm copper. The anomalous copper value was attributed to trace amounts of copper minerals associated with pyrite, since no other copper minerals were observed.

It is probable that the nickel in the areas of outcrop is in silicates since no nickel sulfides were observed. Hawkes and Webb (1962) give a range of nickel values of 160-1,200 ppm for mafic and ultramafic rocks. Consequently the nickel values present in surface samples near Asik Mountain are not unusually high. The highest chromium values were in the 1-2% range which is too low grade to be of economic interest. Although samples in the area were analyzed for copper and platinum group metals, no anomalous values were noted.

However, the Asik Mountain area in general may be of some interest. The unusually strong coincident magnetics-gravity anomaly is centered over the lowland area, where no geological or geochemical information is available. The geophysical anomaly could be due to magnetite-chromite mineralization in buried ultramafic rocks.

6.4.2 Mineralization and Mineral Potential

Layered mafic and ultramafic bodies such as those in the western Brooks Range are fairly rare geologic phenomena and present unique exploration targets for various metals. Similar intrusions of the Bushveld Complex in South Africa and the Stillwater Complex in Montana contain economically significant concentrations of chromium, iron, and platinum group metals. Others such as the Sudbury erruptive of Ontario, Canada, contain major deposits of nickel, copper, and platinum group metals. However, the Brook Range bodies appear to be of the Alpine ultramafic-type which differs from the Bushveld-Stillwater-Sudbury type of body.

Newmont Mining Company apparently examined several valleys in the Avan-Kelly Rivers ultramafic complex for platinum potential. Low-grade chromite and magnetite mineralization occur in various, if not all, of the far west Brooks Range ultramafic bodies, suggesting relatively unassessed potential for economic concentrations of chromium, perhaps with associated platinoid metals. Nickel, nickel-copper and/or copper, copper-iron, and asbestos may be present in significant concentrations in portions of one or more of the ultramafic complexes located on withdrawn lands in the far west and northern Brooks Range. Copper sulfides occur in one or more basins on d-2 lands in the Maiyumerak Mountains, although the specific reported location(s) were not pinned down during the course of the Bureau of Mines program. Previous experience indicates that copper values in silt in excess of 300 ppm commonly indicate presence of copper sulfides in the upstream direction, particularly in shaley inter-volcanic layers. Values exceeding 300 ppm have been obtained from the Maiyumerak Mountains during the current program.

The occurrence of nephrite jade and asbestos has been noted above in the discussion of the Cosmos Hills carbonate-schist belt (Sequence 1) in the Cosmos Hills and Jade Mountains. Jade deposits are presently being worked in these areas, and asbestos was produced from a serpentinized body in the Cosmos Hills. The serpentine bodies and other ultramafic rocks along the south flank of the Brooks Range have modest potential for discovery of additional commercial jade and/or asbestos occurrences. This potential has apparently not been tested outside of the Cosmos Hills-Jade Mountains.

Basaltic volcanics and interbedded sediments in the mafic sequence have a moderate potential for copper-pyrite or copper-nickel volcanogenic massive sulfide deposits similar to the Cyprus or Western Australia types.

Summarily, any one or more of the above-named minerals (metals) may be present in economic proportions in ultramafic complexes or mafic rocks in the study area. The geology is favorable, and there are known occurrences of these minerals (metals) in appropriate host rock types. The level of knowledge is very low.

Reference is made to the following sections of this report for additional information on ultramafic and mafic rocks in the project region: Avan River, Misheguk Mountain, and Maiuymerak Mountains.

6.5 SEQUENCE 5: CRETACEOUS-JURASSIC SEDIMENTARY AND IGNEOUS ROCKS

6.5.1 Geology

Cretaceous and Jurassic graywacke, mudstone, sandstone, and coal underlie extensive areas in the northern foothills of the Brooks Range and the Arctic Coastal Plain. Within the project area these rocks occur only in the northwestern corner of the d-2 lands (Fig. 4), principally within the Misheguk Mountain and DeLong Mountains quadrangles. A number of named units comprise the sequence, including Ogotoruk, Telavirak, Kisimilok, Okpikruak, Fortress Mountain, and Torok Formations, and the Nanushuk and Colville Groups (Detterman, 1973).

Deformation, uplift, and erosion of predominantly Paleozoic sedimentary rocks and Paleozoic to Mesozoic granitic intrusive rocks in the ancestral Brooks Range provided debris which was deposited in Jurassic and Cretaceous basins north of the range (Brosgé, et al., 1962, Detterman, 1970). Most of the sedimentation was of marine flysch-type, consisting of graywacke, siltstone, and mudstone. Non-marine sandstone, siltstone, shale, and coal intertongue with the marine rocks in the upper part of the sequence over large areas. The non-marine rocks north of the study area

Contain major coal reserves, (Barnes, 1967) but the coal-bearing units have not been reported to extend southward to the d-2 lands.

A similar extensive Jurassic(?)-Cretaceous sequence, containing abundant intermediate to felsic volcanics and intrusives, underlies the Yukon-Koyukuk province (Koyukuk basin) to the south of the Brooks Range (Patton, 1973). The rocks crop out in the two southerly projections of the d-2 lands within the Waring Mountains, northeastern Selawik Hills, and eastern Lockwood Hills (Patton, 1973; Patton and Miller, 1966).

The principal rock types in the Koyukuk basin are marine volcanic graywacke and mudstone with lesser conglomerate and tuff (Patton and Miller, 1966; Patton, et al., 1968). A thick pile of andesitic volcanic rocks with lesser felsic volcanics occur near the base of the sequence. The volcanic assemblage consists predominantly of volcaniclastic rocks but contains abundant andesite flows and hypabyssal intrusive rocks (Patton, 1973). Cretaceous and Tertiary felsic volcanics and Tertiary and Quarternary basalts occur in certain areas, but have not been shown separately on Figure 4.

Non-marine sediments, including coal beds, are present in the upper portion of the Koyukuk basin Cretaceous sequence. A Late Cretaceous non-marine conglomeratic facies with some coal occurs along the Kobuk Valley at the northern edge of the basin.

Intermediate to felsic Cretaceous plutons are widespread in the Koyukuk basin, particularly in the more volcanic sections. These rocks range from granodiorite to granite but include more alkalic varieties, such as syenite and nepheline syenite. Granitic intrusives of a similar age also occur in the Brooks Range Paleozoic metasedimentary terrane (Sequence 2), but do not show the alkalic affinities of those in the Koyukuk basin. The Brooks Range plutons have been discussed further in the Sequence 2 section.

Within the d-2 lands of the project region marine sediments are apparently the dominant rocks comprising the Koyukuk basin Cretaceous section, however, andesitic volcanics and intrusive rocks occur in a small area northeast of the Lockwood Hills and extensively in the Selawik Hills. The former area is within the southern extension of the Gates of the Arctic withdrawal; the latter occurs along the southern edge of the Selawik Wildlife Refuge withdrawal.

6.5.2 Mineralization and Mineral Potential

Large reserves of coal occur in non-marine Cretaceous sediments of the Arctic slope (Barnes, 1967), and coal is also known in non-marine sediments of the Koyukuk basin. The presence of abundant bentonite and tuff in non-marine sediments of the Arctic slope and the presence of tuffs in the Koyukuk sediments indicates that these units are permissive for the occurrence of sandstone-type uranium deposits similar to those of the Colorado Plateau and Wyoming basins. The apparently limited extent of non-marine deposits within the Cretaceous sequences on the d-2 lands suggests that only a modest potential exists for coal and sandstone-type uranium deposits on these lands.

Campbell (1967) noted phosporite nodules in mudstones of the Jurassic or Cretaceous Ogotoruk and Telavirak Formations of the Lisburne Peninsula, west of the d-2 lands. The potential for phosphate deposits was not investigated in the course of the present study and so cannot be properly assessed.

The intermediate to felsic plutons and their contact zones in the Selawik Hills and northeast of the Lockwood Hills have potential for porphyry-type disseminated copper mineralization and related base metal-precious metal contact or vein deposits.

The plutonic rocks, particularly more alkalic varieties, could contain uranium deposits of late-stage hydrothermal or igneous-type within veins, dikes, pegmatities, or other igneous differentiates (Miller, 1972, 1976). Exploration for this type of deposit in similar rocks is currently in progress in several adjacent areas (Miller, 1976). Similar rocks occur within the d-2 lands in the northeastern Selawik Hills and in the southern extension of the Gates of the Arctic withdrawal, consequently, there is potential for igneous-hosted uranium deposits in the area. At the present stage, however, this potential cannot be quantified.

6.6 REGIONAL GEOLOGIC INTERPRETATION AND GEOLOGIC HISTORY

This section briefly summarizes the writers' thoughts on the regional geologic history of the study area. Evidence for the conclusions stated here is given in previous sections.

Most of the Brooks Range is underlain by metasedimentary and sedimentary rocks deposited in a Lower Paleozoic geosyncline. The Skajit Limestone, Hunt Fork Shale, and related rocks were deposited in a wide miogeosynclinal basin principally during the Middle Devonian, but the basin may include some older rocks.

A eugeosynclinal trough existed on the south side of the basin, receiving quartzose sediments of the Devonian and older(?) Arctic Schist Belt. Mafic volcanic flows and sills were emplaced at irregular time intervals. Emergence of the Cosmos Hills carbonate shelf and the development of an east-west trending rhyolitic volcanic arc took place in the upper portion of the eugeosynclinal sequence. Subsidence of the carbonate platform produced a high-relief reef complex. Individual dolomite reefs are flanked by thick, steeply dipping aprons of reef talus. Quartzose sediments and volcanic detritus were deposited in the intervening Ambler Lowland basin, and reached only to the edge of the carbonate shelf. A blanket of carbonaceous fine-grained clastic sediments was deposited over both the shelf and arc-trough environments.

Miogeosynclinal conditions, with occasional disconformities (i.e. between the Skajit and Hunt Fork units), prevailed in the region north of the trough until Late Devonian. Major uplift of an area north of the present Brooks Range resulted in deposition of non-marine chert-pebble conglomerate and sandstone of the Kanayut Conglomerate and equivalents in the northern Brooks Range. Evidence from the northeastern Brooks Range and Arctic slope suggests that the uplift accompanied deformation and intrusion of granitic plutons during a widespread Late Devonian orogeny (Churkin, 1973).

Upper Paleozoic to Lower Mesozoic marine sedimentary rocks of the northern Brooks Range and Arctic slope consist of limestone, chert, and organic shale. The Lisburne Group in the lower part of the sequence is transgressive to the north. The sediements were deposited under relatively quiescent conditions, although unconformities exist between the Lisburne Group (Mississippian), Siksikpuk Formation (Permian), and Shublik Formation (Triassic). Like the Kanayut Conglomerate, the Mississippian to Triassic sediments are believed to have a northerly source.

The presence of Permian to Jurassic balsaltic lavas, diabasic sills, gabbros and layered mafic and ultramafic rocks to the south of the present Brooks Range indicates the presence of oceanic crust at that time.

Widespread orogenic activity began in the Jurassic and continued through the Cretaceous. Radiometric age dates suggest that certain orogenic activity may have occurred as early as Permian (Wiltse, 1975). Large scale north-directed thrust faulting and recumbent folding, accompanied by metamorphism, may have involved tectonic transport of up to 150 miles, although gravity slide mechanisms may account for much of this distance. The ophiolite suite was (tectonically) emplaced over older rocks. Compressional tectonic effects resulted in north-south shortening of Paleozoic basinal dimensions, and in juxtaposition of rocks of similar age but varying lithologies. In particular, relationships between the Arctic Schist Belt and the Skajit-Hunt Fork section were obscured; metamorphism was greatest in this area, with local development of gneissic fabrics. Shortening may also have occurred between the Arctic Schist Belt and the Cosmos Hills carbonate shelf.

Cretaceous granitic plutons were emplaced in the central Brooks Range, most commonly into the Skajit-Hunt Fork Section.

Sedimentary basins were formed on either side of the developing ancestral Brooks Range, and were filled with Jurassic to Cretaceous, and minor Tertiary, deposits, principally marine graywacke-type sandstones and mudstones. Large volumes of andesitic volcanics erupted in the Koyukuk basin south of the Brooks Range in the Lower Cretaceous, and were accompanied by granitic intrusives. Non-marine sediments commonly intertongue with the graywackes in the Upper Cretaceous. Orogenic activity continued into the Cretaceous and Early Tertiary, and Cretaceous rocks were involved in folding and thrusting. Tertiary and Quarternary uplift has produced the present mountain ranges.

7. INVENTORY OF MINERAL OCCURRENCES

The following table summarizes known and reported mineral occurrences in the project area.

Prior to conducting field work in 1975 and 1976, meetings were held with representatives of the U.S. Bureau of Mines and at those times, proposed examination areas were reviewed. The areas selected for field inspection were as a result of those meetings.

A total of 45 examinations were made from the 61 mineral occurrences, geochemical anomalies or mining claims listed. Several of the locations include multiple examinations (i.e. color anomalies, Number 2).

The listing of mineral occurrences is by quadrangle, and their locations are shown on Figure 2.

TABLE 7.1

DELONG MOUNTAINS QUADRANGLE

Name	Map No.	Reference	Latitude-Longitude	Township Range	Examined	Reason	Mineralization	Type of Occurrence
Red Dog	1	Tailleur 1970	68°04'N-162°50'W	T31N - R18W	yes	reported Zn-Pb $BaSO_4$	Zn, Pb, Ag, $BaSO_4$	stratabound & breccia zones
Color Anomalies	2	Tailleur 1970	68°07'N-162°54'W	T31N - R19W	yes	possible occurrences of base metal sulfides. Similar to Red Dog	None observed	--
	2	"	68°10'N-163°09'W	T32N - R19W	yes	"	" "	--
	2	"	68°11'N-163°05'W	T32N - R19W T33N - R19W	yes	"	" "	--
	2	"	68°14'N-163°00'W	T33N - R19W	yes	"	Pb	--
Avan	3	SEE MISHEGUK MOUNTAIN QUADRANGLE						

WGM INC

NOATAK QUADRANGLE

Name	Map No.	Reference	Latitude-Longitude	Township Range	Examined	Reason	Mineralization	Type of Occurrence
Maiyumerak Mts.	7	WGM	67°45'N-162°05'N	Tps. 27, 28N, Rs. 15, 16W	yes	unexplored ultramafic body	none found	ultramafic rocks
Ah Lee	8	M.I.R.L. No. 24	67°26'N-162°30'N	T.24N R.17W	no	land available for native selection	Chromite(?)	ultramafic rocks

MISHEGUK MOUNTAINS QUADRANGLE

Name	Map No.	Reference	Latitude-Longitude	Township Range	Examined	Reason	Mineralization	Type of Occurrence
Avan	3	Kardez 19-3 19-4	68°08'N-161°58'W	Tps. 31,32, 33,34N, Rs. 13,14,15W	yes	previous claims	Chromite	ultramafic pluton
Kuguru-rok	4	TDM 5-R	68°00'N-161°53'W	T30N - 14W	no	piece of stream float along river	Chromite	derived from Avan area?
Misheguk Mountain	5	Kardez 19-1	68°15'N-161°00'W	T33N - Rs10, 11W	yes	reported Cu-asbestos previous claims	Chromite	ultramafic pluton
Amaktuk-vik Pass	6	Kardez 19-5	68°17'N-160°15'W	T33N - R7W	no	one claim - no reported mineralization	(?)	(?)

BAIRD MOUNTAINS QUADRANGLE

Name	Map No.	Reference	Latitude-Longitude	Township Range	Examined	Reason	Mineralization	Type of Occurrence
Loesche	9	Kardex 27-25	67°30'N-161°50'W	T24N - R14W	no	claims not located by helicopter flight	Au	(?)
Agashas-hok River	10	Kardex 27-24	67°37'N-161°28'W	T26N - R12W	yes	18 copper claims	none seen-claims not found	---
Agashas-hok River	10	OFR 274	67°38.5'N-161° 21'W	T26N - R12W	yes	1% copper reported	Cu	quartz vein
Agashas-hok River	10	WGM	67°37.5'N-161° 17'W	T26N - R12W	yes	visible iron stain	none	---
Agashas-hok River	10	WGM	67°37'N-161°15'W	T26N - R12W	yes	visible iron stain	none	---
Nakolikur-rok Creek	11	OFR 274	67°37'N-160°23'W	T26N - R8W	no	small quartz vein	Cu	quartz vein in green-stone sills
Omar	12	Bigelow 1975	67°30'N-160°55'W	T24N - R10W	yes	high grade copper sul-fides	Cu	Cu sulfides in large fractures zone in car-bonates

BAIRD MOUNTAINS QUADRANGLE (Cont.)

Name	Map No.	Reference	Latitude-Longitude	Township Range	Examined	Reason	Mineralization	Type of Occurrence
Frost	13	Bigelow 1975	67°29'N-160°38'W	T24N - R9W	yes	known barite,	$BaSO_4$, Zn, Cu	barite in carbonates; Cu-Zn in quartz cal-cite barite vein
Klery Creek	14	many given from 1910-1972	67°05' to 67°30'N 160°14' to 160° 39'W	Tps. 19-24N Rs. 7-9W	yes	placer gold district 194 claims	Au	placer gold
Chevron	15	Anderson 1944	67°52'N-159°47'W	T29N - R5W	yes	0.5% Cu over 10 foot width	Cu	quartz vein
Hub	16	WGM	67°46'N-159°37'W	T27N - R4W	yes	field discovery of Cu minerali-zation	Cu	quartz-cal-cite vein
Temby	17	OFR 274	67°35'N-159°33'W	T25N - R4W	yes	1.5% Cu - size not known	Cu	quartz vein
Tundra	18	Kardex 27-27	67°33'N-159°38'W	T25N - Rs. 4 and 5W	no	claims not found	Au?	(?)
Salmon	19	WGM	67°41'N-159°48'W	T26N - R5W	yes	field discovery of Cu minerali-zation	Cu	quartz vein

SELAWIK QUADRANGLE

Name	Map No.	Reference	Latitude-Longitude	Township Range	Examined	Reason	Mineralization	Type of Occurrence

No reported mineralization - no work done in quadrangle

HOWARD PASS QUADRANGLE

Name	Map No.	Reference	Latitude-Longitude	Township Range	Examined	Reason	Mineralization	Type of Occurrence
Eskimo Venture	20	Kardex 20-2	?	(?) Tps. 34, 35N, Rs. 1, 2, 3E	no	Vague location	?	ultramafic rocks

WGM INC

AMBLER RIVER QUADRANGLE

Name	Map No.	Reference	Latitude-Longitude	Township Range	Examined	Reason	Mineralization	Type of Occurrence
Malfiatti	21	Cobb 1972	67°32'N-158°59'W(?)	T25N-R1W(?)	no	1912 claim - vague location	Cu?	Limestone-Schist(?)
Hunt River	22	Kardex 28-45	67°10'N-158°58'W	T20N-R1W	no	1 placer claim on Kobuk River	Au?	placer?
Redstone River	23	Kardez 28-46	?	?	no	vague location	Au?	placer?
Kaluich	24	Pessel 1975	67°33'N-158°11'W	T25N-R3E	yes	reported Pb, F Zn geochemical anomalies	Pb, F, Zn	granite contact
Atongarak Creek	25	Kardez 28-43	67°56'N-157°24'W	T29N-R6E	no	placer claims - similar environment as Midas Creek	Au?	placer Au in glacial debris
Imelyak River	26	U.S.B.M. OFR 20-73	67°33'N-157°05'W	T25N-R8E	no	unable to locate claims	Au	?
KAV	27	WGM	67°48'N-156°47'W	T28N-R9E	yes	discovered 1975 by WGM field party	Cu, Ag, Sb	quartz vein dolomite breccia
Tunukuchiak Creek	28	Kardex 28-38	67°45'N-156°33'W	Tps. 27, 28N R10E	no	similar to Midas Creek	Au	placer gold

AMBLER RIVER QUADRANGLE (Cont.)

Name	Map No.	Reference	Latitude-Longitude	Township Range	Examined	Reason	Mineralization	Type of Occurrence
Douglas Creek	29	WGM	67°54'N-156°30'W	Tps. 29, 30N Rs. 10-11E	yes	geology similar to Midas Creek	none found	--
Ningyoyak Creek	30	Kardex 28-24	67°52'N-156°17'W	T29N-R11E	yes	reported copper mineralization	Cu	copper in quartz-calcite veins
Midas Creek	31	Kardex 28-24 Smith, 1913	67°50'N-156°16'W	Tps. 28, 29N R12E	yes	"type" example placer deposit	Au	placer gold
Shishakshinovik Pass	32	AOF 37	67°25'N-156°16'W	Tps. 23, 24N, Rs. 11 12E	yes	strong geochemical value	Pb, Zn, Ag, Mo	granite contact
Kutarlak Creek	33	AOF 37	67°23'N-156°05'W	Tps. 23, 24N Rs. 12, 13E	yes	reported high geochemistry	none found	--

SHUNGNAK QUADRANGLE

Name	Map No.	Reference	Latitude-Longitude	Township Range	Examined	Reason	Mineralization	Type of Occurrence

No reported mineralization - no work done in quadrangle

KILLIK RIVER QUADRANGLE

Name	Map No.	Reference	Latitude-Longitude	Township Range	Examined	Reason	Mineralization	Type of Occurrence

No reported mineralization in project area - no work done in quadrangle

SURVEY PASS QUADRANGLE

Name	Map No.	Reference	Latitude-Longitude	Township Range	Examined	Reason	Mineralization	Type of Occurrence
Nigikpal-vgururvrak	34	none	67°42'N-155°54'W	T27N-R13E	yes	active placer mine	Au	placer gold
Igning River	35	none	67°38'N-155°52'W	Tps. 24, 25 26N, R13E	yes	no available geochemistry - general recon.	none	--
Iyhuna Creek	36	State Annual Report 1971	67°33'N-155°15'W	Tps. 24, 25N Rs. 15, 16E	yes	reported high Pb-Zn geo-chemistry	none	--
	36	"	"	"	"	"	"	"
	36	"	"	"	"	"	"	"
Angunel-chak Pass	37	Cobb, 1972 Smith, 1930 State Annual Rpt. 1971	67°20'N-155°18'W	T22N-R16E	no	geochemistry similar to Iyhuna Creek. Vague location of reported Ag	Ag?	"
Twelve-mile Creek	38	State Annual Rpt. 1971	67°35'N-155°10'W	Tps. 25, 26N R17E	no	geochemistry lower than Tupik Creek	--	"
Tupik Creek	39	State Annual Rpt. 1971	67°31'N-155°07'W	Tps. 24, 25N R17E	yes	reported high Pb-Zn geochem-istry	Pb, Zn, Cu, Ag	granite & granite con-tact zone
	39	"	"	"	"	"	"	"
	39	"	"	"	"	"	"	"

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SURVEY PASS QUADRANGLE (Cont.)

Name	Map No.	Reference	Latitude-Longitude	Township Range	Examined	Reason	Mineralization	Type of Occurrence
Angiaak Pass	40	State Annual Rpt. 1971	67°26'N-155°05'W	T24N-R17E	yes	reported high Pb-Zn geochemistry	Pb-Cu	granite and granite contact zone
Glacier Creek	41	"	67°30'N-154°59'W	T24N - Rs.17, 18E	yes	reported high Pb-Zn geochemistry	Pb, Zn, Cu, Ag	granite and granite contact zone
Mount Papiok	42	"	67°34'N-155°01'W	T25N-R17E	yes	reported high Pb-Zn-Ag geochemistry	none	--
Lucky Six	43	Cobb (1972)	67°33'N-154°57'W	Tps. 25, 26N, Rs.17, 18E	no	U.S.G.S. assay value show trace gold	Cu, Sb, Au	quartz vein(s)
Walker Lake West	44	Andrews 1975	67°08'N-154°29'W	T20N-R20E	yes	high copper geochemical value	none found	schist belt rocks
	44	State Annual Rpt. 1971	67°05'N-154°32'W	"	yes	high lead geochemical value	" "	" "
Walker Lake East	45	State Annual Rpt. 1971	67°11'N-154°17'W	T21N-R21E	yes	high copper zinc geochemical values	" "	" "
Arrigetch Peaks	46	General Crude Oil	67°26'N-154°09'W	Tps. 23, 24N, Rs. 21 22E	yes	reported mineralized tactite zone	Cu, Zn, W	tactite zone

SURVEY PASS QUADRANGLE (Cont.)

Name	Map No.	Reference	Latitude-Longitude	Township Range	Examined	Reason	Mineralization	Type of Occurrence
Helpme Jack	47	Cobb 1972	67°00'N-153°33'W	T19N-R24E	no	vague location	Au?	placer gold?
Malamute	48	Cobb 1972	67°00'N-153°23'W	T19N-R25E	no	" "	"	" "
Alatna South	49	Cobb 1972	67°08'N-153°25'W	T20N-R25E	no	" "	"	placer
Nahtuk	50	Ruzicka 1975	67°28'N-153°09'W	T24N-R26E	yes	reported zinc, silver mineralization	none found	--
Quartz Hill	51	U.S.B.M. OFR 20-73 No. 24	?	?	no	two locations reported, 2 miles apart	Au	placer
Igikpak	52	U.S.B.M. OFR 20-73	67°22'N-155°05'W	T23N-R17E	no	placer gold in v. small drainages	Au?	placer
Walker Lake South	53	U.S.B.M. OFR 20-73	67°06'N-154°27'W	T20N-R21E	no	placer gold at edge of lake	"	placer?
Pingaluk River	54	U.S.B.M. OFR 20-73	67°30'N-153°49'W	Tps. 24, 27N, Rs. 23 24E	no	placer gold along 8 mile drainage	"	placer
Alatna North	55	U.S.B.M. OFR 20-73	?	Tps. 24, 25N Rs. 20, 22E	no	placer gold along 10 mile drainage	Au	placer

HUGHES QUADRANGLE

Name	Map No.	Reference	Latitude-Longitude	Township Range	Examined	Reason	Mineralization	Type of Occurrence
Lake Shelby	56	Map I-459	66°53'N-155°48'W	T17N - R14E	no	examined by U.S.G.S.	Cu	quartz vein in conglomer-ate
Angeta	57	Kardex 38-22	66°51'N-155°35'W	T17N - R15E	no	graywacke - mudstone	Au	?

CHANDLER LAKE QUADRANGLE

Name	Map No.	Reference	Latitude-Longitude	Township Range	Examined	Reason	Mineralization	Type of Occurrence

No reported mineralization in project area - no work done in quadrangle

WISEMAN QUADRANGLE

Name	Map No.	Reference	Latitude-Longitude	Township Range	Examined	Reason	Mineralization	Type of Occurrence
Sheep Creek	58	General Crude Oil	67°33'N-152°00'W	T32N-R20W	yes	reported copper mineralization	Cu	fault controlled copper mineralization in carbonates
Tobin	59	Ruzicka 1975	67°40'N-151°31'W	T33N-R18W	yes	reported high zinc geochemical values	none found	pyritic phyllites
Kinnorutin	60	U.S.B.M. OFR 20-73	67°55'N-150°23'W	T36N-R13W	no	two claims inactive without any work	Au? Pt?	?
St. Patricks Creek	61	General Crude Oil (Alvenco)	67°52'N-150°30'W	T35N-R13W	yes	reported high Cu geochemical values	none found	volcanics

PHILIP SMITH QUADRANGLE

Name	Map No.	Reference	Latitude-Longitude	Township Range	Examined	Reason	Mineralization	Type of Occurrence

No reported mineralization in project area - no work done in quadrangle

CHANDALAR QUADRANGLE

Name	Map No.	Reference	Latitude-Longitude	Township Range	Examined	Reason	Mineralization	Type of Occurrence

No reported mineralization in project area - no work done in quadrangle

8. EXAMINATION REPORTS

Section 8 includes individual examination reports on the prospects and areas examined during the project. Several sections discuss more than one examination area because of their proximity and similarities.

In general, the order of discussion is from a west to east direction, beginning in the DeLong Mountains quadrangle and ending in the Wiseman quadrangle (Fig. 1).

The amount of detail presented in individual sections is variable depending upon availability of data and upon the amount of work conducted during the current field investigation. Follow-up of reported geochemical anomalies normally received less field work than did examination of verified mineral occurrences. Setting priorities for work areas was accomplished in concert with the U.S.B.M. Follow-up of geochemical anomalies generated by the current program was conducted when possible. Several anomalies were not followed up because of late receipt of analytical results or weather and logistical factors. Areas warranting further follow-up are cited in the recommendations section of each examination area. The description of the general geologic setting in each examination area is brief, both because it was beyond the scope of the program to conduct regional mapping activities, and partly because geologic maps covering much of the project area are either very preliminary or non-existent.

Examinations covered in sections 8.1, 8.2, 8.3, 8.6, 8.7, 8.15 and 8.24 are considered to be the most important because: (1) of apparent economic significance; (2) the area is underlain by rock types similar to those found elsewhere in the Brooks Range that are known to contain large tonnages of base metal sulfides; and/or (3) mineralization was discovered in an area previously not known to be mineralized.

Recommendations have been made for further work based on economic geology considerations and do not take into account restrictions imposed as a result of land classification.

8.1 Red Dog Prospect

8.1.1 Introduction

It was decided to examine this area because of the results of the work of Tailleur (1970), who reported the presence of lead-zinc-barite mineralization. Tailleur, in the course of mapping the geology of the DeLong Mountains (1:250,000-scale quadrangle) inspected part of the prospect area, at which time he named the main stream draining the area "Red Dog Creek".

Tailleur collected 9 samples, including one stream sediment sample. The analytical results from the rock samples showed a range in lead content from 0.5 to more than 2.0%, accompanied by values of zinc that ranged in excess of 1.0%. The stream sediment sample analyzed in excess of 10% (>100,000 ppm) lead.

We are not aware of other examinations subsequent to Tailleur's inspection and prior to enactment of ANCSA.

8.1.2 Summary

This is a very impressive prospect - a number of outcrops containing high values in lead, zinc, silver and barite are present over a length of 9,000 feet and a width of 3,500 feet.

In addition there are areas of high grade rubble at the surface that indicate similarly mineralized bedrock is prosent under thin talus. Outcrops typically carrying 5 to 20% combined zinc and lead and up to 2 oz/ton silver are widily distributed at Red Dog prospect.

In addition to the outcropping mineralization referred to above, a strongly anomalous area of 3.5 square miles has been outlined through geochemical stream silt sampling.

A preliminary electromagnetic survey conducted to the west of outcropping mineralization has disclosed presence of a conductor. The conductor may reflect the presence of sulfides inasmuch as no graphite has been noted. If the response is due to sulfides, the overall potential is enhanced.

Additional work is strongly recommended at Red Dog and at similar geologic environments in the west Brooks Range. Regional work should consist of geologic mapping, geochemical stream silt sampling, and prospecting. Work at Red Dog should be directed toward diamond core drilling of sufficient detail to define the tonnage/grade configuration of the mineralization. The dimensions of the surface target area and the grade of mineralization are of a magnitude which, if confirmed by additional investigation, would likely warrant production.

8.1.3 Location and Access

The Red Dog prospect is located in the DeLong Mountains of the west Brooks Range (Fig. 4), in the DeLong Mountains 1:250,000 scale quadrangle (Fig. 1). The closest villages are Noatak (30 miles to the south on the Noatak River) and Kivalina (50 miles to the west on the coast of the Chukchi Sea). Kotzebue is about 80 air miles south.

Access to the property is by helicopter during the summer; travel by tracked vehicle across frozen ground is possible during the winter.

8.1.4 Physiography

The topography of the prospect area is characterized by four east-west trending ridge spurs of Deadlock Mountain and one north-south ridge spur. The ridge spurs are rounded with elevations ranging from about 900 feet up to about 1,250 feet at the area of interest. Deadlock Mountain is the highest peak in the immediate area (2,995 feet). Red Dog Creek, which drains the local area, flows westerly into the south-flowing Ikalukrok Creek.

Vegetation in the area is tundra with a few small willows and bushes present along streams. Frost-riven rubble and talus is common along most hillsides and along ridgetops. Locally, bedrock outcroppings are present, usually in stream cuts.

8.1.5 Work Accomplished

The WGM appraisal was intended to investigate the reported occurrences and provide a general assessment of the mineral potential of these within a limited time. Therefore efforts were concentrated on the reported mineralization rather than on regional reconnaissance.

Eighteen man days were spent examining the Red Dog prospect. Bedrock outcrops within an area of 2.2 square miles were mapped at a scale of 1" = 500'. Mineralized rock float was also mapped to establish limits of surface and near-surface mineralized zones. Rock chip samples were collected from all observed mineralized outcrops and from mineralized talus and rubble. A limited number of soil samples were collected in areas lacking outcrop or rubble to aid in locating covered mineralization. Stream silt samples were collected over an area of about 30 square miles at a sample density of about 1.5 samples per square mile (exclusive of samples within the mineralized area) to test for sub-outcropping mineralization in the immediate vicinity. Reference specimen of each mineralized rock-type were collected. Thin and polished sections were made from selected specimens and studied in the laboratory after the field season.

An electromagnetic survey totalling 1,200 feet was conducted at the prospect to determine if high-grade mineralization observed at one location is continuous and responsive to this type of geophysical method.

The following table lists the number and type of samples collected at the Red Dog prospect and nearby areas.

SUMMARY OF SAMPLING

DELONG MOUNTAINS A-2 QUADRANGLE

Type of Sample	Number Collected
Rock chip (talus & bedrock)	49
Soil	15
Stream silt	104
Reference specimen	19
TOTAL	187

Results of this sampling are presented in following sections.

8.1.6 Geology and Mineralization

8.1.6.1 Regional Geology

The regional geology in the DeLong Mountains has been summarized by Martin (1970) who included the Paleozoic and Mesozoic sedimentary units of the region in the DeLong Sequence. This consists largely of Mississippian clastics (Noatak Formation) that are overlain by carbonates and sandstones (Utukok Formation) and in turn grade upward into a thick succession of carbonates with subordinate cherts (Kogruk Formation), and the Permian Tupik Formation which also consists largely of limestone and chert units. The overlying Mesozoic sediments feature widespread Triassic cherts and Lower Cretaceous flysch units. In some areas, the clastic Noatak Formation is separated from similar Upper Devonian clastics (Kanayut Formation) by low angle faulting. The DeLong Sequence corresponds to sequence No. 3 on Figure 4.

The geology has not been mapped in detail in the vicinity of Red Dog Creek, however, Tailleur (1970) has outlined a tentative distribution of principle rock types, which include an undivided group of chert, carbonate, and shale ranging in age from Mississippian to Triassic. A series of overlying, but older, Upper Devonian and Lower Mississippian quartzite and clastics, belonging to the Endicott Group, are described as being separated from the chert-carbonate-shale sequence by low-angle faults.

Much of the complex structural displacment in this region appears to be the result of tectonic events along the northern margin of a Mesozoic ancestral Brooks Range. Tailleur and Snelson (1966, 1968) have attributed the widespread low-angle faulting in this region to underthrusting along Mesozoic plate boundaries related to spreading in an ancestral Arctic Ocean.

Martin (1970), on the other hand, has interpreted these faults as representing major gravity slides along the northern flanks of a geanticline located in the Baird Mountains, resulting in the stacking of a series of thin, allochthonous plates over a very broad area in the DeLong Mountains.

8.1.6.2 Local Geology

Figure 5 illustrates the general geology of the Red Dog prospect. Poor bedrock exposures and time limitations prevented a detailed study of the general geology, although widespread talus deposits permit a review of the dominant lithologic units in the area.

Cherty sediments appear to be the most widespread rock type. The majority of these are fine-grained, dark gray to black, and thinly bedded. Interbedded with the cherty sediments are shales and limestones as well as barite, barite-sulfide and massive sulfide units.

In general, the sedimentary units are north-trending and display shallow to moderate easterly and westerly dips. These attitudes suggest a broad anticlinal structure located along the central portion of Red Dog Creek (Fig. 5). However, there was no field evidence to determine tops and, as indicated on the accompanying geologic map, there are many exceptions to the above generalizations. Local folding may present a much more complicated pattern than currently provided by the information available.

8.1.6.3 Mineralization

Field and laboratory studies indicate five principal types of sulfide and barite mineralization. Each type is discussed separately although field relations indicate lateral gradations among several of these, and vertical gradations may also be present. The assay results are summarized in a following section.

Bedded Chert-Sulfide

This type is fairly well-exposed in several outcrops within or immediately adjacent to the main creek channel (Figs. 5 & 5-A). The outcrops consist of a dark gray, fine-grained siliceous rock displaying thin laminae, (Fig. 5-E). If the simple anticlinal interpretation of the local structure is correct, this is probably the oldest unit in the immediate prospect area.

Thin sections of this material show that it consists largely of very fine-grained cherty laminae. The planar features appear to be due to fine-grained carbonaceous matter.

Sulfides consist of pyrite, marcasite, sphalerite, galena or a combination of these. Pyrite occurs either as an

FIGURE 5-E

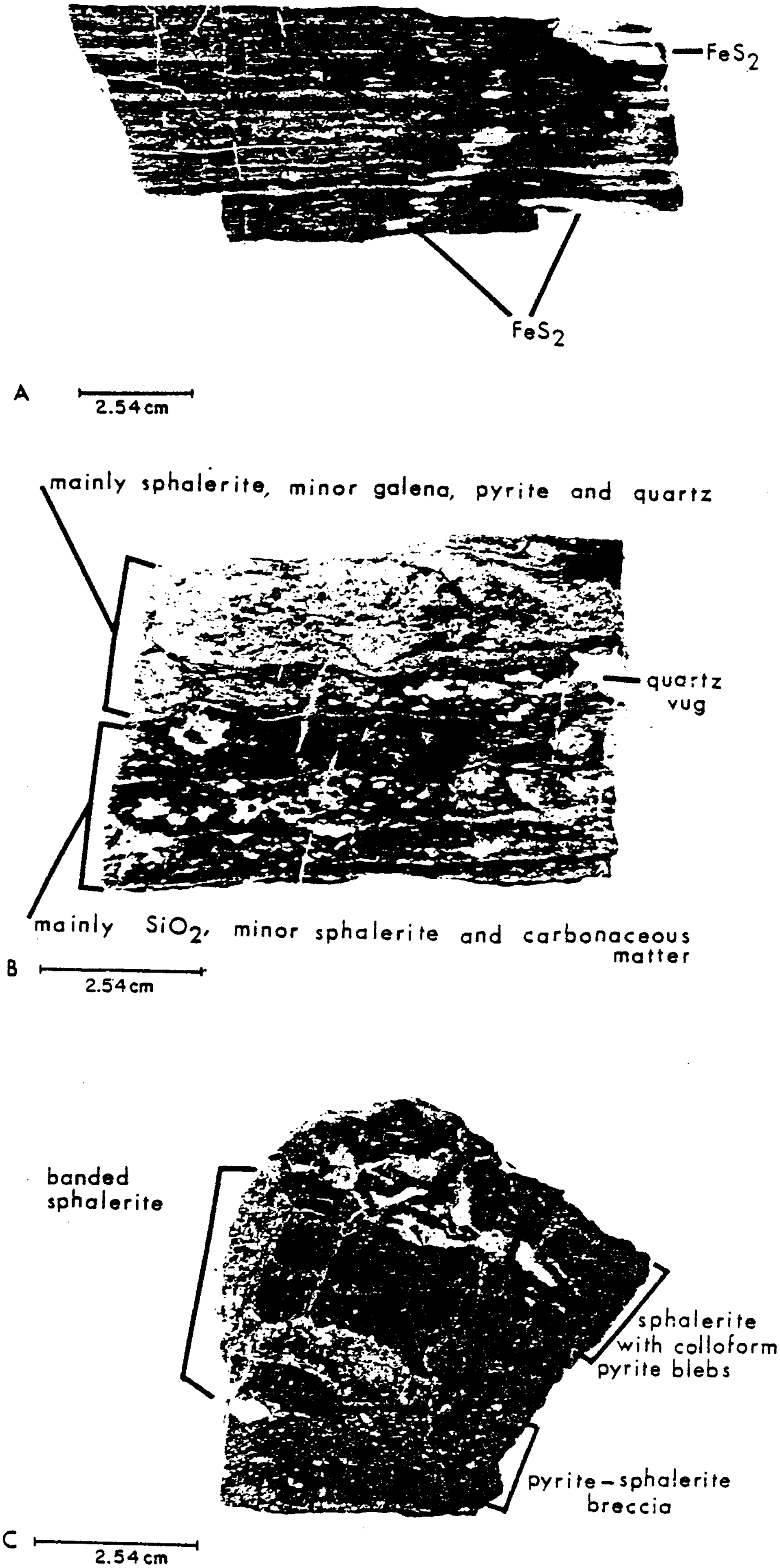
PHOTOGRAPHS OF SELECTED SAMPLES

RED DOG PROSPECT

(A) Finely banded black chert with short conformable lenses of FeS_2. Minor ZnS and very fine-grained carbonaceous matter present (reference sample).

(B) Banded chert-sphalerite (reference sample).

(C) Vein sulfides (BM 86).


FeS2
FeS2
A
2.54 cm
mainly sphalerite, minor galena, pyrite and quartz
quartz vug
mainly SiO2, minor sphalerite and carbonaceous matter
B
2.54 cm
banded sphalerite
sphalerite with colloform pyrite blebs
pyrite – sphalerite breccia
C
2.54 cm

accessory mineral or, in many cases, as a major constituent. The pyrite is present in a variety of forms including isolated cubes, framboids, intergranular skeletal masses, colloform blebs and short lenses which, in general, are conformable to the chert laminae. In some cases, these latter occurrences display a step-like pattern and, in few examples, individual lenses actually cut across the sedimentary layering at low-angles. Polished specimens of pyritic samples indicate that most of these are composed of both pyrite and marcasite.

Both sphalerite-chert rocks and and pyrite-marcasite-chert rocks are present. These two varieties commonly occur in close proximity to each other, and display features in common (Fig. 5-E). Banded sphalerite-chert rocks consist largely of light brown sphalerite intermixed with darker bands of chert and carbonaceous material. Coarse blebs of relatively massive sphalerite (Fig. 5-E) also contain considerable pyrite-marcasite and galena. The coarse bands frequently grade into thinly banded layers of chert and sphalerite. The banding of the sphalerite is essentially the same as the banding in cherty sediments.

Galena is widespread in most sphalerite-rich cherts but is virtually absent from the pyrite-marcasite-chert rock.

The galena occurs as coarse, irregular masses with abundant inclusions of sphalerite, iron sulfides or chert. A very fine-grained opaque inclusion (<0.01 mm) has been observed in numerous galena blebs. The optical characteristics of this inclusion mineral suggests that it is probably polybasite, however, there has been no chemical corroboration of this identification.

Insufficient data is available to determine configuration and distribution patterns of the sphalerite-rich rocks. The observation that the mineralization is concordant with the sedimentary layering suggests the occurrence could be significantly widespread.

Average assays of rock samples from the banded chert are 2.3% lead, 5.3% zinc and 1.0 oz/ton silver (Table 8.1.5). One outcrop was observed for 100 feet in length by 30 feet in thick (BM 10), while another was 45 feet long by 4 feet thick (BM 61). At both of these and at other locations, the mineralized rocks may be more extensive since mineralized outcrops extend under surface cover along strike and dip.

Massive Sulfide

Outcrop and sub-outcrop exposures of massive sphalerite occur in several locations (Fig. 5 & 5-A). Samples from these exposures are typically rusty weathered, medium to fine-grained and massive.

Most specimens of this type of mineralization are extremely sphalerite-rich although fine-grained galena is prominent in some. Grains and masses of pyrite-marcasite are present, but overall are not abundant. Chert and barite are principal non-opaque minerals.

Sphalerite usually occurs as anhedral grains or blebs (0.5 to 1 mm in dimension) with or without galena and/or pyrite (framboidal) inclusions. Separate galena masses are also present and these frequently contain inclusions of sphalerite and/or pyrite as well. Very fine-grained polybasite(?) inclusions have been observed in some galena blebs.

The exact relation between the massive sulfides and host rocks may only be inferred due to the limited number of exposure. The massive sulfide exposures, however, appear to occur at a common stratigraphic position, and, accordingly, it appears that the mineralization is stratabound.

Massive sulfide outcrops occur within the same stratigraphic position as mineralized chert, and pieces of chert rubble contain sphalerite in amounts intermediate between massive sphalerite and sphalerite-rich chert suggesting lateral gradations between the two units.

The highest grade sample (BM 108) was from a massive sulfide outcrop and assayed 42.75% zinc, 1.85% lead and 2.0 oz/ton silver over a 10-foot width.

Average assay values for observed massive sulfide outcrops (excluding BM 108) are 5.4% lead, 15.6% zinc and 2.2 oz/ton silver (Table 8.1.5).

Maximum dimensions of outcrop exposures located to date are greater than 300 feet along strike and in the range of 4 to 50 feet in width. The thickness is unknown. A chip sample (BM 132, Fig. 5-A) taken along a 300-foot strike length and 8 foot thickness of this outcrop assayed 24.9% zinc, 1.0% lead and 1.6 oz/ton silver.

Barite with Sulfide

Extensive talus exposures of barite occur along both the east and west slopes adjacent to Red Dog Creek (Fig. 5 and 5-A). The barite float generally consists of light to to medium gray cobbles and pebbles, which upon hammering emit a very noticeable fetid odor. Most samples are medium to coarse-grained, although some fine-grained variaties have also been observed. Hand specimens often appear to be massive but frequently contain irregular, banded features. When slabbed, these specimens usually indicate that the banding is much more regular than is evident on the weathered surface. One outcrop of dark gray relatively fine-grained barite adjacent to Red Dog Creek (BM 81) contains nodules (up to 10 mm in diameter) of light colored barite (Fig. 5-F). The nodules consist of radiating blades of coarse sulfate in a much finer-grained ground mass consisting of anhedral barite, chert, carbonaceous matter and fine-grained sphalerite and galena. Banding in other types of barite occurrences is due to alternating layers of coarse-bladed barite and finer-grained barite-chert. When viewed under the microscope, the fine-grained chert commonly displays a very distinctive extinction pattern which resembles a flower petal arrangement.

The color of the barite usually is indicative of the amount of carbonaceous matter and/or sulfide present in the rock. Dark gray samples usually contain considerable carbonaceous material while light gray samples contain negligible organic matter. Barite samples with substantial amounts of pyrite usually display a rusty-weathered surface.

FIGURE 5-F

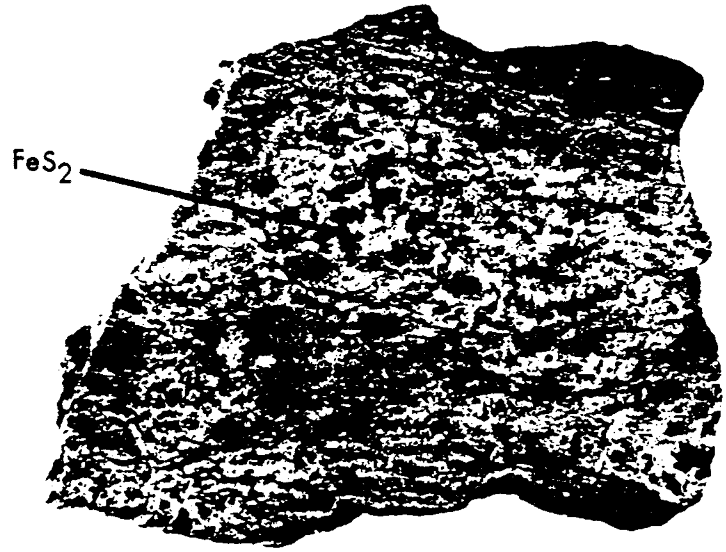
PHOTOGRAPHS OF SELECTED SAMPLES

RED DOG PROSPECT

(D) Massive sphalerite with coarse blebs of FeS_2. Primary (?) banding in lower right hand corner (BM 61).

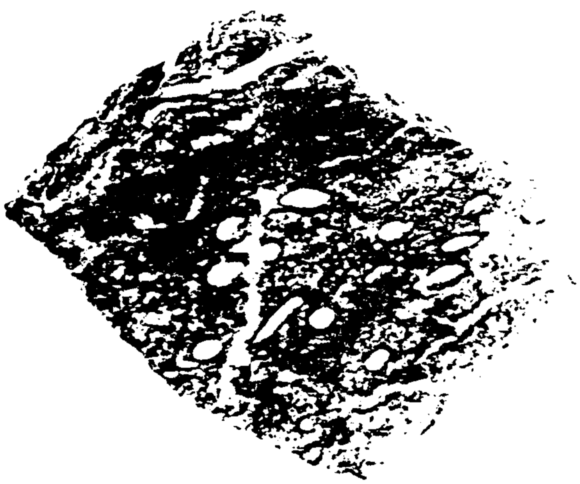
(E) Coarse barite showing banding very fine-grained sphalerite and galena present (not visible in photograph) (reference sample).

(F) Nodules of white barite in a dark gray fine-grained barite host.



D 2.54 cm

E 2.54 cm



F 2.54 cm

Sulfides are associated with most barite occurrences. Sphalerite is the dominant sulfide present, although galena content may be substantial and is proportionately higher than in the cherty or massive sulfide occurrences. In many cases, anhedral blades of barite are surrounded by anhedral masses of granular sphalerite (Fig. 5-G).

Despite the general lack of bedrock exposure of barite, the talus accumulations suggest that individual bodies of barite are probably extensive lenses or blanket-like bodies which, in most cases, exceed 300 feet along strike. There is no well-documented evidence of the thickness of these units although most probably exceed 20 feet. If the structure and stratigraphy are as simple as presently believed, then it is conceivable that some of the barite bodies may exceed 50 to 100 feet thick and may extend laterally for many 100's or even 1,000's of feet.

These occurrences average 83% barite, 2.2% lead, 1.4% zinc and 0.9 oz/ton silver (Table 8.1.5). However, talus assay sample results (BM 116, BM 117) suggest that less sulfide-rich, but more barite-rich bodies, may grade into more sulfide-rich bodies.

FIGURE 5-G

PHOTOMICROGRAPHS OF SELECTED SAMPLES

RED DOG PROSPECT

(G) Coarse bleb of colloform FeS_2 (pyrite and marcasite) surrounded by sphalerite (BM 86).

(H) Rounded grains of sphalerite surrounded by zoned quartz grains (BM 90)

(I) Crystals of barite (white) surrounded by granular sphalerite (BM 59).

Symbols used: py = pyrite

mc = marcasite

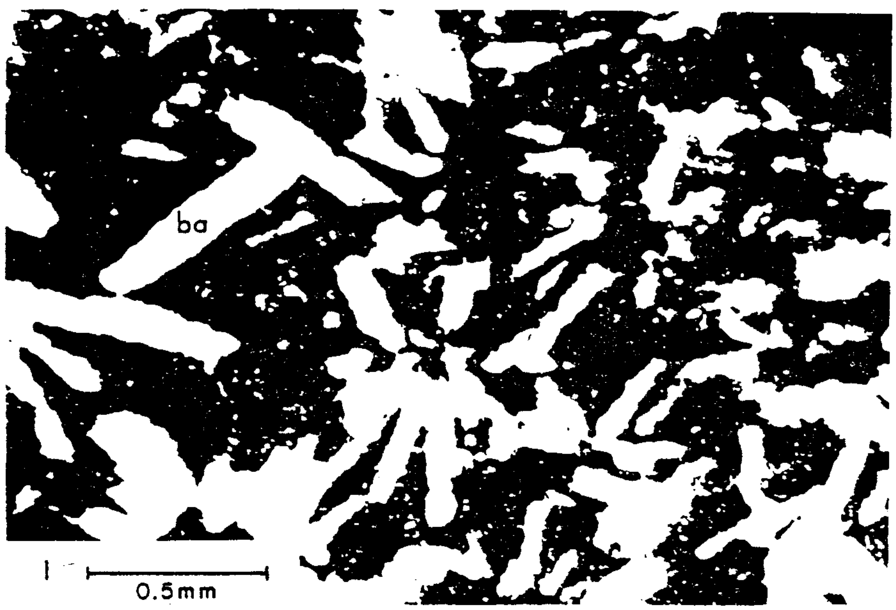
sl = sphalerite

q = quartz

ba = barite


py-mc
G
0.25mm


q
sl
q
H
0.1mm


ba
I
0.5mm

Sulfides in Massive, Siliceous Host Rock

A medium-gray siliceous rock containing significant amounts of sphalerite and galena is present in several outcrops on the west side of Red Dog Creek (Figs. 5 & 5-A). This rock is relatively fine-grained, massive, and is very porous and closely resembles volcanic cinder on weathered surfaces. The lighter gray color and massive appearance easily distinguish it from nearby dark, cherty sediments.

Examinations under a microscope reveal a mosaic of zoned quartz grains (usually 0.5 to 1.5 mm in maximum dimension) containing intergranular sulfide and/or barite (Fig. 5-G). The zoned pattern appear to be marked by narrow bands of dust-like inclusions. The interior of zoned grains also may contain inclusions of sphalerite and barite, but the banded zones rarely do. Under crossed nicols, individual zoned grains actually consist of aggregates of anhedral sub-grains with each sub-grain displaying a different optical orientation.

Sphalerite and/or galena occur as disseminations and as irregular masses. Irregular masses of granular light brown sphalerite consist of very fine-grained, individual, petal-like grains while the galena is usually coarser grained and more massive. The exact relationship between the siliceous unit and and the surrounding sedimentary host rocks has not been established. However, observed exposures suggest that the mineralization occurs in thick conformable lenses hundreds of feet long and approximately 10 to 30 feet thick. Average assays for this material are 3.3% lead, 3.5% zinc and 1.6 oz/ton silver (Table 8.1.5).

Vein and Breccia Sulfides in Black Cherts

Several outcrops of black cherty sediments in or immediately adjacent to Red Dog Creek contain considerable sulfide mineralization in the form of veins or as matrix in a chert breccia (Fig. 5 & 5-A). The veins consist largely of sphalerite or pyrite in short, narrow fractures (<6 mm wide) or in much larger veins (approximately 5 to 15 inches wide) which are commonly exposed for about 15 feet but occasionally can be traced to 36 feet along strike. Most of the mineralized fractures are northeast trending and steeply-dipping although numerous, smaller, mineralized cross-fractures are present as well.

Polished specimens of the veins sulfides consist largely of narrow bands of reddish-brown sphalerite with irregular but conformable pods of colloform pyrite and marcasite. Some portions of the veins contain brecciated sulfide and chert. Only very sparse amounts of galena are present in the veins although the mineralized chert breccia contains substantial amounts.

Exposure of vein sulfides (BM 86) indicate grades of 0.6% lead, 2.6% zinc, and 0.4 oz/ton silver over an area of 180 by 50 feet, and are representative of numerous mineralized veins and fractures. Since adjacent surfaces are covered, the mineralization may be much more extensive.

One highly mineralized outcrop located in the main creek bed (BM 272 and 473) consists of a breccia (tectonic?) with angular chert clasts cemented by coarse, massive sulfides. The breccia has metal values of 5.0% lead, 24.1% zinc and 2.4 oz/ton silver over an area measuring 30 by 36 feet.

TABLE 8.1.1

RED DOG PROSPECT

SUMMARY OF SIGNIFICANT ASSAY RESULTS

Sample No.	% Pb	% Zn	oz/ton Ag	% Ba	% Barite	Sample Description
BM 10	0.35	0.30	0.78	--	--	B/R chip: 30'x100' black chert w/ many small quartz veins
33	2.75	1.65	1.2	50.8	86.3	Talus sample close to B/R: 150' length, 30' thick; siliceous-barite; gray weathering
58	1.25	.05	0.48	54.4	92.5	Talus chip: 100'x100' slope area; barite with minor sulfides; close to B/R
59	1.30	1.90	0.69	51.9	88.3	Talus chip: 150'x150'; mineralized barite
60	2.15	1.25	0.66	42.6	72.5	Talus chip: 250'x250'; mineralized barite; close to B/R
61	2.95	8.00	0.41	0.9	1.6	B/R chip: 45' strike length exposed x 4' strat. thickness; massive sulfide in black chert
62	2.00	2.30	0.81	51.0	86.7	Subcrop chip: aprox. 60'x10' area; mineralized barite
63	1.50	0.75	0.76	53.9	91.6	Talus chip: approx. 200'x400' slope area; mineralized barite

TABLE 8.1.1 (Cont.)

RED DOG PROSPECT

SUMMARY OF SIGNIFICANT ASSAY RESULTS

Sample No.	% Pb	% Zn	oz/ton Ag	% Ba	% Barite	Sample Description
BM 64	0.60	.05	0.73	--	--	Character sample of cherty sed. overlying mineralized barite
65	5.75	11.70	2.4	6.3	10.7	Chip sample of large blocky outcrop: B/R source approximately 100' in length mineralized siliceous rock
66	5.90	12.70	1.9	31.3	53.2	B/R chip over 50'x12'x8': massive sulfide in siliceous barite
67	3.85	2.65	2.0	--	--	Subcrop chip: approx. 60' length siliceous rock
68	5.40	11.00	2.2	0.6	1.0	Talus chip close to B/C: 20'x30' slope area; siliceous rock
81	2.35	2.30	1.1	51.4	87.4	B/R chip sample: 60' strike length, 12' thickness; mineralized barite
82	1.65	2.65	1.1	2.1	3.6	B/R chip: 80' strike x 15' thick; mineralized siliceous rock
83	0.95	1.85	0.39	0.8	1.3	B/R chip: three small outcrops covering approx. 100' strike length; siliceous rock
84	1.25	0.12	0.38	---	--	B/R character sample of fairly widespread gossan near BM-83

TABLE 8.1.1 (Cont.)

RED DOG PROSPECT

SUMMARY OF SIGNIFICANT ASSAY RESULTS

Sample No.	% Pb	% Zn	oz/ton Ag	% Ba	% Barite	Sample Description
BM 85	3.20	1.15	1.9	1.2	--	B/R and talus; 30'x10' area; siliceous rock
86	0.65	2.65	0.41	0.3	--	B/R chip; 180'x50' area; numerous sulfide veins in black chert
87	1.30	0.20	0.33	54.6	92.8	B/R chip: 19'x5' area; barite with sulfides
90	1.95	0.20	1.2	--	--	B/R chip: 80'x60' area; siliceous rock (same exposure as BM 145)
91	2.60	1.90	1.4	--	--	Talus chip: 200'x10' slope area; sulfides in barite
92	1.50	0.30	0.51	53.9	91.6	Talus chip: 150' length: mineralized barite
93	3.05	1.55	1.2	51.0	86.7	Talus chip: 150' length: mineralized barite
108	1.85	42.75	2.0	--	--	B/R chip: character sample over 10' strike length; cherty rock
115	5.15	4.65	--	3.0	5.2	B/R and talus chip: two small outcrops 30' apart of mineralized siliceous rock

TABLE 8.1.1 (Cont.)

RED DOG PROSPECT

SUMMARY OF SIGNIFICANT ASSAY RESULTS

Sample No.	% Pb	% Zn	oz/ton Ag	% Ba	% Barite	Sample Description
BM 116	3.40	5.05	1.6	25.6	43.6	Talus chip: approx. 700' along slope; close to B/R source; mineralized barite
117	5.05	4.5	2.0	22.2	37.7	Talus chip: approx. 700' along slope; 150' above BM 116; mineralized barite
132	1.05	24.9	1.6	--	--	B/R chip: 300' strike x 8' thick; massive sulfide in black chert host
						Trace elements; Hg 48,000 ppb, Sb 321 ppm, Cd 1,500 ppm, Co 65 ppm, Ni 21 ppm, Bi <2 ppm, Sn-ND
145	2.25	0.25	1.8	--	--	B/R chip: approx. 80'x60' area; siliceous rock (same exposure as BM 90).
						Trace elements; Hg 7,250 ppb, Sb 80 ppm, Cd 17 ppm, Co 8 ppm, Ni 14 ppm, Bi <2 ppm, Sn 17 ppm

WGM INC

TABLE 8.1.1 (Cont.)

RED DOG PROSPECT

SUMMARY OF SIGNIFICANT ASSAY RESULTS

Sample No.	% Pb	% Zn	oz/ton Ag	% Ba	% Barite	Sample Description
BM 147	2.70	1.40	1.2	--	--	Subcrop chip: 60'x100' area; barite similar to BM 92 and BM 93 Trace elements; Hg 7,450 ppb, Sb 4 ppm, Cd 110 ppm, Co 5 ppm, Ni 4 ppm, Bi <2 ppm Sn-ND
159	3.70	7.65	1.0	--	--	B/R chip: 20'x15' area; black chert. Cd 700 ppm, Sb 125 ppm
160	1.90	0.20	1.2	53.5	91.0	Talus chip: 150' length; barite Cd 23 ppm, Sb 12 ppm
161	2.45	0.30	--	54.8	93.2	Talus chip: 200'x150' area; barite Cd 50 ppm, Sb 8 ppm
162	2.85	0.60	1.4	54.4	92.5	Talus chip: 200'x50' area; barite Cd 60 ppm, Sb 40 ppm
163	1.35	1.05	0.74	55.1	93.7	Talus chip: 100'x50' area; barite Cd 75 ppm, Sb 8 ppm
165	3.02	0.38	--	--	--	Talus chip: 300'x300' area; weathered siliceous rock
168	8.95	13.90	3.3	28.3	48.1	Subcrop chip: 30'x50' area; massive sulfides in siliceous barite. Cd 900 ppm Sub 325 ppm

TABLE 8.1.1 (Cont.)

RED DOG PROSPECT

SUMMARY OF SIGNIFICANT ASSAY RESULTS

Sample No.	% Pb	% Zn	oz/ton Ag	% Ba	% Barite	Sample Description
BM 169	5.90	11.0	1.8	38.8	66.0	B/R chip: 50'x60' area; sulfide in siliceous barite rock. Cd 600 ppm, Sb 180 ppm
190	1.60	0.15	0.56	56.6	96.2	Talus chip: 75'x100' area; sulfide in barite
194	1.35	1.05	0.72	52.4	89.1	Talus chip: 100'x50' area; barite
196	1.45	0.85	0.71	41.9	71.2	Talus chip: 200'x300' area; barite and chert
272	4.35	23.5	2.5	--	--	B/R chip: 30'x36' area; massive sulfides in chert breccia zone. N-S sample lines
473	5.65	24.6	2.3	--	--	B/R chip: samle loc. as BM 272; sampled in E-W direction

B/R = Bedrock Sample
\- = not analyzed
ND = not detected

Collected by: Degenhart
Griffis
Via
Fairchild

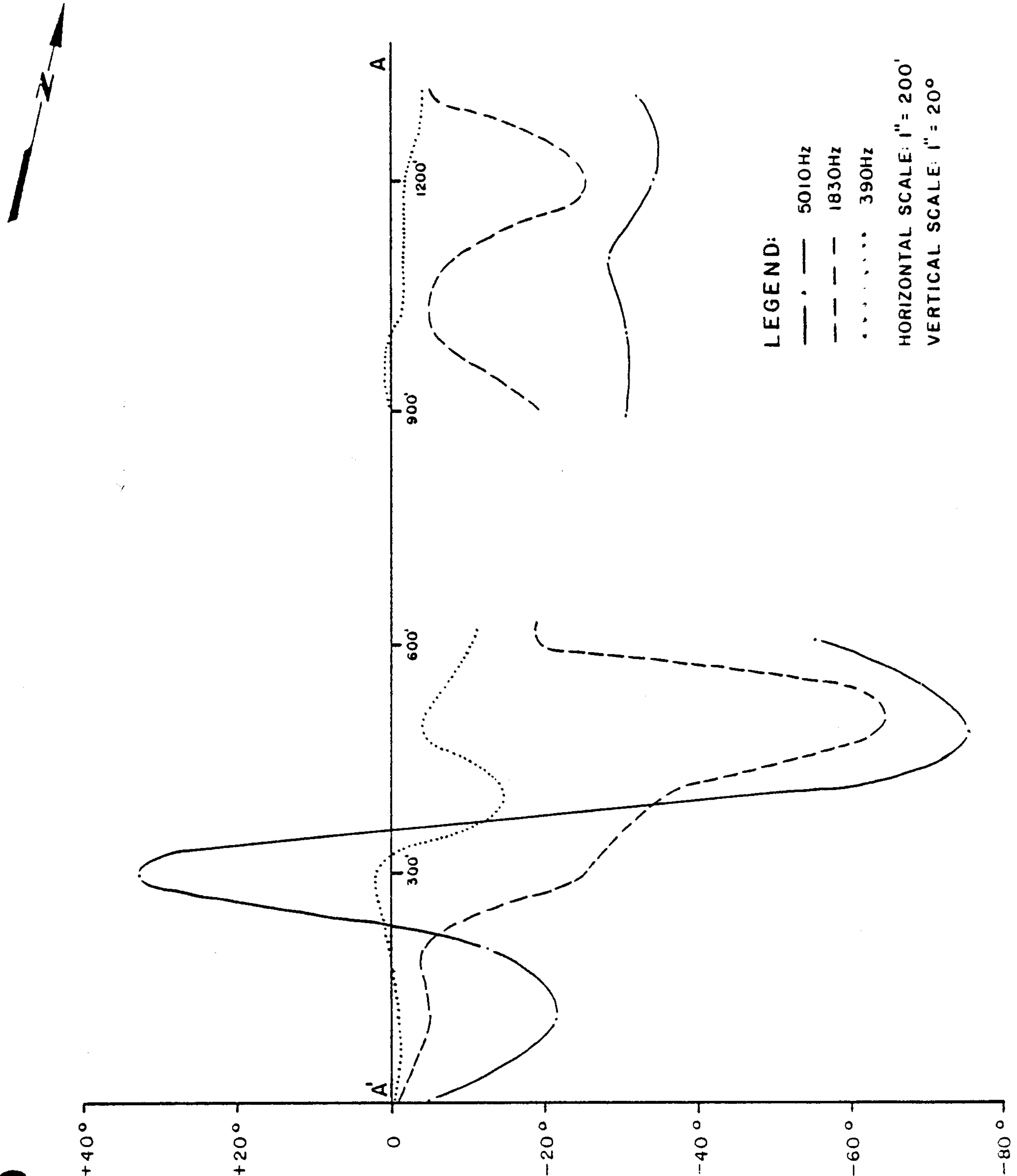
8.1.7 Geophysics

One electromagnetic (Crone shootback method) traverse was run at Red Dog over a length of 1,200 feet. Figure 5 shows the location of the line and Figure 5-D shows the results of the survey.

The traverse was intended to be primarily a "test case" to determine if: (1) the sulfides were responsive to this geophysical method, and (2) outcropping high grade sulfides located about 400 feet to the east continue to the west under cover. There is gossan present where the survey was conducted, which indicates the presence of iron sulfides.

The survey detected an anomaly (Fig. 5-D) whose source is a low to moderate conductive body. The conductor is what would be expected from a body containing a minimum of 5-10% lead and iron sulfides. The curve (Fig. 5-D) fits a model described by Lin (1969). The results indicate a 35 foot depth to the top of the conductor and a dip of approximately 30° to the northwest. The indicated width of the conductive body is about 75 feet.

Lin's model curve produces a correct estimation of the dip of the conductive body but the actual width may be more than what is indicated by the model curve.



GM INC — MINING & GEOLOGICAL CONSULTANTS, ANCHORAGE, ALASKA	DWN BY: T.D.	REVISED	RED DOG PROSPECT
SCALE: AS NOTED	DATA BY: WJM		HORIZONTAL SHOOTBACK ELECTROMAGNETIC SURVEY
	DATE: 6/76		FIGURE 5d — 9M127

The northward dip of the conductor appears to be contrary to the attitude of the local geology, however, it is possible that the massive sulfide breccia zone (BM 272 and BM 473) extends under this area and is the cause of the anomaly.

8.1.8 Geochemistry

General Statement

Results from geochemical stream silt sampling indicate that geochemistry provides an effective method of defining areas containing base metal sulfide and barite mineralization in this geologic environment. At numerous locations along Red Dog Creek and its tributaries, the presence of base metal sulfide and barite mineralization in stream float and outcrop confirms that the high geochemical silt values obtained reflect the presence of these minerals.

Regional stream silt geochemical sampling has not been conducted in this portion of the DeLong Mountains, which makes determination of normal or background geochemical values for this geologic environment impossible at this time.

According to Hawkes and Webb (1962), geochemical background values for barium, lead, and zinc may range up to 700, 400, and 1,000 ppm respectively in a black shale environment, a "model environment" which may be considered similar to Red Dog.

Numerous results from Red Dog are significantly high and obviously reflect the presence of base metal sulfides and barite regardless of what values are assigned as background. The following geochemical ranges are arbitrarily assigned based on inspection of the data available.

	Values in ppm			
	Pb	Zn	Ag	Ba
Strongly anomalous	+250	+1,000	+6	+5,000
Moderately anomalous	90-249	400-999	4-5.9	3,000-4,999
Weakly anomalous	50-89	250-399	2-3.9	1,500-2,999

Lead and zinc silt geochemistry defines an area of approximately 3.5 square miles, which is considered to contain significant amounts of base metal sulfide mineralization (Fig. 5-B). Many of the high geochemical values correspond to areas of exposed sulfide mineralization, however, geochemistry provides a method of detecting the presence of mineralized units covered by soil, tundra and talus.

Figures 5-A and 5-C show assay and geochemical results for the main mineralized portion of the property at a scale of 1" = 500'.

The very high geochemical values obtained from many of the stream drainages are not surprising since base metal bearing sulfide float and bedrock is present in these drainages.

Certain other stream silt and soil samples warrant further discussion since their strong geochemical values indicate that covered areas are underlain by rock units containing base metal sulfides and/or barite.

Of particular importance are stream silt samples BM 94, BM 149, BM 150 and BM 456. These samples were taken approximately one mile west of the main mineralized showings in Red Dog Creek (Fig. 5-B, Table 8.1.2).

The highest lead, zinc, silver and barium values range up to 9,300 ppm, 4,600 ppm, 9.0 ppm and 36,200 ppm respectively, not necessarily from the same sample. These values are quite significant when compared, for instance, with sample BM 107. This sample (BM 107) was collected about 500 feet downstream from a stream bed outcrop of massive sulfides grading nearly 30% combined lead and zinc, and shows 2,600 ppm lead, 3,800 ppm zinc, 10 ppm silver, and 17,000 ppm barium.

The results from these samples indicate the presence of lead and zinc sulfides and barite in a covered area lacking bedrock exposures. It could be speculated that the mineralization, exposed nearly one mile to the east, may extend under Dog Bone Ridge and along its west side. Samples BM 455 and 456, collected at the junction of Red Dog Creek and Sad Dog Creek, are considered highly anomalous in lead, zinc and barium. More importantly, these two samples show 230 ppm and 380 ppm copper which are two of the highest copper geochemical values obtained from the Red Dog prospect (Table 8.1.2).

Both samples were collected at an elevation of less than 800 feet which places them at a lower stratigraphic horizon than other Red Dog samples, assuming that the mineralization is shallow dipping. A review of Table 8.1.4 shows that geologically similar deposits commonly show vertical zoning within the ore bodies, with copper-bearing units stratigraphically below lead-zinc-barite zones. It is possible that samples BM 455 and BM 456 are indicative of copper mineralization in an underlying stratigraphic horizon. An alternative interpretation of the copper content may be that it represents lateral variations in mineralogy.

Another group of geochemical samples which deserves discussion consists of BM 457, BM 459, BM 460 and BM 461 (Fig. 5-B).

The bedrock at these sample sites is mapped as undivided Triassic, Permian, or Mississippian rocks (Tailleur, 1970). Sample BM 457 is located in Section 18, nearly two miles northwest of the main mineralized showings in Red Dog Creek, and shows 630 ppm lead and 1,120 ppm zinc. Both values are considered strongly anomalous since the stream containing sample site 457 is about five miles long and drains an area of about 13 square miles.

Samples sites 459 and 460 are located in the same drainage about one mile northeast of sample site 457. Lead geochemical values for sample BM 459 and BM 460 decrease to 65 and 33 ppm, respectively, which represents a decrease of about 10 to 20 times the metal content of sample BM 457. Zinc geochemical values for samples BM 459 and BM 460 are considered weakly to moderately anomalous in this metal. Sample BM 459 is also considered weakly anomalous in lead; additionally, both samples are strongly anomalous in barium.

Sample BM 461, which is located about one-half mile upstream from sample BM 459 shows 620 ppm zinc and is considered moderately anomalous. The zinc geochemical value obtained from this sample probably indicates the presence of zinc mineralization. The barium content of this sample is only 4,700 ppm. A significant increase in the barium content of samples BM 459 and BM 460 (both in excess of 20,000 ppm) located one-half mile downstream suggests a second source of barium between BM 461, BM 459 and BM 460.

It is concluded from these results that at least two mineralized units are present two miles north-northwest from the exposed mineralization in Red Dog Creek. One unit reflected by BM 459 and BM 460 is considered to contain significant amounts of barite associated with lead and zinc sulfides; the second unit reflected by BM 461 is presumed to contain zinc sulfide mineralization associated with minor amounts of barite.

Rock sample BM 161, (2.4% lead, 0.3% zinc, 93.2% barite) located on North Dog Leg Ridge about 3,500 feet north of the junction of Big Dog Tributary and Red Dog Creeks, confirms that base metal sulfides in a barite host rock are present a significant distance north of the junction of Red Dog Creek and Big Dog Creek, where similar type mineralization was observed.

Additional close-spaced geochemical sampling north and west of the main mineralized showings in Red Dog Creek is necessary to fully define the area underlain by lead-zinc-barium-bearing rock units.

Sample BM 263 is located about three miles northeast of the mineralization in Red Dog Creek and shows 730 ppm zinc and 10,400 ppm barium. The geology at this sample site is mapped as Upper Devonian and Lower Mississippian rocks of the Endicott Group (Tailleur, 1970). The Endicott Group rocks appear to be unmineralized in this location. The relatively high zinc and the strongly anomalous barium geochemical values probably reflect leakage from underlying mineralized rocks.

Stream silt samples BM 256 and BM 257 (Fig. 5-B) are considered significant. Sample BM 256 shows 355 ppm zinc and 10,600 ppm barium, while sample BM 257 collected from the Red Dog Creek drainage, shows 860 ppm lead, 5,900 ppm zinc and 10,000 ppm barium. The zinc and barium results from sample BM 256 are surprisingly high since Ikalukrok is a relatively large stream (about 30 to 40 feet wide and 2 to 4 feet deep in July) which drains an area in excess of 56 square miles. Likewise the lead, zinc and barium values obtained from sample BM 257 are considered to be very strongly anomalous.

The explanation for high geochemical values at the mouth of Red Dog Creek is attributed to mechanical breakdown of the sulfide float train from the Red Dog area. The creek bed contains cobbles with lead and zinc sulfides and barite at this location. The presence of mineralization over a distance of 3.5 miles downstream from Red Dog is likely a reflection of rapid transport during flood periods. It is conceivable that there is a local source for the mineralization from side gullys draining into Red Dog Creek from ridges in Sections 13 and/or 14.

The anomalous value at Ikalukrok Creek may represent spillover of the clastic material from Red Dog Creek during high water periods. The obvious alternative is that additional lead-zinc-barite mineralization occurs upstream in the Ikalukrok Creek Basin.

The eastern and southern limits of exposed and sub-outcropping base metal sulfide mineralization are clearly defined by stream silt geochemistry in three west-flowing tributaries to Red Dog Creek and in two southern branches of Red Dog Creek (Figs. 5-B and 5-C). The geochemical pattern for barium is not quite as distinct.

With the possible exception of the southern portion of Red Dog Creek, the other drainages mentioned above show geochemical patterns that define the approximate limits of outcropping base metal sulfides and barite.

The sharp break in the geochemical pattern to the east of Red Dog Creek correlates with the western edge of a thrust fault mapped by Tailleur (1970). It is possible that mineralization continues under the overlying thrust sheet to the east and that the thrust sheet has not been incised deeply enough by streams draining the area to allow geochemistry to trace the extent of the mineralization.

In summary, stream silt geochemistry has defined an area of about 3.5 square miles, which is considered anomalous in base metal sulfide and/or barite content. High geochemical values obtained from streams draining areas of exposed sulfide and barite mineralization prove that geochemistry is an effective exploration tool. High geochemical values obtained from drainages lacking exposures of base metal sulfide and barite mineralization are, by analogy, presumed to reflect the presence of these minerals.

TABLE 8.1.2

RED DOG AREA

STREAM SILT SAMPLE RESULTS

(Values in ppm, unless noted)

Sample No.	Cu	Pb	Zn	Ag	Ba
BM 1	112	4,350	2,200	5.9	33,300
2	62	148	158	1.1	6,100
3	51	108	177	0.5	7,900
4	76	38	253	0.6	5,600
5	17	52	121	0.4	800
6	21	27	75	0.2	600
7	25	17	40	0.2	700
8	23	30	65	0.3	700
9	36	36	109	0.4	800
11	24	11,000	1,640	6.7	13,300
51	81	124	173	0.2	1,820
52	90	4,000	2,300	3.0	2,210
53	80	5,500	4,900	5.1	13,800
54	61	127	325	1.2	3,990
89	196	3,300	790	15.0	18,900
94	92	9,300	2,200	9.0	36,200
95	59	66	135	0.6	1,200
96	47	40	120	0.5	1,390
97	36	104	158	1.0	2,430
98	73	26	245	0.9	3,800
101	208	5,100	5,000	9.1	14,900
102	97	1,200	355	3.8	8,500
103	46	5,350	168	8.3	2,400
104	50	6,550	235	8.0	3,400
106	89	1,120	1,650	2.4	3,800
107	160	2,600	3,800	10.0	17,000
109	61	36,300	139	9.1	16,200
110	70	395	440	1.3	4,700
111	41	6,500	1,240	13.0	5,625
112	30	370	5,300	2.5	3,166
113	30	118	440	1.1	4,100

TABLE 8.1.2 (Cont.)

RED DOG AREA

STREAM SILT SAMPLE RESULTS

(Values in ppm, unless noted)

Sample No.	Cu	Pb	Zn	Ag	Ba
BM 133	200	850	1,560	2.8	8,940
134	262	3,500	1,050	25.0	11,150
135	83	2,700	2,000	2.6	5,660
136	151	41	500	1.2	6,280
137	120	36	265	1.7	6,760
138	74	50	270	1.6	4,010
139	98	28	67	2.4	9,660
140	122	30	230	1.3	6,670
141	71	40	240	1.2	3,300
142	43	30	163	0.8	1,380
143	54	36	180	0.4	1,800
144	91	36	139	2.0	6,460
146	142	7,200	2,220	7.0	43,000
149	56	1,175	900	1.4	Is
150	47	7,000	810	5.7	14,450
151	54	47	150	0.5	1,200
152	57	43	124	0.4	1,100
153	32	24	76	0.3	700
156	33	34	150	0.2	700
157	37	33	94	0.3	700
158	--	13,500	2,100	20.0	---
255	51	46	186	1.2	1,800
256	62	48	355	1.2	10,600
257	74	860	5,900	2.0	10,000
258	114	32	425	2.0	5,100
259	74	27	225	3.0	5,700
260	10	17	112	0.8	1,100
261	28	18	202	1.2	2,200
262	20	20	158	0.8	800
263	76	19	730	2.6	10,400
264	14	16	103	1.5	1,800
265	38	15	105	0.9	1,800
266	41	11	142	1.2	3,800
267	56	24	204	1.6	3,900
268	57	30	155	1.3	1,300
269	57	24	285	3.3	1,600
270	72	37	262	1.4	2,000
271	45	27	172	1.9	1,500

TABLE 8.1.2 (Cont.)

RED DOG AREA

STREAM SILT SAMPLE RESULTS

(Values in ppm, unless noted)

Sample No.	Cu	Pb	Zn	Ag	Ba
BM 401	--	210	134	1.2	1,400
402	--	59	139	0.6	2,720
403	--	61	140	0.4	2,070
404	--	61	164	0.3	2,320
405	--	36	135	0.5	Is
455	380	5,000	4,850	8.5	24,300
456	230	3,900	4,600	2.6	28,500
457	107	630	1,120	1.6	3,950
458	98	4,300	4,750	5.7	7,490
459	60	65	360	0.7	21,650
460	129	33	430	1.4	23,350
461	62	76	620	0.5	4,700
462	61	23	285	1.4	1,820
463	25	18	158	0.3	1,600
464	50	20	230	1.6	3,380
465	26	19	162	2.0	1,880
466	47	54	375	1.8	2,440
467	30	20	96	0.5	1,580
468	40	31	106	0.3	1,230
469	53	32	320	0.9	1,520
470	24	18	178	1.8	1,310
471	48	28	280	1.2	1,970
472	41	18	205	2.8	1,360

Is = insufficient sample
- = not analyzed

Collected by: Degenhart
Griffis
Via
Fairchild

TABLE 8.1.3

RED DOG AREA

ROCK AND SOIL SAMPLE RESULTS

(All values are reported by laboratory)
(ppm, unless noted)

Sample No.	Type	Cu	Pb	Zn	Ag	Ba
BM 55	rx	10	210	500	0.6	6,520
88	rx	57	1,250	1,220	4.3	--
105	rx	12	118	42	5.5	--
114	rx	15	1,100	710	4.3	1,025
148	so	--	0.10%	0.05%	0.1 oz	--
154	so	22	8	22	0.2	0.06%
155	rx	28	55	820	0.4	--
164	so	91	14,000	410	---	--
166	so	314	10.64%	940	---	--
167	so	140	2.23%	920	---	--
189	so	--	5.35%	740	18.0	12.9%
191	so	--	600	219	2.3	2.17%
192	so	--	117	340	1.6	2.77%
193	so	--	83	240	1.2	1.67%
195	rx	--	15,500	380	19.0	9.31%
197	so	--	2.27%	410	17.0	9.48%
198	so	--	4,900	840	10.0	0.94%
199	so	--	12,100	450	19.0	2.36%
200	so	--	4.70%	970	33.0	2.00%

rx = rock sample
so = soil sample
- = not analyzed

Collected by: Degenhart
Griffis
Via
Fairchild

8.1.9 Discussion

The majority of mineralization in the Red Dog prospect area appears to consist mainly of mineralized horizons that are conformable with adjacent sedimentary units. The planar orientation of these mineral occurrences is similar if not identical to primary sedimentary features. Individual sulfide-rich lenses appear to be restricted to the same stratigraphic level in the banded black cherts. The barite occurrences appear to be much more extensive than the sulfide occurrences and probably represent blanket-like units. The barite does not appear to be restricted to a single stratigraphic horizon but appears to be present in a number of stratigraphic levels.

The intimate association of pyritic framboids with petal-like grains and irregular masses of sphalerite, as well as anhedral masses of galena, suggests that these minerals probably formed contemporaneously and very likely were precipitated from low temperature solutions. Likewise, the intimate association of barite with sphalerite and galena suggest that these also formed contempraneously.

The massive siliceous unit containing zoned quartz grains and granular sphalerite is unusual and its origin is presently unknown. However, the apparent conformable nature suggests that it may represent accumulations of siliceous chemical sedimentation. The contained sulfide appears to have formed contemporaneously with the silica.

The vein and breccia mineralization appears to underlie the stratiform sulfide occurrences. The banded nature of the vein sulfide occurrences and the presence of colloform pyrite suggest that these were probably formed by relatively low-temperature hydrothermal fluids. The apparent restriction of the veins to sedimentary units below the stratiform sulfide and barite occurrences suggest that the mineralized fractures may have developed prior to most of the overlying sedimentation, and provided conduits for later mineralization.

The above features point to a sedimentary origin for most of the massive sulfide and barite mineralization. It is difficult to visualized the development of massive sulfide and barite units as the result of normal chemical sedimentation. It would seem more likely that the metals and barium were introduced into an euxinic marine environment by hydrothermal fluids. Possibly the mineralized fractures in the black cherty sediments represent the channels through which the mineralized hydrothermal fluids escaped onto the floor of a sedimentary basin. The sulfur and sulfate may have had a similar origin as the above, although the existence of thick sulfate sequences (i.e. gypsum or anhydrite associated with evaporites in many parts of the world) indicates a possible primary chemical sedimentary origin for the Red Dog sulfate. Marine sulfate may have combined with hydrothermal barium to precipitate barite while some sulfate may have been reduced to sulfide ions by biological activity and thus provide an abundant supply of anions to combine with hydrothermal metallic ions.

Our present knowledge of the Red Dog regional geology provides us with no real idea as to the original source of the metals and barium. A volcanic source would seem a logical possibility but, to date, we have observed no indication of volcanic activity contempraneous with the sedimentation in the Red Dog area. It is also possible that hydrothermal activity may be entirely related to buried connate fluids, which leached metals and barium from underlying sediments and deposited these in hot springs emanating on a sea-floor. The common association of similar sulfide-barite deposits with areas of active volcanism suggests that a magmatic source for the metals and barium may be the more likely explanation. More detailed field and laboratory studies may provide a definite link with volcanic activity.

The distribution of the various sulfides and barite suggest a definite stratigraphic zonation with pyrite-sphalerite being dominant in the lowest units, followed by sphalerite with some galena and, in cases, considerable barite. These, in turn, grade upwards into more barite-rich units which contain a higher proportionate amount of galena than sphalerite.

8.1.9.1 Comparisons with Other Deposits

Sulfide and barite deposits similar to the Red Dog prospect form a very distinctive and important type of ore deposit. Table 8.1.4 summarizes and compares characteristics from several well-known deposits with the Red Dog prospect.

Two deposits similar to the Red Dog prospect are the German deposits at Rammelsberg and Meggan. Virtually all of the small and large scale features in the German deposits have been observed in the Red Dog area. However, one

TABLE 8.1.4

CHARACTERISTICS OF CERTAIN LEAD-ZINC-COPPER-BARITE DEPOSITS

Deposit	Age Host Rock	Major Economic Commodities	Estimated Ore Tonnage	Ore Grade	Form(s) of Ore Bodies	Zonation in ore body (base upward)	Minor Metals	Associated Igneous Activity	Genesis	
Rammelsberg Germany	Middle Devonian clayslate, shale siliceous rock	Pb,Zn,Cu, barite, Ag	$30x10^6$	Variable 5-28% Combined Pb,Zn,Cu	Three lenticular bodies stratiform	Barite(Zn-Pb) Ag-Pb-(Barite) Zn-Fe-Pb Fe-Cu	Sb,Au,As Co,Co,Bi, Sn,Hg,Ni In,Tl	Volcanism as indicated by altered tuff layers	Hydrothermal sedimentary or exhalative sedimentary	(1)
Meggen, Germany	Middle Devonian shales	Zn barite Pb	$60x10^6$ sulfides $15x10^6$ barite	Zn 10% Pb 1.3% $BaSO_4$ 96%	Strati-form	Barite (Pb) Zn-Fe-Pb	?	Distal volcanism indicated by tuff horizons	Sedimentary & diagenetic with exhalative feeding of S and Ba	(2)
Walton-Cheverie, Canada	Mississippian limestone conglomerate, limestone, shale, feldspathic conglomerate, sandstone	Barite, Pb,Zn,Cu Ag	5,000,000 Barite 350,000+ sulfides	90%$BaSO_4$ Pb 5-25% Zn 1-20% Cu 0.5-8% Ag 2-4 oz/t $BaSO_4$ 10-25%	Lensoid barite pipe with replacement sulfide body below	Barite Barite-Pb Zn-Cu-Fe	Mn,Sr,Cd As,Sb,Ni Co	Triassic basic sills	Magmatic ? diagenetic	(3)
Buchans, Canada	Lower & middle Ordovician andesite/dacitic flows with tuffs, breccias arkosic sediments	Zn,Pb,Cu Barite, Ag,Au	+12,000,000	Cu 1.45% Pb 7.85% Zn 15.5% Ag 3.5 oz/t	Lensoid to tabular replacement bodies	Barite(Zn-Pb) Zn-Pb-Fe-Cu-(barite) Fe-Cu-Zn-Pb (barite)		Three known volcanic cycles	Magmatic	(4)
Tom Property, Canada	Devonian-Mississippian black shales, cherty clastics	Zn, Pb Ag, barite	$8.65x10^6$	8.1% Pb 8.4% Zn 2.7 oz/t Ag	Three conformable stratiform bodies	barite(Pb-Zn) Fe-Zn-Pb-Ag Cu-Pb	?	tuffaceous components in depositional basin	exhalative sedimentary	(5)

Deposit	Age Host Rock	Major Economic Commodities	Estimated Ore Tonnage	Ore Grade	Forms(s) of Ore Bodies	Zonation in ore body (base upward)	Minor Metals	Associated Igneous Activity	Genesis
Red Dog, Alaska	Mississippian, Permian, Triassic; chert barite, shale breccias	Barite Zn, Pb, Ag	?	Variable from 1-5% to 15-20% combined Pb-Zn	Conformable lenses Breccia zones	Barite (Zn-Pb) Zn-Pb-Barite Fe-Zn-Pb	Cd	?	Sedimentary Diagenetic (6)
Anvil	Cambrian qtz-musco schist & phyllites	Pb, Zn, Ag	$46x10^6$	Pb+Zn 9.44%	several conformable lenses	?	?		Volcanogenic exhalative (7)
Faro	Cambrian schists graph-schists, volc. lenses	Pb, Zn, (Cu) Ag	$63.5x10^6$	Zn 5.7% Pb 3.4% Cu 0.15% Ag 1.2 oz/t	tabular condordant	?			volcanogenic exhalative (8)
Swim	Ord-Silurian phyl ite	Zn, Pb, (Cu) Ag (significant barite gangue)	$5x10^6$	Pb+Zn 9.5% Ag 1.5 oz/t	tabular concordant	?	?		(9)
Vangorda	Ord-Silurian phyllite	Zn, Pb, (Cu) Ag (barite gangue)	$9.4x10^6$	Zn 4.96% Pb 3.1% Cu 0.27% Ag 1.76 oz/t	tabluar concordant	?	?	greenstones & tuff in section	(10)

Note: Other examples could be cited; however, these examples prove that "similar type" deposits are worldwide in occurrence.

REFERENCES

(1) Stanton (1972) Schot (1971)

(2) Stanton (1972) Zimmerman and Anstutz (1970)

(3) Boyle (1963)

(4) Stanton (1972) Swanson and Brown (1962)

(5) Carne, R. C. (1976) Brathwaite (1974)

(6) Tailleur (1970) WGM (1975)

(7) Carne, R. C. (1976)

(8)
(9) Tempelman-Kluit (1972)
(10)

important difference is the presence of considerable copper mineralization in the European deposit. It is possible that buried copper mineralization underlies some areas of mineralization at the Red Dog prospect (see discussion of geochemical results), although one would expect to see at least some signs of this in overlying units or possibly in the underlying sulfide veins and breccia. The German deposits also display a more direct link with penecontemporaneous volcanic activity.

The Tom deposit, located at latitude 63°10'N and longitude 130°10'W at the Yukon-Northwest territories border in Canada also displays many similarities to Red Dog (Carne, 1976). At this deposit, 9 million tons of proven ore reserves grading 8.6% lead, 8.4% zinc and 2.7 oz/ton silver are known (Carne, 1976). The relatively high pyrite and carbon content of the enveloping rocks indicate biogenesis of lead and zinc sulfides in an euxinic trough environment. However, the lead-zinc-silver-barite-silica assemblage in conjunction with mineral zoning have been attributed to an external source, possibly of an exhalative nature.

Bedded deposits of barite with no significant sulfide mineralization are well known and also display many features similar to the Red Dog barite occurrences. The Ordovician deposits in Nye County, Nevada (Shawe et al., 1969) consist of several laterally extensive barite units ranging in thickness from 5 to 50 feet. The units are associated with eugeosynclinal sedimentation over a broad area in Central Nevada. Similar Lower Paleozoic barite deposits occur in northeastern Washington (Mills et al., 1971), as well as in Arkansas, range in thickness from <1 foot to approximately 100 feet and are laterally extensive. The sedimentary banding, fetid odor and barite content, as well as fine-grained sedimentary and petrographic features in the Arkansas deposits (Zimmerman, 1969), closely resemble characteristics observed in the Red Dog occurrences. Zimmerman (1969) has provided strong evidence that suggests that the Arkansas barite is largely sedimentary in origin.

The importance of comparing features of the Red Dog prospect with other similar deposits lies in the assessment of potential extensions of the types of mineralization currently exposed in the Red Dog area. These comparisons suggest a strong possibility for significant subsurface extensions of sulfide and barite mineralization throughout much of the Red Dog prospect area. Our interpretation of the local structure suggests that such extensions may occur at relatively shallow depths. On a much broader scale, the geological environment with which similar sulfide and barite deposits are associated clearly suggests the excellent potential for discovery of similar occurrences to the Red Dog deposits in large areas of the northwestern Brooks Range.

8.1.10 Conclusions

The Red Dog prospect is considered to be the most impressive surface mineral showing in the Brooks Range and perhaps in Alaska. Bedrock and talus exposures of base metal sulfide and barite mineralization are present over a north-south distance of 9,000 feet (BM 161 and BM 91) and an east-west distance of 3,500 feet (BM 33 and BM 61). Geochemistry defines an area of about 3.5 square miles that is considered to be anomalous in base metal and barium content.

Five principal types of base metal sulfide and barite mineralization are recognized at the Red Dog prospect. Additional types may be discovered, such as a copper-enriched zone located stratigraphically below the outcropping mineralization. Four of the five types of mineralization appear to be conformable with adjacent sedimentary units, and it appears that barite-rich zones and possibly sulfide-rich siliceous zones may be repeated in the stratigraphic sequence. Vein and breccia zone mineralization appear to underlie the stratiform mineralizaton and may represent channelways through which mineralized fluids reached the floor of a sedimentary basin.

Until additional work is done, one can only speculate about the grade and extent of the mineralization. For instance, do individual, widely separated surface outcrops of mineralization represent continuous mineralized stratigraphic units or simply small lenses or pods within a favorable host unit? The stratabound nature of the observed mineralization and the geochemical expression suggest that subsurface extensions of sulfide and barite mineralization may be extensive throughout much of the Red Dog prospect area.

Average grades of mineralization from rock samples have been compiled and shown on Table 8.1.5. These are of definite economic significance.

Figure 5-A shows the boundary of a mineralized area of about 6.4 million square feet. Using a weight of 240 pounds per cubic foot, 768,000 tons per vertical foot are indicated, at grades similar to those indicated on Table 8.1.5.

Barite-rich rock containing variable amounts of base metal sulfides appears to be the most widespread type of mineralization, however, this type of mineralization is situated stratigraphically above other mineralized units and, because of its weathering characteristics, may mask the extent of underlying units.

Without diamond drill hole data, it is impossible to give tonnage or grade figures for the mineralization at the Red Dog prospect.

TABLE 8.1.5

RED DOG

AVERAGE GRADES OF MINERALIZATION

1 - Chert - Sulfides

Sample No.	Pb %	Zn %	Ag oz/ton
10	0.35	0.30	0.78
61	2.95	8.00	0.41
159	3.70	7.65	1.90
Average	2.3	5.3	1.0

2. - Massive Sulfides*

Sample No.	Pb %	Zn %	Ag oz/ton
66	5.90	12.70	1.90
132	1.05	24.90	1.60
168	8.95	13.90	3.30
169	5.90	11.00	1.80
Average	5.4	15.6	2.2

* Exclusing BM 108

3 - Barite with Sulfides

Sample No.	Pb %	Zn %	Ag oz/ton	$BaSO_4$%
33	2.75	1.65	1.20	86.3
58	1.25	0.05	0.48	92.5
59	1.30	1.90	0.69	88.3
60	2.15	1.25	0.66	72.5
62	2.00	2.30	0.81	86.7
63	1.50	0.75	0.76	91.6
81	2.35	2.30	1.10	87.4
87	1.30	0.20	0.33	92.8
91	2.60	1.90	1.40	----
92	1.50	0.30	0.51	91.6
93	3.05	1.55	1.20	86.7
116	3.40	5.05	1.60	43.6
117	5.05	4.50	2.00	37.7
147	2.70	1.40	1.20	----

TABLE 8.1.5 (Cont.)

RED DOG

AVERAGE GRADES OF MINERALIZATION

Sample No.	Pb %	Zn %	Ag oz/ton	$BaSO_4$%
160	1.90	0.20	1.20	91.0
161	2.45	0.30	----	93.2
162	2.85	0.60	1.40	92.5
163	1.35	1.05	0.74	93.7
190	1.60	0.15	0.56	96.2
194	1.35	1.05	0.72	89.1
196	1.45	0.85	0.71	71.2
Average	2.2	1.4	0.96	83.4

4 - Sulfides in Siliceous Host Rock

Sample No.	Pb %	Zn %	Ag oz/ton
65	5.75	11.70	2.40
67	3.85	2.65	2.00
68	5.40	11.00	2.20
82	1.65	2.65	1.10
83	0.95	1.85	0.39
85	3.20	1.15	1.90
90	1.95	0.20	1.20
115	5.15	4.65	----
145	2.25	0.25	1.80
165	3.02	0.38	----
Average	3.3	3.6	1.6

5 - Vein and Breccia Sulfides

Vein

Sample No.	Pb %	Zn %	Ag oz/ton
86	0.65	2.65	0.41

Breccia

Sample No.	Pb %	Zn %	Ag oz/ton
272	4.35	23.50	2.50
473	5.65	24.60	2.30
Average	5.00	24.05	2.40

8.1.11 Recommendations

The Red Dog prospect represents one of the most attractive exploration targets in Alaska. Considering the prosent land status, only governmental agencies or contractors are allowed to conduct exploration work, and certain types of work would be restricted or banned under existing regulation.

Two approaches to additional exploration must be considered: work conducted directly by governmental agencies and work carried out by private concerns. Work by governmental agencies should be directed toward regional scale work with a minor amount of effort expended on individual mineralized showings within the regional setting.

Specific governmental work recommended is:

1. Geologic mapping at a scale of 1:250,000 of at least the DeLong Mountains quadrangle. Emphasis should be placed on structural and stratigraphic work. Priority mapping of other quadrangles could be determined as a result of the work in the DeLong Mountains quadrangle.

2. Stream silt geochemical sampling in conjunction with the work outlined in No. 1 above.

3. At Red Dog, detailed mapping and a limited amount of drilling should be carried out. Drilling should be directed initially toward a study of local geologic conditions rather than defining ore reserves.

If the land classification at Red Dog were changed from d-2 to d-1, private companies could begin a detailed property examination. The following work is considered necessary to evaluate the Red Dog prospect.

1. Diamond core drilling: An initial test program of five holes to test for thickness and grade of the best exposures of mineralization, with additional drilling to follow. It is not possible to outline the program of drilling that might eventually be required, although even on a broadly spaced grid it could easily total 40,000 feet and well over 100 holes.

2. Carry out detailed geologic mapping (scale of 1" = 500') to provide detailed structural and stratigraphic data.

3. Carry out stream silt and soil sampling to better define the limits of the geochemical anomalous area.

The following drill holes are strongly recommended as a preliminary test program.

Approximate Location	Reason for Hole
Near sample BM 272 & 473 - two holes	To test extent and grade of sulfide breccia and vein mineralization
Near sample BM 132 - at least two holes	To test thickness of high grade mineralized unit (24.9% Zn)
Near soil sample BM 166 - one hole	To test the bedrock source of the extremely high-grade soil sample (10.6% Pb)

8.2 COLOR ANOMALIES - DELONG A-2 QUADRANGLE

8.2.1 Introduction

Geologic mapping of the DeLong Mountains quadrangle is incomplete, however, Tailleur (1970) presented a generalized geologic map of a portion of the quadrangle. In this open-file report the Red Dog prospect was first mentioned in the literature, and several localities west and northwest of Red Dog, displaying limonitic-stained stream beds and/or orange or red soil, were reported.

Prior to the 1975 field work, WGM personnel, in conjunction with representatives of the U.S.B.M., decided that a visit should be made to several of the reported color anomalies, even though they are located outside the project area. This region of the western DeLong Mountains was heretofore considered to have a low potential for base metal sulfide occurrences. It was felt that since these color anomalies probably reflect weathering sulfides (pyrite) and that base metal sulfides commonly occur with pyrite, a previously unknown trend of base metal sulfide occurrences might be present. A total of five zinc values in excess of 500 ppm and one lead value of 170 ppm were recorded from two of the areas. A very minor amount of galena was noted in a piece of sandstone(?) at one location. A stream silt sample (BM 40) collected from a small gully draining the area where the galena was noted shows only 22 ppm lead.

Subsequent to the public news release concerning Red Dog, numerous companies entered the area and began intensive exploration and claim staking activities. As of July 1976 three of the four areas examined had been claimed. The fourth area at which galena was observed apparently had not been claimed.

8.2.2 Summary

A brief visit to four reported color anomalies in the open d-1 lands west and northwest of the Red Dog prospect failed to reveal significant amounts of base sulfide mineralization.

Several anomalous geochemical values were recorded (Table 8.2.1), and it is believed that the areas yielding the anomalous values have been subsequently claimed. We would normally recommend follow-up of these anomalies; however, since these areas are claimed, it is likely that additional work has already been carried out.

8.2.3 Location and Access

The four color anomalies visited are situated in the DeLong Mountains A-2 1:63,360 scale quadrangle and are located as follows (Fig. 6):

1. Section 1, T.31N., R.19W.

2. Section 7, T.32N., R.19W.

3. Section 5, T.32N., R.19W. and
   Section 34, T.33N., R.19W.

4. Section 26, T.33N., R.19W.

Three of the areas are drained by the Wulik River and the fourth by Ikalukrok Creek.

Kivalina is about 50 miles to the west and Noatak is 30 miles to the south.

A helicopter provides the most effective means of transportation to the color anomalies. Small fixed-wing aircraft can land at several locations along the Wulik River.

8.2.4 Work Accomplished

Four color anomalies were visited and 11 stream silt samples and one soil sample were collected. No geologic mapping was carried out.

8.2.5 Geology and Mineralization

Tailluer (1970) described the geology of this area as a deformed assemblage of chert, shale and limestone which is probably correlative with the Mississippian Lisburne Group, the Permian Siksikpuk Formation, the Triassic Shublik Formation, or Cretaceous units. These rocks are apparently lowest structurally. Thrust plates consisting of carbonates of the Lisburne Group and thick clastics of the Devonian and Mississippian Endicott Group overlie the younger rocks in adjacent areas, but have been eroded from upfolds in this area to expose the younger units.

Our examination at the color anomalies was very brief and was directed toward discovery of base metal sulfide mineralization rather than geologic mapping.

As mentioned previously, only a very minor amount of galena was seen, this being near sample BM 40. A visual estimate of the galena observed in the one piece of sandstone(?) is less than 0.1%.

8.2.6 Geochemistry

Geochemical results and a description of geologic observations made at each site are presented on the following table and sample site locations are shown on Figure 6.

Zinc geochemical values in excess of 500 ppm were recorded at five sample sites; one lead value of 170 ppm was obtained; and two values in excess of 4 ppm silver were recorded. All of these values are considered moderately anomalous in comparison to values obtained at Red Dog, and could indicate the presence of buried mineralization.

8.2.7 Conclusions

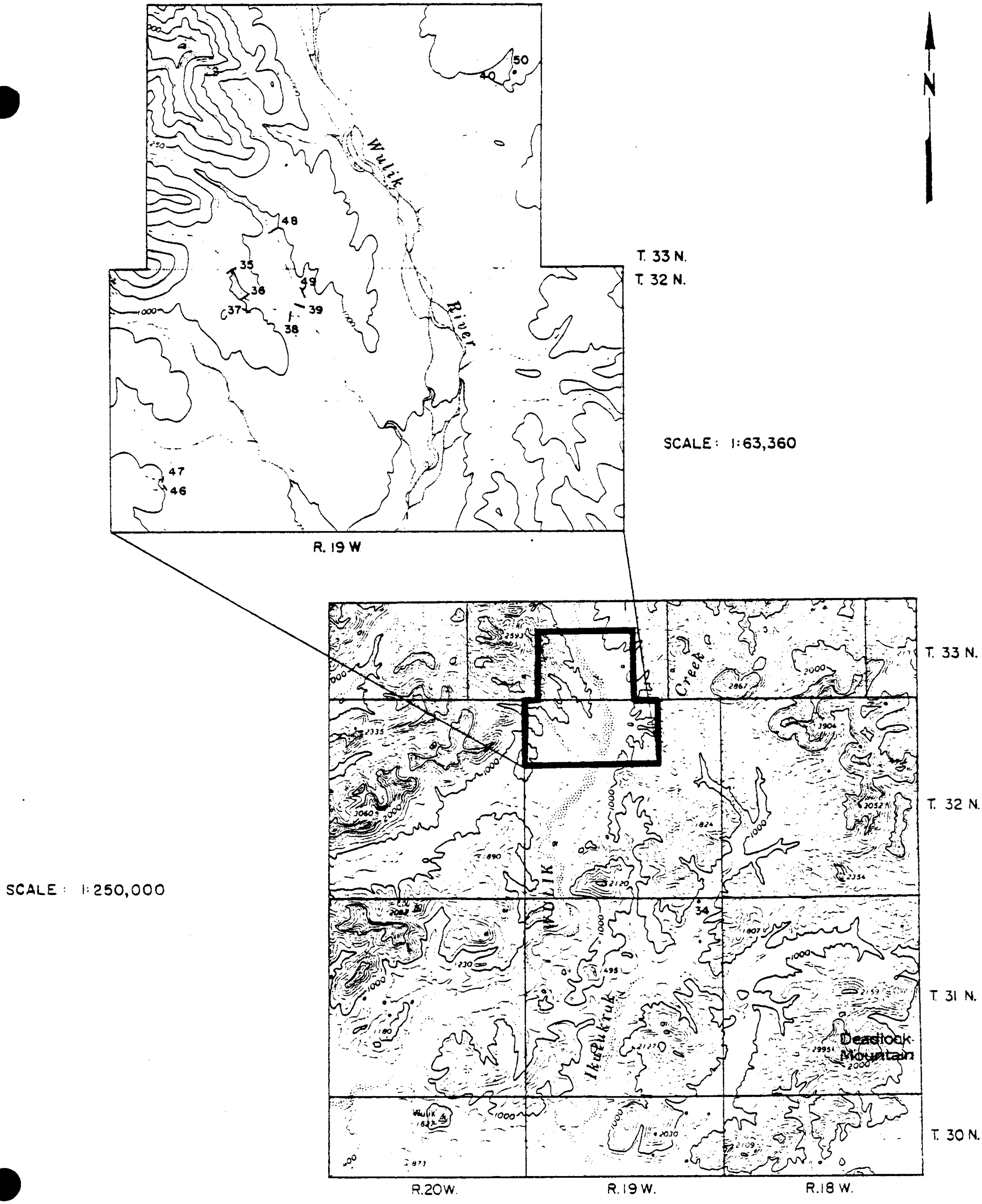
The purpose of examining the reported color anomalies was to determine if a "mineral trend" could be determined west to northwest from the Red Dog prospect. The examination was inconclusive since no significant mineralization was found, and the source of the zinc and lead geochemical values is undetermined. The recent claim staking activity in this area suggests that mineralization has been discovered.

8.2.8 Recommendations

Since all of the anomalous geochemical sample locations have been claimed, no recommendations for these areas are made.

The presence of significant mineralization at Red Dog, coupled with the discovery of anomalous geochemical anomalies in a similar geologic environment, and the location of numerous mining claims northwest of Red Dog in this geologic environment indicates that this area warrants additional minerals exploration.

Regional geologic mapping is required in this area of northwestern Alaska. Geochemical stream silt sampling and prospecting is necessary as part of the evaluation of the area and this work is being carried out by private companies on the lands open to minerals exploration.



WGM INC — MINING & GEOLOGICAL CONSULTANTS, ANCHORAGE, ALASKA	DWN BY N.B.	REVISED	SAMPLE SITE LOCATIONS
	DATA BY WGM		COLOR ANOMALIES
SCALE: AS SHOWN	DATE 7/75		DELONG MOUNTAINS A-2 QUADRANGLE

FIGURE 6

3M116

TABLE 8.2.1

SUMMARY OF DATA FROM DELONG A-2 COLOR ANOMALIES

(Values as presented by laboratory)

Location	Sample No.	Cu	Pb	Zn	Ag	Ba	Remarks
		(Values in ppm, unless noted)					
Sec. 1 T.31N., R.19W.	BM 34	81	23	3	0.7	320	100' x 300' area of ferricrete. Bedrock to NW consists of black to tan chert, and shale. No visible sulfides.
Sec. 7 T.32N., R.19W.	46	52	170	1,000	6.3	1,440	No bedrock seen. Intense iron staining on recent fluvial deposit. No sulfides noted.
	47	36	23	560	2.7	2,210	
Sec. 5 T.32N., R.19W. Sec. 34 T.33N., R.19W.	35	79	28	215	Is	0.8%	Bedrock alternating sequence of thinly bedded black chert and black shale. Intensely folded. Intense iron stain on all stream float. No visible sulfides.
	36	129	24	670	1.0	0.4%	
	37	122	28	330	4.1	0.12%	
	38	136	41	1,010	1.2	0.25%	
	39	56	25	310	1.0	0.34%	
	48	70	24	320	2.3	8,000	
	49	50	80	820	3.3	2,060	
Sec. 26 T.33N., R.19W.	40	167	22	56	0.8	0.38%	Rubble present on subdued ridge consists of chert, shale, graywacke, and sandstone, with minor galena noted in one piece of sandstone(?)
	59(soil)	78	17	20	0.9	2,140	

Is = insufficient sample
All samples are stream silts unless otherwise noted

8.3 AVAN RIVER AREA

8.3.1 Introduction

The Avan River area is dominated by a large ultramafic body. Limited geologic information is available and published maps do little more than outline the borders of the pluton. Even less information concerning the mineral potential is available.

Martin (1970) and Tailleur and Snelson (1966, 1968) have presented papers on the regional geology of the western Brooks Range, which include mention of the Avan River pluton.

U.S.B.M. open-file report 20-73 (1972) shows eight lode and 173 placer claims located along the Avan River. The claims which were recorded in 1968, apparently are not being worked. The open-file report does not specify for what commodity the placer claims were located, although platinum is suspected. The lode claims were located for gold.

Because of the potential economic significance and a lack of information available on the Avan River ultramafic body, WGM conducted a limited reconnaissance of the area. Considering the size of the ultramafic body (300 square miles), the work was directed toward discovery of nickel, platinum, chrome, and asbestos. It was beyond the scope of the program to examine the entire ultramafic body.

8.3.2 Summary

Part of a large ultramafic pluton in the western Brooks Range was examined to determine if obvious economic minerals occur in association with this ultramafic body.

A total of 110 samples was collected for analyses and representative samples were collected for microscope work.

Disseminated chromite is widespread in the pluton, and two locations were discovered where the chromite occurs as small layers or bands. Geochemical results indicate the presence of nickel, however, it is believed that the nickel is present in silicates. No indications of other types of mineralization were observed, however, evaluation of ultramafic bodies commonly requires many years of intensive work.

Additional exploration is recommended for the Avan River pluton and for other ultramafic bodies in the Brooks Range.

8.3.3 Location and Access

The Avan River ultramafic complex occupies all or portions of Tps.31-34N., Rs.13-16W. in the Misheguk Mountain and

DeLong Mountains 1:250,000 scale quadrangles (Figs. 1, 3 and 7). The southern part of the area is about 20 miles northeast of the village of Noatak.

The western part of the complex is drained by the Kelly River; the central portion by Avan River; and the eastern side by Kagvik Creek and Kugururok River, all of which flow into the Noatak River.

Access is best gained by helicopter, however small boats can travel up the Kelly River. A gravel bar near the mouth of the Kelly River can accommodate small fixed-wing aircraft.

8.3.4 Work Accomplished

A total of 152 samples were collected of which 110 were analyzed for combinations of copper, lead, zinc, silver, nickel, chromium, platinum, and palladium (Fig. 7; Table 8.3.1). Additional samples were collected for reference and microscope work; approximately 40 thin sections were studied. Float and bedrock were examined for occurrence of economic minerals.

8.3.5 Geology and Mineralization

The Avan River geology is dominated by an ultramafic complex of approximately 300 square miles largely surrounded by a variety of Paleozoic and Mesozoic marine sediments (Martin, 1970).

The assemblage is located along the northern structural boundary of the main Brooks Range in an area characterized by extremely complex folding and faulting.

The marine sediments consist mainly of Mississippian and/or Permian limestones and cherts, Triassic cherts, and Cretaceous flysch units similar to rocks found at the Red Dog area. The units are referred to in the literature as the DeLong Sequence (Martin, 1970). The Paleozoic sediments appear to be related to the development of a geosyncline along the present Arctic coastal region, while the source area for the Mesozoic terringenous units appears to be an ancestral Brooks Range located immediately south of the present study area (Churkin, 1973).

Major thrust faulting in this region has been interpreted, by Tailleur and Snelson (1966, 1968), as underthrusting at ancient plate margins perhaps related to rifting in a Mesozoic Arctic Ocean. Martin (1970) accepts the general model proposed by Tailleur and Snelson, but interprets the low-angle fault structures to be the result of gravity sliding along the flanks of a major geanticline located in the Baird Mountains. According to the latter interpretation, the Avan River ultramafic pluton, the DeLong Sequence, as well as several other stratigraphic sequences, represent thin allochthonous masses which may have been moved northwards a distance of 50 to 60 miles.

The Avan River ultramafic pluton is well exposed and visible for tens of miles, because of its considerable relief and characteristic rusty-colored appearance, which is in sharp contrast with the surrounding lighter gray-colored sediments.

Most of the exposed pluton appears to consists largely of non-banded ultramafic rocks, although small-scale (2-5 cm wide) and large-scale (1-5 m wide) banding is evident in several areas along the western margin and in the interior of the pluton. The banding is usually regular and can be easily traced over large distances. The eastern one-third of the pluton contains large exposures of medium to dark gray mafic material. It is not known if the mafic rock is a concordant phase of the ultramafic or whether it represents a separate intrusive phase.

Chromite mineralization is widespread in the pluton and is found as small layers or bands at two locations. No significant amounts of other potentially economic metals were discovered nor are any indicated by the results of the geochemical stream silt sampling.

Approximately 40 thin-sections were made from a representative selection of rock specimens collected from the Avan River lithologies. A summary of the petrographic studies are presented below. Petrographic nomenclature used in this report follows the guidelines suggested by "Systematics of Igneous Rocks" (Streckeisen, 1973).

The majority of samples examined are peridotites. Olivine is commonly the dominant mineral and in many cases is sufficiently abundant to warrant classifying many samples as dunites (>90% olivine). Most of the olivine is in the compositional range of forsterite (Mg-rich olivine). Individual olivine grains are usually in the size range 0.5 to 5 mm.

Orthopyroxene (the second most abundant mineral) is clearly seen in many hand specimens where its cleavage surfaces easily distinguish it from conchoidal fracturing olivine. Most grains are subhedral, and the long diameter is generally in the range of 1 to 5 mm. The orthopyroxene is Mg-rich. Peridotites containing abundant orthopyroxene tend to have darker brown-weathered surfaces than do the more olivine-rich ultramafics. Numerous specimens contain enough orthopyroxene to be classified as harzburgites (essentially olivine and orthopyroxene with <10% clinopyroxene). The banding in some exposures consists largely of alternating layers of pyroxene-rich and olivine-rich material.

Clinopyroxene is a minor constitutent in most samples, although in a few specimens it is an essential mineral. Where clinopyroxene is an essential mineral, the rock is in the compositional range of lherzolite periodite (at least 40% olivine and >10% each of ortho- and clinopyroxene). At least one sample contains sufficient clinopyroxene to be properly classified as olivine clinopyroxenite. The clinopyroxene in this sample is in the compositional range of augite or subcalcicaugite.

Plagioclase was observed only in a few narrow mafic bands within the main ultramafic mass. The bands are 2 to 5 cm across but can be traced for lateral distances of several hundred feet. The plagioclase composition appears to be >60% anorthite.

Chromite is an accessory mineral in many of the specimens examined. It occurs as isolated, rounded grains (generally <0.5 mm) within larger olivine masses or along the boundaries of silicate grains.

Serpentinization of olivine-rich rocks varies from incipient to extensive. Antigorite is the most widespread serpentine mineral, but narrow fractures (usually <4 mm wide) containing chrysotile are present in a few samples. The serpentinization appears to have produced some very fine-grained, dust-like magnetite as well as a yellowish alteration mineral (iddingsite?).

Numerous peridotite samples display textural features consisting of large olivine and/or orthopyroxene grains surrounded by much finer grained olivine. There appears to be every gradation between rock in which there is relatively minor fine-grained intergranular olivine to samples with only a few larger, generally rounded grains surrounded entirely by finer grained material. The coarse olivine almost invariably displays a very noticeable wavey extinction pattern. The features appear to be classic cataclastic textures.

The few mafic specimens collected from the eastern portion of the pluton consist principally of plagioclase (approximately 60% anorthite) and clinopyroxene (largely augite). Minor secondary reddish-brown colored biotite and actinolite are concentrated in some of the pyroxene grains.

Figures 7-A through 7-B illustrate typical examples of a few of the features described above.

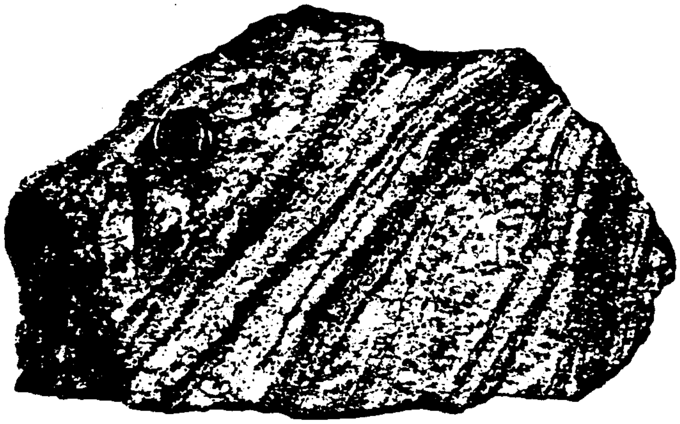
FIGURE 7-A

PHOTOGRAPH AND PHOTOMICROGRAPH OF SELECTED SAMPLES

AVAN RIVER AREA

(A) Dunite with narrow bands of chromite (reference sample).

(B) Massive, fractured chromite (BM 100).



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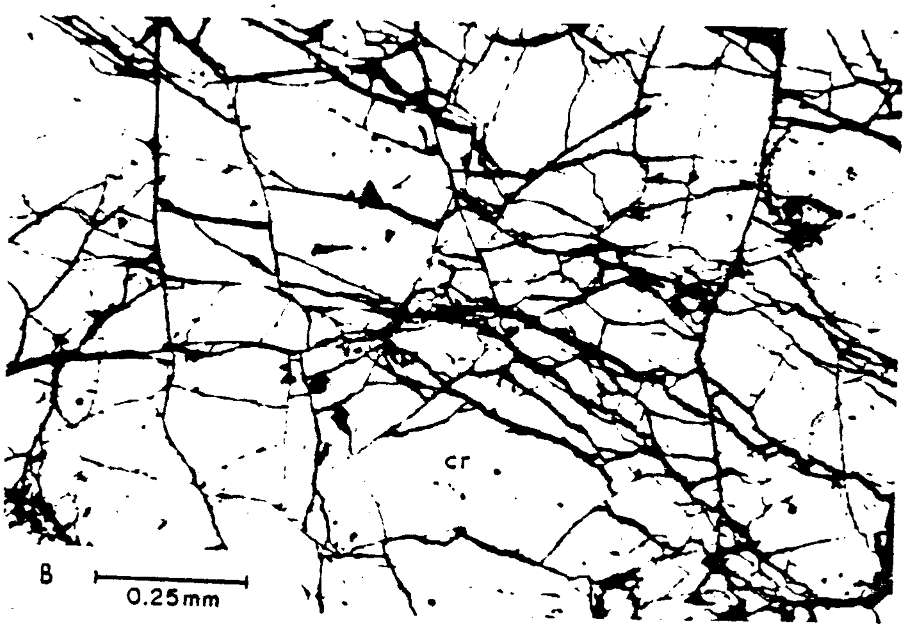


FIGURE 7-B

PHOTOMICROGRAPHS OF SELECTED SAMPLES

AVAN RIVER AREA

(C) Rounded grains of chromite with adjacent grains of pyrrhotite in fractured olivine matrix (BM 100).

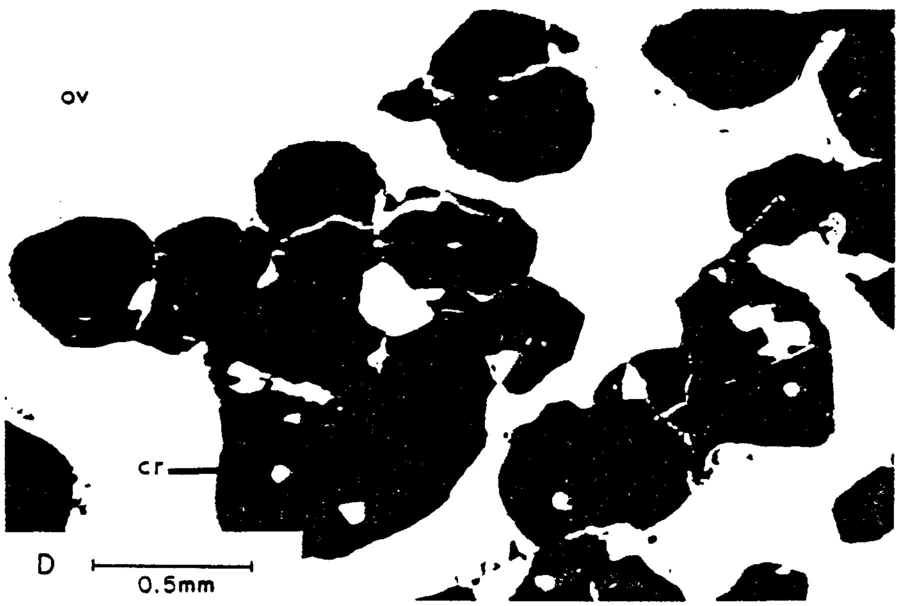
(D) Granular chromite in olivine matrix (BM 301).

Symbols used: po = pyrrhotite

cr = chromite

ov = olivine


po
cr
po
cr
C
0.25mm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In addition to the common accessory amounts (<5% by volume) of chromite, there are areas in the pluton where chromite becomes an essential mineral. Our reconnaissance work has indicated two such areas in the northcentral portion of the intrusive.

The areas are represented by the following samples and are shown on Figure 7.

Sample No.	Location	% Cr.	Description
BM 302	Sec. 28, T.33N., R.14W.	0.65	Bedrock samples: 200'x 100' area, 1/2" bands and disseminations of chromite in serpentinite, bands trend N20°E, dip 70°E.
303	Sec. 28, T.33N., R.14W.	0.35	Talus samples: 400' length, disseminated chromite in serpentinite
304	Sec. 27, T.33N., R.14W.	2.50	Selected talus sample of bands of chromite in serpentinite.
305	Sec. 27, T.33N., R.14W.	0.50	Bedrock sample: 150'x 40' area, disseminated chromite in coarse-grained serpentinite
423	Sec. 20, T.33N., R.14W.	0.86	Bedrock sample: 100' length, small bands of chromite in serpentinite
424	Sec. 20, T.33N., R.14W.	1.40	Bedrock sample: 200'x 200', small bands of chromite in serpentinite

Typically, the occurrences consist of fine-grained disseminations and narrow, ill-defined chromite bands (usually <2 cm wide) in thin olivine-rich host rock. Individual chromite-rich bands consist of aggregates of coarse (up to approximately 2 mm) chromite and olivine. The bands are often wavey or irregular and may coalesce or subdivide. Individual layers can rarely be traced for more than 1 to 2 meters.

Several cobbles consisting largely of massive chromite were found in stream channels in the northcentral portion of the complex in the valley immediately west of Avan River (BM 419 drainage) (Fig. 7). Attempts at tracing the occurrences to bedrock were largely unsuccessful although they were at least traceable to general areas where chromite was an essential rock constituent. The samples with chromite mineralization consist of granular aggregates of fractured chromite with at least some intergranular olivine. Very likely the more massive chromite respresents material derived from larger bands or lenses similar in nature to the smaller bands described in the previous paragraph.

Polished specimens of chromite samples indicate that the more massive chromite occurrences are highly fractured and in some cases brecciated. Rare grains of pyrrhotite and pentlandite were observed in a few specimens, and in one specimen a very fine-grained (approximately 0.01 to 0.03 mm) inclusion displays optical properties closely resembling those of sperrylite (Pt As_2).

8.3.6 Geochemistry

Of a total of 86 stream silt samples analyzed for chromium, 54 show values in excess of 0.5% and 20 in excess of 1% (Fig. 7; Table 8.3.1). The high values are primarily attibuted to the disseminated chromite found throughout the ultramafic complex. It is premature to correlate the geochemical chromium values with significant local occurrences of chromite. Samples BM 501 to BM 507 show the lowest chromium values, from 0.004% to 0.19%, which collected at or near the southeast margin of the ultramafic body. The bedrock is mainly intermediate composition intrusive rock and metasedimentary rocks.

Most geochemical nickel values are in excess of 1,500 ppm with a few containing in excess of 2,000 ppm. The seemingly high values are probably caused by nickel silicate minerals, since only a very few grains of pentlandite were observed under the microscope and none in hand specimen. Values of the magnitude noted are typical of many ultramafic terrains with silicate nickel.

Most samples were analyzed for copper and a few for lead, zinc, silver, platinum and palladium. None of the analyses show values considered anomalous for these metals.

8.3.7 Conclusions

The tectonic setting and petrological characteristics of the Avan River ultramafic pluton indicate that it belongs to the alpine-type of peridotites. The association of dunite, harzburgite, lherzolite, olivine-clinoproxenite and gabbro has been well documented (Thayer, 1967). The general association has been closely linked with ophiolite sequences emplaced along continental or oceanic plate margins (Dewey and Bird, 1970). Both Martin's (1970) and Tailleur's (1968) interpretation of the Mesozoic tectonic setting in the Baird and DeLong Mountains is compatible with the generalizations. The apparent plate-like form of the Avan River pluton as well as numerous other ultramafics (Martin, 1970) appear to be explained by Martin's suggestion of major gravity slides along the northern flanks of an ancestral Brooks Range geanticline centered in the Baird Mountains. The gravity slides have resulted in displacement of large sedimentary and ultramafic slices many miles from the original tectonic setting.

The chromite occurrences themselves are a further indication of an alpine setting. These types of occurrences are generally described and classified as podiform deposits (Thayer, 1967) to distinguish them from distinctive stratiform occurrences which are atypical of alpine geological settings. Well-known and important commercial examples of the deposits include those in the Masinloc area of the Philippines (Stoll, 1958), the Guleman-Soridag District in Turkey (Thayer, 1964), and in the Camaguey Province of Cuba (Flint, et al., 1948).

The lenticular, disseminated, and massive concentrations of chromite in the Avan River pluton are very similar to features described in the above deposits. The principal chromite occurrences in the eastcentral portion of the Avan River complex suggest a possible spatial correlation between chromite and adjacent areas containing considerable gabbro. Such a relationship has been noted in Cuban (Flint, et al., 1948) and Philippine deposits (Stoll, 1958).

Individual podiform deposits of chromite tend to be quite small. The vast majority contain less than one million tons of chromite (Mikami, 1975) although there maybe numerous small deposits in a cluster with combined tonnages of one million tons or more. The irregular and unpredictable form of the deposits make them very challenging exploration targets.

The geochemical characteristics of podiform chromities indicate that they contain less Cr and Fe but more Al and Mg than the much larger stratiform deposits. Platinum is a minor constituent of many chromiferous alpine peridotites but is rarely of economic importance in such occurrences (Mertie, 1969). Placer concentrations of platinum derived from alpine peridotites can be of considerable economic value (Mertie, 1969). The fact that a minor amount of pentlandite occurs is significant. Additional work may lead to discovery of Yakobi-type copper-nickel sulfide pods.

8.3.8 Recommendations

Additional reconnaissance of the Avan River ultramafic body is recommended. The entire pluton should be examined in sufficient detail to determine if chromite mineralization of possible economic importance is present. The work should include geologic mapping and rock sampling. Attention should also be given to a search for nickel, copper, platinum group metals and asbestos. Stream silt samples should be collected routinely from the smaller basins draining the ultramafic and surrounding geologic terranes.

Other ultramafic plutons in this region should be examined during the course of a regional scale exploration program.

TABLE 8.3.1

AVAN RIVER AREA

GEOCHEMICAL AND ASSAY RESULTS

(Values in ppm, unless noted)

Sample No.	Type	Cu	Pb	Zn	Ag	Ni	% Cr	Cr	ppb Pt	ppb Pd
BM 41	ss	13	--	--	--	1,750	0.52	--	--	--
42	ss	13	--	--	--	1,650	0.90	--	--	--
43	ss	10	--	--	--	1,750	1.35	--	--	--
44	rx	44	--	--	--	600	0.23	--	--	--
45	ss	10	--	--	--	1,750	1.20	--	--	--
99				Reference Sample						
100				Reference Sample						
201	ss	10	--	--	--	1,575	1.75	--	--	--
202	ss	12	--	--	--	1,575	1.30	--	--	--
203	ss	6	--	--	--	2,130	0.40	--	--	--
204	ss	8	--	--	--	2,140	0.21	--	--	--
205	ss	12	--	--	--	2,050	0.35	--	--	--
206	ss	14	--	--	--	2,030	0.74	--	--	--
207	ss	10	--	--	--	2,020	2.65	--	--	--
208	ss	16	--	--	--	1,860	1.00	--	--	--
209	ss	16	--	--	--	1,750	0.64	--	--	--
210	ss	12	--	--	--	1,860	1.15	--	--	--
211	ss	12	--	--	--	2,200	0.31	--	--	--
212	ss	24	--	--	--	1,820	0.83	--	--	--
213	ss	20	--	--	--	950	0.62	--	--	--
214	ss	19	--	--	--	1,080	0.57	--	--	--
215	ss	8	--	--	--	1,750	1.85	--	--	--
216	ss	10	--	--	--	1,850	0.78	--	--	--
217	ss	12	--	--	--	1,900	1.10	--	--	--
218	ss	15	--	--	--	1,800	0.84	--	--	--
219	ss	14	--	--	--	1,870	0.28	--	--	--
220	rx	10	--	--	--	600	0.27	--	--	--

TABLE 8.3.1 (Cont.)

AVAN RIVER AREA

GEOCHEMICAL AND ASSAY RESULTS

(Values in ppm, unless noted)

Sample No.	Type	Cu	Pb	Zn	Ag	Ni	% Cr	Cr	ppb Pt	ppb Pd
BM 221	ss	11	--	--	--	1,920	0.62	--	--	--
222	ss	9	--	--	--	1,850	0.49	--	--	--
223	ss	14	--	--	--	2,000	0.55	--	--	--
224	ss	12	--	--	--	2,250	0.66	--	--	--
225	ss	13	--	--	--	2,370	0.44	--	--	--
301				Reference Sample						
302	rx	--	--	--	--	-----	0.65	--	<50	<5
303	rx	--	--	--	--	-----	0.35	--	<50	<5
304	rx	--	--	--	--	-----	2.50	--	<50	<5
305	rx	--	--	--	--	-----	0.50	--	<50	<5
306				Reference Sample						
307	rx	--	--	--	--	-----	0.25	--	--	--
308	rx	--	--	--	--	-----	----	120	--	--
406	rx	29	32	126	--	600	0.12	--	--	--
407	ss	34	32	78	--	1,150	0.23	--	--	--
408	ss	17	32	44	--	1,420	0.29	--	--	--
409	ss	7	31	31	--	2,000	0.58	--	--	--
410	ss	7	26	34	--	1,800	0.25	--	--	--
411	ss	55	--	--	--	390	0.13	--	--	--
412	ss	20	--	--	--	700	0.23	--	--	--
413	ss	8	--	--	--	1,830	0.71	--	--	--
414	ss	16	--	--	--	1,450	0.73	--	--	--
415	ss	6	--	--	--	1,650	1.55	--	--	--
416	ss	46	--	--	--	950	1.00	--	--	--
417	ss	11	--	--	--	1,725	0.68	--	--	--
418	ss	10	--	--	--	1,850	1.05	--	--	--
419	ss	9	--	--	--	1,725	0.85	--	--	--

TABLE 8.3.1 (Cont.)

AVAN RIVER AREA

GEOCHEMICAL AND ASSAY RESULTS

(Values in ppm, unless noted)

Sample No.	Type	Cu	Pb	Zn	Ag	Ni	% Cr	Cr	ppb Pt	ppb Pd
BM 420	ss	4	--	--	--	1,750	1.20	--	--	--
421	ss	6	--	--	--	1,725	0.63	--	--	--
422	ss	4	--	--	--	1,775	0.69	--	--	--
423	rx	11	--	--	--	2,650	0.86	--	--	--
424	rx	--	--	--	--	-----	1.40	--	--	--
425	ss	5	--	--	--	1,520	0.81	--	--	--
426	ss	11	--	--	--	1,600	1.00	--	--	--
427	ss	8	--	--	--	1,625	0.65	--	--	--
428	ss	8	--	--	--	1,800	1.00	--	--	--
501	so	18	23	42	1.7	1,850	0.19	--	--	--
502	ss	30	17	136	1.2	270	0.03	--	--	--
503	ss	21	14	120	1.3	40	0.02	--	--	--
504	ss	9	17	151	1.1	250	0.01	--	--	--
505	so	50	15	81	0.9	30	0.01	--	--	--
506	so	12	30	60	2.6	20	0.004	--	--	--
507	so	14	16	143	2.4	50	0.01	--	--	--
508	ss	78	30	163	1.6	150	0.01	--	--	--
509	ss	36	24	131	1.7	900	0.26	--	--	--
510	ss	16	26	48	1.4	1,620	0.36	--	--	--
511	ss	5	29	28	1.8	1,890	0.43	--	--	--
512	ss	5	28	33	1.7	1,910	0.44	--	--	--
513	ss	12	26	41	1.8	1,400	0.47	--	--	--
514	ss	18	13	73	1.1	650	0.25	--	--	--
515	ss	11	6	97	0.4	200	0.001	--	--	--
516	ss	11	24	44	1.6	1,700	0.37	--	--	--
[illegible]7	ss	10	39	38	1.8	1,840	0.58	--	--	--
51[illegible]	ss	[illegible]	28	[illegible]	[illegible].9	1,[illegible]	[illegible].00	[illegible]	[illegible]	[illegible]

-229-

TABLE 8.3.1 (Cont.)

AVAN RIVER AREA

GEOCHEMICAL AND ASSAY RESULTS

(Values in ppm, unless noted)

Sample No.	Type	Cu	Pb	Zn	Ag	Ni	% Cr	Cr	ppb Pt	ppb Pd
BM 519	ss	68	22	25	2.1	200	0.12	--	--	--
520	ss	31	22	29	2.0	950	1.15	--	--	--
521	ss	12	27	40	1.7	1,700	2.25	--	--	--
522	ss	16	21	44	1.2	1,300	2.50	--	--	--
523	ss	16	34	27	1.8	1,625	1.50	--	--	--
524	ss	4	29	26	2.1	1,600	0.87	--	--	--
525	ss	5	31	28	2.0	2,030	0.81	--	--	--
526	ss	10	37	29	2.0	1,880	0.29	--	--	--
527				Reference Sample						
528	ss	16	37	33	2.1	1,900	0.59	--	--	--
529	ss	6	28	29	2.0	1,600	0.42	--	--	--
530	ss	8	30	29	1.8	1,575	0.30	--	--	--
531	ss	5	34	33	2.2	1,900	0.61	--	--	--
532	rx	--	--	--	---	-----	0.30	--	<50	<5
533	rx	--	--	--	---	-----	1.45	--	<50	<5
534	rx	--	--	--	---	-----	0.40	--	<50	8
535				Reference Sample						
536	ss	--	--	--	---	-----	----	8,000	--	--
537	ss	--	--	--	---	-----	----	8,300	--	--
538	ss	--	--	--	---	-----	----	7,900	--	--
539	ss	--	--	--	---	-----	----	1,250	--	--
540	ss	--	--	--	---	-----	----	2,800	--	--
541	ss	--	--	--	---	-----	----	7,600	--	--
542	ss	--	--	--	---	-----	----	2,660	--	--
543	ss	--	--	--	---	-----	----	230	--	--
544	rx	--	--	--	---	-----	2.25	--	<50	<5
545	rx	--	--	--	---	-----	0.30	--	<50	<5
546	rx	--	--	--	---	-----	0.86	--	<50	<5
547	ss	--	--	--	---	-----	----	6,200	--	--

TABLE 8.3.1 (Cont.)

AVAN RIVER AREA

GEOCHEMICAL AND ASSAY RESULTS

(Values in ppm, unless noted)

Sample No.	Type	Cu	Pb	Zn	Ag	Ni	% Cr	Cr	ppb Pt	ppb Pd
BM 548	ss	--	--	--	---	-----	----	7,400	--	--
549	ss	--	--	--	---	-----	----	3,800	--	--
550	rx	--	--	--	---	-----	0.25	--	--	--
551	ss	--	--	--	---	115	----	420	--	--
552	rx	--	--	--	---	-----	0.20	--	--	--
553	rx	--	--	--	--	-----	0.35	--	--	--

ss = stream silt sample
so = soil sample
rx = rock sample
\- = not analyzed

Collected by: Degenhart
Griffis
Via
Fairchild

8.4 MISHEGUK MOUNTAIN

8.4.1 Introduction

A brief reconnaissance was incorporated in the program at Misheguk Mountain to determine if copper, nickel, chromium, platinum, or asbestos mineralization is associated with ultramafic rocks which were reported to underlie the mountain.

Part of the Misheguk Mountain 1:250,000-scale quadrangle has been mapped by the U.S.G.S., and the results of this work are available as an open-file report at 1:100,000-scale (Brosgė, et al., 1967). Martin (1970) presents a review and interpretation of the structure of the western Brooks Range which provides useful information of a regional nature.

A U.S.B.M. open-file report (20-73) shows no mining claims present at Misheguk Mountain, however, a review of the State of Alaska Kardex file shows an inactive copper lode claim or claims located at 68°15'N latitude, 161°W longitude. This location shows this claim or claims to be located along an eastward flowing drainage of Misheguk Mountain.

8.4.2 Summary

Assay values of 4.3% chromium and 0.22% nickel (BM 231) were obtained over a 50-foot length. Chromite appears to be fairly widespread and is found as bands, lenses, and disseminations in serpentinite. The nickel is possibly present in silicates. Platinum analyses show less than 50 ppb.

Additional work is recommended to test the entire ultramafic body for significant occurrences of chromium, nickel, asbestos, and platinum.

8.4.3 Location and Access

Misheguk Mountain is located in T.33 N., Rs.10 and 11 W. in the Misheguk Mountain quadrangle. The mountain is about 70 miles northeast of the village of Noatak (Fig. 2) and about 15 miles south of the southern boundary of Petroleum Reserve No. 4. Streams draining the mountain flow into Trail and Okotak Creeks, which in turn drain into the Kugururok River, a major tributary of the Noatak River. Access to the area is by helicopter.

8.4.4 Work Accomplished

Traverses totaling about six miles were made and 36 samples were collected from two drainage basins at Misheguk Mountain, which is part of an ultramafic complex of about 32 miles by 13 miles. Misheguk Mountain is part of a large, serpentinized, ultramafic body flanked by mafic volcanics and intrusive rocks.

8.4.5 Geology and Mineralization

Misheguk Mountain is part of a large ultramafic body which is approximately 32 miles long in a northeast direction and about 13 miles wide in a northwest direction (Grybeck, et al., 1977).

The central part of the ultramafic body is mapped as a Jurassic, Triassic or Permian serpentinized complex of gabbroic and ultramafic rocks flanked on three sides by an ophiolite complex of mafic volcanic and intrusive rocks (Grybeck, et al., 1977). The southwest edge of the complex is bounded by Mississippian carbonate and clastic rocks (Utukok and Kogruk Formations) and by Cretaceous and Jurassic rocks consisting of graywacke, sandstone, quartzite conglomerate, siltstone, shale, and argillite.

In the area examined, serpentinite and diorite appeared to be the predominant rock types present, however, near sample BM 441, located on the west edge of the mountain, north-northeast trending limestone is apparently in fault contact with the ultramafic rocks.

The only sulfide identified consists of disseminated pyrite in serpentinite. Chromite occurs in serpentinite as discontinuous bands less than one inch wide, small pods, and disseminations. Individual bands or occurrences noted during the brief reconnaissance are rarely traceable for more than 30 feet. The extent of the chromite mineralization is unknown, but observations indicate it may be widespread.

Sample BM 231 was collected across a 50-foot long outcrop of serpentinite containing three bands and abundant disseminated chromite. None of the bands exceeded one inch in width but ranged from 10-30 feet in length. The sample assayed 4.3% chromium and is considered representative of the chromite mineralization observed at Misheguk Mountain. A greenish mineral has been tentatively identified as garnerite. Samples BM 228 and BM 231 assay 0.22% nickel. It is likely that the nickel occurs as garnerite (H_2 (Ni, Mg) SiO_4+H_2O) or another nickel silicate since no nickel sulfides or sulfide gossans have been noted.

Four rock samples analyzed for platinum and palladium show less than 50 ppb and 5 ppb, respectively. No asbestos minerals were observed.

TABLE 8.4.1

MISHEGUK MOUNTAIN

ASSAY RESULTS

Sample No.	% Cu	% Ni	% Cr	ppb Pt	ppb Pd	Description
BM 228	0.01	0.22	7.50	<50	5	Rubble sample - serpentinite with bands and disseminations of chromite
229	0.01	0.18	4.95	<50	5	Rubble sample - 3' chip sample of dunite with 1" band of chromite
231	0.01	0.22	4.30	<50	5	Outcrop sample - 50' chip sample of dunite with several small bands of chromite
235	0.05	0.03	0.40	<50	5	Rubble sample - serpentinite with disseminated chromite

8.4.6 Geochemistry

Thirty-two stream silt samples were collected for analysis of copper, nickel, and chromium. Sample BM 435 was lost in the field.

Three samples (BM 233, BM 238 and BM 247) show values of 200 ppm copper, which are the highest copper values recorded at

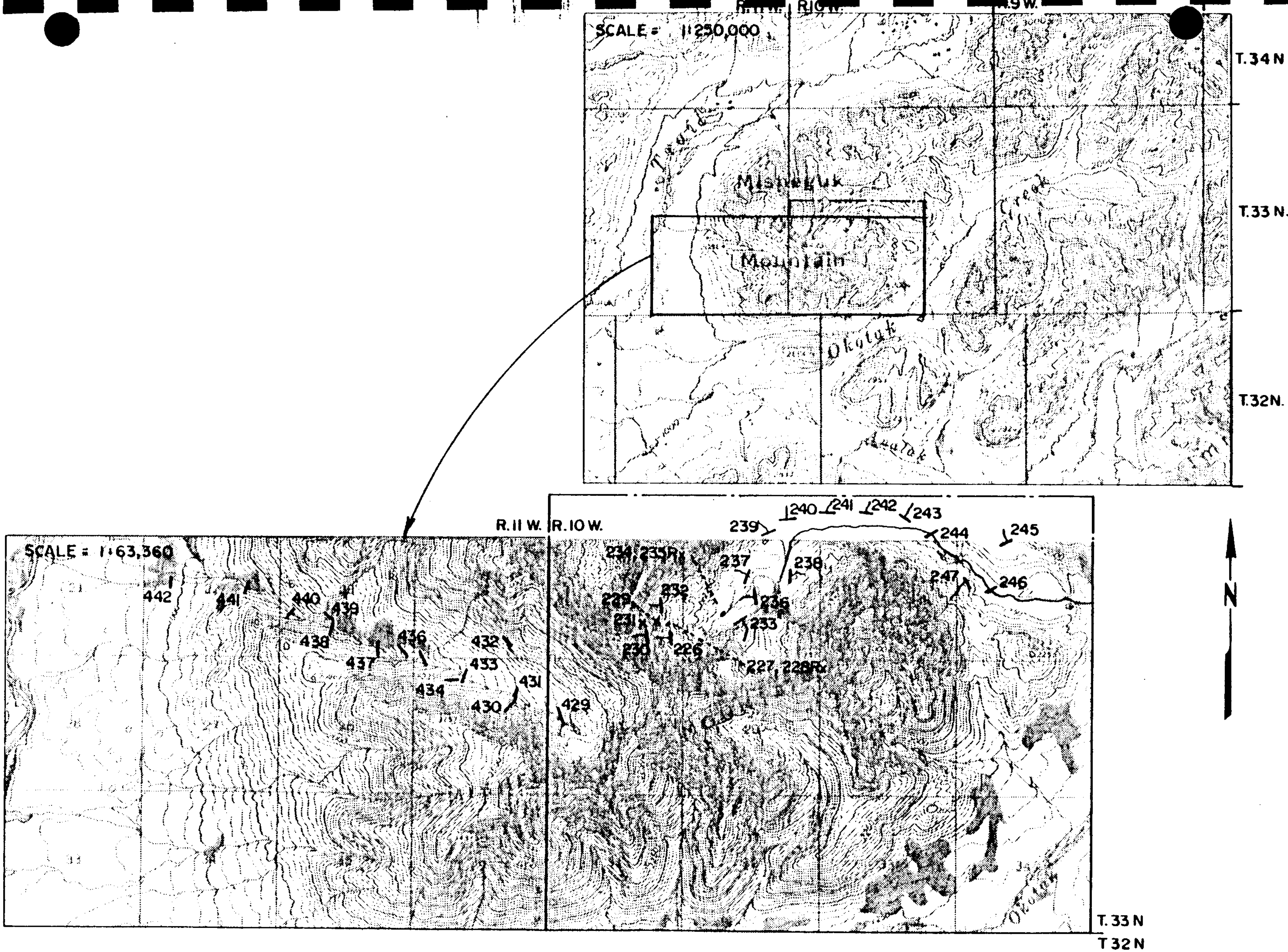
Misheguk Mountain. Bedrock and stream float at the three sample sites is predominantly serpentinite. No copper mineralization was noted at any of the three sites and the geochemical values are attributed to background concentrations in the local bedrock.

Nickel values ranging from 80 ppm to 1,770 ppm were obtained. No nickel sulfide mineral was observed, however, the majority of high nickel values were obtained from drainages on the west side of the Misheguk Mountain and are about 2.5 times greater than those from the east side. Additional sampling is required to determine if a buildup of nickel mineralization is present.

Chromium stream silt values range from a low of 110 ppm up to 7,400 ppm. At most sample sites which show values in excess of 2,000 ppm, serpentinite with minor amounts of chromite is present. Additional detailed silt sampling is required to define areas or zones containing significant amounts of chromite.

8.4.7 Conclusions

A limited amount of work at Misheguk Mountain indicates that chromite associated with serpentinite is fairly widespread



WGM INC MINING & GEOLOGICAL CONSULTANTS ANCHORAGE, ALASKA	DWN BY T.D.	REVISED	**SAMPLE SITE LOCATIONS**	FIGURE
	DATA BY WGM		MISHEGUK MOUNTAINS AREA	**8**
SCALE: AS SHOWN	DATE 6/75		MISHEGUK MOUNTAINS A-4 QUADRANGLE	BM128

in occurrence. The chromite occurs as small bands, lenses and disseminations. Individual bands rarely exceed one inch in width and are not traceable for more than a few tens of feet.

No nickel or copper sulfide mineralization was observed, however, nickel geochemical values obtained from drainages on the west side of the mountain are about 2.5 times greater than those from the east side of the mountain. Nickel assays of 0.22% were obtained from two rock samples located along the headwall of the eastern drainage. The nickel may be present in silicate form.

8.4.8 Recommendations

Additional work consisting of detailed geochemical stream silt sampling and prospecting is recommended for Misheguk Mountain and the entire area underlain by ultramafic rocks covering about 32 miles by 13 miles.

This work should be directed toward discovery of chromium and/or asbestos mineralization of sufficient tonnage/grade configurations to warrant additional work. Attention should also be given to searching for other types of mineralization such as platinum. It should be determined if the nickel mineralization is present in sulfide or silicate form, and if present as sulfide, additional exploration is warranted.

TABLE 8.4.2

MISHEGUK MOUNTAIN

GEOCHEMICAL SAMPLE RESULTS

(Values in ppm)

Sample No.	Type	Cu	Ni	Cr
BM 226	ss	11	1,040	2,600
227	ss	58	1,050	7,400
230	ss	26	1,370	3,200
232	ss	9	920	5,300
233	ss	200	195	170
234	ss	92	860	1,000
236	ss	167	470	330
237	ss	139	670	1,150
238	ss	200	138	130
239	ss	166	270	290
240	ss	151	170	230
241	ss	68	700	2,500
242	ss	80	570	220
243	ss	51	630	560
244	ss	94	300	330
245	ss	71	170	380
246	ss	167	140	170
247	ss	200	80	110
429	ss	102	950	2,100
430	ss	33	1,480	3,300
431	ss	23	1,280	2,700
432	ss	13	1,500	4,700
433	ss	30	1,280	3,400
434	ss	29	1,300	3,500
435	ss		Sample lost	
436	ss	20	1,770	4,000
437	ss	20	--	4,700
438	ss	25	1,460	3,400
439	ss	20	1,670	4,000
440	ss	34	1,460	4,700
441	ss	26	1,420	3,500
442	ss	25	1,360	7,300

ss = stream silt sample
\- = not analyzed

Collected by: Degenhart
Via

8.5 MAIYUMERAK MOUNTAINS

8.5.1 Introduction

Mr. Eskil Anderson visited the area along the Eli River (Anderson, 1945). Anderson traversed along much of the length of the Eli River drainage during July, 1945 and at that time classified a portion of the Maiyumerak Mountains as basic igneous intrusive rocks. Martin (1970) presented a geologic map of part of the western Brooks Range which included a portion of the Maiyumerak Mountains. The U.S.G.S. has released a generalized geologic map as an open-file report which covers part of the Noatak quadrangle (Barnes and Tailleur, 1970).

Members of the WGM staff conducted minerals reconnaissance in portions of the Noatak quadrangle available for selection by the NANA Regional Corporation.

The plans developed for work by WGM in a portion of the Maiyumerak Mountains were twofold: (1) to inspect several areas displaying iron-staining to determine if the cause of this staining was related to pyrite, which in turn might be associated with other sulfide mineralization, and (2) to geochemically test a portion of the mafic environment for possible buildups of chromite and/or copper-nickel sulfides.

8.5.2 Summary

Preliminary reconnaissance activities were carried out over a portion of a large ultramafic pluton in the Maiyumerak Mountains. Several stream silt and soil geochemical values showing in excess of 250 ppm copper and one value of 2,075 ppm zinc were obtained. The moderately high copper values are attributed to minor amounts of chalcopyrite associated with serpentinite and basalt and are not considered significant. The anomalous zinc and one of the copper values remain unexplained and warrant follow-up. Geochemical stream silt sampling and preliminary minerals exploration are recommended for the pluton.

8.5.3 Location and Access

The Maiyumerak Mountains are located in the northwest portion of the Baird Mountains quadrangle and in the northeastern part of the Noatak quadrangle (Figs. 1 and 3). The examination area, which includes parts of Tps. 27-28N., Rs.14-16W., is located about 22 to 30 miles northeast of Noatak. Streams drain the examination area in a radial drainage pattern, flowing north and east to Uvgoon Creek, and south and west to the Eli River. Local access is by helicopter. Small fixed-wing aircraft can land on gravel bars along the Eli River less than one mile from the base of the south side of the mountains.

A preliminary examination was concentrated in the portion of the mountains located in the Noatak quadrangle, with only a minor amount of work conducted in the Baird Mountains quadrangle.

8.5.4 Work Accomplished

A total of 66 samples for analyses were collected from an area of approximately 36 square miles. Two traverses were made along drainages which are deeply incised in the mountains to inspect the bedrock and talus for indications of mineralization. The area has not been geologically mapped.

8.5.5 Geology and Mineralization

The Maiyumerak Mountains are considered to be part of the Asik Mountain Pluton, which is one of seven ultramafic plutons reported in the Brooks Range (Martin, 1970). The Asik Mountain igneous complex extends for about 67 miles in a northeast direction and may be as much as 25 miles in width. The western margin is obscured by alluvial cover in the

Noatak Valley. The east margin is apparently in fault contact with Devonian and Mississippian carbonates and shales of the Endicott and Baird Groups (Barnes and Tailleur, 1970). Tailleur and others (1967) and Martin (1970) conclude that the seven plutons are allochthonous and may have travelled a distance of 65 to 70 miles from the southeast.

A portion of the Maiyumerak Mountains is mapped as a Jurassic, Triassic, or Permian igneous complex consisting of mafic volcanic and intrusive rocks composed of basalt, diabase, diorite, gabbro, radiolarian chert, peridotite, and dunite with local flows, tuffs, breccias, and interbedded sediments (Beikman and Lathram, 1976).

Serpentinite and dark green to black basalt with amygdules filled with calcite and epidote appear to be the most common rock types. The serpentinite commonly contains small amounts of fine-grained pyrite as disseminations and fracture fillings. The weathering of the pyrite produces large orange to red-stained areas on outcrops and along streams. A minor amount of malachite was noted on occasional calcite fillings in the basalt, and very minor chalcopyrite is apparently associated with the serpentinite.

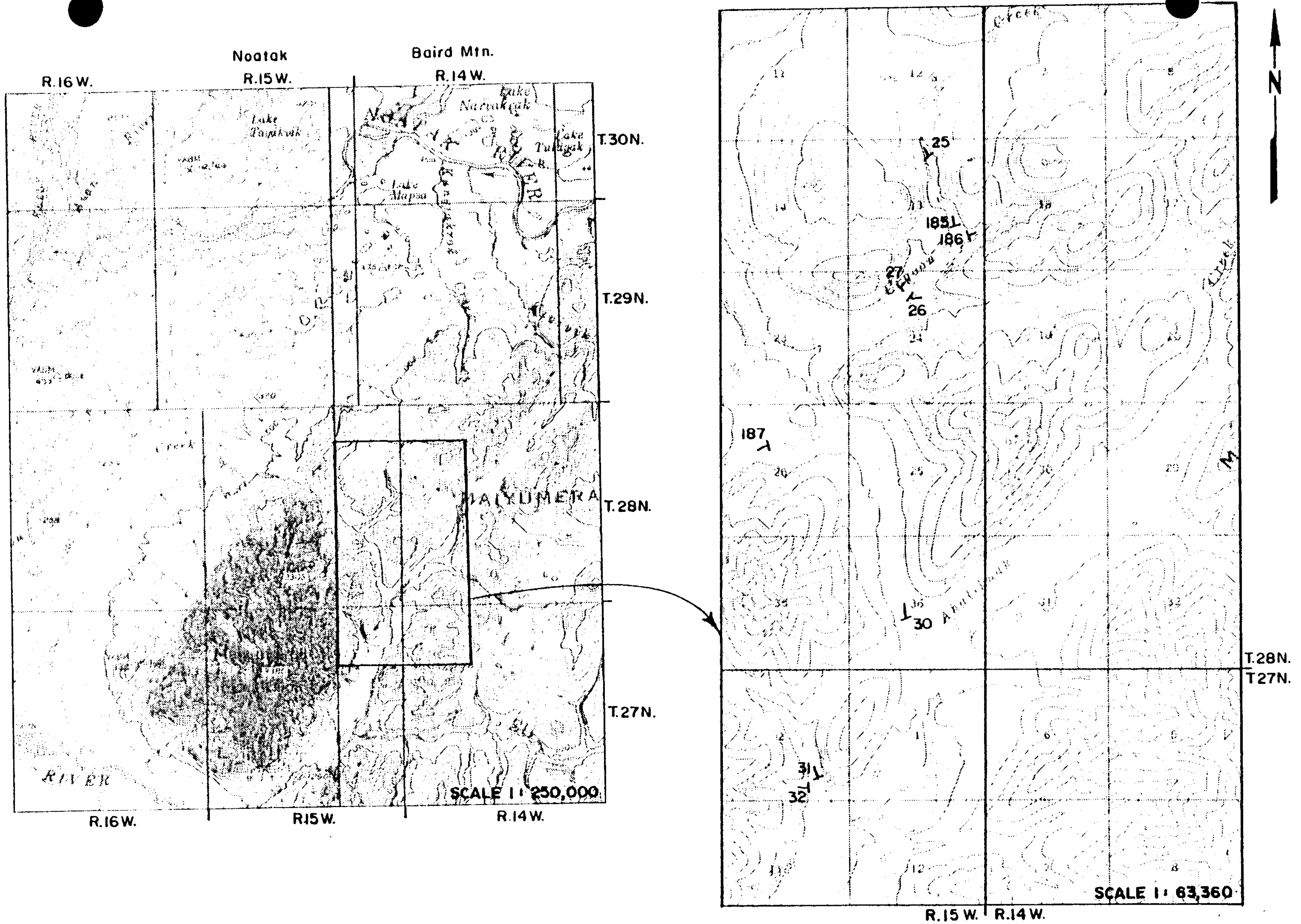
8.5.6 Geochemistry

Figures 9 and 9-A show sample site locations of 66 samples collected in the Maiyumerak Mountains. Analytical results are given in Table 8.5.1. All samples were analyzed for copper and nickel. Approximately one-half of the samples were analyzed for lead, zinc, and silver and four samples for chromium as a precautionary measure.

Copper values in excess of 250 ppm were obtained from seven samples. Six of these samples were collected from areas of basalt and/or serpentinite bedrock which contained minor amounts of fine-grained pyrite and chalcopyrite as disseminations. The high copper geochemical values are attributed to a minor amount of disseminated chalcopyrite.

Sample BM 27 which was collected from Uvgoon Creek (Fig. 9) analyzed 1,400 ppm copper and 2,075 ppm zinc. No bedrock is present at this sample site; however, stream float consists mainly of pyritic serpentinite and diorite(?). The source of the copper and zinc is unknown.

Sample BM 69 shows 110 ppm lead, which is about four to five times greater than the other lead values obtained in this



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SCALE AS SHOWN

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DATA BY WGM

DATE 6/75

REVISED

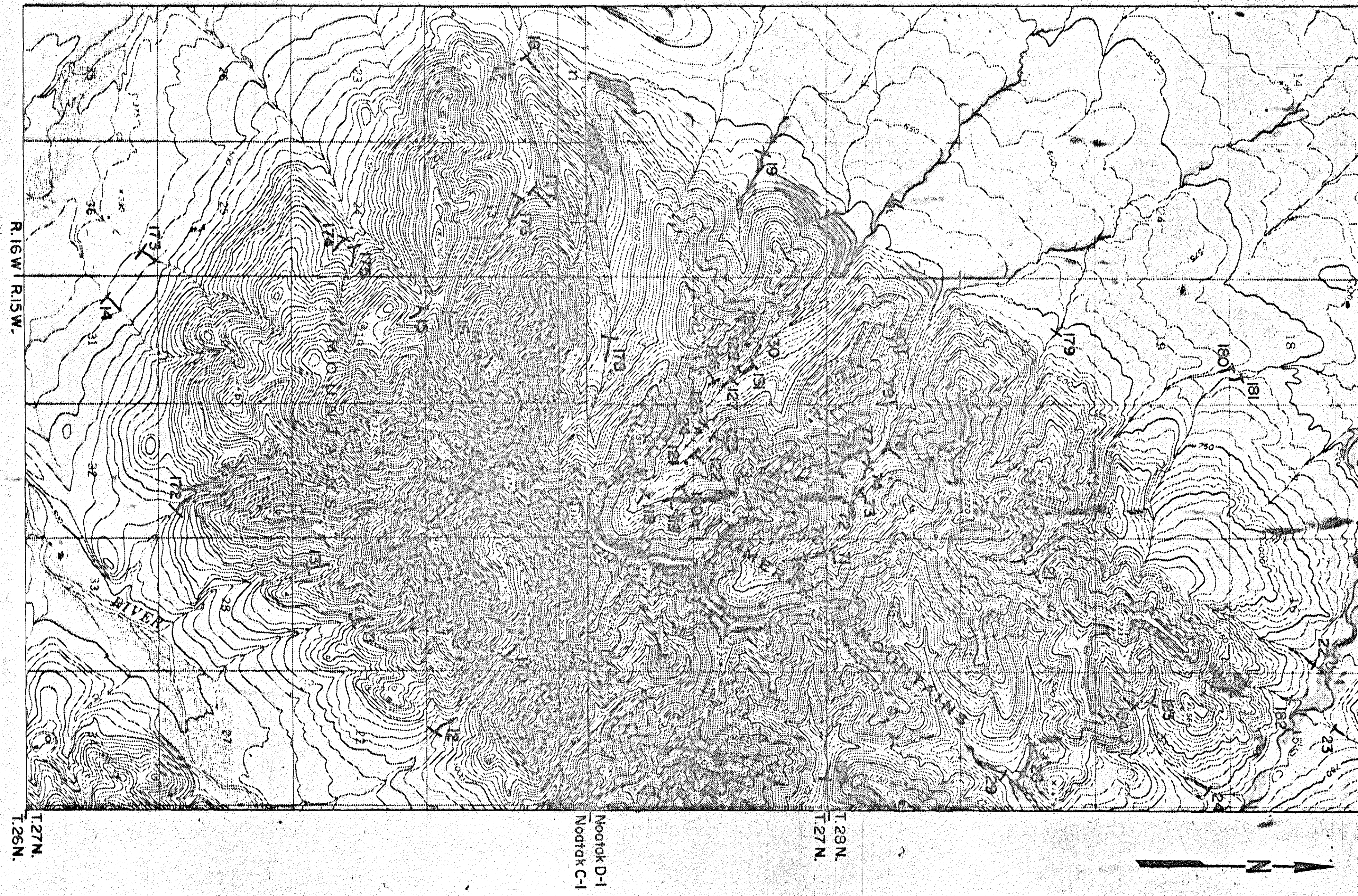
SAMPLE SITE LOCATIONS

MAIYUMERAK MOUNTAINS AREA

BAIRD MOUNTAINS C-6, D-6 QUADRANGLES

FIGURE 9

BM129



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SAMPLE SITE LOCATIONS
MAIYUMERAK MOUNTAINS AREA
NOATAK C-1, D-1 QUADRANGLES

FIGURE
9a
BM130

area. Stream float at this sample site consists mainly of serpentinite with a minor amount of intermediate volcanic rock.

No nickel, silver or chromium values obtained are considered anomalous.

8.5.7 Conclusions

An area of about 36 square miles underlain by part of a large igneous complex of up to about 67 miles long by 25 miles wide was covered by preliminary geochemical sampling. Results from the work indicate that serpentinite and basalt contain minor amounts of pyrite and chalcopyrite.

Anomalous zinc (2,075 ppm) and copper (1,400 ppm) values at BM 27 are worthy of follow-up. One lead value (110 ppm) at sample site BM 69 also deserves additional work.

No anomalous values were recorded for nickel, silver or chromium.

8.5.8 Recommendations

Additional work is recommended to follow-up on the anomalous values obtained from sample BM 27. This work should consist of additional sampling and prospecting in anomalous drainage basin and should involve not more than one or two man days.

As part of a regional scale exploration program, the entire ultramafic body should receive preliminary geochemical stream silt sampling and prospecting.

TABLE 8.5.1

MAIYUMERAK MOUNTAINS

GEOCHEMICAL SAMPLE RESULTS

(Values in ppm, unless noted)

Sample No.	Type	Cu	Pb	Zn	Ag	Ni	% Cr
BM 12	ss	133	28	196	---	39	--
13	ss	116	21	140	---	27	--
14	ss	62	16	78	0.3	15	--
15	ss	96	12	58	0.4	27	--
16	ss	182	20	96	0.4	23	--
17	ss	138	17	84	1.6	41	0.01
18	ss	110	15	84	1.5	33	0.01
19	ss	220	15	132	1.7	28	0.006
20	ss	102	17	72	0.2	56	--
21	ss	112	21	72	---	21	--
22	ss	72	18	124	0.3	48	--
23	ss	30	17	124	---	130	--
24	ss	72	17	78	0.2	28	--
25	ss	52	22	180	0.4	53	--
26	ss	56	20	120	0.4	53	--
27	ss	1,400	21	2,075	0.6	51	--
28	ss	72	16	94	0.3	28	--
29	ss	70	18	71	0.3	46	--
30	ss	66	18	109	0.3	23	--
31	ss	40	21	112	0.4	24	--
32	ss	76	19	112	---	20	--
69	ss	110	100	103	0.5	31	--
70	ss	100	35	85	0.4	33	0.01
71	ss	85	24	77	0.3	33	--
72	ss	98	21	73	0.2	38	--
73	ss	92	23	77	0.3	44	--
74	ss	90	20	76	0.2	119	0.02
75	ss	110	18	106	0.2	27	--
76	ss	218	16	79	0.2	40	--
77	ss	140	18	81	0.2	31	--
78	ss	288	20	196	0.2	69	--
79	ss	480	I7	54	0.4	19	--
80	ss	380	19	146	0.3	23	--
118	ss	126	--	---	---	31	--
119	ss	96	--	---	---	30	--
120	ss	94	--	---	---	29	--
121	so	55	--	---	---	27	--
122	ss	110	--	---	---	29	--
123	ss	84	--	---	---	27	--

TABLE 8.5.1 (Cont.)

MAIYUMERAK MOUNTAINS

GEOCHEMICAL SAMPLE RESULTS

(Values in ppm, unless noted)

Sample No.	Type	Cu	Pb	Zn	Ag	Ni	% Cr
BM 124	rx	84	--	---	---	8	--
125	ss	98	--	---	---	28	--
126	ss	217	--	---	---	30	--
127	ss	108	--	---	---	33	--
128	rx	258	--	---	---	18	--
129	so	920	--	---	---	35	--
130	ss	500	--	---	---	14	--
131	ss	81	--	---	---	28	--
170	ss	182	--	---	---	23	--
171	ss	142	--	---	---	23	--
172	ss	106	--	---	---	23	--
173	ss	33	--	---	---	11	--
174	ss	30	--	---	---	17	--
175	ss	54	--	---	---	17	--
176	ss	142	--	---	---	32	--
177	ss	127	--	---	---	48	--
178	ss	132	--	---	---	28	--
179	ss	104	--	---	---	18	--
180	ss	98	--	---	---	47	--
181	ss	42	--	---	---	55	--
182	ss	82	--	---	---	45	--
183	ss	80	--	---	---	24	--
184	ss	77	--	---	---	25	--
185	ss	51	--	---	---	52	--
186	ss	91	--	---	---	47	--
187	ss	76	--	---	---	43	--
188	ss	110	--	---	---	25	--

ss = stream silt sample
so = soil sample
rx = rock sample
\- = not analyzed

Collected by: Degenhart
Griffis
Via
Fairchild

8.6 OMAR COPPER PROSPECT

8.6.1 Introduction

Copper mineralization was discovered in 1961 by Bear Creek Mining Company, exploration subsidiary to the Kennecott Copper Corporation. A reappraisal in 1965 led to land acquisition. Approximately 50 lode claims were staked by Bear Creek. Examination work consisted of geologic mapping, soil-silt-rock geochemical sampling, rock assay sampling, ground geophysical, and a modest amount of diamond core drilling (Bigelow, C.G., per. comm., 1975).

Ground electromagnetics and induced potential surveys conducted by Bear Creek produced indifferent results (Schwenk, C.G., per. comm., 1975), although conducted in areas with known mineralization to several percent copper (Bigelow, C.G., per. comm., 1975).

A surface examination was scheduled for the U.S.B.M. program, since the data from the Bear Creek activities were not available for the current study.

8.6.2 Summary

The prospect, which is located in the Baird Mountains 40 miles northwest of Kiana, was examined by Bear Creek Mining Company in the early and mid-1960's. Approximately 50 mining claims were allowed to lapse. The results of the Bear Creek work are not publically available, but it is known that geological, geophysical and geochemical surveys, and an estimated 2,000 to 3,000 feet of drilling were completed.

Surface copper mineralization occurs locally along several NNW trending fracture over a distance of about 9,000 feet. The fracture zones, which locally are up to 100 feet in width, are located in an area with an east-west distance varying from 1,000 feet to 3,500 feet. Surface indications of copper mineralization are present only along the fracture zones confined to the west side of the prospect area. The highest grade assays occur at the southern (15.3% copper) and northern ends (9.6% copper) of the mineralized area. The high grade samples were collected from talus. Samples collected at occasional exposures along the intervening 9,000-foot length, range in values from 0.1% copper to greater than 2% copper. The individual surface shows located along the NNW fractures are separated by barren rubble zones to hundreds of feet in length.

The original Bear Creek claims were staked and appraised at a time when the area appeared to be far more remote than today. The property was allowed to lapse prior to the appearance of numerous competitors in the Brooks Range, and before the discovery of the significance of Red Dog during the course of this program. Several deposits with less impressive surface showings are presently the objects of extensive appraisal programs elsewhere in the Brooks Range, and in other parts of Interior Alaska. The very brief examination conducted during the Bureau of Mines program has confirmed the exploration potential of the prospect, and shows that additional work is justified.

Geological mapping over a three square mile area indicates that copper mineralization is associated with NNW trending fracture zones in Devonian carbonate rocks. Surface mapping of the mineralization was hampered by the fact that the copper at many of the mineralized outcrops have been highly leached.

The environment at Omar is favorable for the occurrence of at least two types of copper mineralization:

1. Fracture control. Strong copper mineraliation occurs sporadically at the surface along the

trend of NNW trending fractures that apparently extend for at least 9,000 feet near the west side of the old property. The mineralization is in fractured dolomite and intertonguing calcareous phyllite layers. Copper mineralization also occurs in fractured dolomite at the east side of the prospect.

2. "Reef" control. Most of the mineralization at the surface at Omar is in mottled massive gray dolomite similar in appearance to mineralized algal-mottled dolomite at Bornite-area copper deposits.

For comparative purposes, it is noted that Bornite area (Ruby Creek-Pardner Hill) mineralization appears to be fracture controlled at the surface due to weathering and attendent supergene alteration and veining (Bigelow, per. comm.). The copper mineralization at depth is almost invariably most intense within algal- cemented reef front dolomite clastic breccia facies, with local high grade in intertonguing pale green-sericitic-calcareous-phyllite layers. The intensity of copper mineralization decreases inward from the reef front environment toward the core of the reef. It abruptly terminates at the point where the reef talus and near off-reef facies are succeeded by normal bedded shelf carbonates in the seaward direction. Well-developed reef aprons, and intertonguing near off-reef facies have yet to be discovered at Omar, and it is these facies which would be sought at depth.

A third possibility is a comibination of (1) and (2), above. There are indications of at least minor remobilization at the Ruby Creek and Pardner Hill deposits. The reef front clastic breccias have been tectonically brecciated, with local migration of sulfides outward from high-grade material into narrow veins. However, the most intensive copper sulfide mineralization invariably are adjacent to and/or replace reef front facies, and fragments of reef material that have been engulfed in off-reef facies.

The geologic environment at Omar is similar in many respects to Mississippi Valley-type environments. Drilling is required to determine if the surface shows at Omar are the tips of significant carbonate-hosted massive sulfide deposits.

8.6.3 Location and Access

The Omar prospect is located in T.24N., R.10W. in the Baird Mountains quadrangle, approximately 40 miles northwest of Kiana, and 65 miles northeast of Kotzebue (Figs. 1, 2 and 4).

The prospect area is drained by two southerly flowing forks of the Omar River, which is a tributary to the easterly flowing Squirrel River. The Squirrel River is a tributary to the Kobuk River. Access to the area is by helicopter. Fixed wing aircraft have been landed at extensive terraces located about 8 miles to the southwest from the property.

8.6.4 Work Accomplished

A total of 272 samples and specimens were collected within an area of approximately three square miles. Laboratory analyses and/or petrographic studies were conducted on 127 of the samples. Mapping is at a scale of 1:12,000.

8.6.5 Geology and Mineralization

8.6.5.1 Regional Geology

The preliminary geology of the Baird Mountains quadrangle is published at a scale of 1:1,000,000 (Brosgė et al., 1967 and Beikman and Lathram, 1976). The paucity of data makes it virtually impossible to describe the regional setting in more than a general way. The prospect is underlain by Devonian rocks which cover an area of about 550 square miles. The strata consist predominately of limestone and/or marble, and shale of the Baird Group.

8.6.5.2 Local Geology

The geology of the Omar prospect is shown on Figures 10 and 10-A. A more detailed geological map is presented as Figure 10-A.

A variety of north-trending massive to bedded dolomite units typically display shallow to moderate westerly dips, with numerous local deviations indicative of localized folding, and possibly steep initial dips.

Most of the dolomites are fine-grained, dark gray massive bodies which display very few sedimentary features. The units are exposed mainly on crests and ridges in the vicinity of hills 2415 and 2455 (Fig. 10-A). Fossils are abundant locally. The majority of the megafossils are favositid corals, although there is a great variety of fossil assemblages in many exposures (Oliver, 1976; written comm.). The abundance and variety of coral forms has prompted Oliver to assign a probable Devonian age. The distribution and general character of the fossils suggest they probably formed in a paleo-reef environment.

Light tan to gray colored dolomites displaying thin sedimentary laminations are relatively widespread in the central and eastern parts of the property. At least some of the dolomitic bodies are lensoid reefs(?). Associated local breccia cones may represent clastic reef breccia aprons. No visible fossils have been detected in the bedded units which appear to intertongue with and/or be interbedded with the more massive dolomites. This is in common with the Bornite area (Ruby Creek-Pardner Hill) deposits where virtually all readily identifiable fossils are restricted to the massive dolomites and massive dolomite clastic breccia fragments. The suggestion is that the fossiliferous massive dolomites developed on the seaward side of the platform areas, whereas the bedded units formed in protected lagoonal waters. Much of the bedded carbonate probably was derived from degradation of the "reefs".

Limestone units, which are widespread along the western portion of the study area, are typically finely banded and commonly interbedded with light or dark gray dolomites. Interbedded dolomite and dolomitic limestone contain a variety of coralline fossils at several exposures on the southern flank of hill 2455. The grass and talus covered saddles between hills 2415, 2540, and 2455 contain several small exposures of dark gray, thinly bedded limestone units, suggesting that most of the covered saddle areas are underlain by similar limestone.

Large exposures of thinly banded iron-stained limestone occur adjacent to the northern crest of hill 2415. The highly foliated character of the exposures suggest they may have been thrust over portions of adjacent massive dolomites. However, there is very little convincing field evidence to support this possibility.

The carbonate sequences at the Omar prospect , have been folded into broad anticlines and synclines of variable attitudes. Detailed mapping at Omar indicates the presence of a series of steeply-dipping NNW trending fracture systems. The fracture zones are not always obvious in individual exposures, although the presence of highly fractured rocks along a NNW alignment strongly suggest their existence.

In many cases, fracturing has resulted in a stockwork of very narrow, white colored, dolomite-filled fractures in dark gray, generally massive dolomite host rocks. Dolomite breccias featuring rounded or angular clasts in a finer-grained matrix are common. Polished slabs suggest a tectonic origin for the breccias. Exposures at the prospect display many examples of fracturing that are gradational between the two extremes. The variation in intensity of fracturing apparently reflects structural extremes between mild, incipient fracturing and complete rupturing and dislocation.

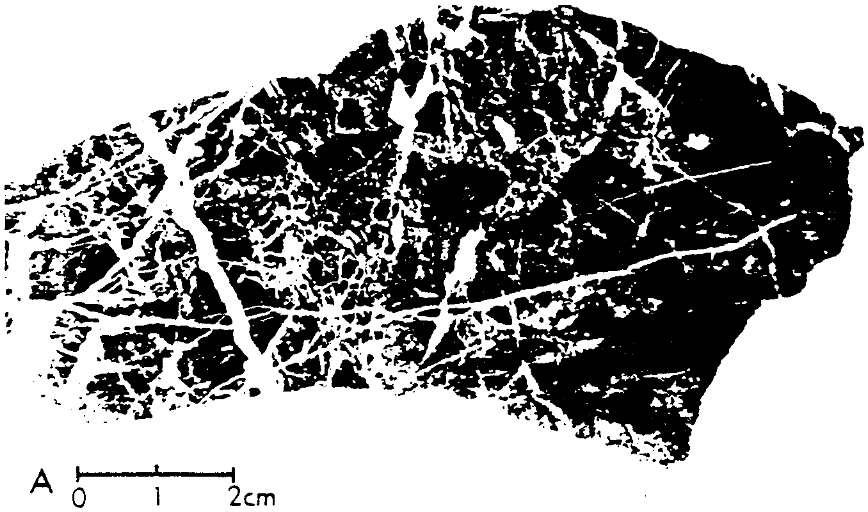
Figure 10-D illustrates several typical carbonate breccias. Some of the breccias are original sedimentary features

FIGURE 10-D

PHOTOGRAPHS OF SELECTED SAMPLES FROM THE OMAR COPPER PROSPECT

(A) Black fractured dolomite with white dolomite veins: central portion of sample shows brecciation (reference sample).

(B) Black dolomite fragments cemented in white dolomite matrix: matrix is slightly vuggy (Reference sample).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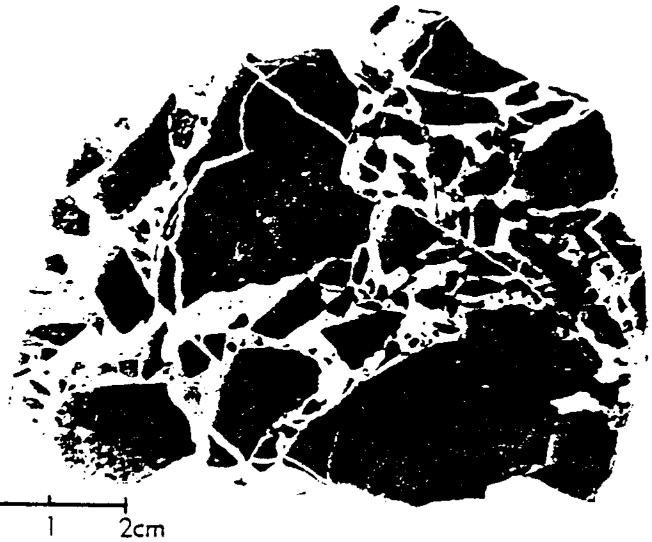
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developed in high energy shelf environments while others may be the result of solution collapse. The apparent NNW alignment of many of the breccia zones, as well as the existence of clearly observable faulting, suggests widespread tectonic brecciation. There is a reasonable possibility that at least some of the breccias are composite in origin, that is original clastic breccia zones deposited along structurally controlled NNW platforms have been subsequently shattered by fracturing along the same zone of recurring structural weakness (Bigelow per. comm., 1975).

8.6.5.3 Mineralization

Surface indications of copper mineralization are widespread (Fig. 10-A). Gaudy bornite mineralization is confined to dolomite float samples located on the northern flank of hill 2415. The area, which was referred to as the Blind Spot by Bear Creek, is the northernmost known mineral showing at the property.

Numerous small pits and trenches in the southern and central area of the property contain highly leached gossan material showing conspicuous to minor amounts of malachite. Samples BM 450, BM 451 and BM 452 show: 1,070 ppm, >20,000 ppm and 13,400 ppm copper respectively. The samples were collected from gossan in three trenches of about 30 to 40 feet in length across the width of a zone of fractured dolomite. The areal extent and the spongy nature of the gossan indicates that the grade fresh rock contains as much as 5% to 10% copper over a minimum width of 10 feet.

Bedrock exposures of mineralized rock are limited in areal extent, although fractures at several areas contain smears of malachite and/or leached gossan. The mineralization occurs as windows in pervasive talus - tundra in some areas and in other areas is more or less surrounded by barren to very weakly mineralized rock.

The vast majority of the areas with indicated subsurface mineralization are clearly related to fracture zones of inferred extensions of these structural features. What is not known is the relative importance of sedimentary versus structural controls of the mineralization. Perhaps, the depositional-structural-mineralization histories are inter-twined and related to a common recurring theme.

Hand specimens of mineralized samples from the Blind Spot area consist of medium gray, massive dolomite displaying considerable malachite, as well as substantial amounts of bornite, chalcopyrite and covellite. The sulfides occur in irregular masses from 3 to 7 inches in length, and as fracture fillings of less than 2 mm in width. Assay results of grab samples from mineralized float are shown in Figure 10-B and Table 5. Sample BM 372, which shows 9.60% copper is considered to be fairly typical of the grade of the talus mineralization. This selected sample of mineralized rubble was taken over a slope contour width of about 100 feet. Non-selective sampling of the rubble shows several percent copper. The source of the rubble, which was not found, is under slabby limestone screen which masks the top of the mineralized dolomite.

Sample No. BM 396, located on the southwest slope of hill 2455, shows 15.39% copper, while samples BM 371 and BM 372, located about 9,000 feet to the NNW assay 9.66% and 9.60% copper, respectively. Ten additional samples collected along the 9,000-foot interval show values ranging from 0.1% up to several percent copper.

It is probable that mineralization at depth is not continuous over the entire 9,000-foot strike length of intermittent surface exposures of copper mineralization. Virtually nothing is known about continuity downdip, or the distribution patterns at individual shows.

Geologic mapping results indicate that the copper sulfide mineralization is related to tectonically fractured dolomite zones. Figure 10-A shows observed locations of copper bearing and/or gossanous material and their apparent relationship to the northerly trending fractures. The observed copper mineralization and locations of drill sites appear to line up along the three westernmost fracture zones.

Figures 10-B and 10-C shows the location of samples collected at the Omar prospect and Tables 8.6.1 and 8.6.2 show the results from the sampling. Eleven polished specimens of the Blind Spot mineralization studied with a reflecting microscope are indicative of a relatively simple sulfide mineralogy dominated by bornite, but with considerable chalcopyrite and covellite. The typical occurrences and habits of the minerals are illustrated in Figure 10-E.

Bornite (Cu_5FeS_4) occurs as large irregular masses in well-defined fractures, and as extremely fine-grained (<0.1 mm), intergranular blebs. The myraid of small fractures that are apparent in hand specimens appear to be relatively discontinuous, irregular features when observed at higher magnifications. They usually display jagged, unmatched walls.

Chalcopyrite ($CuFeS_2$) commonly occurs as large, anhedral inclusions (usually between 0.1-2.0 mm) enclosed in the

FIGURE 10-E

PHOTOMICROGRAPHS OF SAMPLES FROM THE OMAR COPPER PROSPECT

(A) Dolomite, black host rock.

Bornite, medium gray.

Chalcopyrite, white, occurring as blebs and needles.

Covellite, along fracture in central portion of photograph (reference sample).

(B) Dolomite, dark gray to black host rock.

Bornite, medium gray "vein".

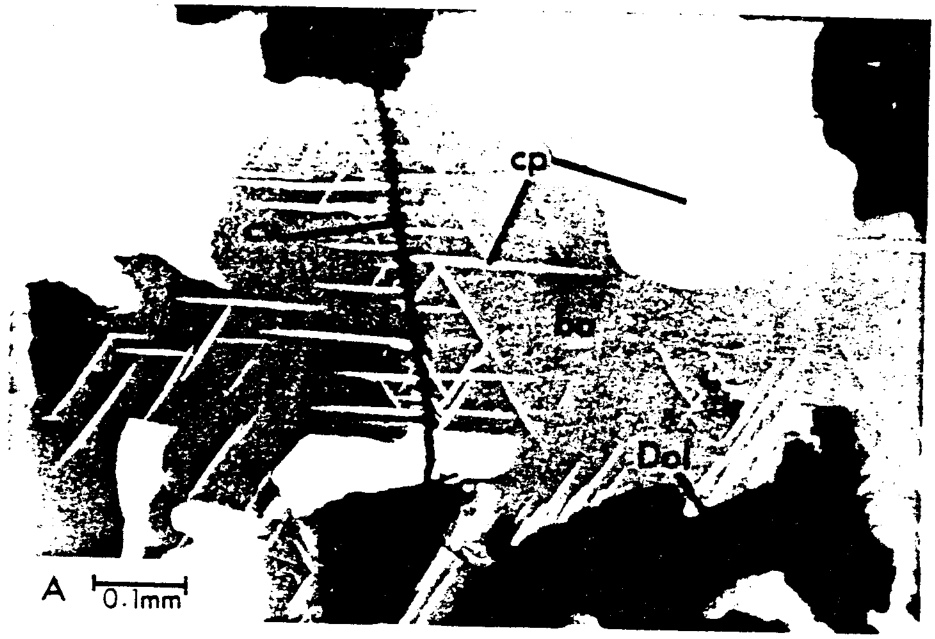
Chalcopyrite, white, as needles in bornite (reference sample).

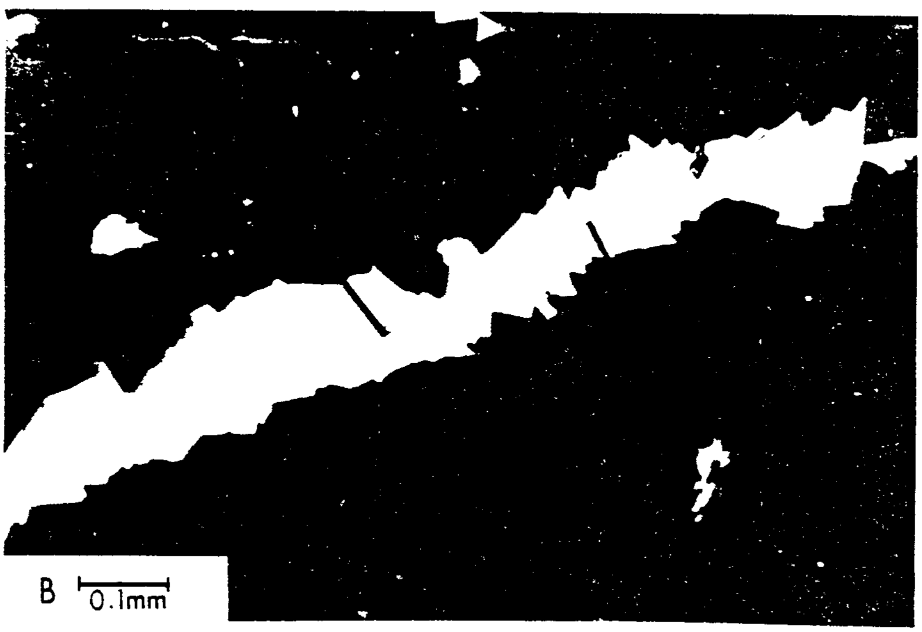
Symbols used: dol = dolomite

bo = bornite

cp = chalcopyrite

cv = covellite


cp
Ba
Dol
A
0.1mm


B
0.1mm

bornite masses, although a considerable amount occurs as tiny, needle-like inclusions (usually <0.2 mm long) in the bornite host. The needle-like structures are frequently concentrated along the margins of bornite grains or adjacent to fractures within the bornite.

Covellite (CuS) typically occurs as very narrow, inconspicuous envelopes along the margins of bornite grains and around the tiny chalcopyrite needles. However, it has also been observed as larger, irregular inclusions in coarser bornite masses or as fine-grained disseminations (<0.1 mm long) in dolomite host.

Inclusions of pyrite, usually less than 1 mm long, are common in both chalcopyrite or bornite. Most of the observed pyrite occurs as very fine-grained (approximately 0.01 to 0.05 mm) framboidal-like grains in carbonate host. A few grains of tennantite (silver-bearing copper arsenide) were observed in both chalcopyrite and bornite masses.

The textural features of the coarse bornite and chalcopyrite grains suggest the minerals are probably coeval. The chalcopyrite needle structures are very likely the result of exsolution, although local concentration adjacent to fractures suggests that they may be related to secondary (supergene?) processes. The relationship between the sulfides and dolomite host suggests that much of the sulfide was probably deposited in secondary fractures and primary pore spaces rather than by extensive replacement of host material. The apparent restriction of mineralization to NNW trending fracture zones clearly suggests an epigenetic origin for most of the sulfide. The framboidal pyrite grains probably formed syngenetically, and appear to be only coincidently related to the copper mineralization.

The general lack of available data concerning the regional geology makes it virtually impossible to correlate the Omar mineralization with other geological events in the region. The present study suggests that the mineralization was controlled by structural features, probably influenced by geochemical (i.e. favorable dolomite host rock) and sedimentary (i.e. pore-space availability) factors. The sulfide assemblage is suggestive of relatively low temperature conditions. The existence of a few highly altered mafic intrusive float samples suggests a possible link between mineralization and nearby magmatic activity. However, such a link is purely speculative and may be entirely coincidental, particularly since no similar mineralization has been discovered in nearby geologic terranes that include greenstones (Bigelow per. comm., 1975).

Examples of copper sulfide deposits associated with dolomitic reefs and carbonates are not abundant in the geological literature. However, the Ruby Creek deposit (Runnells, 1969) located approximately 100 miles ESE of the Omar prospect displays some similar features. The latter is a stratabound copper deposit associated with Middle Devonian reefs. Chalcopyrite, bornite, chalcocite and tennantite-tetrahedrite are the most important economic minerals in the Ruby Creek deposit which, according to Runnells (1969), were introduced into the carbonate host rocks from an outside, but unknown, source. While exact figures on the size and grade of this deposit are unavailable, it appears they are in the range of 100 million tons grading approximately 1.2% copper (Lund, 1961). Various figures have been verbalized concerning tonnage/grade configurations at Ruby Creek to suggest that substantial tonnages at 5% to 20% copper are present. The Pardner Hill deposits in the western Cosmos Hills also contain high grade copper mineralization of unpublished significance in reef dolomite.

In terms of sedimentary associations, both the Omar and Ruby Creek deposits display similar characteristics to many stratabound lead-zinc and/or copper deposits which are intimately related to paleo-reef environments (Monseur, 1973).

The potential for discovery of significant tonnages of high-grade copper mineralization is considered to be reasonable at the Omar prospect. Three target models are envisioned at the property: (1) the first and most obvious is copper sulfide mineralization related to the NNW trending fracture zones. The fracture(s) near the western side of the examined area are known to contain (at least locally) significant copper mineralization; (2) the existence of additional fracture zones to the east offers a second target area for discovery of additional copper mineralization at depth; and (3) the third target concept at the Omar prospect envisions occurrence of base metal sulfide mineralization in dolomite breccia aprons along reef front trend, similar to the Ruby Creek deposit located about 100 miles ESE from Omar. The sulfide may have been remobilized and redeposited in the same general areas as the original deposition during and after tectonic shattering of the clastic breccias.

8.6.6 Geochemistry

8.6.6.1 Local

Geochemical stream silt and grid soil sampling at many of the shows at the Omar prospect are of limited value due to pervasive rubble cover in most areas and lack of accumulation of silt in most drainages.

Figure 10-C shows sample site locations and results obtained at the Omar prospect. Eleven stream silt samples collected in Section 10 from an eastward flowing stream and its tributaries show values in excess of 150 ppm copper. The sample values are considered highly anomalous for a carbonate environment, however, several pits and trenches were excavated in the area by Bear Creek in proximity to the stream bed. The excavations expose mineralization assaying greater than 2% copper. It is likely that the stream silts are enriched by transport of copper sulfides and oxides downstream from the pits and trenches. Malachite is visible in the silt fraction of the stream with a handlens.

Extensive rubble cover and rapid downslope migration of the rubble prevents development of soil horizons at the prospect. Accordingly, soil sampling is not an effective method of tracing the mineralization.

8.6.6.2 Regional Implications of the Geochemistry at Omar

The Omar prospect was discovered as a result of stream silt geochemical sampling during the course of the Bear Creek regional exploration program conducted in the early 1960s. The results of subsequent regionally oriented geochemical programs revealed that standard statistical approaches developed to discriminate between background and anomalous metal values tend to confuse rather than to assist the investigator. Results are generally low and anomalies subtle or non-existent at any distance downstream from mineralization (Bigelow, C.G. per. comm., 1975). The exception is that occasionally very high values may result from either a major occurrence or a minor one if an isolated piece of copper oxide or sulfide is included in the silt sample.

Numerous regional exploration programs in the west Brooks Range have shown that copper-in-silt background is less than 20 ppm in stream basins of one to three square miles in area. A majority of the values are less than 15 ppm copper, and locally no more than 5 ppm. Values as low as 35 ppm have been followed up successfully to copper sulfides in outcrop.

Silts collected downstream from some of the greenstone dikes and sills that outcrop locally yield values of 50 to 250 ppm copper. Misleading anomalies of this type are discriminated by sampling the silt directly upstream from the greenstone.

A second caution pertains to basins that contains quartz-sericite-chlorite schist and phyllite in addition to carbonate rocks. The schists in the Brooks Range commonly yield copper-in-silt-values as high as 150 to 300 ppm in basins with areas of 1.5 to 2.0 square miles. The danger is that the geochemical dispersion of the schist may mask the presence of nearby significant carbonate anomalies.

Summarily, close-spaced sampling and normal prospecting are required in the carbonate terranes in the west Brooks Range. Values as low as 35 ppm copper-in-silt in areas with normal values below 20 ppm have led to discovery of copper mineralization. Values of 50 ppm and higher are considered to be highly anomalous, unless schist and cupriferous greenstone are present. The conclusions cited assume that silt samples are taken from drainages that do not exceed one to 1.5 square miles in area.

8.6.7 Conclusions

Copper mineralization has been traced along a strike length of about 9,000 feet apparently associated with NNW trending fracture zones of up to 100 feet wide. This, coupled with the presence of float samples showing up to 15.3% copper presents an attractive exploration target. If it is determined that high grade copper mineralization is associated with the fracture zones, the presence of additional NNW trending fractures, which apparently are unmineralized at the surface, offers a target that warrants further investigation.

The possibility of discovery at Omar burried reef front dolomite facies containing base metal sulfide mineralization similar to that found at the Bornite area deposits has not been tested. Mineralized reefs at Ruby Creek in the Bornite area are reported to contain up to 100 million tons at 1.2% copper, including "substantial" tonnages to 10%, or more.

Although limited diamond core drilling was done by Bear Creek Mining Company, the fact that Bear Creek dropped the claims is not viewed as an indication that significant mineralization is not present. During the period of 1971 to 1973, Bear Creek also dropped a large number of claims in the Ambler District. Virtually, all of the Ambler District claims have subsequently been restaked, and several thousand additional claims have been located by major mining corporations in the same area. At least some of the lapsed claim blocks are being aggressively appraised.

Further detailed work is therefore definitely warranted.

8.6.8 Recommendations

The following work is recommended at the Omar prospect, and at surrounding carbonate terranes:

1. A minimum of 10 diamond drill holes along the apparent NNW trend of the mineralization. The holes could be spaced up to a thousand feet apart along the projected strike length of the traceable mineralization. The objective of the drilling would be to test the western fracture zones including the Blind Spot, at depth for the presence and thickness of copper mineralization.

2. Contingent upon results from (1) above, additional diamond drill holes at closer spacing would be required to determine the continuity and tonnage/grade configuration of the zone(s).

3. A minimum of 4 diamond drill holes are recommended to test the fracture zones on the east side of the property to determine if fracture and/or reef front controlled mineralization is present.

4. Detailed geologic reconnaissance of nearby carbonate terranes is recommended. The recommended work includes very detailed geochemical stream silt sampling and foot-traverse prospecting.

5. A limited amount of geologic mapping is recommended at the property, with extension of same to the

northwest. The mapping could be accomplished in conjunction with drilling activities, and close-in prospecting.

TABLE 8.6.1

OMAR PROSPECTS

ROCK AND SOIL SAMPLE RESULTS

(Values in ppm unless noted)

Sample No.	Type	Cu	Pb	Zn	Ag	ppb Au
BM 309	rx	180	220	109	0.6	-
310	rx	18,500	400	1,200	2.6	-
315	rx	4,600	1,150	5,300	2.4	<5
316	rx	60	70	400	0.2	-
320	rx	>20,000	139	152	2.0	-
327	so	154	36	153	2.1	-
329	so	30	33	80	1.7	-
331	rx	1,130	44	28	0.3	-
336	rx	430	56	10	0.2	-
342	rx	580	1,160	9,400	2.8	-
344	so	120	33	100	1.5	-
346	so	180	52	250	0.8	-
348	rx	12,900	1,440	9,500	10.0	-
354	rx	7.10%	<.05	0,10%	.06 oz	tr
357	rx	16,000	1,330	2,900	3.4	-
358	rx	400	66	103	2.4	-
361	rx	108	58	84	2.6	-
362	rx	>20,000	75	300	3.1	-
371	rx	8.66%	<.05%	<.05%	.04 oz	tr
372	rx	9.60%	<.05%	<.05%	tr	tr
373	rx	2,500	-	-	3.2	5
375	rx	9,200	-	-	0.5	-
377	rx	10	-	-	3.6	5
383	rx	250	-	-	0.3	-
384	rx	1.46%	-	-	.02 oz	tr
393	rx	200	59	25	0.5	-
396	rx	15,39%	-	-	0.4 oz	tr
398	rx	26	44	93	0.4	<5
450	so	1,070	76	500	-	-
451	so	>20,000	280	840	-	-
452	so	13,400	166	1,260	-	-
481	so	13	60	23	-	-
484	so	210	64	203	-	-
489	so	9	56	12	-	-
490	so	18	38	12	-	-
491	so	90	58	62	-	-
492	so	10	34	10	-	-

Sample No.	Type	Cu	Pb	Zn	Ag	ppb Au
BM 566	rx	320	51	185	-	-
570	rx	490	45	32	-	-
571	so	18	36	12	-	-
572	rx	156	37	10	-	-
905	so	59	45	55	-	-
913	so	8	30	10	-	-

rx = rock sample
so = soil sample
- = not analyzed
> = greater than

Collected by: Degenhart
Griffis
Via
Fairchild

TABLE 8.6.2

OMAR PROSPECT

STREAM SILT SAMPLE RESULTS

(Values in ppm)

Sample No.	Cu	Pb	Zn	Ag
BM 251	22	58	40	-
252	14	58	26	-
253	25	49	44	-
254	43	45	112	-
318	23	53	33	4.1
326	13	54	22	4.2
328	9	53	17	4.2
334	25	53	59	4.1
337	26	53	108	4.0
338	21	51	65	4.0
339	39	50	192	3.6
349	370	58	186	3.4
350	450	50	245	2.7
352	560	50	400	1.8
353	640	48	380	2.0
365	20	50	25	4.0
366	20	53	60	4.1
369	4	52	28	3.4
370	4	48	12	3.7
379	58	64	143	3.6
448	15	58	80	-
449	810	83	660	-
453	680	66	165	-
474	11	68	148	-
475	9	50	36	-
556	22	56	40	-
557	40	38	52	-
558	47	29	97	-
559	23	56	32	-
560	30	-	-	-
561	20	-	-	-
569	32	52	72	-

Sample No.	Cu	Pb	Zn	Ag
BM 573	35	52	163	-
574	34	46	149	-
575	13	57	21	-
577	26	34	45	-
578	6	56	10	-
580	10	56	17	-
581	25	54	8	-
582	6	53	6	-
595	72	39	190	-
596	18	40	198	-
597	91	62	140	-
598	12	54	37	-
599	25	54	39	-
600	10	55	17	-
801	50	48	80	-
802	44	37	56	-
803	54	46	150	-
804	20	48	45	-
805	10	54	32	-
806	13	51	61	-
807	17	50	72	-
808	52	45	122	
809	44	34	170	2.0
811	35	24	108	1.4
812	32	48	148	0.2
813	20	49	66	3.0
814	8	49	23	3.0
815	7	52	26	3.4
816	14	44	56	2.6
817	9	45	46	2.9
818	10	50	22	0.2
820	20	48	55	0.3
821	44	46	260	0.2
822	23	50	117	0.4
823	24	50	97	0.2
824	780	60	410	0.4
825	2,600	76	510	1.0
826	96	58	115	0.4
827	660	64	660	1.1
828	260	37	230	0.8
829	150	39	450	0.6
830	112	63	520	0.6
831	1,350	73	340	0.5

Sample No.	Cu	Pb	Zn	Ag
BM 832	240	55	155	0.5
833	24	49	128	0.3
834	20	56	79	0.3
835	10	42	36	0.3
836	11	50	31	0.2
908	14	50	17	-
915	39	47	320	-
917	16	51	62	-

- not analyzed

Collected by: Degenhart
Griffis
Via
Fairchild

8.7 FROST PROSPECT

8.7.1 Introduction

The Frost prospect was discovered by Bear Creek Mining Company while conducting regional exploration in the Baird Mountains quadrangle. The prospect was discovered as a result of follow-up of the discovery of base metal sulfide float. A total of 16 lode claims staked in the mid-1960's were allowed to lapse in the early 1970's. Preliminary examination work conducted by Bear Creek consisted of geologic mapping, sampling and trenching. Apparently, there has been no diamond drilling.

Available data pertinent to the Frost prospect is limited to governmental geologic maps at the 1:1,000,000 scale (Beikman and Lathram, 1976, and Brosgé, et al., 1967), and results from the aeromagnetic survey of the eastern two-thirds of the Baird Mountains quadrangle (AOF-77).

The Frost prospect was examined because of reported base metal sulfide and barite mineralization (Bigelow, C.G., 1975, per. comm.). Results from the Bear Creek work have not been incorporated in this report.

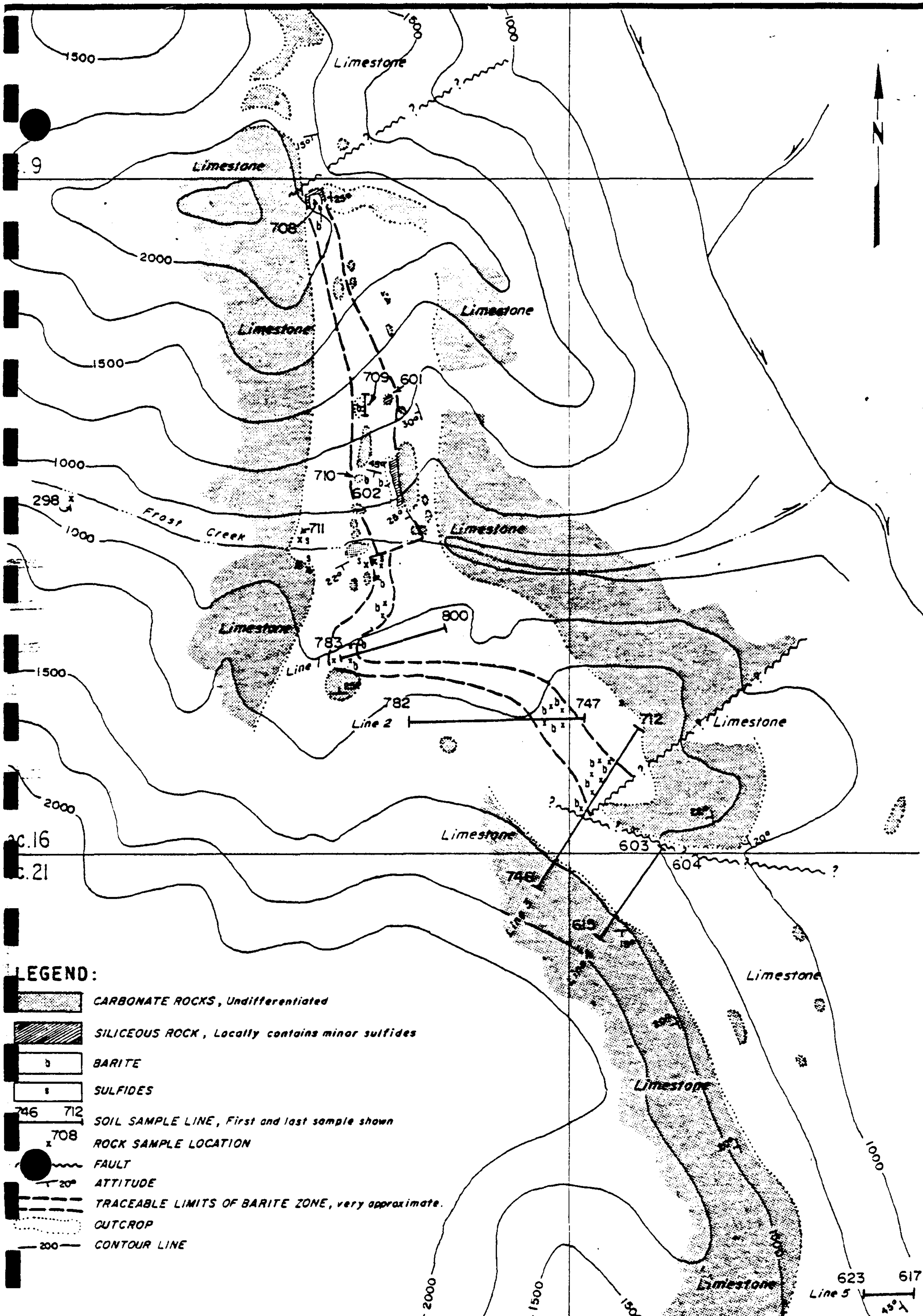


FIGURE **11a** BM131

FROST PROSPECT
GENERALIZED GEOLOGIC MAP
HAIRD MOUNTAINS B-4 QUADRANGLE

REVISED

DWN BY: T. D.
DATA BY: WGM
DATE: 7/1976

WGM INC MINING & GEOLOGICAL CONSULTANTS ANCHORAGE, ALASKA

SCALE: 1" = 1000'

The largest exposure of barite observed is represented by sample BM 708. The dimensions of the barite outcrop are: 75 feet strike length, 30 feet width and 30 feet dip length. The outcrop appears to be an isolated pod or lens of barite sandwiched between overlying and underlying iron-stained silicified carbonate(?) of about three feet of thickness. The silicified rock appears to be conformable with overlying and underlying limestone. A sample from the barite outcrop assayed 73.9% barite.

Three additional outcrops of barite are shown on Figure 11-A. The exposures are represented by samples BM 602, BM 709 and BM 710 which assayed 72.9%, 56.4% and 67.4% barite, respectively.

Barite talus along the north-facing side hill was traced to the south as far as Soil Sample Line #3, a distance of 5,000 feet. It is presumed that the talus is derived from lenses or pods similar in grade/width to the four observed in outcrop, as noted above.

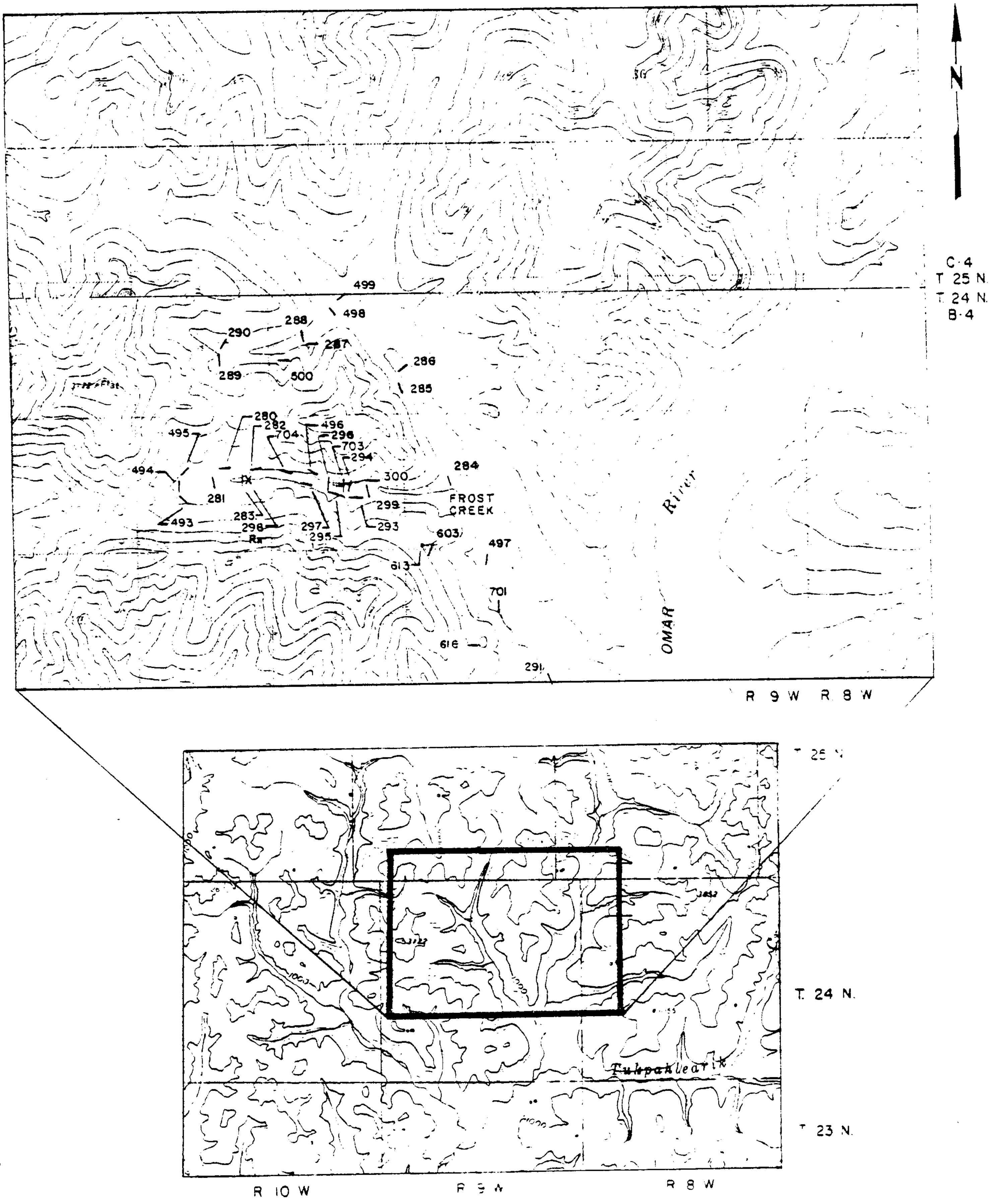
The quartzose rock that rims the barite exposures is also weakly mineralized as shown by analytical results of sample BM 601. This sample collected from a 20-foot by 35-foot by 2.5-foot exposure shows 0.21% copper and 18.9% barite.

The average grade of the four outcrops sampled is 67.6% barite. The presence of barite as pods or lenses, which are a minimum of 30 feet in thickness, up to 100 feet or more in strike length and found over a distance of about 5,000 feet presents a target for additional work.

The second type of mineralization at the Frost prospect occurs in the area of sample sites BM 298 and BM 711 (Fig. 11-A). Sample BM 298 was collected from a pinching and swelling quartz-calcite vein or lens which varies from 0.5 to 2.5 feet in width and extends for 10 feet in a N70°E direction before pinching out in limestone. The mineralization passes under cover to the west. The sample assayed 0.17% copper and 2.1% zinc.

Sample BM 711 is a representative chip collected from a vein 8 feet in width. The sample covers an area of 8 feet down the dip and 10 feet along the strike. The vein, which contains quartz, calcite, barite and sulfide assays: 0.49% copper, 13.2% zinc and 20.7% barite. The vein, which is exposed along the north side of Frost Creek, could not be traced to the north or south along its projected strike because of alluvial cover. It is possible that the vein is similar to the vein sample site BM 298. If so, it may pinch out in a few feet in both directions.

SCALE 1:63,360



SCALE 1:250,000

WGM INC MINING & GEOLOGICAL CONSULTANTS ANCHORAGE, ALASKA	DWN BY N.B / DATA BY WGM	REVISED	SAMPLE SITE LOCATIONS FROST AREA	FIGURE 11

indicate presence of mineralization. Unfortunately widespread talus material that originates upslope from the mineralization limits the application of the technique. Stream silt sampling provided information regarding the presence of the mineralization in nearby areas.

8.7.5 Geology and Mineralization

Bedrock at the Frost prospect consists entirely of Devonian Skajit Limestone facies. The Skajit is composed of light-to dark-gray limestone, and medium- to coarse-grained stratified dolomite and marble. Several ridges to the west and south of the prospect are capped by rusty-colored rocks consisting of muddy limestone and interbeds of shale. The rusty-colored rocks are similar to the Eli Limestone described by Tailleur et al., (1967).

Two seemingly unrelated occurrences of mineralization are present at Frost: (1) a zone consisting of barite pods(?) immersed in lenses of dolomite. The dolomite-barite zone is enclosed in silicified(?) carbonate which contains barite and sparsely disseminated chalcopyrite and sphalerite, and (2) pinching-swelling quartz-calcite-barite veins, one of which contains up to 13.7% combined Cu-Zn-Pb mineralization over a maximum known width of 8 feet.

The barite zone appears to be conformable with superjacent and subjacent limestone units which strike north-northwest and dip 25° to 45° to the west-southwest. Folding is evident to the west of the barite zone, and is most apparent on the south side of Frost Creek. An antinclinal structure with one overturned limb is present at this location. The barite zone is apparently unaffected by the folding.

Faulting may be responsible for terminating the barite zone at the northern and southern limits. The barite zone appears to be abruptly terminated by a fault at the northernmost exposure. No trace of barite could be found beyond the northern exposure shown in Figure 11-A. The limestone changes strike direction from north-south to east-west in a distance of about 100 feet at this location. Faulting at the southern end of the barite is not so apparent, however, no barite rubble was observed to the south of Soil Sample Line #3.

Lack of bedrock exposures makes it impossible to determine the exact dimensions of the mineralization without trenching and drilling. However, examination of the distribution of mineralized rubble, in conjunction with soil sampling, provides a means estimating extent and grade of the two types of mineralization.

8.7.2 Summary

The Frost prospect was examined to evaluate showings of two apparently unrelated types of mineralization.

1. Barite mineralization is present as discontinuous pods or lenses along a north-south distance of about 5,000 feet. Individual lenses are at least 75 feet by 30 feet.

2. Zinc and copper sulfides are associated with quartz-calcite-barite veins or lenses which pinch and swell along strike. A representative sample from one of these veins assayed 13.2% zinc, 0.49% copper and 20.7% barite. The vein is 8 feet in width where sampled.

Stream silt sampling was used to help define the extent of the mineralization and resulted in detecting three anomalous values which deserve additional follow-up work. Soil sampling has been helpful in establishing continuity in areas along the mineralized trend that are not covered with debris originating upslope from the target zone.

Additional work is recommended for this prospect, and in nearby carbonate terranes.

8.7.3 Location and Access

The Frost prospect is located in the Baird Mountains B-4 quadrangle in parts of sections 15, 16 and 22, T.24N., R.9W. (Figs. 1, 3 and 11).

Kiana, the nearest settlement, is about 37 miles south of the prospect, and the now-abandoned gold mining camp of Klery Creek is about 22 miles south of the prospect.

Frost Creek drains the property and flows into a southeast flowing tributary of the Omar River.

Access to the prospect is by helicopter since gravel bars along the Omar River do not offer good landing sites for small fixed-wing aircraft.

8.7.4 Work Accomplished

A total of 149 samples were collected during the Bureau sponsored program, including: 34 stream silt, 108 soil, and 7 rock. Analytical results are listed in Table 8.7.1, 8.7.2 and 8.7.3. Figures 11 and 11-A show the locations of the samples. Other field work consisted of geologic mapping and prospecting. Soil sampling was used where possible to

8.7.6 Geochemistry

Figure 11 shows the location of stream silt samples collected at and near the Frost prospect. Figure 11-A shows the locations of five soil sample lines.

Stream silt and commonly soil sampling cannot be considered as definitive at Frost due to pervasive talus which fill many of the small gullies and masks the presence of normal stream silt and/or soil. However, soil sampling is effective in the area to the south of Frost Creek and has provided an effective means of tracing barite mineralization in an area covered by alders and tundra.

Eight stream silt samples show values considered to be anomalous in one or more elements. Five samples (BM 284, 285, 293, 299 and 300) show anomalous values that are attributed directly to mineralization observed in the drainage basin from which the samples were collected.

Two of the other three samples considered to be anomalous were collected near the head of Frost Creek. Sample BM 281 shows 2,000 ppm barium, and sample BM 493 shows 300 ppm zinc. The two anomalous sample values may indicate the presence of additional mineralization to the west of the

Frost barite and base metal occurrences described previously. It is likely that additional quartz-calcite-barite vein(s) or lenses similar to that described at sample sites BM 298 or BM 711, are present.

The other anomalous stream silt sample (BM 500) shows 780 ppm copper which is the highest copper value obtained from stream silt samples at Frost, and ranks with the stronger values obtained downstream from the nearby Omar deposit, and is higher than any sample collected to date downstream from the Ruby Creek copper deposit at Bornite. This sample was collected about one mile north of Frost Creek. No mineralized stream float or bedrock was observed at this sample site, and the source of the anomaly is unexplained.

Detailed soil sampling conducted to the south of Frost Creek produced anomalies that resulted in the discovery of barite rubble as far south as Soil Line #3, a distance of about 5,000 feet from the northernmost exposure.

Results from sampling along line #1 indicate that barite is present over a distance of about 75 feet, along line #2 a 150-foot width of barite mineralization is indicated, and 500-foot width is suggested along line #3. No anomalous barium values were recorded along lines #4 and 5. Soil sampling results have defined targets for additional exploration, but trenching or drilling is required to determine the true width of the barite lenses.

8.7.7 Conclusions

Mineralization averaging about 67% barite is present as discontinuous pods or lenses along a zone of about 5,000 feet in length. Only four outcrops of barite were observed in the talus and vegetation covered area. However, soil sampling has provided an effective method of tracing the barite south of Frost Creek. The maximum dimensions of the largest barite lens located to date are 75 feet long by 30 feet thick.

Zinc and copper mineralization are associated with quartz-calcite-barite veins or lenses at two locations at Frost.

One of the mineralized occurrences is about 10 feet long by 2 feet wide and assays 2.1% zinc. This vein pinches out in both directions along strike. A second 8-foot wide quartz-calcite-barite vein assayed 0.49% copper, 13.2% zinc and 20.7% barite. This vein could only be traced to about 10 feet along strike before it passes under talus cover in both directions. It is possible that the strongly mineralized occurrence pinches and swells along strike.

Stream silt geochemical sampling results indicate that additional zinc-barite mineralization may be present near the headquarters of Frost Creek, and that copper mineralization may be present about one mile to the north of Frost Creek.

Additional work is warranted to define the source of the anomalies at Frost.

8.7.8 Recommendations

Additional work is recommended at Frost and at nearby areas located in the local carbonate terranes. Specific work recommended consists of trenching along the barite zone to determine if the apparently discontinuous exposures of barite are continuous at depth and/or to determine their size.

Trenching followed by drilling is recommended to determine the extent and grade of the sulfide-bearing vein along strike and downdip.

Additional recommended work consists of follow-up of the three unexplained geochemical anomalies.

Regional-scale exploration is recommended in this virtually unexplored region. The work should consist primarily of stream silt sampling of the carbonate terranes.

TABLE 8.7.1

FROST PROSPECT

STREAM SILT SAMPLE RESULTS

(Values in ppm)

Sample No.	Cu	Pb	Zn	Ba
BM 280	45	32	295	Is
281	44	44	170	2,000
282	25	25	134	900
283	41	30	170	1,300
284	43	77	1,110	3,500
285	42	69	710	1,100
286	17	64	76	600
287	18	29	147	700
288	21	32	64	500
289	29	37	270	1,800
290	22	30	55	300
291	15	25	46	600
292	16	14	55	500
293	63	30	345	932
294	26	38	126	784
295	23	32	120	Is
296	28	26	147	845
297	46	36	255	1,546
299	62	165	2,250	3,689
300	112	260	2,100	4,157
493	38	45	300	Is
494	44	62	250	Is
495	22	29	62	300
496	26	38	107	500
497	20	26	130	600
498	18	32	97	800
499	10	22	44	300
500	780	41	104	200
603	28	---	---	1,452
616	41	---	---	642
701	33	14	465	700
702	12	49	24	100
703	20	36	108	Is
704	36	42	157	1,052

Is = Insufficient sample
\- = Not analyzed

Collected by: Degenhart
Via

TABLE 8.7.2

FROST PROSPECT

SOIL SAMPLE RESULTS

(Values in ppm)

Sample No.	Cu	Ba
BM 604	32	797
605	42	952
606	43	1,171
607	38	965
608	52	1,171
609	46	965
610	52	1,200
611	44	990
612	64	1,299
613	50	1,120
614	33	743
615	47	825
617	19	809
618	21	485
619	43	1,200
620	36	685
621	33	535
622	30	464
623	34	525
712	30	456
713	48	1,029
714	36	723
715	48	792
716	50	1,052
717	52	1,251
718	58	1,241
719	560	4,537
720	1,080	4,630
721	1,320	8,558
722	280	4,426
723	370	10,692
724	188	6,953
725	6.0	5,026
726	300	7,107
727	265	7,531
728	112	6,890
729	39	3,310
730	41	4,379

TABLE 8.7.2 (Cont.)

FROST PROSPECT

SOIL SAMPLE RESULTS

(Values in ppm)

Sample No.	Cu	Ba
BM 731	43	887
732	36	935
733	42	859
734	44	1,245
735	48	870
736	45	1,152
737	42	867
738	38	814
739	35	872
740	23	610
741	38	677
742	38	857
743	54	915
744	49	891
745	49	864
746	47	894
747	118	1,180
748	110	960
749	78	1,330
750	105	1,351
751	82	1,443
752	208	1,203
753	124	1,300
754	670	1,769
755	220	4,577
756	240	3,977
757	220	5,023
758	153	3,370
759	180	3,068
760	31	923
761	32	730
762	34	747
763	30	812
764	38	819
765	36	823
766	30	607
767	34	753
768	41	972
769	35	815
770	46	987
771	32	747

TABLE 8.7.2 (Cont.)

FROST PROSPECT

SOIL SAMPLE RESULTS

(Values in ppm)

Sample No.	Cu	Ba
BM 772	48	1,167
773	44	932
774	38	899
775	40	995
776	44	917
777	40	803
778	34	827
779	36	734
780	34	786
781	58	1,634
782	56	1,357
783	104	10,529
784	134	13,218
785	55	2,235
786	36	1,354
787	45	1,368
788	28	1,219
789	39	1,288
790	44	1,349
791	48	1,475
792	42	1,465
793	40	1,327
794	44	1,395
795	52	1,629
796	42	1,786
797	44	1,564
798	48	2,318
799	44	1,995
800	45	3,480

Collected by: Degenhart
Via
Drew

WGM INC

TABLE 8.7.3

FROST PROSPECT

ASSAY RESULTS

(Values in percent, unless noted)

Sample No.	Cu	Pb	Zn	oz/ton Ag	$BaSO_4$	Description
BM 298	0.17	0.05	2.1			Bedrock chip sample across 2' width of quartz-calcite vein or lens; 10' strike length; strike N70°E, 65°SE; limestone host rock
601	0.21	0.05	0.05	0.05	18.9	Bedrock chip sample over 20' x 30' x 2.5'; siliceous rock intermixed with iron-stained barite
602	0.03	0.05	0.05	0.02	72.9	Bedrock chip sample over 30' x 25' area; pod or lens of barite bounded by siliceous rock and limestone
708	0.02	0.05	0.05	0.04	73.9	Bedrock chip sample over 75' x 30' x 30'; pod or lens of barite bounded by siliceous rock. Attitude - N15°W, 55°SW
709	0.02	0.05	0.05	0.04	56.4	Bedrock chip sample over 100' x 5' area; 100' long lens(?) of barite

TABLE 8.7.3 (Cont.)

FROST PROSPECT

ASSAY RESULTS

(Values in percent, unless noted)

Sample No.	Cu	Pb	Zn	oz/ton Ag	$BaSO_4$	Description
BM 710	0.01	0.05	0.05	0.04	67.4	Bedrock chip sample over 15' x 15' area; pod(?) of barite
711	0.49	0.05	13.2	0.04	20.7	Bedrock chip sample over 8' x 8' x 10'; quartz-calcite-barite vein. Attitude N-S, near vertical dip; bounded by limestone

8.8 KLERY CREEK

8.8.1 Introduction

Placer gold was discovered at Klery Creek in 1909 and has been mined from it and some of its tributaries nearly every year since (Cobb, 1973). Gold production figures from Klery Creek have been included with those from the Cosmos Hills. Cobb (1973) places the combined official figures for these two areas at about 34,550 fine ounces through 1960. However, actual production may be double that amount.

Nearly all placer mining activity in the Klery Creek area has been small-scale utilizing only a few men, however, a dredge was used for several seasons. During our 1975 visit to the area no active mining operations were in progress.

Interest in the area by governmental agencies dates back to 1910 when the area was visited by a U.S.G.S. party (Smith, 1913). From 1910 through 1940, yearly reports by the U.S.G.S. provided information concerning mining activity at Klery Creek. It was not until the 1960's, however, that systematic geologic mapping was conducted in the Baird Mountains quadrangle by the U.S.G.S. During 1967 a geologic map of the quadrangle at 1:1,000,000 was released as an open-file report (Brosgé et al., 1967). Since 1967, an aeromagnetic survey has been flown over the eastern two-thirds of the Baird Mountains quadrangle and the results of this survey were released by the State of Alaska as an open-file report (AOF-77). An unknown amount of geochemical stream silt sampling and geologic mapping has been carried out by the U.S.G.S. during the early 1970's but all the results from this work are not published and were not available. A geologic map of northern Alaska at 1:1,000,000 scale including the Baird Mountains quadrangle, was released in 1976.

Exploration work of a regional nature was carried out in the Baird Mountains quadrangle by Bear Creek Mining Company prior to enactment of ANCSA.

The number of active and/or inactive placer claims along Klery Creek and its tributaries is about 194 (U.S.B.M. OFR 20-73). Of this total, 172 are believed to be in the present study area.

It was beyond the scope and budget of this program to evaluate the placer gold potential of Klery Creek and its tributaries.

Smith (1911) mentioned that magnetite, ilmenite, pyrite and minor garnet were minerals commonly found in concentrates from the placer operations, however, no analytical results were reported for any of the concentrates. WGM visited the area and collected silt and panned concentrate samples for analysis. The objective of the work was to determine if base metal sulfides and/or tungsten mineralization was present in the area.

8.8.2 Summary

A brief examination of the Klery Creek placer gold district was conducted. The objective of the work was to geochemically test a portion of the area for the presence of other mineralization in addition to placer gold, which is known to be present. Sixty-two samples were collected, half being stream silt samples, the rest panned concentrate samples. In several panned concentrate samples, ilmenite was observed and, therefore, analyses for titanium were obtained in addition to copper, lead, zinc, silver, tungsten and gold. Zirconium analyses were also obtained since zircon was tentatively identified by one worker. The analytical results do not indicate the presence of zircon and it is likely that the mineral is garnet.

Seven anomalous gold values (one being 67,000 ppb or about 2 oz) and four anomalous tungsten values were obtained from panned concentrates. The gold anomalies are attributed to placer gold which is known to be present; the tungsten anomalies remain unexplained.

No work is recommended to test the remaining placer gold recoverable at Klery Creek. As part of a regional scale exploration program, a limited amount of work is suggested to define the source of the tungsten anomalies.

8.8.3 Location and Access

The old townsite of Klery Creek is located near the confluence of Jack and Klery Creeks in T.21N., R.8W. in the Baird Mountains quadrangle (Figs. 1, 3 and 12). Kiana, the nearest village is about 15 miles south of Klery Creek and a winter trail connects the two locations.

Klery Creek flows south into the Squirrel River, which in turn drains into the Kobuk River at Kiana.

A small unimproved landing strip, in need of repair, is located about 5 miles southwest of the old townsite.

8.8.4 Work Accomplished

At each of 31 sample sites, a stream silt and panned concentrate sample were obtained. Equal volumes of gravel were collected at each sample site and reduced to a standard volume in order to obtain analytical results which would be comparable between sample sites. The identification of ilmenite in a few of the panned concentrate samples prompted analyses for titanium in addition to tungsten, gold, silver and copper. Zirconium analyses were also obtained, however, a mineral tentatively identified as zircon was probably garnet.

8.8.5 Geology and Mineralization

Available geologic maps of this part of the Baird Mountains provide only a very general description of the geology. It appears that the Klery Creek area is underlain by an assemblage of north trending Lower Paleozoic and Upper Devonian rocks which includes: quartz-mica schist, mafic greenschist, calcareous schist, chloritic-quartz schist, phyllite, graphitic schist and limestone.

In the drainages sampled, rock types observed either as bedrock or float, consists mainly of graphitic schist containing quartz veins or stringers, quartz-mica schist, chloritic quartz schist and bluish white limestone.

The only known mineralization in the Klery Creek area is placer gold. Smith (1911) described two distinct types of gold at Klery Creek, and suggested that the placer gold was derived from several localities along the creek. One type of gold is coarse, dark colored and commonly still attached to country rock. This gold apparently has not travelled far from its source.

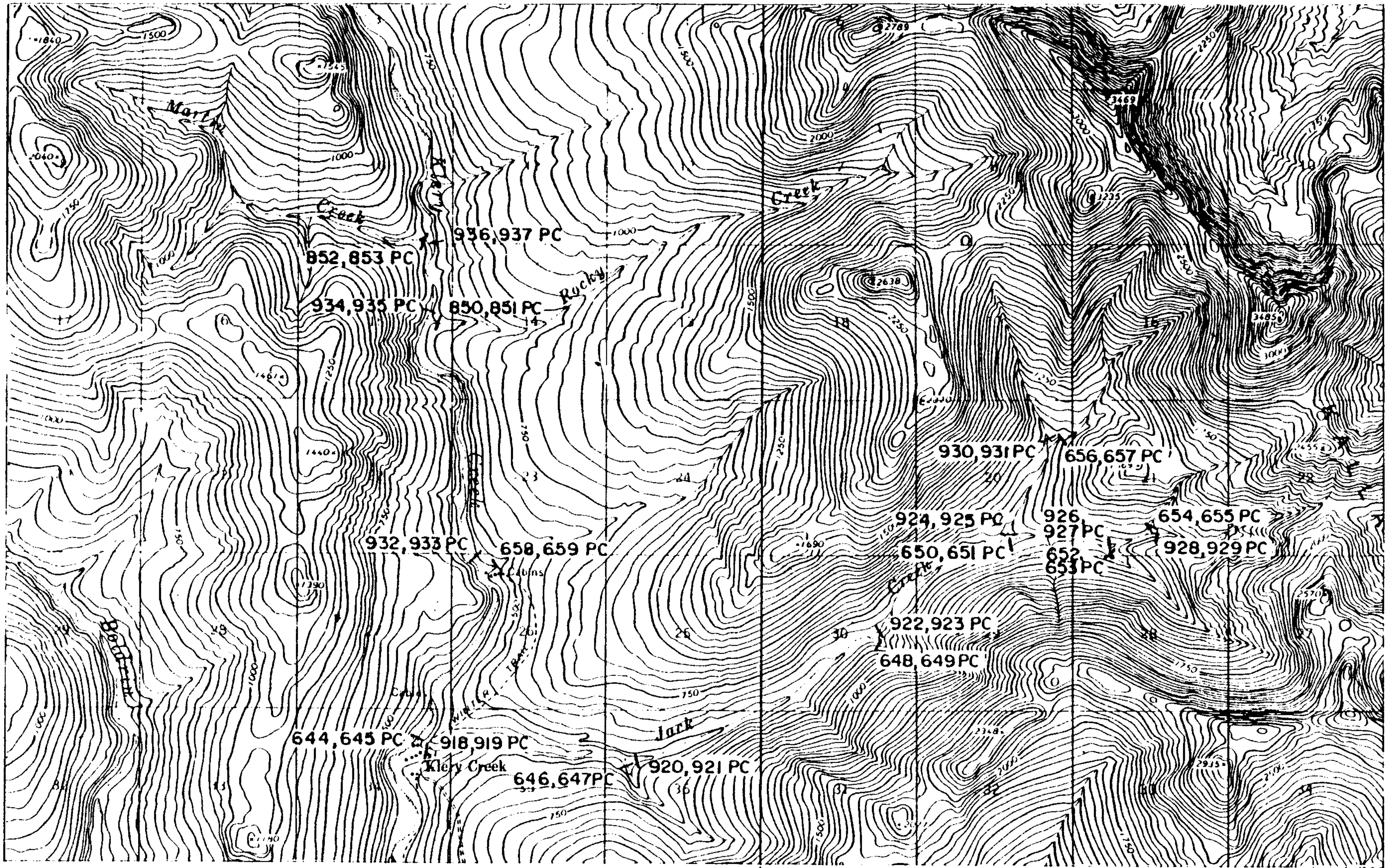
The second type of gold is very fine and brightly colored and appears to have travelled much farther from its source than the first type mentioned.

8.8.6 Geochemistry

Seven samples anomalous in gold and/or tungsten were identified out of a total of 62 stream silt and panned concentrate samples collected from 31 locations (Figs. 12 and 12-A).

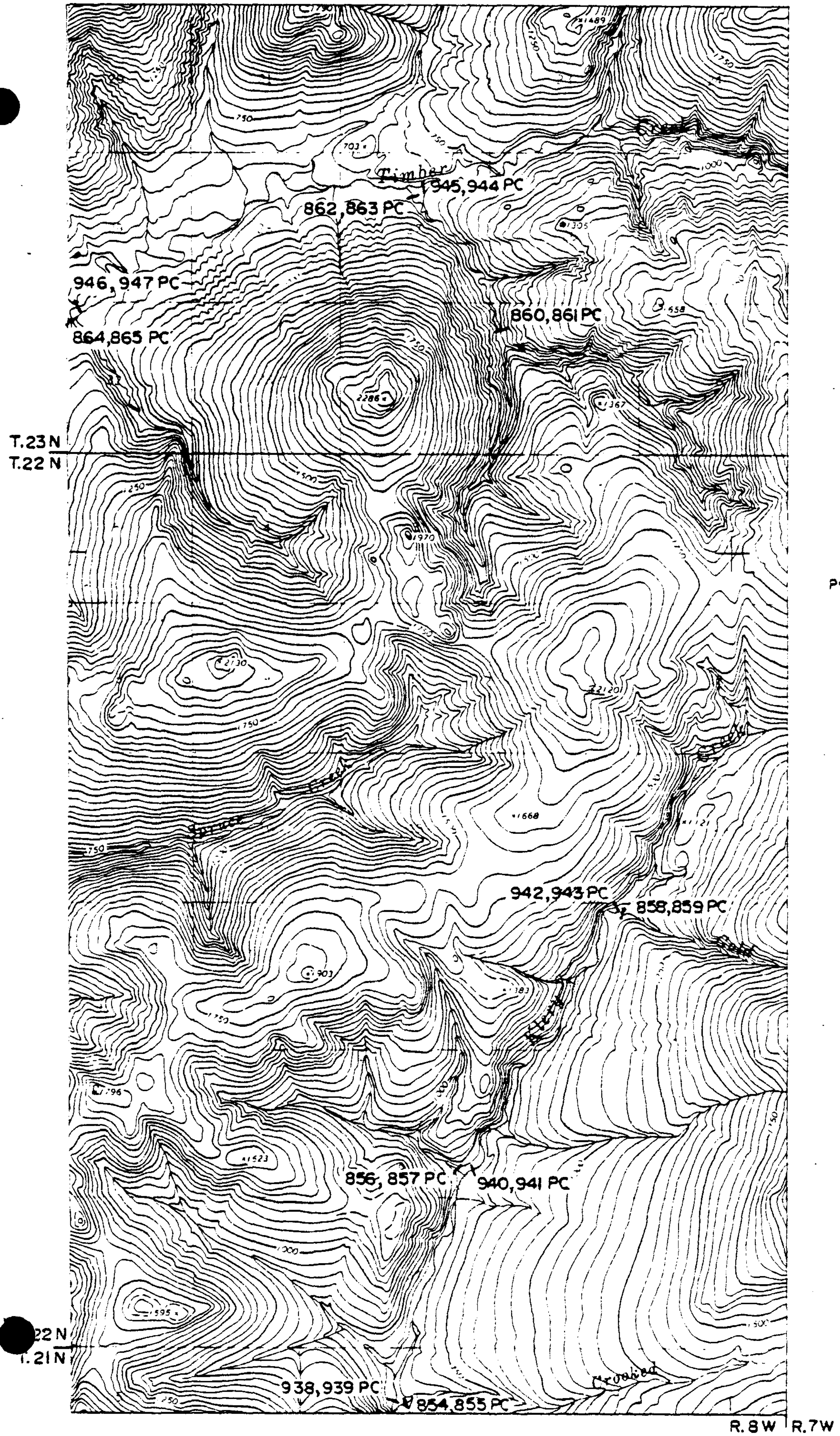
Gold values of 10 ppb or less were obtained from 55 of the samples. The seven weakly to highly anomalous values ranged from 20 to 67,000 ppb gold. Since the Klery area is a placer gold district, it is not surprising to obtain anomalous gold values of nearly any magnitude. Accurate sampling of placer gold deposits is impossible without resorting to drilling and/or digging to bedrock and collecting large representative samples. Samples BM 644 and BM 918, which recorded values of 140 and 210 ppb respectively, serve to illustrate that the distribution of placer gold in stream silts and gravels is impossible to determine in small samples. Both of these samples were stream silt samples; the panned concentrate samples collected at the same locations returned values of only <5 and 30 ppb gold.

Three of the four panned concentrate tungsten values considered anomalous are from samples collected in Klery Creek, the fourth was obtained from Timber Creek (Fig. 12-A). No tungsten was reported in 16 samples; 5 or less ppm was obtained from 11 samples; and values of 10 to 18 ppm were obtained from the 4 samples considered anomalous. Stream float at the sample sites consists of graphitic schist, quartz-mica schist and unaltered bluish-white limestone. No geochemical results considered anomalous in copper, lead, zinc, silver, zirconium or titanium were obtained.



PC indicates Panned Concentrate sample

WGM INC	MINING & GEOLOGICAL CONSULTANTS ANCHORAGE, ALASKA	DWN BY T.D.	REVISED	SAMPLE SITE LOCATIONS	FIGURE
SCALE:	1:63,360	DATA BY WGM		KLERY CREEK AREA	12
		DATE: 7/75		BAIRD MOUNTAINS A-3 QUADRANGLE	BM132



PC indicated Panned Concentrate sample.

WGM INC MINING & GEOLOGICAL CONSULTANTS ANCHORAGE, ALASKA	DWN BY: T.D.	REVISED	SAMPLE SITE LOCATIONS
1 : 63,360	DATA BY: WGM		KLERY CREEK AREA

FIGURE 12a

8.8.7 Conclusions

A very limited potential is recognized for economic reserves of placer gold in this area which has been intermittently worked since the early 1900's. As a result of mining activity over a span of 65 years, it is unlikely that the Klery Creek drainage basin contains reserves of gold large enough to support more than small placer operations.

Geochemical sampling at 31 locations in the Klery Creek area recorded seven values considered anomalous in gold and four tungsten values which appear to be anomalous. The anomalous gold values are erratic, ranging from 20 to 67,000 ppb, which is common when sampling placer gold deposits unless large volume samples are collected.

The source of the tungsten anomalies is unexplained by our limited amount of work. No rock types indicative of significant tungsten mineralization were observed and these samples warrant a limited amount of follow-up work.

No potential for copper, lead, zinc, silver, zirconium or titanium mineralization is indicated by results from the sampling.

8.8.8 Recommendations

No work is recommended to assess the remaining placer gold reserves in the Klery Creek area, since the area has been work for many years and the "best" placers have apparently been worked.

As part of a regional scale exploration effort, a few days time should be allotted to follow-up the tungsten anomalies. This work should consist of panned concentrate sampling of sufficient detail to locate the source of the tungsten anomalies.

WGM INC

TABLE 8.8.1

KLERY CREEK AREA

STREAM SILT AND PANNED CONCENTRATE RESULTS

(Values in ppm unless noted)

Sample No.	Type	Cu	Pb	Zn	Ag	ppb Au	Zr	% Ti	W
BM 644	ss	20	18	62	0.9	140	215	1.23	--
645	pc	18	--	--	1.1	<5	213	1.69	ND
646	ss	17	20	76	0.8	<10	247	0.63	--
647	pc	12	--	--	0.7	10	216	0.62	ND
648	ss	30	38	92	1.0	<10	238	0.58	--
694	pc	24	--	--	1.0	<5	218	0.57	ND
650	ss	30	17	126	0.8	<5	222	0.52	--
651	pc	29	--	--	0.8	<5	205	0.59	3
652	ss	40	15	114	0.7	<5	236	0.70	--
653	pc	50	--	--	1.9	<5	210	1.02	3
654	ss	42	16	161	0.8	<5	218	0.61	--
655	pc	36	--	--	0.7	<5	225	0.63	ND
656	ss	25	15	81	0.6	<5	278	0.69	--
657	pc	31	--	--	2.2	<5	218	1.45	3
658	ss	15	14	68	0.8	<5	248	0.73	--
659	pc	15	--	--	0.6	<5	193	0.86	5
850	pc	15	--	--	0.6	<5	206	1.09	5
851	ss	7	14	47	0.5	<5	175	0.39	--
852	pc	14	--	--	0.8	<5	216	0.58	3
853	ss	13	16	76	0.6	<5	219	0.50	--
854	pc	16	--	--	0.8	<5	208	0.75	ND
855	ss	17	20	170	1.0	<10	215	0.65	--
856	pc	18	--	--	1.0	67,000	200	0.77	5
857	ss	20	14	78	0.9	<5	222	0.53	--
858	pc	17	--	--	0.7	<5	254	1.02	ND
859	ss	16	15	61	0.6	<5	272	0.65	--
860	pc	24	--	--	0.9	20	192	1.24	ND
861	ss	24	17	78	0.9	<5	206	0.46	--
862	pc	23	--	--	0.8	<5	193	0.98	ND
863	ss	20	16	73	0.7	<5	196	0.44	--
864	pc	26	--	--	0.8	<5	194	0.74	ND
865	ss	19	17	90	0.8	<5	197	0.60	--
918	ss	19	26	80	1.1	210	201	0.46	--
919	pc	17	--	--	0.7	30	186	1.26	ND
920	ss	20	19	72	1.0	10	206	0.63	--
921	pc	19	--	--	0.8	<5	192	0.76	ND
922	ss	22	15	93	0.6	<5	207	0.46	--
923	pc	22	--	--	0.7	5	207	0.88	ND
924	ss	26	18	80	1.0	30	229	0.69	--
925	pc	20	--	--	0.7	20	214	0.70	ND

TABLE 8.8.1 (Cont.)

KLERY CREEK AREA

STREAM SILT AND PANNED CONCENTRATE RESULTS

(Values in ppm unless noted)

Sample No.	Type	Cu	Pb	Zn	Ag	ppb Au	Zr	% Ti	W
BM 926	ss	35	16	138	0.7	5	202	0.45	--
927	pc	29	--	--	0.6	<5	202	0.44	ND
928	ss	38	20	132	0.9	10	188	0.41	--
929	pc	29	--	--	0.7	<5	168	0.40	ND
930	ss	21	18	84	0.9	<5	228	0.44	--
931	pc	17	--	--	0.6	<5	193	0.44	ND
932	ss	14	16	72	0.9	<10	251	0.61	--
933	pc	14	--	--	0.8	<5	224	1.00	15
934	ss	11	12	60	0.5	<5	229	0.46	--
935	pc	14	--	--	0.8	<5	224	1.13	[illegible]
936	ss	17	14	64	0.8	<5	222	0.55	--
937	pc	16	--	--	0.8	5	208	1.10	10
938	ss	15	15	68	0.8	<5	240	0.75	--
939	pc	15	--	--	0.8	<5	210	1.48	10
940	ss	12	14	65	1.0	<5	236	0.50	--
941	pc	13	--	--	0.9	<5	227	1.04	5
942	ss	11	13	59	0.7	<5	224	0.41	--
943	pc	16	--	--	1.1	<10	211	1.31	3
944	ss	21	16	92	0.8	<5	218	0.45	--
945	pc	19	--	--	0.9	<5	224	1.05	3
946	ss	19	20	87	1.1	<10	217	0.77	--
947	pc	17	--	--	0.7	<5	206	1.17	18

ss = stream silt sample
pc = panned concentrate sample
ND = not detected
\- = not analyzed

Collected by: Degenhart
Via
Fairchild

8.9 TEMBY COPPER PROSPECT

8.9.1 Introduction

Previous geologic work in this area of the Baird Mountains is very limited. A generalized geologic map at a scale of 1:1,000,000 (Brosgė, et al., 1967) is available as a U.S.G.S. open-file report. This map also shows sample site locations and results from a limited amount of sampling carried out by the U.S.G.S. One of these samples B-203 (U.S.G.S. number), assayed 1.5% copper over unspecified dimensions.

A claim location map of the Baird Mountains quadrangle, available from the U.S.B.M., shows 19 placer gold claims in the vicinity of the Temby prospect.

8.9.2 Summary

An assay value of 1.5% copper was noted in a U.S.G.S. open-file report. Examination of the area from which the sample was collected led to the discovery of three weakly mineralized quartz veins, which vary in width from several inches up to three feet, and which may be traced along strike for 100 feet to 250 feet. Four samples averaged 1.1% copper, 0.07 oz/ton silver with a trace of gold.

No significant tonnage or grade of material is indicated and no additional work is recommended at the prospect.

8.9.3 Location and Access

The Temby copper prospect is located in T.25N., R.4W. in the Baird Mountains quadrangle (Figs. 1 and 3), and is situated on a ridge saddle about 1.5 miles northeast of Survey Monument V.A.B.M. Temby. The prospect is at an elevation of 1,600 feet on a flat tundra and alder-covered area.

Kiana is the nearest settlement and is about 50 miles south of the examination site.

8.9.4 Work Accomplished

WGM visited the Temby area to examine the reported copper mineralization and to attempt to determine the extent and grade of the mineralization. During the course of the helicopter flight to and from the area, the 19 reported placer gold claims were sought as well as signs of mining activity on the claims. The reported copper mineralization was found, however, no sign of the placer claims or of mining activity along the stream was noted.

Four rock samples representative of the exposed mineralization were collected and analyzed for copper, silver and gold. A sketch map of the prospect at 1" = 100' was drawn and is presented as Figure 13.

No geochemical sampling was carried out at or near the examination site, since this mineral occurrence did not appear to warrant any work beyond the limited surface sampling.

8.9.5 Geology and Mineralization

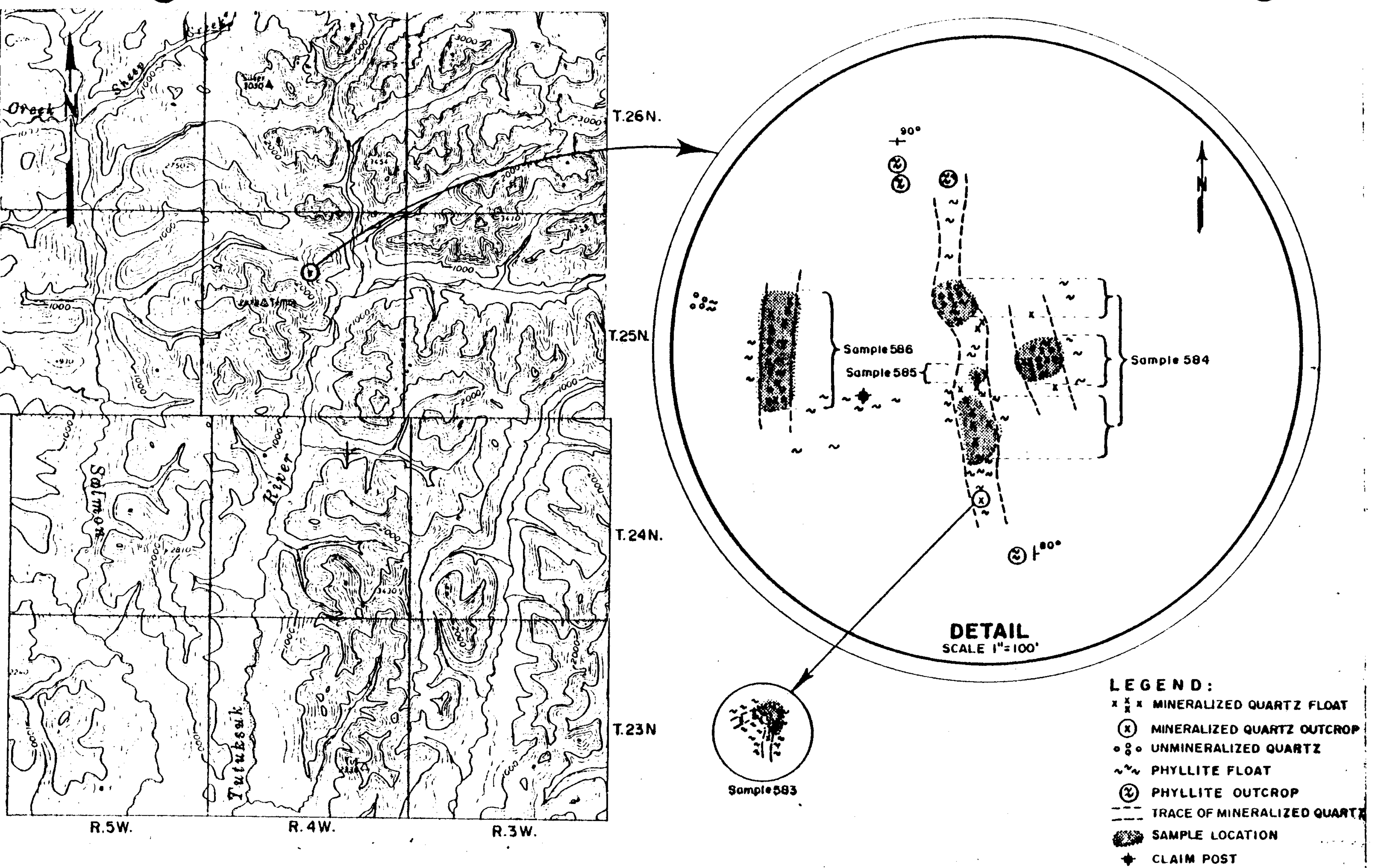
It is evident from a generalized geologic map of this region (Brosgė, et al., 1967) that the geology is complex. Insufficient work has been done to provide a detailed description. In general, Paleozoic clastic rocks, which trend northwest across the Ambler River quadrangle and the eastern part of the Baird Mountains quadrangle, assume a northward trend in this general area near the Salmon River. These clastic rocks are bounded to the north and east by Paleozoic carbonate rocks, and to the south and west by metamorphic and calcareous clastic rocks.

Bedrock at the Temby prospect consists of gray graphite-chlorite-quartz phyllite which hosts quartz veins. The attitude of the phyllite is variable from east-west to north-south over short distances. Small-scale folding probably accounts for the variations in attitude.

Mineralization consists of pyrite, chalcopyrite and malachite associated with the quartz veins. The sulfides are found as discontinuous stringers and small blebs. Individual sulfide stringers are less than one-half inch wide by six inches long.

Distribution of the quartz rubble indicates that three mineralized quartz veins are present within a zone 200 feet wide. The veins vary from 6 inches up to 3 feet in thickness, and can be traced for 100 feet to 250 feet along strike.

The average assay values for the four samples is 1.1% copper, 0.07 oz/ton silver and a trace amount of gold. The following table describes the four rock samples.



WGM INC	MINING & GEOLOGICAL CONSULTANTS ANCHORAGE, ALASKA	DWN BY T. D.	REVISED	TEMBY PROSPECT	FIGURE
SCALE:	1 : 250,000	DATA BY WGM		LOCATION AND GEOLOGIC SKETCH MAP	13
		DATE 6/75		BAIRD MOUNTAINS C-2 QUADRANGLE	BM139

Sample No.	Cu %	Ag oz/ton	Au oz/ton	Description
BM 583	1.70	0.08	0.005	Bedrock sample: 3" x 4' quartz vein in phyllite
584	0.15	0.12	tr	Rubble sample: quartz vein material scattered over 100' x 50' area
585	0.88	0.06	tr	Bedrock sample: 1.5' x 6' quartz vein in phyllite
586	1.60	0.04	0.005	Rubble sample: quartz vein material over 75' x 30' area

tr = trace amount

Collected by: Degenhart
Fairchild

8.9.6 Conclusions

Nineteen placer claims reported in the general vicinity of the Temby prospect were not found, however, at the examination site one old claim(?) post was noted. No signs of past exploration work were noted.

The extent and grade of the mineralization at Temby is limited. Four assays of bedrock and rubble derived from three quartz veins averaged 1.1% copper. The width of the quartz veins varies from several inches up to three feet, and the veins can be traced for 100 feet to 250 feet along strike. Less than 0.1 oz/ton silver and only a trace amount of gold is present. No significant tonnage/grade of material is indicated at this prospect.

8.9.7 Recommendations

No work is recommended at this prospect.

8.10 HUB COPPER PROSPECT

8.10.1 Introduction

A generalized geologic map of the Baird Mountains quadrangle is available at a scale of 1:1,000,000 (Brosgė, et al., 1967, Grybeck, et al., 1977). This map is available as a U.S.G.S. open-file report and shows the locations and results of about 50 samples collected in the Baird Mountains quadrangle.

No significant mineralization was discovered at the Hub Prospect and only a minor amount of additional work is recommended. However, regional scale exploration is strongly recommended for the area.

8.10.2 Summary

A minor amount of copper mineralization in the form of chalcopyrite and malachite was discovered as stream float in the upper reaches of the Salmon River. Follow-up work revealed outcropping copper mineralization at two widely separated locations (1,000 feet). This outcropping copper mineralization is in small (6 inch) quartz-calcite veins hosted by dolomite. No previous report of this mineralization is known, although representatives of the U.S.B.M., U.S.G.S.

and D.G.G.S. (Mowatt, Tailleur & Pessel, 1975 per. comm.) reported mineralization in this general area.

Soil sampling is recommended at the prospect, but more importantly, regional scale exploration is recommended in this virtually unexplored region.

8.10.3 Location and Access

The Hub Prospect is located in the Baird Mountains d-2 quadrangle in T.27N., R.4W. (Figs. 1, 3 and 14). The prospect is situated in a small north-facing valley about 3 miles east of the junction of Kanaktok Creek with the Salmon River. Kiana is the nearest settlement and is located about 60 miles to the southwest.

The prospect is reached with a helicopter.

8.10.4 Work Accomplished

During a helicopter traverse along the upper reaches of the Salmon River a refueling stop was made at the mouth of a small tributary of the Salmon River. Several pieces of stream float containing chalcopyrite were noted, and a foot traverse was made in the drainage basin to search for the source of the mineralization. Two similar, but widely separated, occurrences of copper mineralization were located.

Three rock and two stream silt samples were collected during the visit. Analytical results of these samples are shown on Table 8.10.1 and their locations on Figure 14. No geologic mapping was carried out because the brief visit did not reveal the presence of significant mineralization.

8.10.5 Geology and Mineralization

The geology of the northeast part of the Baird Mountains quadrangle is characterized by a major deflection from the overall east-west structural trend of the Brooks Range. In this area, the rock units assume a northerly trend. A generalized geologic map by Grybeck et al., (1977) shows that the Hub Prospect is found in carbonate rocks (Skajit Limestone) bounded to the east, west and north by Lower Paleozoic schists and phyllites.

Bedrock at the prospect is predominately dolomite and limestone underlain by green phyllite. These rocks strike N30°W and dip about 50°W.

Chalcopyrite and malachite were found on the east and west sides of the valley at an elevation of about 1,800 feet. Character samples were taken from the rubble at both showings. Sample BM 665 collected on the east side of the valley assayed 0.35% copper. The copper mineralization occurs in a quartz-calcite vein as disseminations and small blebs.

On the west side of the valley approximately 1,000 feet in a N70°W direction from sample BM 665, sample BM 873 was collected from a bedrock area of 5 feet by 2 feet. Chalcopyrite was noted in several small (<6") quartz-calcite veins and the sample analyzed 11,100 ppm copper (1.1% Cu).

The host rock of the quartz-calcite veins at both sample sites is fractured dolomite.

No mineralization was noted across the 1,000-foot interval separating the two sample sites and the relationship, if any, between the two mineral occurrences is not known. Erosion in the valley may have removed the upper portion of the vein between the two showings. Tundra cover on the present valley-bottom obscures bedrock.

8.10.6 Geochemistry

Stream silt sample BM 871 was collected near the mouth of the stream draining this small valley (Fig. 14). No bedrock is exposed at the sample site, stream float, however, consis-

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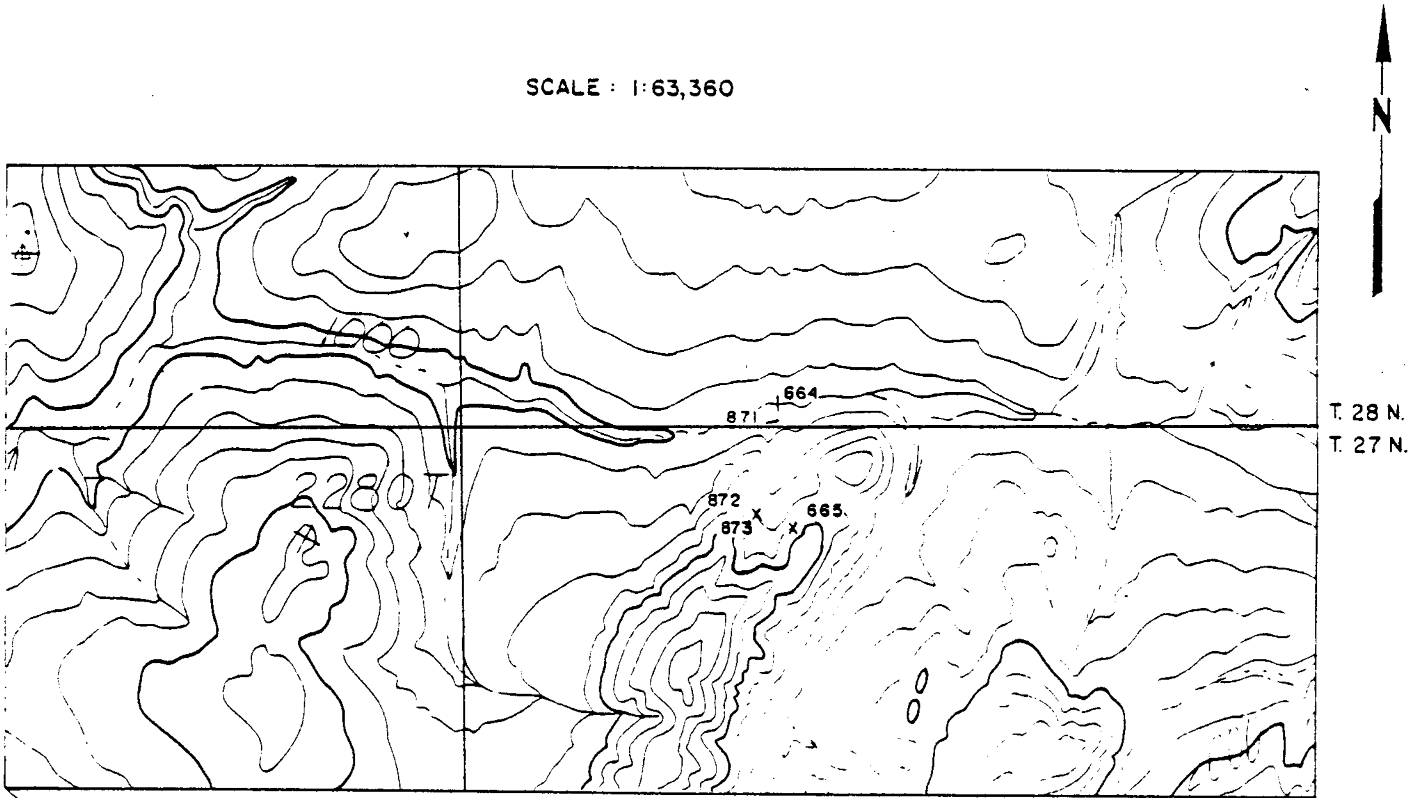

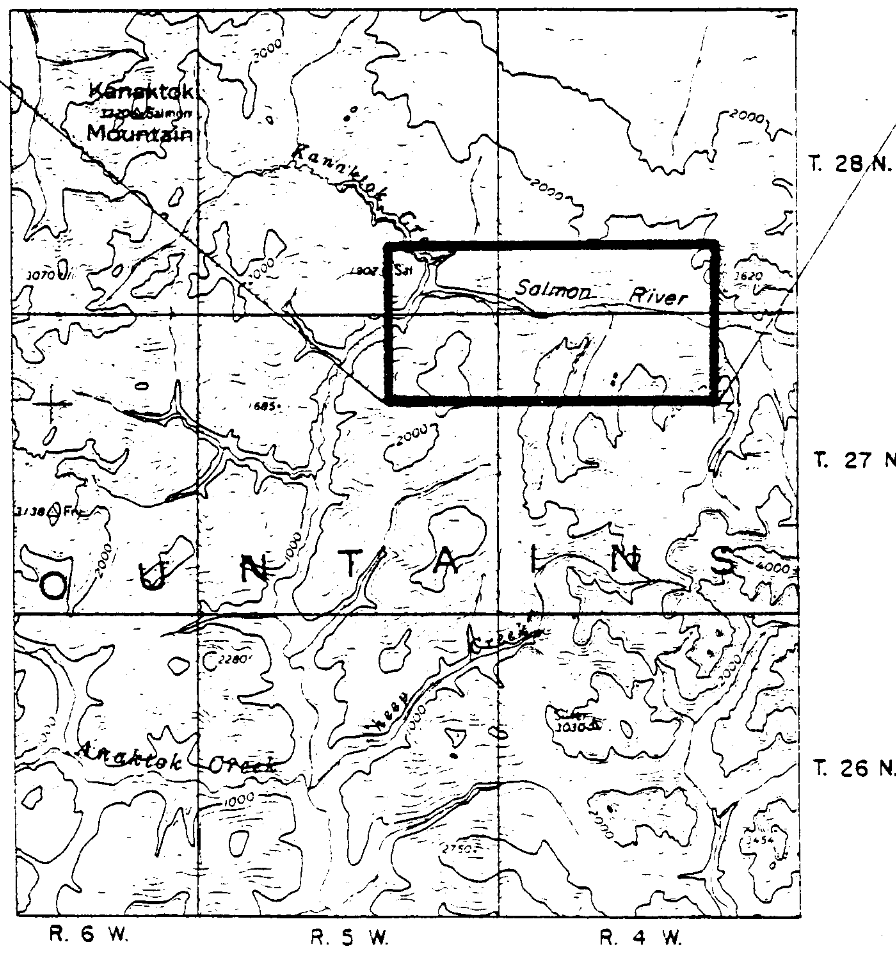

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WGM INC	MINING & GEOLOGICAL CONSULTANTS ANCHORAGE, ALASKA	DWN BY N.B.	REVISED	SAMPLE SITE LOCATIONS HUB	FIGURE 14
		DATA BY WGM			

mainly of carbonate rocks and phyllite. Several pieces of copper bearing quartz-calcite material were also observed. This silt sample analyzed only 27 ppm copper. The low copper value is attributed to the abundance of carbonate rocks which suppress chemical transport of copper ions.

All samples were analyzed for copper, lead, zinc, silver and gold. No anomalous values were recorded except for copper.

8.10.7 Conclusions

Copper mineralization is present at two locations which are 1,000 feet apart. At both locations the mineralization is found in quartz-calcite veins in dolomite, which suggests that the two showings may have a common relationship. Tundra cover on the valley bottom separating the two showings obscures bedrock and prohibits tracing the mineralization across the 1,000-foot interval.

8.10.8 Recommendations

The only work recommended at this prospect is a limited amount of soil sampling across the 1,000-foot interval which separates the two mineralized occurrences. Results from this work should indicate if the two separated occurrences are related in which case, additional work may be warranted.

Regional scale minerals exploration is strongly recommended for the northeastern part of the Baird Mountains quadrangle. This area has received very little exploration except for gold. The discovery of previously unreported copper mineralization in a one-day visit to the area points to the need for systematic exploration in this untested area. Minimum work suggested should consist of geologic mapping and geochemical stream silt sampling. The mapping and sampling are necessary to define rock units which may be hosts for mineralization. It is premature to speculate on types of mineralization which may be present, except for copper-in-carbonate rocks.

TABLE 8.10.1

HUB COPPER PROSPECT

SAMPLE RESULTS AND DESCRIPTIONS

(Values in ppm, unless noted)

Sample No.	Type	Cu	Pb	Zn	Ag	ppb Au	Description
BM 664	ss	24	19	44	1.5	<5	Stream silt sample collected from Salmon River drainage. Float is predominately carbonate rocks.
665	rx	0.35%	0.05%	0.05%	tr	tr	Character sample of mineralized quartz-calcite rubble. Host rock is dolomite.
871	ss	27	22	60	1.9	<5	Stream silt sample from mouth of stream draining prospect area; float consists of carbonate rocks, phyllite and copper bearing quartz-calcite.
872	rx	230	19	4	0.9	<5	Character sample of rubble downslope from outcropping mineralization. Quartz-calcite with minor chalcopy-rite and pyrite.
873	rx	11,100	22	44	2.2	5	Bedrock sample 5' x 2' area: several small quartz-calcite veins in dolo-mite - chalcopyrite and pyrite in veins.

ss = stream silt sample
rx = rock sample
tr = trace amount

Collected by: Degenhart
Fairchild

8.11 CHEVRON COPPER PROSPECT

8.11.1 Introduction

One lode mining claim was located at "The head of the Salmon River" in 1932. (State of Alaska Kardex File 27-20). The location of this claim is reported at latitude 69°42' to 69°50'N and longitude 159°45' to 160°W which does not constitute an accurate location.

Anderson (1944) made a traverse down the Salmon River drainage, at which time he observed copper mineralization in the general area of the reported claim.

A generalized geologic map of the Baird Mountains quadrangle is available at a scale of 1:1,000,000 (Brosgé, et al., 1967, Grybeck, et al., 1977).

It is not known if any other geologic or examination work has been done in this part of the Baird Mountains quadrangle.

8.11.2 Summary

During the course of a helicopter flight, quartz rubble was observed in this area. A subsequent ground inspection showed mineralization assaying from 0.21% to 0.53% copper associated with a quartz lens(?) of about 100 feet in length by 6 feet in thickness. No significant tonnage or grade of material is inferred and no additional work is recommended at this prospect. Regional scale minerals exploration is recommended.

8.11.3 Location and Access

The examination site is located in T.29N., R.5W. in the Baird Mountains D-2 quadrangle (Figs. 1 and 3). The prospect is situated about midway between the peak of Kanaktok Mountain and Survey Monument Chevron, a distance of ten miles and is at an elevation of about 2,200 feet on a flat tundra-covered divide between drainages to the Noatak and Kobuk Rivers (Fig. 15). North flowing drainages from the divide flow into Aklumayuak Creek, a tributary of the Noatak River while south flowing drainages enter Kanatok Creek, a tributary of the Salmon River. The Salmon River drains into the Kobuk River some 50 miles south of the prospect.

Kiana, the nearest settlement, is about 66 miles southwest of the prospect.

Access to the prospect is by helicopter.

8.11.4 Work Accomplished

A visit was made to the area to locate and examine the reported claim. Several helicopter traverses failed to reveal any sign of the claim, however, quartz rubble was observed at one location and a brief ground examination was carried out. Two samples of mineralized quartz rubble were collected and the approximate limits of exposed quartz rubble determined.

No geochemical stream silt or soil sampling or geologic mapping was done, because the apparent limits of the mineralization were visually determined.

8.11.5 Geology and Mineralization

The geology of the area is mapped as an Upper Devonian clastic sequence of shale and sandstone of the Hunt Fork Shale in the Endicott Group (Grybeck, et al., 1977).

Observed bedrock and rubble at the prospect is gray graphite-chlorite phyllite, which hosts a mineralized quartz lens(?). The apparent attitude of the phyllite and the quartz lens(?) is about N22°E with a 10° dip to the west.

Chalcopyrite-bearing quartz as outcrop, sub-outcrop, and rubble is present over an area of about 100 feet by 75 feet.

An additional 200-foot by 60-foot area displays unmineralized quartz outcrop and rubble.

Pyrite and chalcopyrite were the only sulfides observed at the prospect. A very minor amount of malachite, and a modest amount of iron oxides are also present.

It could not be determined if only one quartz lens(?) or if several parallel lenses, are present. One bedrock exposure of the mineralized quartz lens(?) measured 6 feet by 7 feet, which indicates a minimum thickness of 6 feet. Rock sample BM 593 collected from this outcrop assayed 0.53% copper and a trace of gold. This sample represents the northernmost exposure of mineralization. Sample BM 594 was collected from mineralized rubble over an area of 12 feet by 6 feet, approximately 100 feet southwest of BM 593. This sample assayed 0.21% copper and a trace of gold, and represents the southernmost extent of the observed mineralization. Only trace amounts of gold and less than 0.1 oz/ton of silver are present in the quartz.

Surface exposures and rubble indicate that the dimensions of this mineralized quartz lens(?) are about 6 feet by 100 feet, averaging 0.37% copper. Regardless of the downdip extension or if the overall thickness and length are of somewhat larger dimensions, the inferred tonnage/grade configuration is very small and of no economic interest.

8.11.6 Geochemistry

No geochemical silt or soil samples were collected at this examination site or nearby areas. Surface exposures and rubble appeared to define the extent of the mineralized quartz.

8.11.7 Conclusions

The mineralization observed at the Chevron prospect consists of chalcopyrite associated with quartz. The mineralized quartz lens(?) appears to be about 100 feet in length and 6 feet thick, with an average grade of 0.37% copper.

The potential for discovery of a significant tonnage of material assaying more than 0.4% copper is considered remote.

8.11.8 Recommendations

No additional work is recommended at this examination site. As part of a regional scale exploration program, the general area should at least receive a modest amount of geochemical stream silt sampling.

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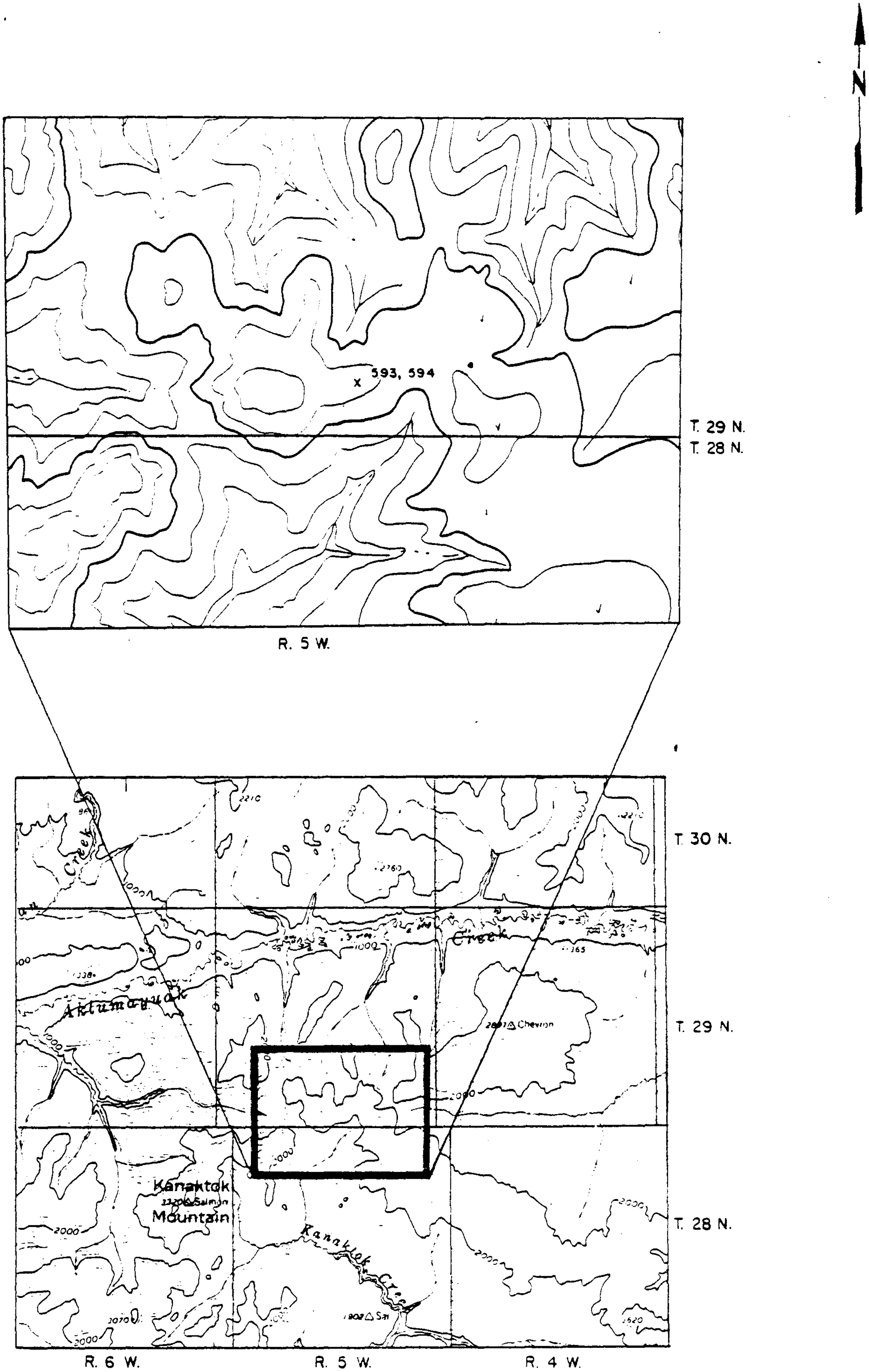

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MGM INC MINING & GEOLOGICAL CONSULTANTS ANCHORAGE, ALASKA

DWN BY: N.B.	REVISED	SAMPLE SITE LOCATIONS CHEVRON	FIGURE 15
DATA BY WGM			

8.12 SALMON RIVER

8.12.1 Introduction

Known previous work in the Salmon River drainage basin is limited to: apparently unsuccessful prospecting for placer gold as indicated by abandoned equipment; regional scale geologic mapping and a limited amount of sampling (Brosgé et al., 1966 and 1967); a traverse along the Salmon River by Anderson (1944); an aeromagnetic survey over part of the Baird Mountains quadrangle (AOF-77); and regional scale reconnaissance in the quadrangle by Bear Creek Mining Company.

Anderson (1944) reported that zinc, copper and lead-bearing float was present at the mouth of a stream draining into the Salmon River. WGM made a brief reconnaissance to the area to search for this mineralized float, and if warranted, attempt to discover the bedrock source. It should be noted that Anderson did not have topographic map coverage of the area, and made a Brunton compass sketch map of his travels.

Copper mineralization in the form of chalcopyrite associated with quartz was found at two locations, however, no lead or zinc mineralization was noted. The small amount of mineralized quartz float observed and its low grade was not considered significant enough to warrant additional follow-up work during this program.

8.12.2 Summary

Attempts to locate previously reported zinc-lead-copper mineralization resulted in confirmation of the presence of a minor amount of copper mineralization associated with quartz, but failed to reveal the zinc and lead mineralization.

Chalcopyrite associated with quartz was found as stream float at two locations. One sample assayed greater than 20,000 ppm copper and another 8,200 ppm copper.

Additional work in the form of a systematic regional scale exploration program is recommended for the area.

8.12.3 Location and Access

The area visited is located in the upper reaches of the Salmon River in Tps. 26 and 27N., Rs.5 and 6W. of the Baird Mountains C-2 quadrangle (Figs. 1 and 3). This area is about 52 miles northeast of Kiana.

Access to this area is possible by tracked vehicle, at least after freeze-up. During the summer months, small boats can travel up the Salmon River to within about 10 miles of the area visited by WGM, however, a helicopter provides the best method of access to the area.

8.12.4 Work Accomplished

WGM personnel examined stream float in several tributaries of the Salmon River in an attempt to locate the zinc-copper-lead mineralization described by Anderson. A total of 15 samples were collected for analysis, of which three were rock samples and the rest stream silt samples.

8.12.5 Geology and Mineralization

The geology of this area can only be described as north trending Paleozoic sedimentary and metamorphic rocks (Brosgė et al., 1967 and Grybeck et al., 1977).

Stream float and bedrock observed consisted of graphitic schist, chloritic schist, light-colored quartz mica schist and abundant quartz. The light-colored schist appears similar to schist found to the east in the Ambler River quadrangle, where large tonnages of base metal sulfides have been discovered. This schist may correspond to the Lower Paleozoic and (or) Precambrian schist unit shown by Grybeck et al., 1977.

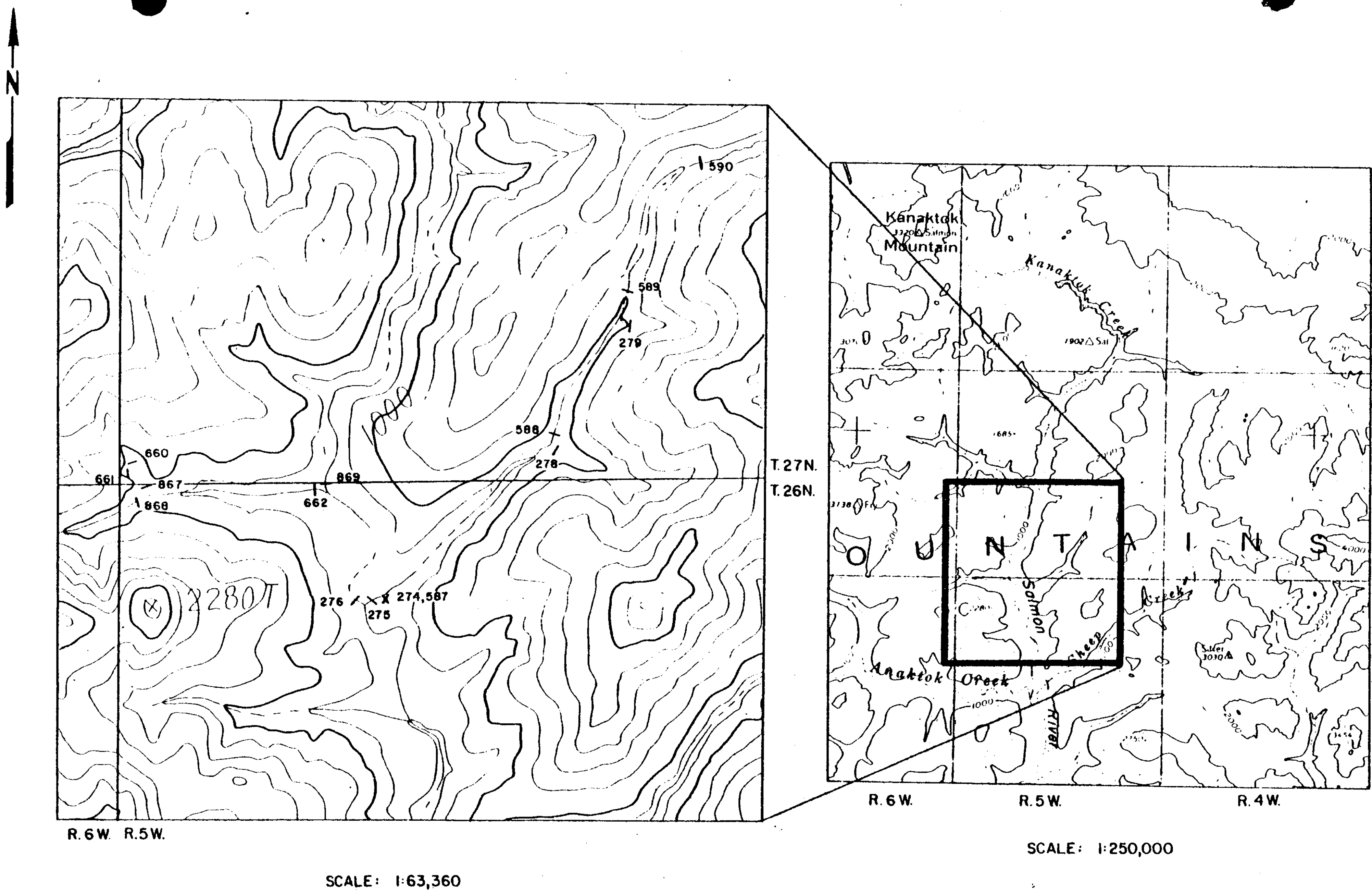
The mineralization noted was chalcopyrite associated with quartz. Sample BM 274 assayed in excess of 20,000 ppm copper, 6 ppm silver and 80 ppb gold. This sample represented a one-foot diameter piece of quartz float found in a tributary of the Salmon River (Fig. 16). Sample BM 277 was collected from the Salmon River and also was chalcopyrite-bearing quartz float. This sample analyzed 8,200 ppm copper, 11 ppm silver and 5 ppb gold.

8.12.6 Geochemistry

Of the 12 stream silt samples analyzed for copper, lead, zinc, silver and gold, no values suggesting significant amounts of these metals were reported. An insufficient amount of sampling was done to determine background geochemical values for this geologic environment, however, all values obtained are considered well within or below background metal values for the rock types observed.

8.12.7 Conclusions

Results from a brief reconnaissance of the upper reaches of the Salmon River confirmed the presence of copper mineralization associated with quartz at two locations. Although the grade of the mineralization at one location is greater than 20,000 ppm copper, the limited amount and size of the mineralized float does not suggest that large quantities



WGM INC	MINING & GEOLOGICAL CONSULTANTS ANCHORAGE, ALASKA	DWN BY N.B. DATA BY WGM DATE 7/75	REVISED	SAMPLE SITE LOCATIONS SALMON AREA BAIRD MOUNTAINS C-2 QUADRANGLE	FIGURE 16 BM115
SCALE: AS SHOWN					

of this material are present. Geochemical stream silt sampling does not indicate the presence of copper, lead, zinc, silver or gold mineralization.

Regional scale minerals exploration should be conducted in this portion of the Baird Mountains quadrangle.

8.12.8 Recommendations

No specific work is recommended for the drainage sampled during this program, however, this area is virtually unexplored and a regional-scale exploration program is strongly recommended. This program should consist of detailed geochemical stream silt sampling in conjunction with geologic mapping. The primary objective of such a program should be directed toward discovery of base metal sulfides associated with the Paleozoic and (or) Precambrian schist.

TABLE 8.12.1

SALMON RIVER

GEOCHEMICAL RESULTS

(Values in ppm, unless noted)

Sample No.	Type	Cu	Pb	Zn	Ag	ppb Au
BM 274	rx	20,000	37	38	6.0	80
275	ss	22	11	38	0.5	5
276	ss	31	22	108	1.0	15
277	rx	8,200	94	74	11.0	5
278	ss	20	9	32	0.3	15
279	ss		13	37	0.4	5
587	rx	60	12	18	---	--
588	ss	17	11	40	---	--
589	ss	22	12	48	---	--
590	ss	12	16	56	---	--
661	ss	42	21	111	1.1	5
662	ss	45	18	126	1.1	5
866	ss	56	15	95	0.9	30
867	ss	40	20	113	1.0	5
868	ss	99	20	160	1.4	5
869	ss	23	13	78	1.0	5

ss = stream silt sample
rx = rock sample
> = greater than
< = less than
\- = not analyzed

Collected by: Degenhart
Fairchild

8.13 AGASHASHOK RIVER AREA

8.13.1 Introduction

A generalized geologic map and sample locality index, which covers the Baird Mountain quadrangle at a scale of 1:1,000,000 (Brosgė et al., 1967) is available as a U.S.G.S. open-file report. Through the courtesy of Mr. I.L. Tailleur, a copy of the field geologic map of the Baird Mountains quadrangle at a scale of 1:200,000 was provided by the U.S.G.S. for this study.

Bear Creek Mining Company conducted first-pass or preliminary geochemical stream silt sampling throughout most of the quadrangle. Results from this work by Bear Creek were not available for the Bureau sponsored study.

A claim location map of the Baird Mountain quadrangle compiled by the U.S.B.M. from Alaska State Division of Geology and Geophysical Surveys Kardex file shows 18 lode claims present in Sec. 13, T.26N., R.12W. (U.S.B.M. OFR No. 20-73).

U.S.G.S. open-file report 274 reports that a mineralized quartz vein material assaying 1% copper is located in Sec. 20, T.26N., R.12W., about four miles southwest of the reported claims.

The WGM field crew attempted to find the reported lode claims and visited the copper showing.

8.13.2 Summary

Helicopter flights and foot traverses were unsuccessful in locating 18 lode copper claims reported in an area north of the Agashashok River. Sampling in this area failed to indicate the presence of any mineralization. Three additional areas were examined in the Agashashok River region, one of which revealed a minor amount of chalcopyrite in quartz (0.48% Cu). The other two areas revealed no indications of mineralization and no additional work is recommended in any of the four areas.

8.13.3 Location and Access

This area is located near the headwaters of the Agashashok River in T.26N., Rs.11 and 12W. in the Baird Mountains C-5 quadrangle (Figs. 1, 3 and 17). The Agashashok River flows in a west to southwest direction and joins the southerly flowing Noatak River about 40 miles southwest of the examination area. The town of Kotzebue is about 62 miles in a southwest direction from the examination area and the village of Noatak is about 45 miles to the west.

Access is best gained by helicopter, although several gravel bars along the Agashashok River are capable of handling small fixed-wing aircraft.

8.13.4 Work Accomplished

Numerous helicopter flights and foot traverses failed to locate the reported claims, however, two iron-stained areas were noted while flying in the area, and these were examined. The reported copper showing was located and examined. Figure 17 shows sample site locations at the four areas which are designated Areas 1-4, Area 1 being the reported claims, Areas 2 and 3 the iron-stained areas, and Area 4 the reported copper showing.

A total of 34 samples were collected at the four areas and analyzed for copper, lead, zinc and silver. In addition, six of the 34 samples were analyzed for gold.

No attempt was made to conduct geologic mapping in any of the four areas visited since no significant amounts of mineralization were noted.

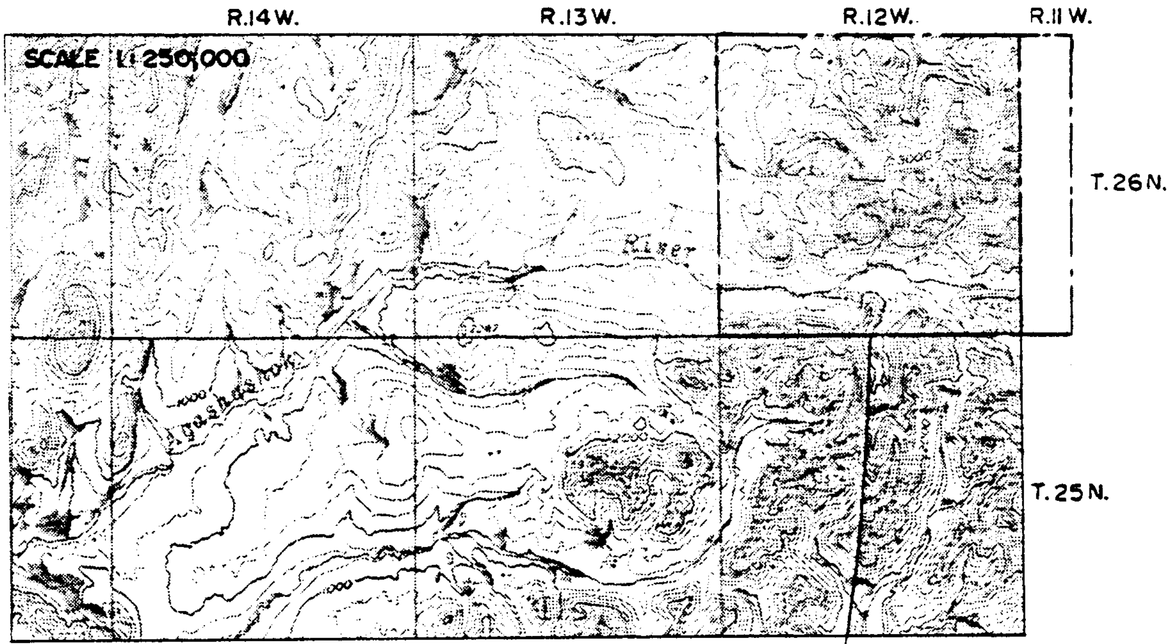
8.13.5 Geology and Mineralization

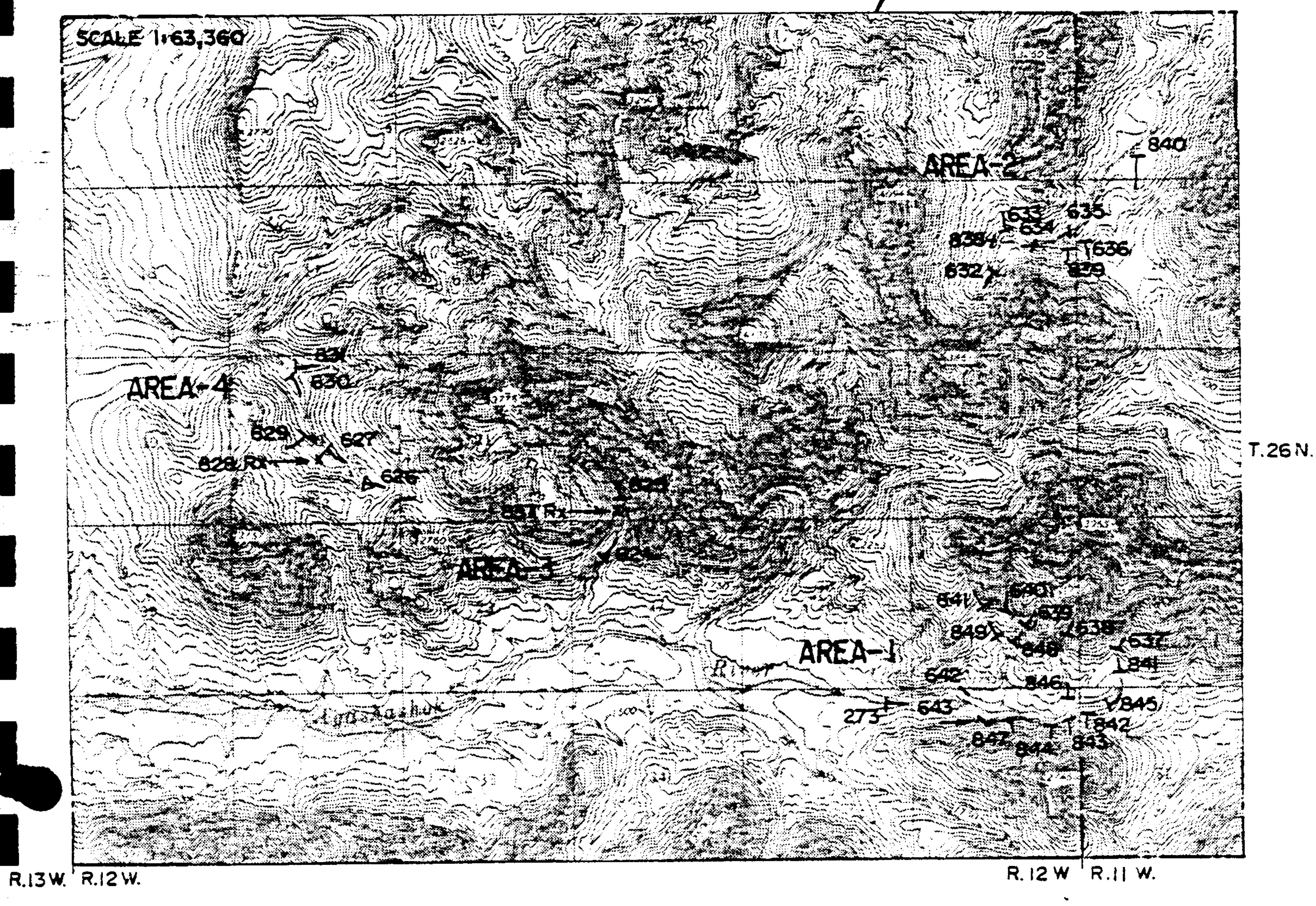
The geology in this portion of the Baird Mountains is mapped as a large undifferentiated body of Paleozoic Skajit limestone, dolomite and marble (Brosgé et al., 1967), which occupies an area of about 700 square miles. Locally, units of gray phyllite containing small quartz stringers were noted.

The only mineralization observed at any of the four locations was at Area 4. At this location, a piece of quartz measuring 7 by 5 by 2 feet and containing small blebs of chalcopyrite and minor malachite staining was observed. This block of quartz occurs as stream float and assays 0.48% copper. The bedrock source of the quartz was not found either upstream or on either side of the stream drainage.

8.13.6 Geochemistry

With the exception of sample BM 628 which assayed 0.48% copper, no other samples show values which are considered even weakly anomalous in copper, lead, zinc, or silver.





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DWN BY T.D. REVISED
DATA BY WGM

SAMPLE SITE LOCATIONS
AGASHASHOK RIVER AREA

FIGURE 17

8.13.7 Conclusions

Eighteen lode claims reported to be present in this area were not located, nor was any mineralization found in the area of the reported claims.

An assay value of 0.48% copper was obtained from a piece of quartz found as stream float, but no additional mineralization was discovered. No stream silt geochemical values obtained at any of the four locations indicate the presence of mineralization.

8.13.8 Recommendations

No additional work is recommended at the four areas which were examined.

As part of regional scale exploration activities, systematic geochemical stream silt sampling should be conducted in the Baird Mountains quadrangle. Too little geological and geochemical information is available for the Baird Mountains to determine the mineral potential.

TABLE 8.13.1

AGASHASHOK RIVER AREA

GEOCHEMICAL SAMPLE RESULTS

(Values in ppm, unless noted)

Sample No.	Type	Cu	Pb	Zn	Ag	ppb Au
Area 1						
BM 273	ss	14	51	44	---	-
637	ss	25	32	38	0.2	-
638	ss	14	41	22	0.2	-
639	ss	13	52	15	0.2	-
640	sa	12	55	29	0.5	-
641	ss	27	43	122	0.2	-
642	ss	13	46	25	0.2	-
643	ss	16	45	25	0.2	-
841	ss	17	38	20	0.2	-
842	ss	6	48	16	0.2	-
843	ss	5	52	9	0.8	-
844	ss	5	55	9	0.2	-
845	ss	13	44	15	0.2	-
846	ss	9	46	18	0.4	-
847	ss	7	51	13	0.2	-
848	ss	7	50	25	0.2	-
849	ss	23	42	53	0.2	-
Area 2						
BM 632	ss	10	60	91	0.2	-
633	ss	30	29	49	0.2	<5
634	ss	21	31	130	0.2	-
635	ss	18	36	94	0.2	-
636	ss	6	56	80	0.2	-
838	ss	26	32	109	0.2	-
839	ss	4	55	27	0.2	-
840	ss	7	46	34	0.2	-
Area 3						
BM 624	ss	10	58	14	0.7	-
625	ss	26	48	27	0.5	-
837	rx	96	50	10	0.4	-

TABLE 8.13.1 (Cont.)

AGASHASHOK RIVER AREA

GEOCHEMICAL SAMPLE RESULTS

(Values in ppm, unless noted)

Sample No.	Type	Cu	Pb	Zn	Ag	ppb Au
Area 4						
BM 626	ss	26	34	87	0.4	<5
627	ss	26	33	60	0.2	<5
628	rx	0.48%	0.05%	0.10%	0.4 oz/t	tr
629	ss	41	21	80	0.2	<5
630	ss	40	31	74	0.5	<5
631	ss	25	30	91	0.2	-

ss = stream silt sample
rx = rock sample
tr = trace
\- = not analyzed

Collected by: Degenhart
Via
Fairchild

8.14 KALUICH AREA

8.14.1 Introduction

The Ambler River quadrangle has been mapped at 1:250,000 scale (Pessel and Brosgė, 1977) and the State of Alaska Division of Geological and Geophysical Surveys has conducted geochemical sampling in this area of the quadrangle (Garland, et al., 1975).

At least one private company (Bear Creek Mining Co.) conducted a limited amount of exploration in the western part of the Ambler River quadrangle, but it is not known if this work included the Kaluich area.

During 1974, an aeromagnetic survey was flown over the western two-thirds of the Ambler River quadrangle by Geometrics under contract to the State of Alaska. The results of this survey were released as an open-file report by the State of Alaska during 1975 and show no significant magnetic expression at this prospect.

A granitic intrusive body in the Kaluich Creek area was selected for follow-up work based on a reported occurrence of galena and fluorite in the granitic rock and the presence of several copper, lead and zinc geochemical anomalies apparently associated with the intrusive (State of Alaska, 1973 Annual Report and Pessel, per. comm.).

8.14.2 Summary

A granitic intrusive was selected for follow-up work based on reported geochemical anomalies and occurrences of mineralization associated with the intrusive.

Forty-five samples were collected for analysis and the results define an area of about 6 square miles along the northern portion of the pluton, which is considered weakly anomalous in lead and/or zinc, in addition to displaying geochemical high values in fluorine, tin, molybdenum, and silver.

Minor amounts of galena, fluorite and malachite are visible in the granitic rocks at the contact zones. Visual estimates up to 1% galena and 1% fluorite were made.

A representative rock chip sample over a mineralized area of 100 by 7 feet shows 2,000 ppm lead, 53 ppm molybdenum, 14 ppm silver, 34 ppm tin and 1,400 ppm flourine. A local concentration of higher grade mineralization is present as indicated by one soil sample, but the potential for discovery of significant tonnages of material assaying greater than the above listed values are considered low, based on observations made during the present investigation.

Additional work is recommended to test the southern margin of the pluton for possible occurrences of tungsten mineralization. Systematic exploration for uranium, base and precious metals, tin, molybendum and fluorite mineralization should be conducted throughout the entire granitic body and its contact zone.

8.14.3 Location and Access

The Kaluich area is located in T.25N., R.3E. in the Ambler River quadrangle (Fig. 1 and 3), about 34 miles north of the village of Ambler, Alaska.

Streams draining the area flow into the Cutler River and Kaluich Creek to the north and into the Hunt River to the south. Access is by helicopter.

8.28.4 Work Accomplished

Field work at the Kaluich area consisted of collecting 52 samples, 45 of which were submitted for analysis. Sample site locations are shown on Figure 18.

Thirteen soil samples were collected at 25-foot spacings along a north-south line across a tundra covered carbonate-intrusive contact zone. This work was intended to test the contact zone for tungsten, molybdenum, and/or base metal sulfide mineralization.

8.14.5 Geology and Mineralization

A granitic pluton in the Kaluich area is one of a series of Cretaceous granitic bodies which are present in the central part of the Brooks Range.

The "Kaluich Pluton" is about 6 miles long in an east-west direction, and from one to one and three-quarter miles wide in a north-south direction. The pluton is in contact with black siltstone and with interbedded marble and quartz-mica schist to the north and east. The western and southern margins of the pluton appear to be in contact with gray to black marble of the Skajit Limestone. The observed contact zones around the northern margin of the pluton appear to be complex. Intermixing of the granitic and country rocks apparently occurred during emplacement of the pluton. Observations along the northern margin of the intrusive reveal a lack of mafic minerals. Intense foliation is present which gives the rocks a schist-like appearance. Chlorite is common along the foliation planes and is probably derived from alteration of biotite in the granitic rocks.

A skarn zone along the granite-carbonate zone is reported near the southeast edge of the pluton (Garland, et al., 1975). However the present investigation failed to discover skarn mineralization along the southern carbonate-granite contact zone.

Scattered mineralization in the form of pyrite, galena, fluorite and malachite was observed in outcrop and/or talus over a distance of about one mile along a northeast trending ridge in the examination area. The samples taken are considered representative of the mineralization associated with that portion of the intrusive body examined.

Additional reconnaissance, along the northern margin of the intrusive failed to reveal the presence of any mineralization, except pyrite. Work along the southern edge of the pluton, likewise, failed to discover base metal or tungsten mineralization.

8.14.6 Geochemistry

The geochemical results obtained by Garland, et al., 1975, and by WGM personnel outline an area of about 6 square miles which can be considered anomalous in lead and/or zinc. This anomalous area appears to be confined to the northern portion of the pluton and to black siltstone and limestone units which are in contact with the granitic body along the north side (Fig. 18). Although the size of this anomalous area is significant, most, if not all, of the anomalous values probably represent only minor amounts of mineralization associated with the northern contact zone as evidenced by sample BM 1214. This sample shows 113 ppm lead and 340 ppm zinc and represents an 8-foot chip sample across an outcrop of interlayered intrusive rocks and dark gray siltstone. Pyrite was the only sulfide mineral observed at this outcrop.

Five values ranging from 10 to 15 ppm tungsten were recorded from soil samples collected over a suspected granite-carbonate contact zone along the southern margin of the intrusive (Fig. 18). An additional five tungsten values ranging from 10 to 25 ppm were obtained from sampling the intrusive.

One soil sample (BM 961) analyzed 10,600 ppm lead, however, sampling of the granitic rocks which apparently underlie sample BM 961, show only 21 ppm lead (BM 679).

Geochemically high amounts of molybdenum (18-53 ppm), tin (20-48 ppm), silver (3.0-14 ppm) and fluorine (1,220-2,550 ppm) were also detected in several samples. The values are considered high enough to warrant some additional investigations.

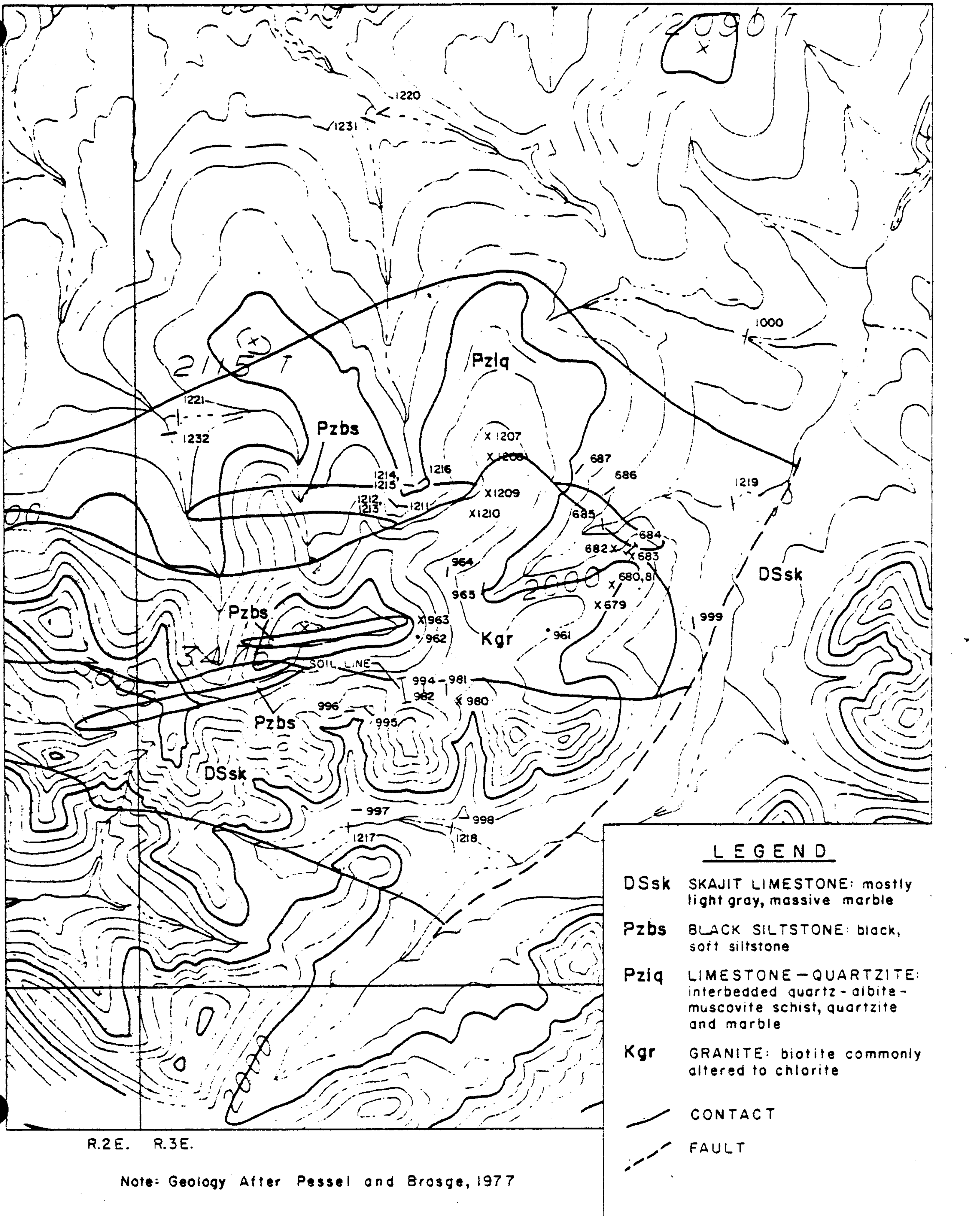
Uranium analyses were not obtained by WGM or by the State of Alaska during their program, however, the geologic setting and the presence of at least trace amounts of the above-mentioned elements may be indicative of a geologic environmental favorable for the occurrence of uranium mineralization.

8.14.7 Conclusions

Minor amounts of pyrite, galena, fluorite and malachite were found in portions of a granitic body which is in contact with siltstone and carbonate rocks. Geochemistry defines an area of about 6 square miles, which is considered anomalous in lead and/or zinc, and displays geochemically high values in other elements.

One soil sample showed a lead value of 10,600 ppm, however, representative samples collected from outcrops of mineralized intrusive rock show only about 2,000 ppm lead.

Minor amounts of lead and zinc mineralization associated with a migmatite-like contact zone along the northern margin



Note: Geology After Pessel and Brosge, 1977

WGM INC	MINING & GEOLOGICAL CONSULTANTS ANCHORAGE, ALASKA	DWN BY: M.H. / DATA BY: WGM	REVISED	SAMPLE SITE LOCATIONS KALUICH AREA AMBLER RIVER C-5 QUADRANGLE	FIGURE 18

of the pluton may be responsible for numerous moderate strength geochemical anomalies obtained in this area. Tungsten values of up to 15 ppm were obtained from soil samples at the southern edge of the pluton where it is in contact with carbonate rocks of the Skajit Limestone Formation, and also from the intrusive.

Based on the results from this investigation, the possibility for discovery of even small tonnages of economic grade material is considered remote.

8.14.8 Recommendations

A limited amount of work should be directed toward discovery of tungsten mineralization. Additional soil sampling over the covered granite-carbonate contact zone is suggested.

Exploration for uranium mineralization is suggested for this pluton and its contact zone. The first phase of uranium exploration should consist of airborne radiometric surveys, followed by ground surveys at any areas defined by the airborne work.

TABLE 8.14.1

KALUICH AREA

GEOCHEMICAL VALUES

(Values in ppm)

Sample No.	Cu	Pb	Zn	Mo	Ag	Sn	F	Comments
BM 682	72	2,100	400	15	--	9	2,550	Talus samples siliceous, foliated intrusive; visible pyrite, fluorite, galena
683	86	2,000	94	53	14.0	34	1,400	Bedrock chip sample over 100' x 7' area - highly foliated greenish fine-grained intrusive rock
684	37	500	110	39	3.3	4	2,520	Bedrock chip sample over 200' x 25' area - same rock as 683
961	640	10,600	560	--	--	2	--	Sample of iron-stained soil overlying brown weathering foliated fine-grained light colored intrusive rock

- = not analyzed

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TABLE 8.14.2

KALUICH AREA

GEOCHEMICAL SAMPLE RESULTS

(Values in ppm, unless noted)

Sample No.	Type	Cu	Pb	Zn	Mo	Ag	ppb Au	W	Sn	F
BM 679	rx	63	21	21	--	--	--	--	2	690
680	rx	16	22	3	4	--	--	--	--	970
681	rx			Reference Sample						
682	rx	72	2,100	400	15	--	--	--	--	2,550
683	rx	86	2,000	94	53	14	105	--	34	1,400
684	rx	37	500	110	39	3.3	20	--	4	2,520
685	ss	40	190	91	--	--	--	--	Is	920
686	ss	106	190	440	--	--	--	--	2	880
687	ss	136	106	400	--	--	--	--	4	730
961	so	640	10,600	560	--	--	--	13	2	--
962	so	50	320	122	--	--	--	25	2	--
963	rx	27	16	100	--	--	--	10	12	--
964	ss	12	154	95	--	--	--	15	12	--
965	ss	14	180	130	--	--	--	25	4	--
980	rx			Reference Sample						
981	ss	21	39	75	4	--	--	ND	4	--
982	so	20	49	85	3	--	--	ND	2	--
983	so	35	23	120	5	--	--	ND	2	--
984	so	47	20	142	9	--	--	ND	3	--
985	so	39	24	108	3	--	--	ND	4	--
986	so	23	29	50	3	--	--	ND	11	--
987	so	8	24	30	2	--	--	ND	3	--
988	so	4	36	20	3	--	--	10	3	--
989	so	6	26	22	2	--	--	13	8	--
990	so	16	52	72	4	--	--	10	10	--
991	so	15	33	54	3	--	--	10	23	--
992	so	15	36	55	4	--	--	5	18	--
993	so	14	39	44	3	--	--	3	20	--
994	so	7	38	17	2	--	--	15	16	--
995	ss	26	42	122	6	--	--	ND	26	--
996	ss	35	40	80	3	--	--	3	20	--
997	ss	15	36	25	5	--	--	ND	Is	--
998	ss	8	46	12	7	--	--	ND	8	--
999	ss	10	60	45	3	--	--	ND	19	--
1000	ss	24	22	108	3	--	--	ND	8	--

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TABLE 8.14.2 (Cont.)

KALUICH AREA

GEOCHEMICAL SAMPLE RESULTS

(Values in ppm, unless noted)

Sample No.	Type	Cu	Pb	Zn	Mo	Ag	ppb Au	W	Sn	F
BM 1207	rx			Reference Sample						
1208	rx			Refere Sample						
1209	rx			Reference Sample						
1210	rx			Reference Sample						
1211	ss	130	240	250	51	1.5	--	--	--	--
1212	ss	134	350	410	34	2.4	--	--	7	1,220
1213	rx	68	20	300	5	0.8	--	--	--	--
1214	rx	30	113	340	4	1.4	--	--	--	--
1215	rx			Reference Sample						
1216	ss	190	395	360	18	2.2	--	--	5	1,240
1217	ss	10	42	22	--	3.0	--	--	--	--
1218	ss	8	45	17	--	2.6	--	--	--	--
1219	ss	54	158	170	--	0.9	--	--	--	--
1220	ss	26	51	124	--	0.6	--	--	48	--
1221	ss	25	44	92	0.3	--	--	--	22	--
1231	ss	59	120	290	15	--	--	ND	14	--
1232	ss	46	49	160	12	--	--	3	10	--

rx = rock sample
so = soil sample
ss = stream silt sample
\- = not analyzed
ND = not detected
Is = insufficient

Collected by: Degenhart
Via

8.15 KAV COPPER PROSPECT

8.15.1 Introduction

WGM's attention was drawn to this prospect during a helicopter flight to another work area during 1975. Two prominent rusty-colored peaks rising above an otherwise subdued and tundra covered area were noted. During the course of several foot traverses, copper mineralization was found scattered along a slope distance of 300 feet. Two grab samples of selected talus material assayed 18.5% and 33.8% copper.

The Ambler River quadrangle has been mapped by the U.S.G.S. (Pessel and Brosgé, 1977) at 1:250,000 scale. There is no record of any work on the prospect. One small rock cairn was noted at the prospect, however no mining claim notice of location, or evidence of physical work was seen. A mining claim location map (U.S.B.M. OFR 20-73) shows no mining claims at this location.

8.15.2 Summary

Four previously unreported occurrences of copper and silver mineralization were found within an area of 0.15 square miles.

Copper mineralization (up to 33.8%) was discovered at one of the occurrences. Although the extent of this mineralization appears to be limited to an area 5 by 850 feet, the discovery indicates presence of a favorable environment for the occurrence of copper mineralization.

Additional work is recommended to assess the prospect and to search for additional copper mineralization. Exploration along the northwest trend of similar carbonate rocks is recommended.

8.15.3 Location and Access

The Kav copper prospect is located in T.28N., R.9E. of the Ambler River quadrangle (Figs. 1 and 3). The prospect is situated along the north side of a creek which flows eastward to Kavachurak Creek, which in turn flows to the Noatak River (Fig. 19). The prospect is about five miles south of the Noatak River and approximately 65 miles north of the village of Kobuk.

Access is by helicopter, although small fixed-wing aircraft can land on nearby gravel bars, and on several small lakes located in the Noatak River valley.

8.15.4 Work Accomplished

A decision to revisit the Kav copper prospect was made after review of the high copper assays. During the 1976 field work, an effort was made to determine the size of the mineralized area and to prospect for additional mineralization. A limited amount of geologic mapping was conducted, and a total of 29 soil samples were collected along five northeast-trending lines over the projected trend of the copper mineralization. The 1976 prospecting turned up additional copper mineralization which was not seen during 1975.

A tabulation of samples collected during the examinations is presented as follows:

Type of Sample	Number Collected
Stream silt	5
Rock	8
Soil	29
Reference	3
TOTAL	45

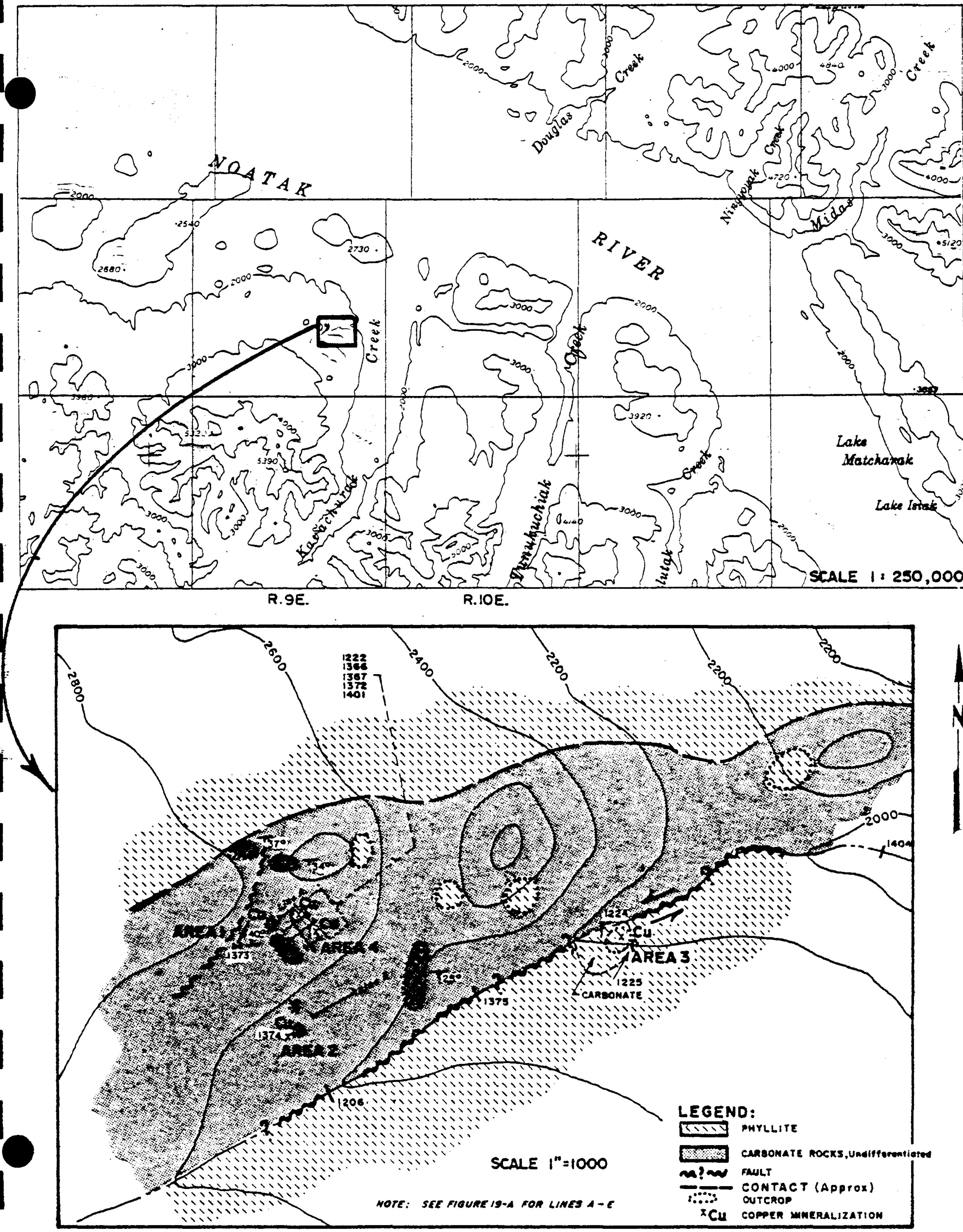
A brief description of significant assay results and a list of other samples and their geochemical values accompanies Figure 19.

8.15.5 Geology and Mineralization

Geologic mapping along the northern flank of the Brooks Range in the vicinity of the Kav copper prospect indicates that the bedrock is dominated by northwest trending units of sedimentary and metamorphic rocks (Pessel and Brosgé, 1977). The rocks are mapped as massive gray limestone (Skajit Limestone?), green phyllite, quartzite and conglomerate (Endicott Group), and marble.

These units pass under cover in the Noatak River valley to the northwest of the prospect.

Two prominent rusty colored peaks consisting mainly of dolomite breccia are present in the prospect area. The dolomite breccia is locally overlain by thinly bedded gray limestone, which appears to be less than 50 feet in thickness. Up to 200 feet of interbedded white, coarse-grained marble, and gray limestone underlies the dolomite breccia and is, in turn, underlain by a sequence of green and purple phyllites. Discontinuous thin bodies of similar appearing phyllite were observed at several locations within the dolomite breccia zone, but their relationship, if any, to the other phyllite is unknown.



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DWN BY: T.D. | REVISED
DATA BY: WGM

GENERALIZED GEOLOGIC MAP AND SAMPLE SITE LOCATIONS

FIGURE 19

A quartz-pebble conglomerate unit about 3 to 5 feet thick underlies the phyllite. The rock is light to medium green and contains fragments of quartz and black to tan colored chert.

A northeast-trending creek located about 1,000 feet south of the most intensely mineralized showing may mark the trace of a strike slip fault with displacement of about 2,500 feet. A second fault with a N27°E trend is located about 250 feet northwest of the main showing and has resulted in displacements of about 100 feet.

Copper mineralization in the form of tetrahedrite, tennantite(?) chalcopyrite, azurite and malachite was discovered at four separate locations within a 0.15 square mile area. At three of the four locations, mineralization was observed in outcrop while at the fourth, only talus was found. The talus is presumed to be close to its bedrock source.

Copper mineralization occurs in quartz veins and in dolomite breccia at the prospect. A discussion of the four areas where mineralization was noted follows:

Area 1 - Sample No. BM 1373

Area 1 shows the weakest copper mineralization of the four areas (Fig. 19). An east-trending quartz vein, 1.5 feet wide, which dips about 40° to the north, was traced for about 75 feet along strike. The host rock is dolomite breccia and white marble. The vein contains scattered chalcopyrite. A representative sample (BM 1373) of the quartz vein assays 0.36% copper. It is not known if the mineralization has been remobilized from nearby dolomite, or was emplaced from the externally derived silica-bearing solutions (see section 8.15.7).

Area 2 - Sample No. BM 1374

Approximately 20 quartz stringers and veins ranging in width from 1/2 to 6 inches were traced for about 75 feet along strike. The host rock is dolomite breccia. The stringers are concentrated in a 100-foot wide zone, which is generally orientrated N15°E with a near vertical dip. Mineralization is found in only a few of the veins. The south end of the 75-foot trend is terminated at a cliff face. The mineralized stringers pass under rubble to the north and no sign of sulfide mineralization has been found in the rubble. Examination of the area across an intervening creek to the south of the cliff reveals that the dolomite rocks are faulted off.

Area 3, which is described immediately below, may be the displaced south segment of the faulted off dolomitic segment described in this paragraph.

A selected composite "grab" from the most intensely mineralized vein (4" to 6" wide shows 6.2% copper, 0.62% zinc, 4.9 oz/ton silver and 3.2% antimony. The copper mineral is tetrahedrite which occurs as small blebs in the quartz.

Area 3 - Sample No. BM 1225

Area 3 is located about 2,500 feet east of Area 2. Sample BM 1225 which represents a 40-foot chip sample across a near-vertical rock face along the south side of the stream, assayed 0.8% copper and 0.48 oz/ton silver. A dolomite breccia is the host rock for numerous small quartz veins. The mineralization consists mainly of chalcopyrite and malachite but minor tetrahedrite may also be present. The mineralization is mainly in quartz veins, and also in dolomite breccia. The 40-foot chip sample represents the total width of the mineralized veins and wall rock; the observed strike length is five feet, but is open to the south under tundra cover for an undetermined distance. The area across the creek from the north end of the outcrop is barren. However, as noted in the discussion of Area 2, the creek may follow an east-west trending fault. Comparison of the geology at Areas 2 and 3 indicates that the rock exposures are of the same unit, with a strike-slip displacement of 2,500 feet.

Area 4 - Sample Nos. BM 1222, 1366, 1367, 1372 and 1401

Area 4 is the most interesting of the four areas visited since the copper mineralization is more intense, and a broader expanse of mineralized environments is exposed. Mineralized talus is scattered over a fan-shaped area which is about five feet wide at the uppermost point and about 100 feet wide approximately 300 feet downslope. The distribution of this mineralized talus appears to be partly controlled by solufluction along the slope of the hillside, but the abundance of mineralized float observed downslope indicates that some of this material is derived from a source directly beneath the rubble. If this is true, the mineralization appears to be widening downslope to the south. The intensity of mineralization also appears to increase in the downslope direction.

Three types of mineralization have been noted in the rubble area. The first consists of quartz-vein material containing chalcopyrite as small blebs. Samples of selected pieces of this rubble across a 50-foot distance along the contour assay 1.55% copper. No more than 5% to 10% of the rubble is mineralized.

The second type of mineralized float which occurs in the same area as the quartz-vein material, consists of dolomite breccia containing masses of tetrahedrite, tennantite, and chalcopyrite, and abundant malachite and azurite staining. Two selected grab samples representative of this type of mineralization taken over contour lengths of 36 and 50 feet, show 18.6% and 33.8% copper, respectively. The sample lines are parallel and approximately 50 feet apart.

A third type of mineralization consists of highly leached gossanous material which assayed about 2.5% copper (Sample 1366). Identification of the host rock type in hand specimen is difficult due to the leaching of sulfides from the rock, however, it appears that dolomite breccia is the host, and that the gossan is derived from the mineralized breccia.

Implications of the Kav Mineralization

The mineralization in the Kav area occurs in quartz veinlets and stringers, and in the dolomite breccia that hosts the fillings. The order of deposition is unknown, but two obvious possibilities are:

1. Copper mineralization was introduced into the system with siliceous solutions, and deposited with the quartz, with minor remobilization into adjacent dolomite breccia; or

2. Copper mineralization migrated into porous and permeable dolomite breccia, with subsequent minor mobilization and development of replacement texture. Minor remobilized copper sulfides were deposited in quartz fillings.

The depositional history at Kav is of more than academic interest with regard to both local and regional implications concerning the mineral potential.

Quartz vein-type mineralization with leakage outward has failed to produce prospective economic or sub-economic potential in the Brooks Range.

On the other hand mineralization of the second type (possibilty 2) constitutes one of the most attractive base/precious metal target potential in the Brooks Range, eg. Ruby Creek and Pardner Hill (Section 6.1) and Omar (Section 8.6.). The second type also includes Mississippi Valley-type deposits in various regions outside of Alaska.

Mapping, trenching, drilling(?), and petrologic and paleontologic studies are required to determine if Kav exhibits potential for massive sulfide mineralization in dolomite breccia and related carbonate facies. If so, all carbonate terranes similar to Kav in the general area are suspect, and accordingly will require appraisal before reasonable conclusions can be drawn regarding the regional potential.

Types of information to be sought include: stratigraphic-paleontologic-petrologic studies to determine the significance of the breccias and other sedimentary rocks; mineral studies to determine if there has been remobilization, the relative age of the vein and breccia mineralization, paragenesis, zoning, etc; and mapping to determine host rock distribution patterns.

The fracturing and veining observed at Kav may be near-surface phenomena resulting from weathering and/or solution by meteoric waters. The future studies should be designed to determine if the intensity of mineralization within the dolomite is related to fracturing and veining, or to the distribution of clastic breccias and related facies developed within a reef complex environment. If the latter case prevails, appraisals should be continued to determine the location and dimensions of favorable carbonate terranes, both at Kav and elsehwere along the carbonate trend.

The marble observed at Area 1 may be recrystallized coarse calcarenite of the type found in high energy environments adjacent to dolomitic (reef) buildups. It has been found that the relative grain size of recrystallized limestones increase toward the reef front from the seaward side of the reefs in the Cosmos Hills, indicating that the relative coarseness of the recrystallized limestone is an indication of the grain size of the original limestone (Bigelow, C.G. pers. comm.).

It is possible that the mineralization observed at Kav is within or remobilized from reef complex facies, as at Ruby Creek and Pardner Hill. If so, Area 4 is closest to the reef core, and includes intense mineralization within reef apron clastic dolomite breccia that has been affected by weathering and/or solution by meteoric waters.

Copper mineralization at the surface at Ruby Creek occurs in fractures which disappear within a few feet below the surface. Quartz veining also disappears downward at Ruby Creek, and rarely is found below the first impermeable phyllite layer.

Summarily, the modest amount of information developed in the course of the brief visits to these hitherto unknown showings is insufficient to determine if the mineralization is restricted to small fillings and adjacent country rock, or is an indicator of the presence of reef complex environments known to be favorable in the Brooks Range, and elsewhere in North America. What is known is sufficient to justify additional mineral appraisal studies.

8.15.6 Geochemistry

Of five stream silt samples collected along the stream draining the prospect area, none appear to reflect the presence of copper mineralization. The low geochemical values may be due, in part, to the subdued nature of the topography and poorly developed drainage. The gentle relief at the prospect area allows very little mechanical movement of copper-bearing particles except by solifluction. The abundance of carbonate rocks tends to suppress chemical movement of copper ions, and further reduces the likelyhood of detecting the copper mineralization in stream silt.

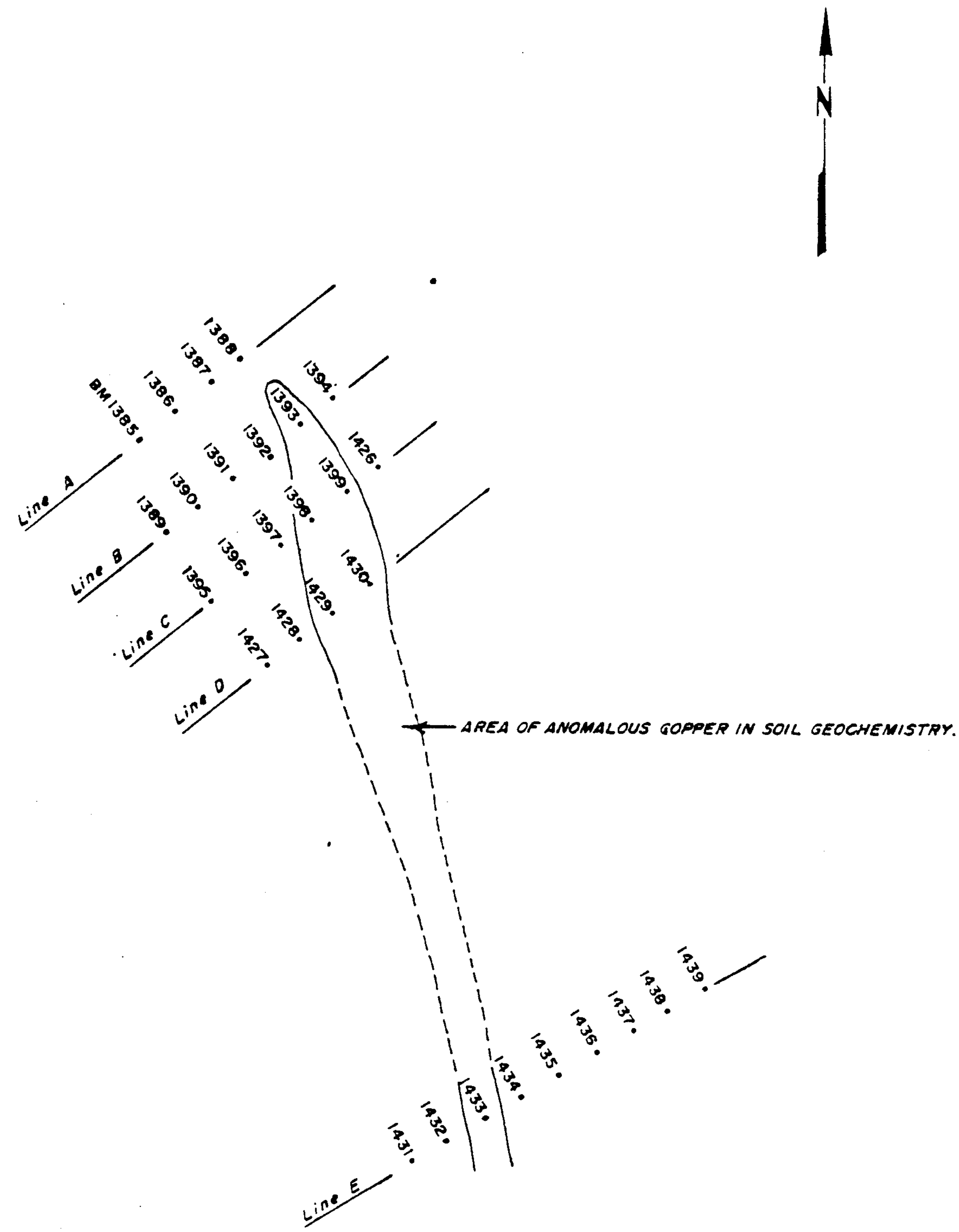
Soil horizons are poorly developed at the prospect because of solifluction. In an attempt to trace the extent of the mineralization at Area 4, "soil" samples were collected at 50-foot spacings along five lines (Fig. 19-A).

Anomalous values obtained from lines B, C and D reflect the presence of the copper mineralization observed as float. At least part of the mineralized float is probably derived from an upslope source although some may be derived from an underlying bedrock source. Sample BM 1433 collected along line E is believed to represent a nearby mineralized occurrence since the soil observed does not appear to be derived from the upslope talus source. If this is the case, copper minerlization may extend under cover for a distance of about 850 feet from sample site BM 1393 south to sample BM 1433. Alternatively, the anomalous copper value obtained at BM 1433 may be derived from a separate mineralized source.

8.15.7 Conclusions

The discovery of copper mineralization in this area of previously unknown mineralization is most interesting. The Kav copper prospect is considered significant.

Mineralization at Kav occurs in and adjacent to quartz veins, and in dolomite breccia. It is not known if the copper migrated outward into dolomite from the quartz veins, or outward from a primary source in the dolomite breccia. By analogy with other areas, the potential is limited if the



NOTE: See figure 19 for location.

G M INC MINING & GEOLOGICAL CONSULTANTS ANCHORAGE, ALASKA	DWN BY: T.D. / DATA BY: K.S.	REVISED	SOIL SAMPLE LOCATIONS KAV COPPER PROSPECT	FIGURE 19a

SCALE: 1" = 300'

mineralization is vein-controlled, and attractive if the primary source is the dolomite.

The presence of fracturing and veining at the surface may be a near-surface phenomenon in response to weathering and movement of ground waters.

The most interesting mineralization yielded values of 18% copper and 33% copper over contour lengths of 36 and 50 feet, respectively (Area 4). The mineralization is in a dolomite breccia, the configuration and extent of which are uncertain. The nature of the mineralization suggests a significant potential for stratabound massive sulfides in dolomite breccia.

Mineralization observed at three other areas outcrops is related to quartz veins. A vein (Area 1) 1.5 feet in width by at least 75 feet in length assays 0.36% copper. At another location (Area 2) the mineralization appears to be restricted to a quartz vein of less than 0.5 feet in width and traceable for 75 feet. An assay shows 6.0% copper, 4.9 oz/ton silver and 3.2% antimony. A third showing (Area 3) contains scattered mineralization across a width of about 40 feet, but of undetermined length. An assay from this occurrence is 0.84% copper and 0.48 oz/ ton silver.

No tonnage potential could be postulated without additional work.

Any stream silt and soil geochemical sampling is hindered because of low mobility of copper in carbonate terranes compounded by subdued topography.

By analogy with base metal mineralization in carbonate terranes elsewhere in the Brooks Range and in Mississippi Valley-type terranes in the Lower 48 States, the evidence available is sufficient to indicate the need for stratigraphic, petrologic, paleontologic, and other mineral studies.

Contingent upon favorable results from studies at Kav, the work should be expanded to locate and appraise similar environments along the Kav carbonate trend.

8.15.8 Recommendations

Recommendations for the Kav copper prospect include:

1. Trenching, and rock sampling in the area of the high grade mineralized float to determine the width of the mineralized zone and allow representative bedrock samples to be collected. Several trenches would be required along the projected trend of the mineralization.

2. Geologic mapping, soil/silt sampling and a electromagnetic geophysical survey to determine controls and distribution patterns of the mineralization. The work recommended includes paleontological, stratigraphic, petrologic, and microscope studies.

3. Core drilling to determine grade, width and continuity of the sulfide mineralization in the carbonate rocks, contingent upon results from 1 and 2, above.

4. Expansion of the work to determine the distribution of carbonate rocks in the area, and contingent upon favorable results to delineate additional

target areas within the favorable carbonate facies.

5. Appraisal of the new discoveries, and assessment of the district potential for base/precious(?) metal mineralization.

TABLE 8.15.1

KAV COPPER PROSPECT

ASSAY RESULTS

Sample No.	% Cu	% Pb	% Zn	Oz/ton Ag	% Sb	Oz/ton Au	Description
BM 1222	18.60	<0.05	<0.05	0.20	----	-----	Talus character sample: pieces of copper bearing dolomite breccia collected over a horizontal distance of 36 feet.
1225	0.84	<0.05	<0.05	0.48	----	-----	Rock chip sample: 40 foot sample across small quartz veins in dolomite breccia.
1366	2.53	----	0.05	1.40	0.04	0.005	Talus character sample: pieces of gossan with minor malachite visible. Pieces up to 10x10x6 inches; collected across 50-foot length.
1367	19.65	----	----	0.27	0.04	-----	Same as BM 1222.
1372	1.55	----	----	0.04	0.02	-----	Talus sample: selected pieces of quartz vein rubble across 50-foot distance.
1373	0.36	----	----	0.04	0.02	-----	Bedrock sample: quartz vein, 75 foot length by 1.5 foot width.

TABLE 8.15.1 (Cont.)

KAV COPPER PROSPCT

ASSAY RESULTS

Sample No.	% Cu	% Pb	% Zn	Oz/ton Ag	Sb	Oz/ton Au	Description
1374	6.18	----	0.62	4.90	3.20	-----	Bedrock sample: 4 to 6 inch wide quartz vein, 75 foot strike length in dolomite breccia host; tetrahedrite in quartz veins; numerous narrow, close-spaced parallel quartz veins, most barren of sulfides.
1401	33.8	<0.05	0.05	----	----	-----	Talus sample: selected pieces of mineralized dolomite breccia same location as 1222.

\- = not analyzed

TABLE 8.15.2

KAV COPPER PROSPECT

GEOCHEMICAL SAMPLE RESULTS

(Values in ppm, unless noted)

Sample No.	Type	Cu	Pb	Zn	Ag	Sb	ppb Au
BM 1206	ss	32	19	79	0.6	--	<5
1224	ss	43	31	88	1.0	--	-
1375	ss	41	27	98	0.2	8	<5
1404	ss	65	31	76	1.3	--	-
1405	ss	62	38	41	1.9	--	-
1385	so	4	46	8	0.2	2	-
1386	so	8	38	10	0.2	1	-
1387	so	15	31	6	0.2	2	-
1388	so	21	33	27	0.2	2	-
1389	so	7	42	38	0.2	5	-
1390	so	8	44	50	0.2	5	-
1391	so	18	39	48	0.2	4	-
1392	so	37	34	49	0.2	5	-
1393	so	420	33	40	0.3	3	-
1394	so	26	36	21	0.2	2	-
1395	so	14	34	42	0.2	6	-
1396	so	7	40	34	0.2	6	-
1397	so	37	27	74	0.2	4	-
1398	so	2600	32	52	1.3	14	-
1399	so	730	34	48	0.2	3	-
1426	so	41	41	15	0.2	2	-
1427	so	31	30	79	0.2	4	-
1428	so	50	29	82	0.2	4	-
1429	so	310	25	34	0.2	4	-
1430	so	172	21	34	0.2	6	-
1431	so	48	12	68	0.2	2	-
1432	so	46	26	56	0.2	4	-
1433	so	270	25	90	0.2	3	-
1434	so	16	27	60	0.2	2	-
1435	so	28	28	46	0.2	2	-
1436	so	32	20	88	0.2	4	-
1437	so	34	22	60	0.2	6	-
1438	so	29	28	46	0.2	4	-
1439	so	29	31	43	0.2	3	-

ss = stream silt sample
so = soil sample
\- = not analyzed

Collected by: Degenhart
Via
Stark

8.16 DOUGLAS, NINGYOYAK AND MIDAS CREEKS

8.16.1 Introduction

Placer gold was discovered as early as 1904 in Midas Creek by William McCarmant (Smith, 1913). During 1911, Mr. McCarmant, accompanied by two other prospectors, again travelled to the region and did a little surface prospecting. Apparently, the returns from their work were not sufficient to induce the men to continue working in this area.

A preliminary geologic map of the Ambler River quadrangle at 1:250,000 scale (Brosgé, 1972) was made available for the present investigation by Mr. I.L. Tailleur of the U.S.G.S.

About 280 active or inactive claims are reported at Ningyoyak and Midas Creeks (U.S.B.M. open-file report 20-73).

Because of the reported gold and the presence of copper lode claims it was decided that the area should be inspected. The principal objective was to determine the grade and extent of the copper mineralization. It was beyond the scope of the field program to attempt an evaluation of placer gold reserves, however, the small size of the alluvial deposit indicates a limited placer gold potential of unknown grade.

8.16.2 Summary

A brief examination of the drainage basins of Douglas, Ningyoyak and Midas Creeks was made to locate and evaluate reported copper mineralization and to attempt to locate the source rock of a placer reported in the area. No attempt was made to evaluate the gold placer reserves (if any), as this was beyond the scope of our assignment. As the tonnage potential of this area is limited, further work is not warranted. No new ideas were developed for the source of the gold which is described as distant (Smith, 1913).

8.16.3 Location and Access

This examination area is located in the northeast portion of the Ambler River quadrangle. The area occupies portions of Tps.28 and 29N., Rs.10, 11 and 12E. (Figs. 1, 2 and 20). The village of Kobuk is the nearest settlement and is about 50 miles to the south.

Access is best gained by helicopter, however, small boats can travel up the Noatak River from Noatak to within 2 or 3 miles of the examination area. Float equipped, fixed-wing aircraft can land on several lakes in the Noatak River valley. Several gravel bars along the Noatak River can also be used as landing strips for small, wheel-equipped aircraft.

8.16.4 Work Accomplished

Several helicopter flights were made along ridge tops between Douglas and Ningyoyak Creeks and between Ningyoyak and Midas Creeks to search for evidence of additional prospecting activity, such as test pits or trenches. The flying failed to reveal signs of work or claims.

Foot traverses were made in the drainage basins of Douglas, Ningyoyak and Midas Creeks. A traverse was also made to the east of Midas Creek to examine the mapped strike extension of the unit found to contain minor copper mineralization at Ningyoyak Creek. Figure 20 shows the location of 70 samples collected and their geochemical and assay values are listed on the table accompanying the figure.

Observations made during the course of the present study indicate that no significant amount of work has been carried out on any of the reported claims. Only a few small prospect pits were noted along the west side of Ningyoyak Creek near the 1,900-foot elevation.

Seventy samples were collected. The majority of these were tested for geochemical purposes, but with the exception of two anomalous gold values, none are considered anomalous.

Two rock samples were collected from an area of copper mineralization and these assayed 0.14% copper and 0.44% copper.

8.16.5 Geology and Mineralization

The geology of the northeastern portion of the Ambler River quadrangle is characterized by northwest trending Upper Devonian Hunt Fork Shale and Kanayut Conglomerate. Much of the area between Douglas Creek and Ningyoyak Creek is mapped as being underlain by a sandstone unit of the Hunt Fork Shale (Brosgé, 1972, and Pessel and Brosgé, 1977).

Brosgé and Reiser (1971) describe the Kanayut Conglomerate as consisting of gray-green massive quartz chert pebble conglomerate, quartzite sandstone and shale. The Hunt Fork Shale consists of black shale, slate and phyllite; interbedded, brown, fine-grained sandstone and quartzite; and lenses of brown muddy limestone with a sandstone member composed mainly of gray-green brown-weathering, thin-bedded, partly calcareous sandstone.

A gray to black phyllite unit of the Hunt Fork Shale appears to be the most interesting rock type in the examination area since it hosts copper mineralization. This phyllite is mapped along the south flank of the mountains in which the Midas and Ningyoyak Creeks head. The only copper mineralization observed in this area is in the phyllite which extends in a northwest direction for at least 9 miles. The phyllite appears to be at the contact with a sandstone unit and quartzite about one-mile west of Ningyoyak Creek. It is likely that this unit continues northwest but is masked by glacial cover.

Copper mineralization is exposed along the west bank of Ningyoyak Creek at an elevation of about 1,900 feet. A limited amount of earlier trenching in this area exposed copper mineralization over an area of about 75 feet by 100 feet and extending to a depth of about 10 feet along the west side of Ningyoyak Creek. Malachite and chalcopyrite are associated with quartz-carbonate stringers, which strike about N20°W and dip to the northeast about 10°. Sample BM 1043 was collected near the top portion of the mineralized outcrop from an area of about 20 feet by 20 feet. This sample assayed 0.44% copper.

The mineralization could extend to the northwest under overburden for about one-half mile, but exposures of phyllite on the east side of Ningyoyak Creek show no sign of mineralization.

Smith (1913) concluded that the gold from Midas Creek was derived either from rocks forming the southern part of the drainage basin or from outwash gravels which have been transported for long distances. Gravels in the upper reaches of Midas Creek apparently are not auriferous, and the gold found near the mouth of the creek is described as consisting of fine particles. The apparent absence of large nuggets of gold, and the presence of gravel beds of presumed glacio-fluvial origin up to an elevation of 850 feet above the mouth of Midas Creek tend to confirm a distant primary source for the placer gold.

The presence of an unknown number of placer claims near the mouth of Ningyoyak Creek is the only evidence suggesting the presence of placer gold at this location. Placer gold is known to be present at Nigikpalvgururvrak Creek which is located about 9 miles to the east.

8.16.6 Geochemistry

Seventy samples were collected in this area, of which 66 were analyzed and 4 were retained for reference. With the exception of rock samples BM 877 and BM 1043 (discussed earlier), and BM 668 no samples are considered anomalous in copper, lead, zinc or silver.

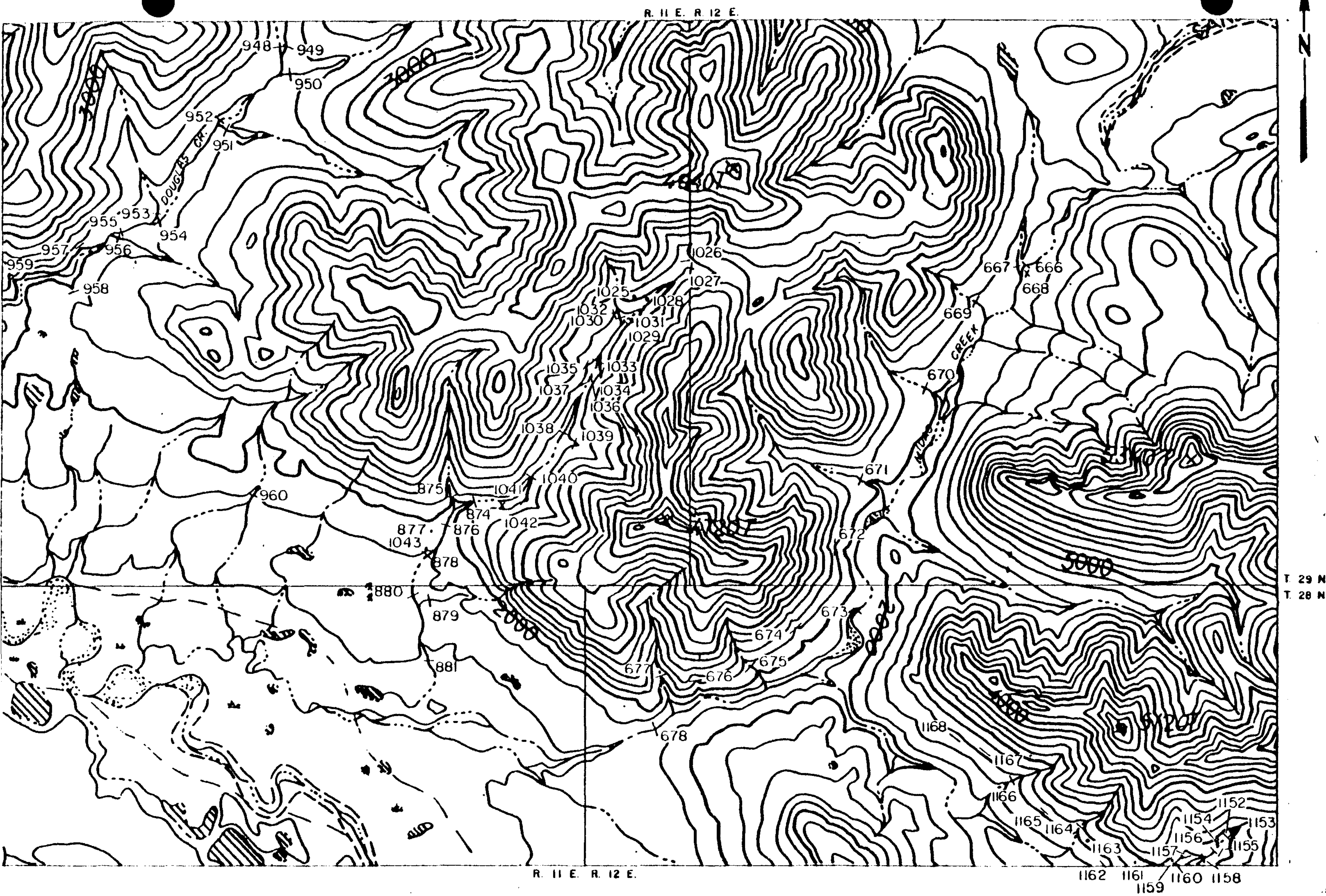
Sample BM 668 represents a piece of quartz found as stream float in the upper reaches of Midas and assays 7.2 ppm silver and 145 ppb gold. No bedrock source for this quartz was noted.

Two stream silt samples are considered weakly anomalous in gold.

Sample BM 677 shows 510 ppb gold, and sample BM 678 shows 50 ppb gold. These two samples were collected from silt in Midas Creek where the stream emerges from the mountains, and they probably represent gold associated with glacial material rather than a local bedrock source.

Geochemical sampling was also conducted in Douglas Creek, which is about 5 miles to the west of Ningyoyak Creek. No geochemical values considered anomalous were obtained from this drainage.

Seventeen geochemical samples were collected to the east of Midas Creek along the strike extension of the phyllite, which hosts the copper mineralization near Ningyoyak Creek



WGM INC	MINING & GEOLOGICAL CONSULTANTS ANCHORAGE, ALASKA	DWN BY: M.H.	REVISED	SAMPLE SITE LOCATIONS DOUGLAS-NINGYOYAK-MIDAS CREEKS AMBLER RIVER D-1 QUADRANGLE	FIGURE 20 BM114
SCALE: 4 0 8 in miles		DATA BY: WGM			
		DATE: 10/76			

some six miles to the west. None of these samples are considered anomalous.

8.16.7 Conclusions

Copper mineralization grading less than 0.5% is found associated with quartz-carbonate stringers in a phyllite host rock. The mineralization is exposed along strike for about 100 feet and appears to be not more than 75 feet in width. Copper staining in the form of malachite is prominent along fractures and shears in the unmineralized phyllite.

Optimistically, the mineralized zone may be up to 2,000 feet in length by 75 feet in width and extend to 100 feet in depth. Using these figures, about 1,000,000 tons of material grading less than 0.5% copper could be expected at this location. Additional work would be required to confirm the above figures, which, in any event, are sub-economic.

Placer gold is reported along the lower reaches of Midas Creek. This gold is considered to be associated with glacial material and has probably been transported a long distance. Additional work would be required to evaluate the placer gold potential of this area which appears to be very limited.

8.16.8 Recommendations

No work is recommended for the areas examined including the copper showing.

TABLE 8.16.1

DOUGLAS, NINGYOYAK, MIDAS CREEKS

GEOCHEMICAL SAMPLE RESULTS

(Values in ppm, unless noted)

Sample No.	Type	Cu	Pb	Zn	Ag	ppb Au
BM 666	ss	25	14	96	---	<5
667	ss	34	20	130	---	---
668	rx	103	--	--	7.2	145
669	ss	39	19	90	---	---
670	ss	34	21	100	---	---
671	ss	35	17	85	---	<5
672	ss	41	22	93	---	---
673	ss	29	14	88	---	<5
674	ss	48	22	90	---	---
675	ss	29	19	78	---	---
676	ss	59	26	106	---	<5
677	ss	47	22	106	---	510
678	ss	25	16	79	0.7	50
874	ss	28	16	82	0.8	---
875	ss	44	22	96	1.0	---
876	ss	30	17	86	1.0	---
877	rx	0.14%	0.05%	0.05%	tr	tr
878	ss	37	20	100	1.0	---
879	ss	34	22	107	1.0	---
880	ss	34	17	96	0.9	---
881	ss	24	15	86	0.5	---
948	ss	33	17	102	---	---
949	ss	26	17	72	---	---
950	ss	32	18	105	---	---
951	ss	25	13	92	---	---
952	ss	26	13	110	---	---
953	ss	24	15	83	---	---
954	ss	27	14	90	---	---
955	ss	22	14	84	---	---
956	ss	12	12	66	---	---
957	ss	33	19	96	---	---
958	ss	26	14	70	---	---
959	ss	37	18	94	---	---
960	ss	32	19	90	---	---
1025	rx	29	--	88	1.5	<5
1026	ss	45	28	85	1.0	---
1027	ss	34	22	100	1.0	---
1028	rx	140	--	25	0.9	<5
1029	ss	38	22	91	1.1	---
1030	ss	41	22	98	1.2	---

TABLE 8.16.1 (Cont.)

DOUGLAS, NINGYOYAK, MIDAS CREEKS

GEOCHEMICAL SAMPLE RESULTS

(Values in ppm, unless noted)

Sample No.	Type	Cu	Pb	Zn	Ag	ppb Au
BM 1031			Reference	Sample		
1032			Reference	Sample		
1033	ss	36	--	93	1.1	---
1034	ss	49	--	110	1.3	---
1035	ss	31	--	89	1.0	---
1036			Reference	Sample		
1037			Reference	Sample		
1038	ss	33	17	84	1.0	---
1039	ss	36	22	116	1.0	---
1040	ss	29	18	96	1.0	< 5
1041	ss	25	18	87	1.0	< 5
1042	rx	--	--	--	---	< 5
1043	rx	0.44%	--	--	tr	tr
1152	ss	41	24	87	0.7	< 5
1153	rx	9	32	77	1.4	< 5
1154	rx	29	16	134	1.0	< 5
1155	ss	38	26	92	0.7	< 5
1156	pc	34	18	89	0.9	< 5
1157	ss	38	25	85	0.8	< 5
1158	ss	58	18	85	0.6	10
1159	rx	78	15	111	1.1	< 5
1160	pc	30	19	39	0.9	< 5
1161	rx	18	26	100	0.8	< 5
1162	ss	37	29	142	0.8	< 5
1163	rx	7	18	21	0.2	< 5
1164	ss	56	33	102	0.7	10
1165	ss	33	25	107	0.8	< 5
1166	ss	32	22	85	0.6	< 5
1167	ss	30	16	85	0.5	< 5
1168	ss	35	20	96	0.9	< 5

ss - stream silt sample
rx - rock sample
pc - panned concentrate sample
tr - trace amount
\- - not analyzed
< - less than

Collected by: Degenhart
Griffis
Via
Fairchild

8.17 SHISHAKSHINOVIK PASS AREA

8.17.1 Introduction

The Ambler River quadrangle has been mapped at 1:250,000 scale (Pessel and Brosgé, 1977). The State of Alaska Division of Geological and Geophysical Surveys has conducted geochemical stream silt sampling in portions of the Ambler River quadrangle, and the results of this work were published as an open-file report, (Gardland, et al., 1973). The work by the State included sampling in the Shishakshinovik Pass area.

During 1974, a group of 29 Federal lode mining claims were located in th northeast corner of T.23N., R.11E. on behalf of Noranda Exploration Company by WGM Inc. These claims abut the examination area to the south and west, and are located on open to mineral entry d-1 lands. The present status of the claims is unknown.

Attention was drawn to the area by a reported geochemical stream silt value of 1,100 ppm zinc and 390 ppm lead (Gardland, et al., 1973). The sample was collected from a northwest flowing drainage about two miles southeast of Shishakshinovik Pass.

8.17.2 Summary

Follow-up of strong geochemical values in a drainage basin in the Shishakshinovik Pass area resulted in the discovery of a boulder (3 x 2 x 2 feet) which assayed greater than 20,000 ppm lead, 16,500 ppm zinc and over 100 ppm silver (BM 1226). The lead and silver values may be substantially higher than reported since the atomic absorption method is accurate only for lower values. Although the minerlization could not be traced to its bedrock source, stream sediment and rock sampling shows that at least minor amounts of lead, zinc and molybdenum are associated with granitic rocks and with the contact zone between the granitic rocks and the surrounding metasedimentary rocks.

A total of 27 samples were collected, of which, 24 were analyzed and 3 retained for reference.

Additional work is recommended to explore for the bedrock source of the rock represented by sample BM 1226. Exploration is recommended along the contact zone between granitic and metasedimentary rocks. If potentially economic mineralization is found, the exploration should be expanded to determine if additional mineralized zones are present.

8.17.3 Location and Access

Shishakshinovik Pass is located in T.24N., R.11E. in the Ambler River 1:250,000 scale quadrangle. The area examined included a portion of Tps. 23 and 24N., Rs.11 and 12E. The Kogoluktuk River flows southward, and the Ipnelivik River northward from Shishakshinovik Pass, which is located about 40 miles northeast of Kobuk. Access to the area is by helicopter.

8.17.4 Work Accomplished

An examination was made in the drainage basin displaying the 1,100 ppm zinc and 390 ppm lead values as well as a drainage basin located immediately to the east. Efforts were directed toward discovery of base metal sulfide mineralization responsible for the strong geochemical anomaly.

A total of 27 samples were collected in this area, 9 of which are rock samples and the remainder stream silt samples. Of the 9 rock samples, 3 were collected for reference and were not analyzed.

8.17.5 Geology and Mineralization

The examination area lies near the northern edge of the Shishakshinovik pluton. Radiometric dating indicates an age of 99 million years for the pluton (State of Alaska Annual Report, 1973).

A granitic body intrudes a sequence of gray to black limestone and dolomite, shale, graphite schist, and quartz chlorite schist at the headwalls of the two drainage basins examined (Fig. 21). The granitic body is probably an apophyses of the Shishakshinovik Pluton.

The intrusive rock is foliated, and biotite is commonly altered to chlorite. Float and rubble observed in the basins indicate that skarn has been developed at the contact zone. The skarn zone does not appear to exceed 20 feet in thickness. The contact zone was traced to a distance of about 1.5 miles.

Mineralization in the form of pyrite, galena, sphalerite and molybdenite was observed during the examination. The most significant mineralization observed (>20,000 ppm lead, 16,500 ppm zinc, >100 ppm silver) occurs in the form of small stringers of galena, pyrite and sphalerite associated with a granitic host rock. The rock was estimated to contain about 5% galena, 10-15% pyrite and 3% sphalerite. The mineralization, which was found in a glacial derived boulder of approximately 3 x 2 x 2 feet could not be traced to outcrop. Only one piece of the mineralized rock was found, which indicates either that the bedrock occurrence is not extensive, or that glacial rubble in the valley masks the source.

Rock-chip sampling of the outcropping granite along the headwall of the basin shows that a minor amount of lead and zinc mineralization is present throughout the granite. Sample BM 1230 shows 630 ppm lead and 400 ppm zinc over a 1,000-foot distance.

In the eastern drainage a minor amount (220 ppm) of molybdenite is associated with the granite (BM 1406). The sample was high-graded along a 3-foot distance and is not representative of the molybdenite content of the granite over any sizeable area. The molybdenite appears to be restricted to widely spaced narrow veinlets or fractures.

Minor mineralization (copper, lead, zinc and silver) is associated with rocks near the contact zone, and with small quartz veins as evidence by samples BM 1408 and 1409. Sample BM 1409 is representative of a 150-foot by 200-foot area of black siliceous rock (quartzite?) near the eastern edge of the exposed granitic body. The sample shows 610 ppm lead and 3.6 ppm silver. A sample of quartz (BM 1408) hosted by chloritic schist shows 380 ppm copper, 190 ppm lead, 1,000 ppm zinc and 2.4 ppm silver. The material occurs as float and was not seen in outcrop. The observed width of the mineralization is approximately 0.5 foot.

8.17.6 Geochemistry

Geochemical stream silt sampling results in the two drainage basins reflect the presence of lead, zinc and molybdenum mineralization over a limited area. The mineralization appears to be confined to the granite, and to the contact zone with the surrounding rocks. Figure 21 shows the location of sample sites. Samples BM 1233 and 1234 were collected from small gullies draining the contact zone along the southwest side of the western drainage basin. Both samples show high lead and zinc geochemical values, and are indicative of the presence of lead-zinc mineralization associated with this contact zone. Additional sampling of small gullies in the western drainage basin failed to yield geochemical values considered anomalous. Several silt samples collected in the western drainage show fairly high lead and zinc values which are attributed to the presence of the sulfide mineralization found near the head of the basin described above.

Stream silt samples BM 1410 and BM 1411 show significant lead and zinc values in the eastern drainage basin. The two samples were collected near the contact zone and apparently reflect the presence of minor amounts of sulfide mineralization.

Three rock and 10 silt samples were analyzed for gold and tin. Silt sample BM 1233 shows 54 ppm tin which is considered to be slightly anomalous.

8.17.7 Conclusions

One piece of mineralized granite float showing greater than 20,000 ppm lead, 16,400 ppm zinc and over 100 ppm silver was discovered during the examination. Additional sampling indicates that at least minor amounts of lead, zinc, and silver and molybdenum are associated with granitic rocks and with a narrow contact zone surrounding the granitic body. The very preliminary examination indicates that only minor amounts of mineralization are associated with the contact zone and the granite itself. The contact zone appears to extend for a distance of at least 1.5 miles, and may reach 20 feet in thickness, but neither its total extent nor size has been fully defined.

Sampling of exposed mineralized rocks indicates that material grading no more than 0.2% lead and 0.2% zinc is present along the contact zone and in the granite. Additional work is required to determine if higher grade material is present under the glacial debris in the valley. Geological mapping is required to determine the extent of the mineralized contact zone.

8.17.8 Recommendations

Additional work is recommended, consisting of detailed geologic mapping to define the extent of the contact zone between the granite and surrounding rocks. Stream sediment and rock sampling should be conducted in conjunction with the mapping to determine if significant amounts of mineralization are present. Reconnaissance of surrounding metasediments is recommended to determine if the mineralization, in and adjacent to the granitic body, is an indicator of more mineralization in the sedimentary facies.

Follow-up is recommended to determine the bedrock source of the mineralized granitic float which shows greater than 20,000 ppm lead, 16,500 ppm zinc and over 100 ppm silver.

It is recommended that the granitic body be flown with radiometric instrumentation as the first phase in evaluating the uranium potential of the area.

TABLE 8.17.1

SHISHAKSHINOVIK PASS AREA

DESCRIPTION OF ROCK SAMPLES

(Values in ppm, unless noted)

Sample No.	Cu	Pb	Zn	Mo	Ag	ppb Au	Sn	Description
BM 1226	58	20,000	16,500	20	100	25	26	Glacial rubble. 3x2x2 ft; granitic rock with small stringers of sulfides.
1229	9	1,800	600	5	9.4	5	13	Bedrock chip sample over 10x10 foot area. Granitic rock w/very minor disseminations of galena.
1230	5	630	400	22	3.7	65	10	Bedrock chip sample over 1,000 feet, granitic rock (1' spacings).
1406	155	22	39	220	0.2	--	--	Bedrock chip sample over 3 feet. Granitic rock with visible molybdenite.
1408	380	190	1,000	6	2.4	--	--	Float sample of quartz vein material in chloritic schist.
1409	28	610	10	9	3.6	--	--	Bedrock sample representative of 150x200-foot area. Black siliceous rock with blebs of pyrite.

TABLE 8.17.2

SHISHAKSHINOVIK PASS

GEOCHEMICAL SAMPLE RESULTS

(Values in ppm, unless noted)

Sample No.	Type	Cu	Pb	Zn	Mo	Ag	ppb Au	Sn
BM 1226	rx	58	>20,000	16,500	20	>100.0	25	26
1227	rx			Reference	Sample			
1228	rx			Reference	Sample			
1229	rx	9	1,800	600	5	9.4	5	13
1230	rx	5	630	400	22	3.7	5	10
1233	ss	26	1,280	1,300	20	4.5	5	54
1234	ss	54	540	790	8	3.0	5	6
1235	ss	44	360	1,340	9	2.6	10	10
1236	ss	12	210	580	6	2.0	15	3
1237	ss	35	290	1,630	9	2.2	10	3
1238	ss	22	22	200	5	1.3	5	2
1239	ss	6	47	158	4	2.3	5	2
1240	ss	14	45	124	4	1.7	10	3
1241	ss	51	56	190	2	0.7	5	2
1242	ss	26	18	57	ND	0.8	5	10
1406	rx	155	22	39	220	0.2	--	--
1407	rx			Reference	Sample			
1408	rx	380	190	1,000	6	2.4	--	--
1409	rx	28	610	10	9	3.6	--	--
1410	ss	42	355	415	14	2.4	--	--
1411	ss	50	130	600	4	1.0	--	--
1412	ss	27	62	420	4	1.2	--	--
1413	ss	18	37	230	3	1.2	--	--
1414	ss	37	30	170	2	1.0	--	--
1415	ss	30	21	120	2	0.8	--	--
1416	ss	45	34	129	ND	0.8	--	--
1417	ss	34	32	53	3	1.3	--	--

rx = rock sample
ss = stream silt sample
ND = not detected
- = not analyzed

Collected by: Degenhart
Via

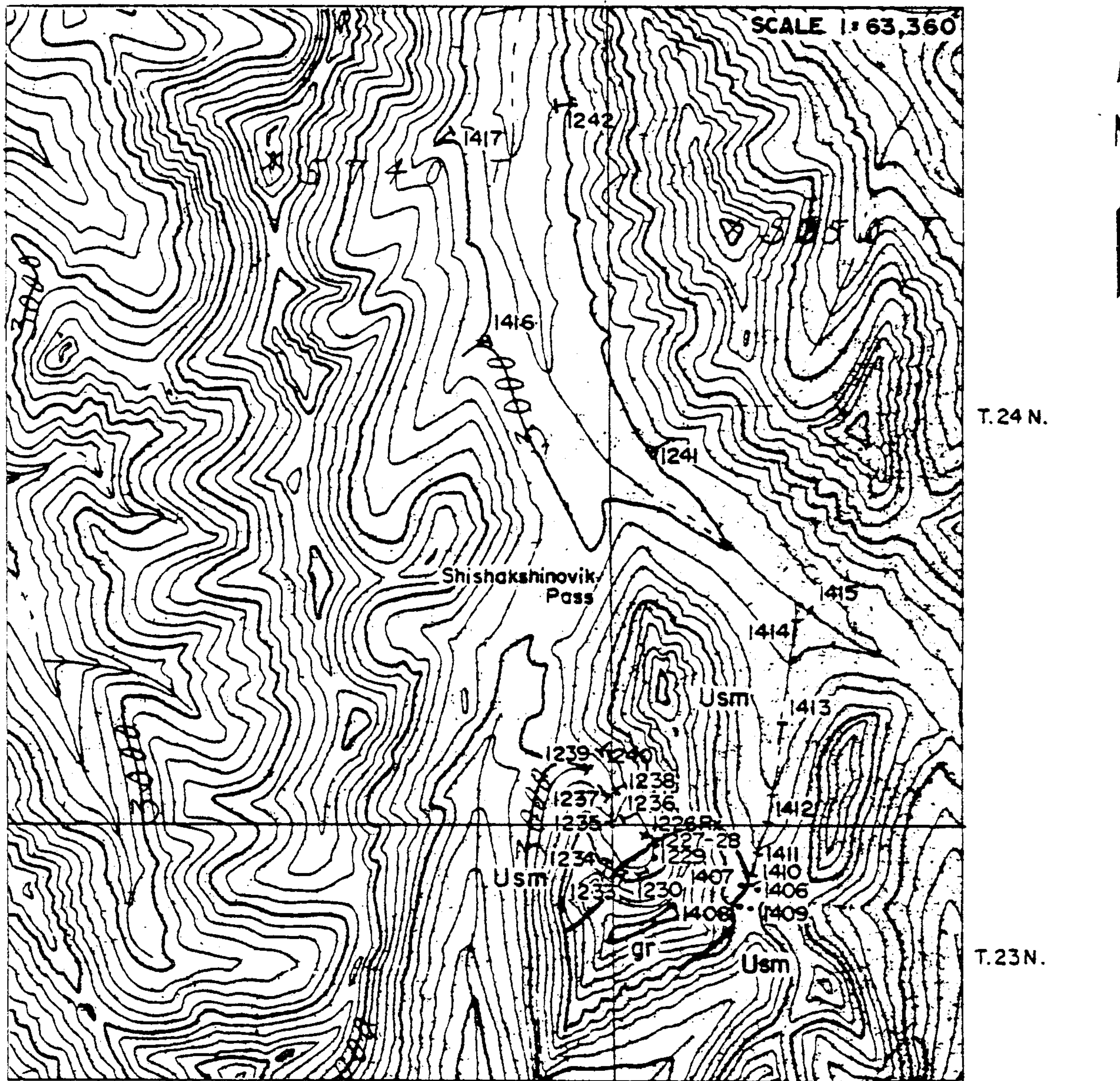
LEGEND

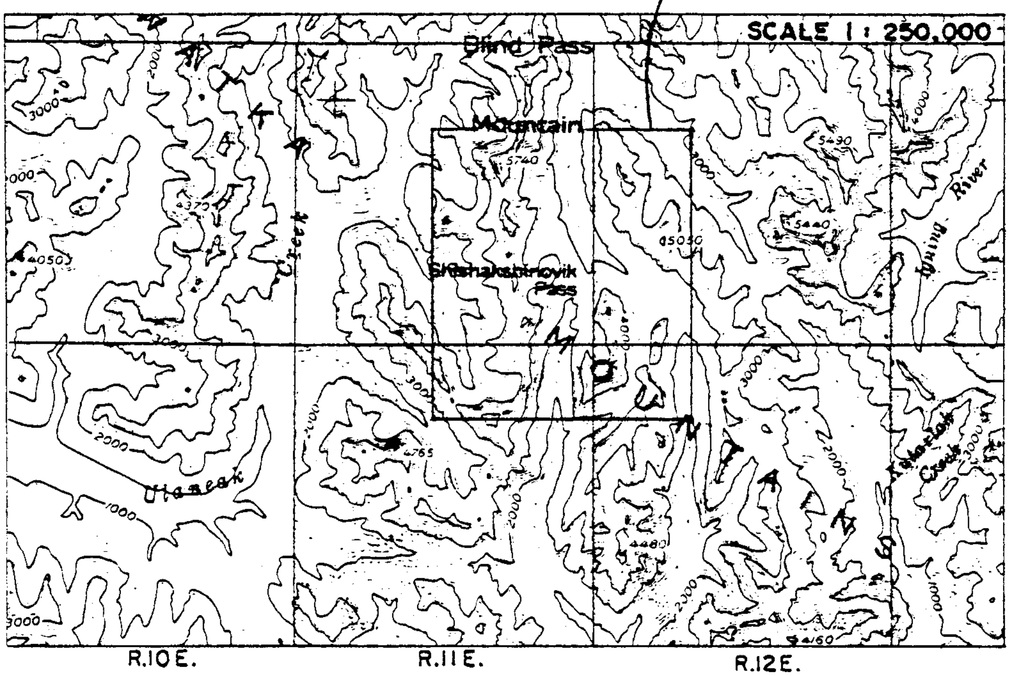
SHISHAKSHINOVIK PASS AREA

gr - Cretaceous granite, foliated with biotite altered to chlorite.

Usm - Undifferentiated sedimentary and metamorphic rocks; includes gray to black limestone and dolomite, shale, graphitic and chloritic schist.

/ - Contact.





GM INC — MINING & GEOLOGICAL CONSULTANTS, ANCHORAGE, ALASKA	DWN BY T.D.	REVISED	GENERALIZED GEOLOGIC MAP AND SAMPLE SITE LOCATIONS	FIGURE 21
SCALE: AS SHOWN	DATA BY C.D. W.V.		SHISHAKSHINOVIK PASS AREA	BM137
	DATE 7/75		AMBLER RIVER B-1 QUADRANGLE	

8.18 KUTARLUK CREEK AREA

8.18.1 Introduction

Geologic mapping has been done in the Kutarluk Creek area (Pessel and Brosgė, 1977) at 1:250,000 scale. The State of Alaska (Garland et al., 1973) conducted a limited amount of geochemical stream silt sampling in this area and reported two anomalous values of 80 ppm lead and one value of 1,660 ppm zinc.

8.18.2 Summary

Geochemical sampling was carried out in the Kutarluk Creek area to check out moderately high geochemical values obtained by previous workers and to geochemically test several iron-stained areas for the presence of mineralization in addition to pyrite.

A total of 83 samples were collected for analysis and eight of these samples returned weakly to moderately high values. These eight seemingly higher than normal values for lead zinc and silver are attributed to trace amounts of mineralization. Pyrite was the only sulfide observed.

No additional work is recommended for the drainage basins examined, however, geochemical sampling and prospecting to the west of the examination area is recommended. The work recommended would be directed towards discovery of mineralization associated with a granite-sedimentary rock contact.

8.18.3 Location and Access

The Kutarluk Creek area is located in the Ambler River quadrangle in Tps. 23 and 24N., Rs. 12 and 13E. (Figs. 1 and 3). Kutarluk River is a tributary to the Kogoluktuk River and is about 30 miles northeast of Bear Creek Mining Company's camp at Bornite.

Access to this area is by helicopter.

8.18.4 Work Accomplished

Foot traverses were made in this area to follow up the anomalous values obtained by the State personnel, and to increase the geochemical coverage at numerous iron-stained areas.

A total of 83 samples were collected for analysis, of which eight are considered anomalous in either lead, zinc or silver.

8.18.5 Geology and Mineralization

The geology in this area is mapped as Devonian interbedded black calcareous phyllite and black argillaceous limestone, calcareous phyllite, siltstone, and grit (Pessel and Brosgé, 1977).

These Devonian rocks are intruded by the Cretaceous Shishakshinovik Pluton about two miles west of the examination area.

Up to 5% pyrite was observed locally in phyllite and small quartz veins. No other mineralization was noted.

8.18.6 Geochemistry

Of the 83 samples collected for analysis (Table 8.18.1, Fig. 22) eight samples returned results which may be considered anomalous.

Sample BM 885 returned the highest geochemical values: 138 ppm copper, 56 ppm lead and 1,100 ppm zinc. This sample was collected from a very small gully underlain by gray to black graphitic phyllite, containing no visible sulfides. Rock sample BM 1045 was collected near the head of this same gully where bedrock is pyrite-bearing graphitic phyllite. Disseminated pyrite in the phyllite was estimated at 5% over a 100-foot by 100-foot area. No other mineralization was observed, and sample BM 1045 shows only 59 ppm copper and 19 ppm zinc.

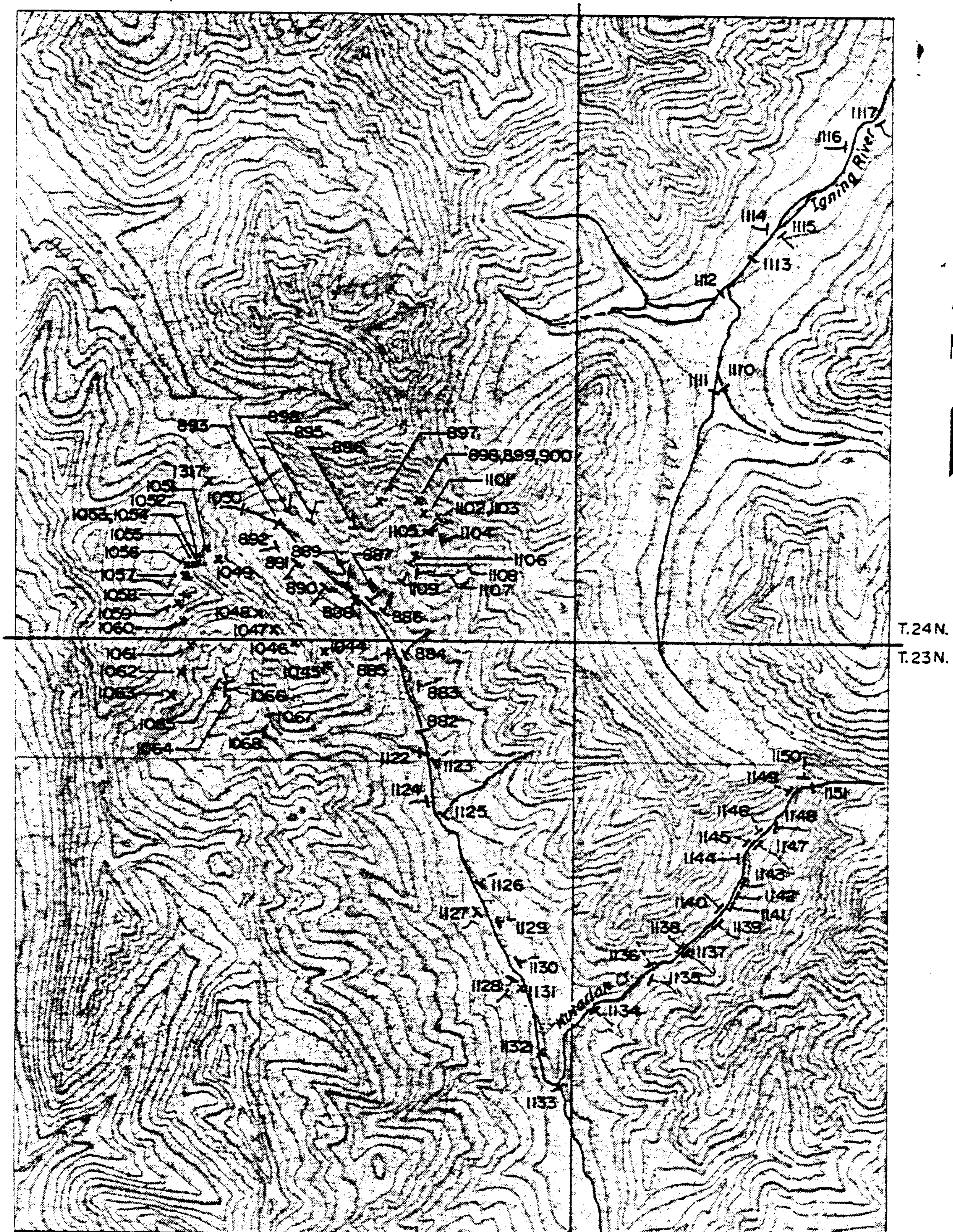
Sample BM 886 which shows 940 ppm zinc was likewise collected from a small gully. At this sample site, a four-foot wide pyritic quartz vein is hosted by iron-stained phyllite and it is assumed that trace amounts of zinc mineralization are associated with the pyrite.

Of the other six samples which returned values considered weakly anomalous, the values are attributed to trace amounts of zinc, lead, or silver associated with visible pyrite, or present trace amounts in the local bedrock.

8.18.7 Conclusions and Recommendations

Anomalous metal values obtained from eight samples are attributed to trace amounts of mineralization associated with pyrite, which is present as disseminations in phyllite and as small blebs in quartz veins.

No additional work is recommended at the areas sampled during this program, however, systematic, detailed geochemical stream silt and rock sampling is recommended to the west of the examination area. This work is recommended to



GM INC MINING & GEOLOGICAL CONSULTANTS ANCHORAGE, ALASKA

SCALE 1:63,360

DWN BY T.D. | REVISED
DATA BY WGM
DATE 7/75

SAMPLE SITE LOCATIONS
KUTARLAK CREEK AREA
AMBLER RIVER B-1 QUADRANGLE

FIGURE 22
BM138

explore the granite-sedimentary rock contact for possible occurrences of mineralization.

TABLE 8.18.1

KUTARLUK CREEK AREA

GEOCHEMICAL SAMPLE RESULTS

(Values in ppm, unless noted)

Sample No.	Type	Cu	Pb	Zn	Ag	ppb Au	W
BM 882	ss	51	24	135	1.4	---	--
883	ss	65	20	142	1.4	---	--
884	ss	44	20	86	1.0	---	--
885	ss	138	56	1,100	2.6	---	--
886	ss	78	24	940	1.6	---	--
887	ss	68	26	146	1.5	---	--
888	rx	116	11	71	0.9	10	--
889	ss	69	24	400	1.4	---	ND
890	ss	40	20	132	1.5	---	ND
891	ss	39	20	112	1.6	---	ND
892	ss	65	28	300	1.3	---	ND
893	ss	90	21	185	1.3	---	ND
894	ss	31	44	280	2.5	---	ND
895	ss	64	51	157	1.8	---	ND
896	ss	82	38	200	1.9	---	ND
897	rx	132	22	87	3.5	---	--
898	rx	2	25	11	1.8	<5	--
899	rx	11	16	10	1.7	---	ND
900			Reference Sample				
1044	rx	83	--	62	1.0	<5	--
1045	rx	59	--	19	0.8	5	--
1046	rx	24	--	84	0.5	5	--
1047			Reference Sample				
1048	rx	20	--	43	0.5	<5	--
1049	rx	34	--	130	1.3	20	--
1050	ss	89	--	300	1.5	<5	--
1051	rx	5	--	4	1.0	10	--
1052			Reference Sample				
1053	rx	6	--	24	1.7	10	--
1054	rx	5	--	500	0.3	5	--
1055	rx	98	--	180	1.5	<5	--
1056	rx	27	--	200	1.0	<5	--
1057	rx	9	--	114	3.6	<5	--
1058			Reference Sample				
1059			Reference Sample				
1060	rx	4	--	8	0.8	5	--
1061	rx	20	--	34	1.0	5	--
1062			Reference Sample				

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TABLE 8.18.1 (Cont.)

KUTARLUK CREEK AREA

GEOCHEMICAL SAMPLE RESULTS

(Values in ppm, unless noted)

Sample No.	Type	Cu	Pb	Zn	Ag	ppb Au	W
BM 1063			Reference Sample				
1064	ss	40	25	150	1.0	10	--
1065	ss	76	26	180	1.4	25	--
1066	ss	64	23	72	2.3	<5	--
1067	ss	69	23	100	2.0	<5	--
1068	ss	60	41	350	1.4	<5	--
1101	rx	33	37	86	2.3	5	--
1102			Reference Sample				
1103	ss	74	20	74	1.2	---	--
1104	ss	62	20	75	1.2	---	--
1105	ss	68	22	84	1.3	---	--
1106	rx	119	27	240	2.6	10	--
1107	ss	79	26	100	1.4	---	--
1108	ss	117	26	300	2.1	---	--
1109	ss	89	20	530	1.5	---	--
1110	ss	15	19	26	1.0	---	--
1111	ss	20	11	32	0.2	---	--
1112	ss	33	15	42	0.5	---	--
1113	ss	27	15	33	0.3	---	--
1114	ss	28	13	92	0.4	---	--
1115	ss	16	25	64	1.4	---	--
1116	ss	25	16	57	0.6	---	--
1117	ss	76	22	168	1.1	---	--
1122	ss	34	29	54	1.6	---	--
1123	ss	47	21	94	1.0	---	--
1124	ss	56	23	72	0.9	---	--
1125	ss	59	22	154	1.4	---	--
1126	ss	58	22	94	1.1	---	--
1127	ss	50	24	118	1.4	---	--
1128	ss	50	50	150	1.0	---	--
1129	ss	50	26	114	1.4	---	--
1130	ss	39	20	94	1.0	---	--
1131	rx	4	11	11	0.4	---	--
1132	rx	35	26	70	1.6	---	--
1133	ss	17	17	37	1.0	---	--
1134	ss	128	34	750	4.1	---	--
1135	ss	39	18	53	0.7	---	--
1136	ss	26	20	56	0.8	---	--
1137	ss	25	17	32	0.6	---	--
1138	ss	28	19	40	0.6	---	--
1139	ss	33	24	41	1.0	---	--

TABLE 8.18.1 (Cont.)

KUTARLUK CREEK AREA

GEOCHEMICAL SAMPLE RESULTS

(Values in ppm, unless noted)

Sample No.	Type	Cu	Pb	Zn	Ag	ppb Au	W
BM 1140	ss	31	19	35	0.8	---	--
1141	ss	33	14	34	0.4	---	--
1142	ss	41	20	41	0.9	---	--
1143	ss	16	25	26	1.8	---	--
1144	ss	25	22	45	1.1	---	--
1145	ss	43	24	42	0.9	---	--
1146	ss	26	19	43	0.8	---	--
1147	ss	49	19	44	0.6	---	--
1148	ss	25	13	50	0.6	---	--
1149	ss	48	18	43	0.7	---	--
1150	ss	67	20	58	0.8	---	--
1151	ss	66	19	52	0.4	---	--
1317		Reference Sample					

ss = stream silt sample
rx = rock sample
\- = not analyzed
< = less than

Collected by: Griffis
Fairchild
Via

8.19 NIGIKPALVGURURVRAK CREEK

8.19.1 Introduction

The Survey Pass quadrangle has been mapped at 1:250,000 scale as a joint effort by the U.S.G.S. and State of Alaska (Pessel and Brosgė, 1977). Additional work, including geochemical stream silt sampling, has not been accomplished in the northwestern part of the quadrangle.

A one-man, seasonal placer gold operation is based on Nigikpalvgururvrak Creek and a small tributary. The present operator, Mr. Gene Joiner, has spent portions of several field seasons working at the placer operation. Production records are not available but are estimated to be not more than a few tens of ounces of gold per year. The amount of gravel present in the drainage appears not to be more than a few feet thick. Numerous large rocks are present in the stream, which makes the placer operation difficult.

8.19.2 Summary

A brief examination was conducted at this area to determine if copper mineralization similar to that found 15 miles to the northwest at Ningyoyak Creek is present in similar black phyllite. An attempt was also made to determine if placer gold currently being mined is derived from a local bedrock source.

No analytical results were obtained which would suggest the presence of more than background concentrations of gold, silver, copper, lead or zinc. It also appears that the placer gold potential is very small.

No further work is recommended in this area unless as part of a regional exploration program.

8.19.3 Location and Access

Nigikpalvgururvrak Creek flows southeastward into the Noatak River and is located in T.27N, R.13E in the Survey Pass quadrangle (Figs. 1, 3 and 23). The mouth of this stream is about 20 miles south of the southern boundary of National Petroleum Reserve, Alaska.

Small fixed-wing aircraft can land near the mouth of Nigikpalvgururvrak Creek, however, the WGM field crew used a helicopter to reach the area.

8.19.4 Work Accomplished

The WGM field party received permission from Mr. Joiner to inspect the area. Fifteen stream silt, rock, and panned concentrate samples were collected from Nigikpalvgururvrak Creek and a small tributary. The limits of the placer claim(s) are not known, however, several samples were collected from the area currently being worked. Figure 23 shows the sample site locations and the table accompanying the figure lists geochemical values of the samples. Of the 15 samples collected all were analyzed for gold, 12 were analyzed for silver, 11 for copper and zinc, and 3 for lead.

8.19.5 Geology and Mineralization

The geology north of the Noatak River is characterized by west- to northwest-trending units of sedimentary and metamorphic rocks. The predominant units are Upper Devonian Hunt Fork Shale and an unnamed unit of Middle or Upper Devonian ferruginous siltstone and black limestone. The Hunt Fork Shale consists of black shale, slate and phyllite with interbedded brown, fine-grained sandstone and quartzite. Lenses of limestone are also present. The ferruginous siltstone and black limestone unit is composed chiefly of light brown and orange weathering, gray calcareous siltstone and phyllite. Dark gray to black limestone interbedded with black siltstone and phyllite is also present.

Black fine-grained graphitic phyllite containing numerous quartz veins is the dominant rock type observed as outcrop. Quartz-calcite veins are also present along tension fractures in the phyllite. The quartz veins predate folding in the phyllite, while the quartz-calcite veins postdate folding. Locally, the phyllite contains up to 5% coarse-grained pyrite as disseminations, and a minor amount of pyrite is also present in several of the quartz veins. No sulfides were noted in quartz-calcite veins.

Near the mouth of Nigikpalvgururvrak Creek, abundant large granitic rocks are present as stream float. The rocks contain very coarse-grained feldspars and display a secondary planar arrangement of muscovite.

The placer gold may be derived from the pyritic quartz veins in the phyllite.

Gravel and moraine appear to be present up to about the 3,000-foot elevation or about 1,000 feet above the creek, and recent reworking of these gravels by streams may have resulted in the concentration of gold in the current stream bed. If this is the case, the original source of the gold may be distant.

8.19.6 Geochemistry

Figure 23 shows the location of 16 samples collected during the examination. None of the samples collected show results considered significant for gold, silver, copper, zinc or lead.

Sample BM 1320 is a character sample from an outcrop of pyritic phyllite. This sample shows 3 ppm copper, 1.6 ppm silver, and 5 ppb gold. These values are not significant enough to warrant additional work

Sample BM 1323 shows only 9 ppm copper, 1.2 ppm silver, and 5 ppb gold, and was collected from a pyritic quartz vein. Likewise these values are not considered significant enough to warrant additional work.

Panned concentrate samples numbered BM 1319, 1322 and 1326 all show less than 5 or 5 ppb gold, which are very low values.

Results from the sampling in this area fail to establish the source rock from which the gold is derived, or to suggest the presence of additional types of mineralization, including copper which was observed in a similar phyllite unit about 15 miles to the northwest.

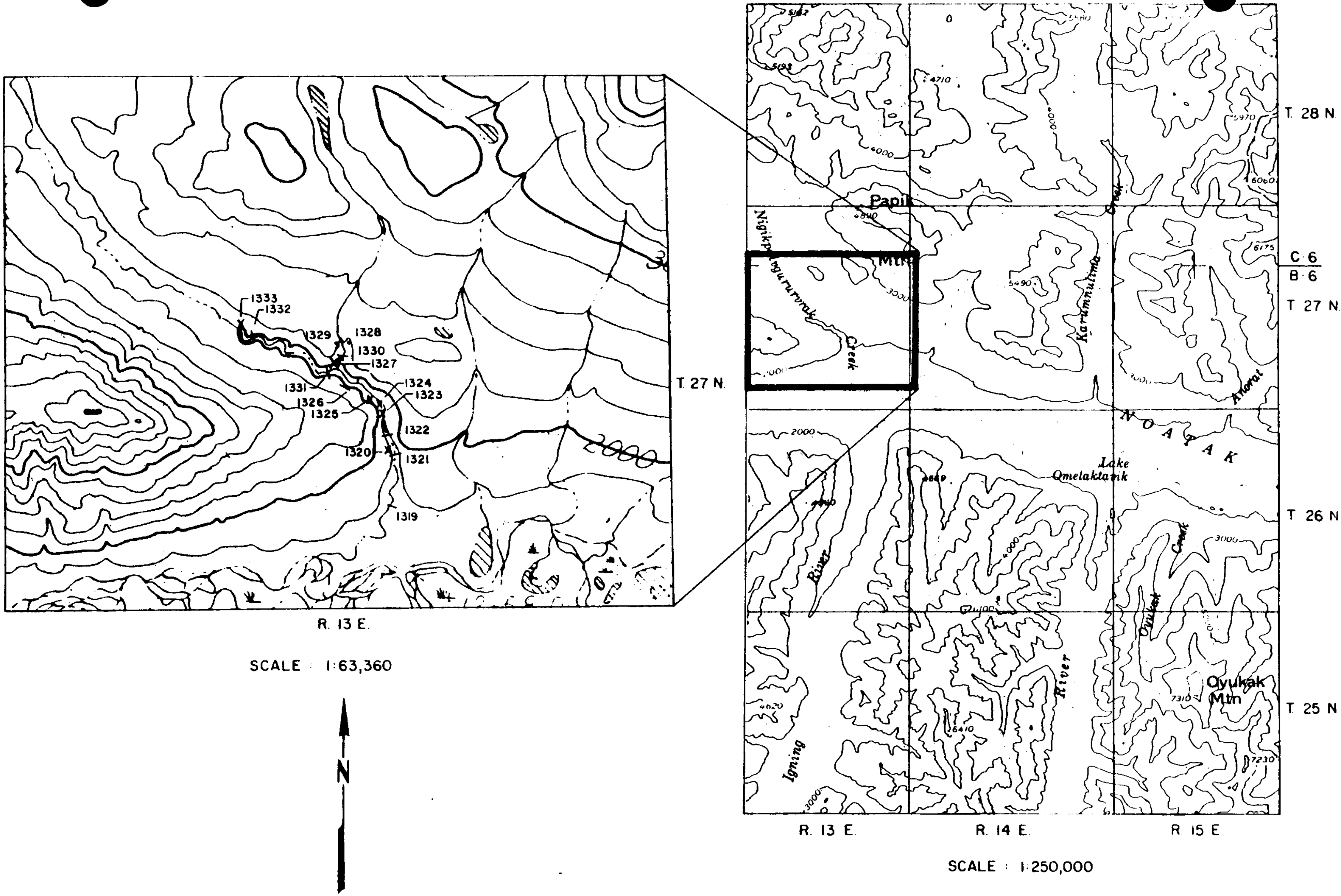
8.19.7 Conclusions

A small but unknown amount of placer gold is present in the area. The source of the gold may be pyritic quartz veins in a phyllite host rock, however, a limited amount of geochemical sampling does not confirm this. Geochemical sampling and field observations do not indicate the presence of other types of mineralization in the area.

It is possible that the gold is being derived from the reworking of moraine present at a higher elevation than the area examined.

8.19.8 Recommendations

No specific work is recommended for Nigikpalvgururvrak Creek. General work suggested for the area should be directed toward discovery of the source of the gold. If the source of the gold is determined to be local bedrock, prospecting along the east-west strike length of the host units may lead to discovery of reserves of gold of a grade or size to be of potential economic significance. If the placer gold, in Nigikpalvgururvrak Creek is being derived from glacial material, prospecting along the Noatak River Valley to the east may reveal the source of the gold.



W G M INC	MINING & GEOLOGICAL CONSULTANTS ANCHORAGE, ALASKA	DWN BY: N.B.	REVISED	SAMPLE SITE LOCATIONS NIGIKPALVGURURVRAK CREEK SURVEY PASS B·6, C·6 QUADRANGLES	FIGURE **23** BM120
SCALE: AS SHOWN		DATA BY: WGM			
		DATE: 7/75			

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TABLE 8.19.1

NIGIKPALVGURURVRAK CREEK

GEOCHEMICAL SAMPLE RESULTS

(Values in ppm, unless noted)

Sample No.	Type	Cu	Pb	Zn	Ag	ppb Au
BM 1319	pc	--	--	--	---	<5
1320	rx	3	--	70	1.6	5
1321	ss	27	14	87	0.6	<5
1322	pc	--	--	--	---	<5
1323	rx	9	--	63	1.2	5
1324	rx	33	--	83	1.1	<5
1325	rx	31	--	152	1.0	<5
1326	pc	--	--	--	---	5
1327	rx	21	--	65	1.0	10
1328	rx	48	--	280	1.6	10
1329	rx	34	--	66	1.0	<5
1330	rx	--	--	--	1.0	5
1331	ss	29	15	89	0.6	5
1332	ss	23	13	84	0.8	5
1333	rx	28	--	57	0.5	<5

pc = panned concentrate sample
rx = rock sample
ss = stream silt sample
- = not analyzed
< = less than

Collected by: Griffis

8.20 IGNING RIVER AREA

8.20.1 Introduction

The State of Alaska D.G.G.S. Annual Report for 1973 includes a mineral occurrences and geochemical anomalies map by Garland and Pessel which shows the locations of four anomalous geochemical samples along the Igning River in the Survey Pass quadrangle. The report does not show the sample density or results, only the locations of sample sites from which anomalous values were obtained.

The Survey Pass quadrangle is mapped at 1:250,000 scale (Brosgé and Pessel, 1977). The mapping was a joint effort between the U.S.G.S. and the State D.G.G.S.

Three of the four sites are reported to be anomalous in zinc, while the fourth is reported as anomalous in copper, zinc, silver and molybdenum.

8.20.2 Summary

Follow-up geochemical sampling in the area of two of the reported anomalies defined an area of about 1.5 square miles, which is considered anomalous in copper, zinc, silver, molybdenum, gold and possibly lead.

Nine samples from the follow-up work and one from the reconnaissance sampling returned values considered anomalous.

Pyrite in amounts of up to 10% of the rock is present in black phyllite, black shale and black limestone. No other sulfides were observed. Stream silt samples collected from drainages underlain by pyritic rocks returned values of up to 210 ppm copper, 950 ppm zinc, 4.7 ppm silver, 32 ppm molybdenum, 635 ppb gold and 52 ppm lead.

Additional reconnaissance stream silt sampling along the Igning River revealed one additional sample considered anomalous. This value was also obtained from an area where the rocks contained visible pyrite.

The high geochemical values are considered typical for a "black shale" environment. However, additional work is suggested to test the extensions of the pyritic rocks for possible economic accumulations of metals since known ore deposits in Alaska, Canada, Africa and Europe are hosted by black shale facies rocks.

8.20.3 Location and Access

The Igning River follow-up and reconnaissance areas are located in Tps. 24, 25 and 26N., Rs. 13 and 14E. in the

Survey Pass quadrangle (Figs. 1 and 3). The Igning River River heads at Shulakpachak Peak, flows north for about 18 miles and drains into the Noatak River.

Shulakpachak Peak is about 45 miles northeast of Kobuk. Access to this area is by helicopter.

8.20.4 Work Accomplished

WGM followed up the multi-element anomaly and one of the zinc anomalies. In addition, reconnaissance stream silt sampling was carried out along a portion of the Igning River (Fig. 24).

A total of 27 samples were collected during follow-up of the two reported anomalies and 60 samples were collected from drainages along the Igning River. Twelve rock samples were collected for reference, eight from the follow-up areas and four from other locations along the Igning River. Eleven rock samples were submitted for analysis of a combination of copper, lead, zinc, molybdenum, silver and gold.

8.20.5 Geology and Mineralization

Mississippian and Devonian rocks underlie the Igning River drainage (Brosgé and Pessel, 1977). The predominant rock types are: black calcareous phyllite, siliceous siltstone, argillaceous limestone, and Skajit limestone. In T.26N, R.13E, Devonian chloritic, calcareous phyllite, siltstone and orange weathering carbonate rocks along with undifferentiated Mississippian shale of the Kayak Shale and schistose quartzite and conglomerate of the Kekiktuk Conglomerate are mapped.

Pyrite was the only sulfide mineral observed during the work in the area. Very fine-grained pyrite is present in calcareous graphitic schist, shale and calcareous muscovite schist. Visual estimates of the amount of pyrite present over several tens of feet vary from 2% up to 10%. Rock sample BM 1092 collected from graphitic schist estimated to contain 2% pyrite, shows 560 ppm Cu, 65 ppm Zn, 1 ppm Mo, 3.6 ppm Ag and less than 5 ppb Au. Rock sample BM 1308 collected from a piece of graphitic schist float estimated to contain 5-10% pyrite, shows 67 ppm Cu, 86 ppm Zn, 1 ppm Mo, 1.8 ppm Ag and 5 ppb Au.

8.20.6 Geochemistry

Figure 24 shows the locations of samples collected during the follow-up work and the reconnaissance sampling at the Igning River area. Sample results accompany the figure.

Nine samples (eight stream silt samples and one rock sample) collected during follow-up of a reported zinc anomaly and copper-silver-zinc-molybdenum anomaly returned values considered anomalous. These samples were obtained from an area of about 1.5 square miles and are numbered BM 1092, 1300, 1301, 1303, 1305 to 1307, 1309 and 1310.

The following ranges and average values obtained from the eight stream silt samples are as follows:

Metal	Range in values (ppm)	Average Value (ppm)
Copper	143-210	178
Lead	34- 52	40
Zinc	340-950	710
Molybdenum	12- 32	24
Silver	2.4-4.7	4.0
Gold	0.005-0.6	0.09

Bedrock and stream float observed at the eight anomalous sample sites in this 1.5 square mile area consisted mainly of pyritic black phyllite and shale in addition to black pyritic limestone.

Hawkes and Webb, (1972) list the following ranges of geochemical values considered typical for a "black shale" environment.

These are:

Metal	Range of Values (ppm)
Copper	20- 300
Lead	20- 400
Zinc	100-1,000
Molybdenum	10- 300
Silver	5- 10
Gold	0.01- 1.0

The area from which the eight samples showing the anomalous geochemical values were collected can be considered "black shale" environment, in which all these values fall within normal or background metal content for this "type" of geologic environment.

Likewise, sample BM 972 which analyzed 113 ppm copper and 590 ppm zinc falls into the above "type" of environment.

The 56 stream silt samples collected for analyses from drainages along the Igning River show average geochemical values as follows:

Metal	Average Value (ppm)
Copper	32
Lead	35
Zinc	118
Molybdenum	3
Silver	1.0
Gold	0.005

Except for the lead values, the average geochemical values from the anomalous area are several times greater than those from the surrounding areas. Stream float and bedrock observed in the drainage basins displaying high geochemical values suggest that the source(s) of the anomalous values is black pyritic phyllite, shale or limestone.

8.20.7 Conclusions

Follow-up of the two reported anomalies, one being zinc and the other copper-zinc-silver-molybdenum, in addition to reconnaissance geochemical sampling in nearby areas, resulted in confirming the previous anomalies. Nine sample values considered anomalous in either copper, zinc, silver, molybdenum or lead were obtained during the follow-up work. In addition, one other sample (BM 972) recorded moderately anomalous values in copper and zinc.

The source of the anomalous values appears to be pyritic black phyllite, black shale and black limestone. Locally, the phyllite and shale contain up to 10% pyrite. No other sulfide mineralization was observed.

Although the high geochemical values obtained fall within the typical range of values assigned to a "black shale" environment, additional work is suggested for this area. This recommendation is based on the known association of base metals mineralization with black shale deposits, e.g. Red Dog in Alaska, the Rhodesian Copper Belt, and deposits in the Road River shale of the Canadian Yukon.

8.20.8 Recommendations

Additional work consisting of geological mapping, rock and silt sampling and prospecting is suggested in the Igning River area.

Specific attention should be given to the rock units which contain up to 10% pyrite. Since these rock types may be the source of the anomalous geochemical values, additional work may lead to discovery of mineralization other than pyrite along the extensions of these rock types.

TABLE 8.20.1

IGNING RIVER AREA

GEOCHEMICAL SAMPLE RESULTS

(Values in ppm, unless noted)

Sample No.	Type	Cu	Pb	Zn	Mo	Ag	ppb Au
BM 688	ss	33	22	65	--	--	--
689	ss	48	23	480	--	--	--
690	ss	26	40	104	--	--	--
691	ss	26	43	86	--	--	--
692	ss	66	24	290	--	--	--
693	ss	35	43	230	--	--	--
694	ss	57	28	70	--	--	--
695	ss	17	39	72	--	--	--
696	ss	32	25	7	--	--	--
697	ss	7	66	40	--	--	--
698	ss	19	45	10	--	--	--
699	ss	7	48	36	--	--	--
700	ss	17	46	465	--	--	--
966	ss	32	32	73	--	--	--
967	ss	86	28	310	--	--	--
968	ss	20	46	76	--	--	--
969	ss	58	36	192	--	--	--
970	ss	27	40	126	--	--	--
971	ss	56	26	167	--	--	--
972	ss	113	24	590	--	--	--
973	ss	20	22	59	--	--	--
974	ss	28	24	100	--	--	--
975	ss	32	19	78	--	--	--
976	ss	27	30	48	--	--	--
977	ss	5	60	4	--	--	--
978	ss	14	49	47	--	--	--
979	ss	10	56	16	--	--	--
1069	rx	2	7	12	1	0.2	<5
1070	ss	17	--	19	ND	0.5	5
1071			Reference Sample				
1072	ss	12	--	32	ND	0.2	<5
1073			Reference Sample				
1074	ss	14	--	26	ND	0.2	<5
1075	ss	22	--	40	ND	0.4	10
1076	rx	46	--	72	2	1.7	<5
1077			Reference Sample				

WGM INC

TABLE 8.20.1 (Cont.)

IGNING RIVER AREA

GEOCHEMICAL SAMPLE RESULTS

(Values in ppm, unless noted)

Sample No.	Type	Cu	Pb	Zn	Mo	Ag	ppb Au
1078	ss	11	--	25	ND	0.2	5
1079	ss	15	--	29	1	0.3	<5
1080	ss	8	--	22	5	2.6	<5
1081	rx	15	--	77	1	1.4	5
1082	ss	13	--	30	ND	0.4	<5
1083			Reference Sample				
1084	ss	18	--	38	3	1.4	5
1085	ss	4	--	7	7	0.4	<5
1086	ss	14	--	38	--	--	--
1087	ss	6	--	17	7	0.2	--
1088	ss	12	--	32	5	1.6	<5
1089			Reference Sample				
1090	rx	9	--	29	4	1.4	--
1091			Reference Sample				
1092	rx	16	560	68	1	3.6	<5
1093			Reference Sample				
1094	ss	106	32	420	19	3.1	5
1095	rx	14	34	35	3	2.5	<5
1096	rx	80	20	188	14	2.6	5
1097			Reference Sample				
1098			Reference Sample				
1099			Reference Sample				
1100	rx	20	--	42	4	2.2	5
1118	ss	92	24	360	--	1.2	--
1119	ss	92	24	370	--	1.4	--
1120	ss	140	27	280	--	1.8	--
1121	ss	30	22	87	--	1.1	--
1200	ss	9	52	56	--	0.4	--
1201	ss	41	29	195	--	--	--
1202	ss	51	38	240	--	--	--
1203	ss	4	55	8	--	--	--
1204	ss	21	29	65	--	--	--
1205	ss	15	33	66	--	--	--
1300	ss	185	40	740	32	4.3	15
1301	ss	172	39	660	26	4.0	5
1302			Reference Sample				

TABLE 8.20.1 (Cont.)

IGNING RIVER AREA

GEOCHEMICAL SAMPLE RESULTS

(Values in ppm, unless noted)

Sample No.	Type	Cu	Pb	Zn	Mo	Ag	ppb Au
1303	ss	210	42	950	27	4.7	15
1304			Reference Sample				
1305	ss	172	35	770	25	4.1	10
1306	ss	149	34	650	23	3.5	10
1307	ss	192	46	760	24	4.6	25
1308	rx	67	--	86	1	1.8	5
1309	ss	200	52	830	29	4.7	30
1310	ss	143	36	340	12	2.4	635
1311	ss	16	23	47	--	0.7	<5
1312	ss	64	22	195	--	1.5	<5
1313	rx	19	20	60	--	0.7	5
1314	ss	18	--	57	--	0.8	--
1315	rx	18	66	35	--	0.2	<5
1316	ss	82	24	390	--	1.4	<5
1318	ss	33	21	54	--	1.2	<5

rx = rock sample
ss = stream silt sample
ND = not detected
\- = not analyzed

Collected by: Griffis
Via
Fairchild

8.21 IYAHUNA CREEK

8.21.1 Introduction

Geologic mapping at 1:250,000 scale has been conducted in the Survey Pass quadrangle (Brosgė and Pessel, 1977).

Attention was drawn to Iyahuna Creek by a report of moderately high zinc geochemical anomalies obtained along a seven-mile length of this stream (Fritts, Eakins & Garland in State of Alaska Annual Report, 1971).

State of Alaska Open-File Reports 64 and 67 indicate the following stream silt samples to be moderately anomalous in zinc:

Map No.	Field No.	(ppm) Cu	(ppm) Pb	(ppm) Zn
39	71Z215	60	15	490
44	71Z221	20	20	380
485	71Z212	35	20	410

8.21.2 Summary

Foot traverses were carried out in the Iyahuna Creek area to follow up anomalous zinc values obtained during geochemical reconnaissance surveys by U.S.G.S. and State of

Alaska teams. Moderate zinc values were obtained but these are attributed to zinc background levels which can be expected in an area underlain by pyritic phyllite. The potential for the discovery of significant mineralization in the three drainage basins examined is low and no additional work is recommended in the examined basins.

8.21.3 Location and Access

These examination areas are located in Tps. 24 and 25N., R.16E. in the Survey Pass quadrangle. The area is about 50 miles in a northeast direction from the village of Kobuk. Iyahuna Creek flows northeasterly for about 10 miles and drains into the Noatak River.

8.21.4 Work Accomplished

Foot traverses were made in each of the three drainage basins represented by the State samples and 30 geochemical samples were collected. Figure 25 shows the sample site locations. Geochemical results are listed on the table accompanying the figure.

8.21.5 Geology and Mineralization

The generalized geology of the three drainages examined in the Iyahuna Creek basin is shown on Figure 25. The predominant rock types consist of dark gray to black, partly calcareous phyllite and black argillaceous limestone. Devonian Skajit Limestone crops out in the northeast portion of Iyahuna Creek.

Pyrite was the only sulfide mineralization noted during the examination. A minor amount of pyrite is present as disseminations in black phyllite and as blebs associated with small quartz stringers. Sample BM 1522 was collected from a piece of pyritic quartz found as stream float. This sample analyzed 2,900 ppm zinc. Disseminated pyrite is also present in a quartz-mica schist unit of the Skajit Limestone.

8.21.6 Geochemistry

Thirty stream sediment, soil and rock samples were collected during the examination. Analyses of 16 of the samples were in excess of 350 ppm zinc and 17 samples contained over 100 ppm copper. Bedrock and/or stream float at these moderately-anomalous sample sites is predominantly pyritic, gray to black phyllite, which locally contains pyritic quartz stringers.

This leads to the conclusion that the moderate-strength geochemical zinc and copper values are attributed to normal concentrations of these metals in this geologic environment and are not considered to represent a buildup of base metal sulfide mineralization.

8.21.7 Conclusions

Follow-up geochemical sampling was conducted in three tributary drainage basins to Iyahuna Creek showing moderately anomalous zinc geochemical values, but failed to reveal the presence of base metal sulfide mineralization.

Weakly pyritic gray to black phyllite is the predominant rock type present in the follow-up areas and the zinc and copper geochemical values obtained are attributed to normal or background geochemical values for this geologic environment.

The potential for discovery of significant mineralization in the drainage basins examined is considered low.

8.21.8 Recommendations

No additional work is recommended for the drainage basins examined.

TABLE 8.21.1

IYAHUNA CREEK

GEOCHEMICAL SAMPLE RESULTS

(Values in ppm)

Sample No.	Type	Cu	Pb	Zn	Ag
BM 1457	rx	--	--	--	0.7
1458	ss	62	13	140	0.6
1459	ss	140	35	660	2.2
1460	ss	91	24	520	1.8
1461	rx	63	42	270	0.6
1462	ss	90	22	620	2.0
1463	ss	51	28	145	0.4
1464	ss	111	29	460	1.9
1465	ss	70	20	350	0.8
1466	ss	68	18	238	0.9
1467	rx	41	21	61	0.4
1468	ss	112	33	500	1.1
1469	ss	160	30	700	2.6
1470	ss	84	18	290	1.5
1515	so	49	18	380	1.2
1516	so	59	19	460	1.1
1517	so	42	12	280	0.4
1518	so	131	37	250	2.0
1519	rx	46	20	20	0.6
1520	ss	143	21	640	2.0
1521	ss	68	16	430	0.6
1522	rx	128	20	2,900	1.8
1523	ss	74	14	590	1.0
1524	ss	68	13	520	0.8
1608	ss	37	31	545	0.2
1609	ss	40	29	230	0.3
1610	rx	50	16	134	0.6
1611	rx	10	23	10	0.2
1612	ss	45	28	142	0.2
1616	ss	65	19	390	1.0

rx = rock sample
ss = stream silt sample
so = soil sample
- = not analyzed

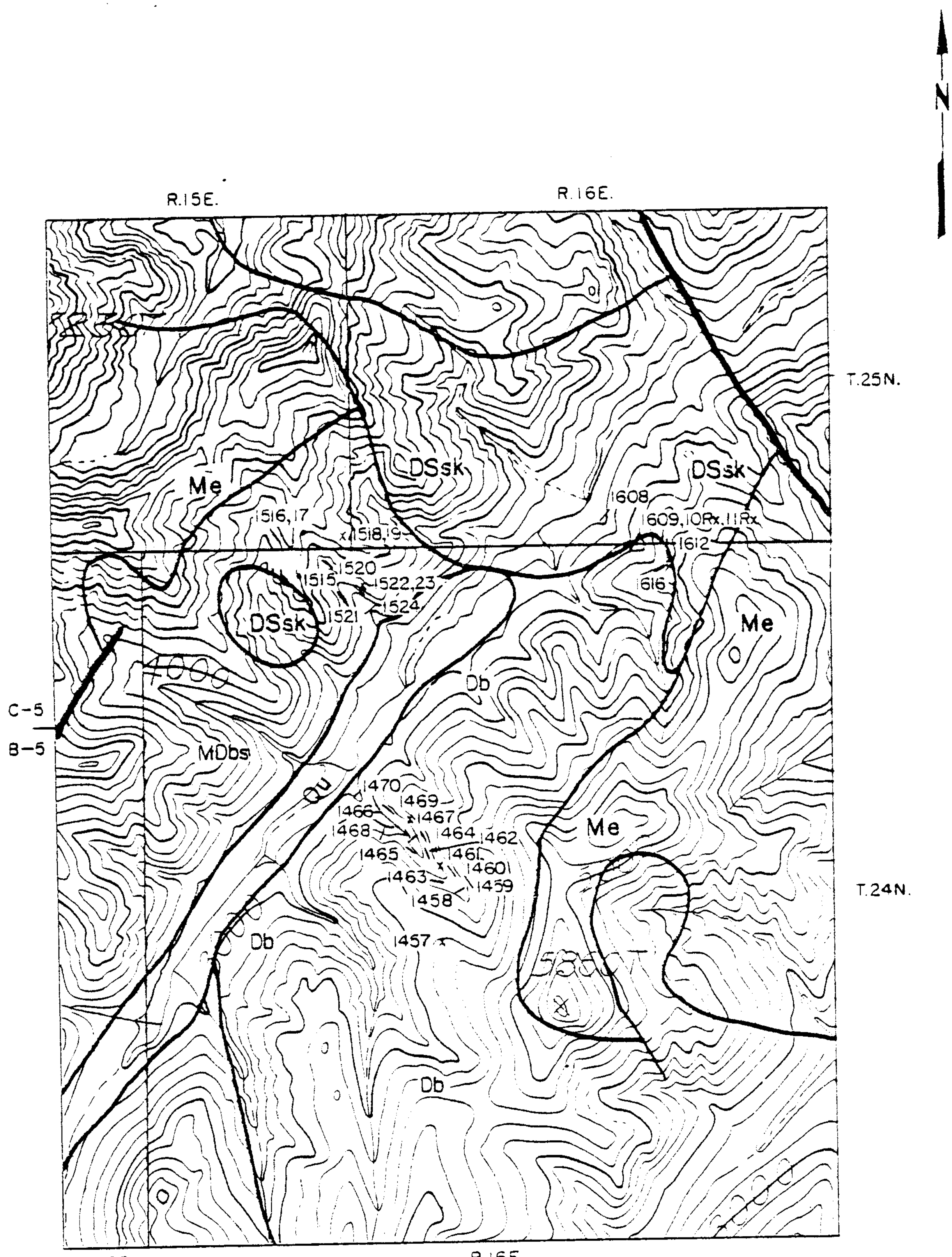
Collected by: Degenhart
Stark
Peale

LEGEND

IYAHUNA CREEK FIGURE 25

Qu:	Undifferentiated Surficial Deposits.
Me:	ENDICOTT GROUP---Undifferentiated black shale and calcareous shale of the Kayak shale, and schistose, chloritoid-bearing, partly calcareous quartzite and conglomerate of the Kekiktuk Conglomerate.
MDbs:	BLACK SHALE AND SILTSTONE---Undifferentiated Kayak shale and black limestone and phyllite.
Db:	BLACK LIMESTONE AND PHYLLITE---Interbedded black, partly calcareous phyllite, black siliceous siltstone, and black argillaceous limestone.
DSsk:	SKAJIT LIMESTONE---Mostly light gray, massive marble; highly sheared and folded in part.
/	Geologic Contact.
/	Fault

(Geology after Brosgé and Pessel, 1977).



Geology after Brosge and Pessel, 1977

WGM INC	MINING & GEOLOGICAL CONSULTANTS ANCHORAGE, ALASKA	DWN BY M.H. DATA BY WGM	REVISED	GENERALIZED GEOLOGICAL MAP AND SAMPLE SITE LOCATIONS	FIGURE 25

8.22 TUPIK CREEK AREA

8.22.1 Introduction

The preliminary geologic map at 1:250,000 scale of the Survey Pass quadrangle (Brosgė and Pessel, 1977) includes the Tupik Creek area. First-pass geochemical stream silt sampling has also been conducted in the area by the Alaska D.G.G.S. which reported several anomalous areas (AOF 64 and 67 and State Annual Report, 1971).

Three drainages were examined in an attempt to follow-up zinc and lead geochemical anomalies recorded by the State, which were reported to range from 300 to 1,000 ppm zinc and 100 to 400 ppm lead.

8.22.2 Summary

Follow-up of reported lead and zinc geochemical anomalies confirm the anomalies and indicate their source to be minor sulfide mineralization in granitic rocks and in small contact zones near the margin of the granite.

One sample (BM 1444) shows 7,350 ppm copper and 30 ppm silver and was obtained from glacial debris. This was the highest geochemical result obtained at the examination area.

Additional work, consisting of geologic mapping, rock and silt sampling, is recommended along the margin of the granite to search for high grade mineralization of a contact-metasomatic origin. A few days should be spent examining the granitic body for any occurrence of large tonnage, copper and molybdenum mineralization. This sampling of the granite would also test for possible economic tin occurrences.

8.22.3 Location and Access

The Tupik Creek area is located on the north side of Mount Igikpak in T.27N., R.17E. in the Survey Pass quadrangle (Figs. 1, 3 and 26). Two drainages examined in this area flow north into the Noatak River, and one flows southward into the Reed River.

8.22.4 Work Accomplished

Fifty-nine silt, rock and reference samples were collected during the course of several foot traverses. Figure 26 shows sample site locations in the drainage basins and a listing of geochemical values accompanies the figure.

8.22.5 Geology

The Mount Igikpak Cretaceous granitic pluton which extends up to 20 miles north-south and may reach 30 miles east-west, underlies the examination areas. The granitic body has apparently intruded several different lithologies, including black, partly calcareous phyllite; black argillaceous limestone; rusty weathering quartzite; orange and green weathering chloritic clastics; and impure carbonate rocks.

A large scale, north-trending, west-dipping fault cuts the pluton (Fritts, et al., 1971). This fault is mapped along a distance of 36 miles and appears to pass near the mouth of Tupik Creek. The fault may be responsible for small-scale shear zones observed in the pluton.

Iron staining is visible at several locations in the examination areas. At one location, near the junction of Tupik and Igikpak Creeks, the iron staining is restricted to a fine-grained phase of the intrusive and appears to be related to a shear zone up to 50 feet wide and several hundred feet long. Locally the fine-grained intrusive contains up to several percent pyrite and visible molybdenite. A chip sample across 20 feet of this iron-stained shear zone (BM 1261) shows 20 ppm copper, 23 ppm lead, 17 ppm molybdenum and 46 ppm tin.

A second iron-stained portion of the intrusive was examined east of Angiaak Pass (Fig. 26). Iron staining at this location is restricted to an area of about 50 feet by 400 feet. Pyrite was the only sulfide mineral observed in bedrock exposures, however, one piece of stream float, represented by sample BM 1450 shows 1,850 ppm copper and 32 ppm molybdenum. This rock is a medium-grained intrusive rock which contained a minor amount of chalcopyrite. No bedrock source of this piece of stream float could be located.

Three tributary basins in the northern and east central portion of Tupik Creek, which drain the contact zone between the intrusive and calcareous phyllite and argillaceous limestone, were briefly examined. Pieces of rubble and stream float indicate development of a skarn zone of undetermined dimensions. Pyrite and minor amounts of galena, molybdenite, and sphalerite were seen, both as disseminations and as small stringers in rocks in two of the drainages. Sample BM 1269 was collected from a piece of stream float measuring 3 feet by 3 feet by 3 feet. This skarn-type rock contained several 1/2" wide stringers of pyrite and a few grains of molybdenite, galena and sphalerite. Analysis of this sample shows 36 ppm lead, 62 ppm zinc, 23 ppm molybdenum and 7 ppm copper. At the second drainage, in which minor amounts of sulfide mineralization were observed, samples BM 1657 and BM 1658 were collected from small (<6 inch diameter) pieces of stream float. Both samples contained an estimated 5% pyrite in small stringers and analysis of these two samples show 9 ppm copper, 8 ppm lead, 89 ppm zinc, 24 ppm molybdenum and 9 ppm copper, 5 ppm lead, 7 ppm zinc and 35 ppm molybdenum respectively. A few additional pieces of mineralized float were observed, however, these were not analyzed. One reference sample of mineralized float was collected which is estimated to contain less than 0.5% combined galena and sphalerite. This sample contains minor galena and sphalerite in a 1/10" wide band of about 3" long. The host rock is white granular dolomite.

In the third basin examined (Glacier Creek), field observations were hampered by the previous winter's snow cover, which had not melted by early July. Figure 26 shows the location of 11 samples collected in this basin.

A minor amount of copper mineralization in the form of malachite was observed on one piece of glacial debris (2 feet by 2 feet by 1 foot) along the east side of the Glacier Creek drainage basin. This rock, which analyzed 7,350 ppm copper, 188 ppm lead, 230 ppm zinc, 30 ppm silver and 7 ppm molybdenum, is biotite-quartz schist. Examination of the area failed to locate a bedrock source.

Minor galena was observed in a one-foot wide quartz vein in the intrusive. The vein is less than 10 feet in length. Sample BM 1601 collected from this quartz vein shows 510 ppm lead. Sphalerite and galena occur as very fine-grained disseminations in an orange-weathering carbonate rock. A few pieces of this rock were noted as glacial debris, but their bedrock source is apparently covered and no samples of this material were collected.

Sample BM 1440 was collected over an area of 2 feet by 2 feet from a granitic rock displaying a light yellow coating. This sample shows 5 ppm molybdenum and 1 ppm uranium.

8.22.6 Geochemistry

A total of 34 stream silt samples were collected from the Tupik Creek area; 6 show over 100 ppm lead and 8 show over 300 ppm zinc. These higher than normal values are attributed to minor amounts of lead and zinc mineralization associated with granitic rocks, quartz veins in the granitic rocks or weakly mineralized contact zones associated with the pluton.

Tin and molybdenum values up to 77 and 30 ppm respectively were obtained from stream silt samples and up to 50 and 35 ppm respectively from rock samples. The values can be considered anomalous and indicate the presence of at least minor amounts of the two metals in this geologic environment.

One sample (BM 1440) was analyzed for uranium because of a light yellow coating on the rock surface. The sample analyzed 1 ppm uranium which is very low; therefore additional uranium analyses were not requested for other samples collected in this area.

8.22.7 Conclusions

Minor copper, lead, zinc, molybdenum, silver and tin mineralization are present in the Tupik Creek area, as indicated by geochemical results or as observed occurrences in bedrock or rubble. Very minor copper, molybdenum and tin mineralization is present in the granitic intrusive. Copper, lead, zinc, molybdenum and silver mineralization apparently is confined to a small zone(s) along intrusive-sedimentary rock contacts.

The most significant geochemical value was obtained from sample BM 1444 (7,350 ppm copper and 30 ppm silver). This sample was collected from a one-foot thick piece biotite-quartz schist found as glacial debris and its bedrock source could not be located.

A limited amount of additional work is warranted in the Tupik Creek area.

8.22.8 Recommendations

Further work in the Tupik Creek area should be limited in scope and be restricted to the granitic body and its margins. Prospecting is suggested to explore the margin of the granite for high-grade mineralization of contact metasomatic origin. The granite intrusive should be examined further to check for occurrences of disseminated, large tonnage copper and/or molybdenum mineralization. Additional sampling of the intrusive is also recommended to test for possible economic amounts of tin mineralization.

TABLE 8.22.1

TUPIK CREEK AREA

GEOCHEMICAL SAMPLE RESULTS

(Values in ppm, unless noted)

Sample No.	Type	Cu	Pb	Zn	Mo	Ag	ppb Au	Sn	W
BM 1261	rx	20	23	46	17	0.7	5	46	--
1262	ss	8	17	38	ND	0.5	5	6	--
1263	ss	6	21	37	1	0.4	5	15	--
1264*	rx	6	20	46	2	0.4	25	--	--
1265	ss	9	38	8	18	0.2	5	3	--
1266	ss	4	20	36	2	0.2	5	29	--
1267	ss	25	56	88	6	1.0	5	4	--
1268	ss	7	22	52	ND	0.9	5	6	--
1269	rx	7	36	62	23	0.6	5	16	--
1270	ss	16	32	305	8	1.1	5	10	--
1271	ss	52	79	51	7	1.2	5	12	--
1272	ss	11	27	40	2	0.4	5	2	--
1344	rx	7	33	52	18	0.5	5	--	--
1345	rx	5	25	4	15	0.3	5	--	--
1346			Reference	Sample					
1347	rx	11	20	9	24	0.5	5	--	--
1348	rx	6	25	10	10	0.9	5	--	--
1349			Reference	Sample					
1350	ss	17	82	86	4	0.8	5	16	ND
1351			Reference	Sample					
1352	ss	12	53	67	2	0.6	5	--	--
1353			Reference	Sample					
1440**	rx								
1441	rx	38	700	360	19	0.3	--	17	--
1442	rx	39	720	370	19	0.4	--	26	--
1443	rx	14	119	138	5	0.2	--	24	--
1444	rx	7,350	188	230	7	30.0	--	--	--
1445	rx	210	56	88	5	0.8	--	--	--
1446	ss	54	34	104	2	0.2	--	--	--
1447	ss	70	44	142	4	0.2	--	--	--
1448	ss	68	120	190	9	0.2	--	--	--
1449	ss	34	134	82	6	0.4	--	26	ND
1450	rx	1,850	96	54	32	2.4	--	24	ND
1451	ss	38	133	92	6	0.6	--	25	ND
1452	ss	19	70	77	2	0.5	--	23	ND
1453	ss	16	56	69	3	0.2	--	13	ND

TABLE 8.22.1 (Cont.)

TUPIK CREEK AREA

GEOCHEMICAL SAMPLE RESULTS

(Values in ppm, unless noted)

Sample No.	Type	Cu	Pb	Zn	Mo	Ag	ppb Au	Sn	W
BM 1454	ss	14	54	60	6	0.3	--	20	ND
1455	ss	3	60	45	2	0.2	--	35	ND
1456	ss	15	67	75	3	0.3	--	20	ND
1510	ss	2	42	57	1	0.2	--	21	ND
1511	ss	19	91	47	4	0.3	--	5	ND
1512	ss	18	94	42	3	0.2	--	12	ND
1513	ss	15	92	48	4	0.2	--	17	ND
1514	rx	18	44	12	8	0.4	--	2	3
1601	rx	48	510	47	8	3.0	--	--	--
1602	ss	76	96	220	10	0.4	--	--	--
1603	ss	81	81	445	16	1.4	--	5	ND
1604			Sample Lost						
1605			Sample Lost						
1606	ss	82	84	450	17	1.2	--	5	ND
1607	ss	115	91	690	30	1.7	--	4	ND
1657	rx	9	8	89	24	0.2	--	6	ND
1658	rx	9	5	7	35	0.2	--	2	ND
1659	ss	90	57	380	7	1.0	--	26	ND
1660	rx	72	15	41	6	0.2	--	50	ND
1661	ss	132	78	242	11	1.7	--	33	20
1662	ss	99	136	460	12	1.0	--	53	13
1663	ss	89	200	350	10	1.2	--	77	5
1664	ss	45	370	550	7	1.0	--	44	ND

* BM 1264 also shows 740 ppn F
** BM 1440 shows 1 ppm U

rx = rock sample
ss = stream silt sample
ND = not detected
- = not analyzed

Collected by: Degenhart
Griffis
Stark
Drapela

LEGEND

TUPIK CREEK AREA - FIGURE 26

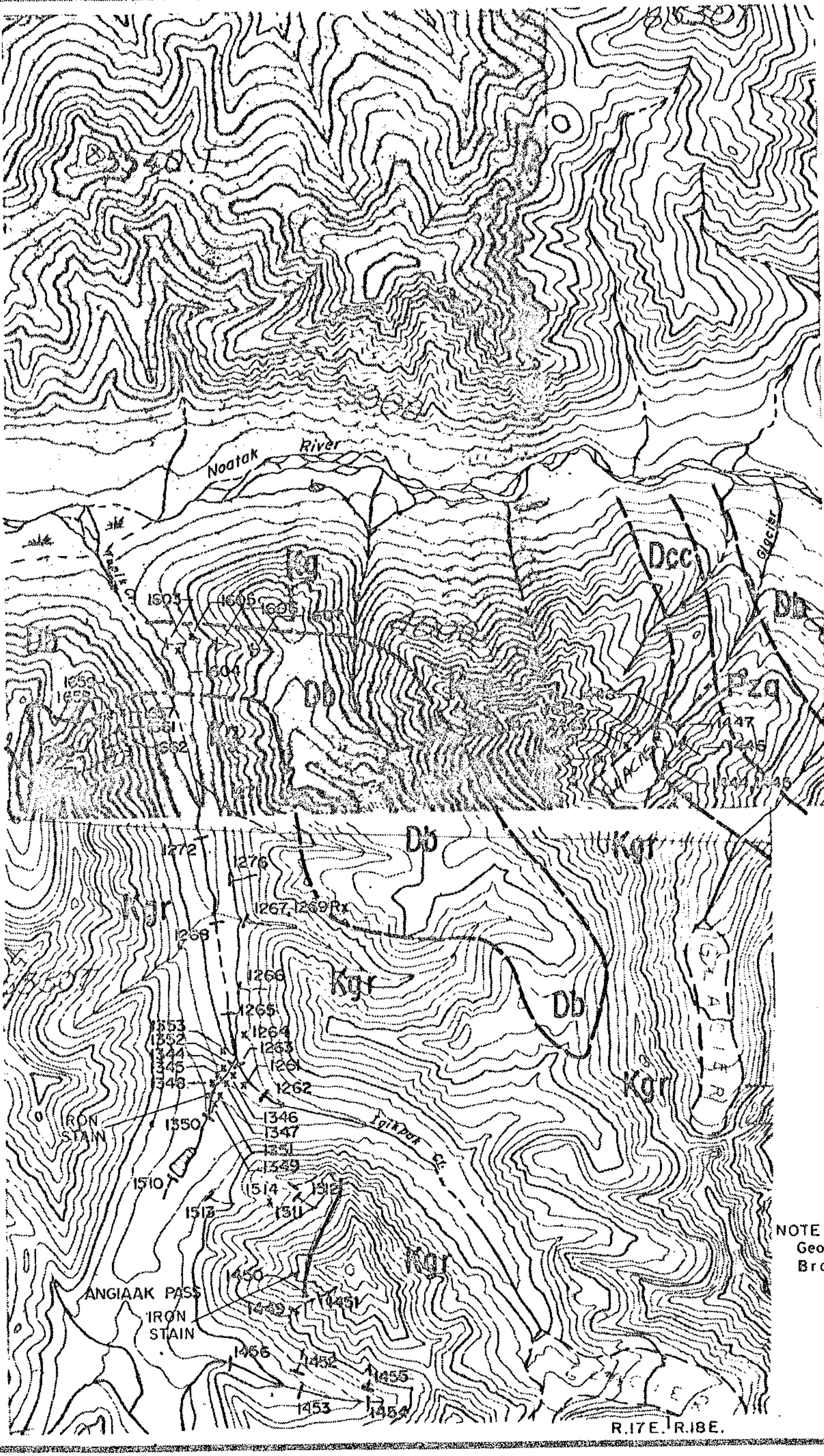
Kgr: GRANITIC ROCKS ... mostly granite and quartz-monzonite.

Db: BLACK LIMESTONE AND PHYLLITE ... interbedded black, partly calcareous phyllite, black siliceous siltstone, and black argillaceous limestone.

Dcc: CHLORITIC AND CARBONATE ROCKS ... green, chloritic, partly calcareous phyllite, siltstone, grit and schist.

Pzq: QUARTZITE ... rusty weathering.

(Geology after - Brosgé and Pessel, 1977).



NOTE:
Geology from
Brosge and Pessel,
1977

FIGURE 26
BM140

GENERALIZED GEOLOGY
AND SAMPLE SITE LOCATIONS
TUPIK CREEK AREA
SURVEY PASS C-4, C-5, B-5 QUADRANGLES

DWN BY T.D.
DATA BY WGM
DATE 7/76

W G M INC
MINING & GEOLOGICAL CONSULTANTS
ANCHORAGE, ALASKA

SCALE 1:63,360

8.23 MT. PAPIOK AREA

8.23.1 Introduction

The Survey Pass 1:250,000 scale quadrangle has been mapped (Brosgė and Pessel, 1977). Part of the quadrangle has been covered by preliminary geochemical stream silt sampling (Fritts et al., 1971), including the Mt. Papiok area.

8.23.2 Summary

Follow-up work in two drainage basins reported to display anomalous lead and zinc geochemical values resulted in confirming the values, however, they are attributed to background metal content of the local bedrock. Bedrock in the area consists mainly of pyritic graphite schist, limestone and siltstone.

A total of 15 samples were collected, of which eight samples analyzed over 300 ppm zinc, three greater than 90 ppm lead and four in excess of 20 ppm molybdenum.

Pyrite was the only sulfide mineralization observed. A minor amount of hematite and rhodochrosite is also present.

No additional work is recommended for the two drainage basins, however, regional scale exploration is suggested for the general area, particularly to the south where a granitic body intrudes sedimentary rocks.

8.23.3 Location and Access

The Mt. Papiok examination area is located in T.25N., R.17E. in the Survey Pass quadrangle (Figs. 1, 3 and 27).

The area is situated north of the Noatak River about 65 miles northeast of Kobuk. One of the drainages examined flows south into the Noatak River, while the other flows northwest into Twelvemile Creek, which drains into the Noatak River.

Access is best gained by helicopter, however, small fixed-wing aircraft can land on gravel bars in the Noatak River valley.

8.23.4 Work Accomplished

Several anomalous lead and zinc geochemical values were recorded by the previous sampling and WGM carried out follow-up work in two drainage basins which displayed zinc values in excess of 300 ppm zinc and 60 ppm lead. The two streams drain a common ridge saddle and it appeared that the reported anomalous lead and zinc values were originating from the same location.

During the course of traverses down two drainages, a total of 15 samples were collected, including three soil samples and one rock sample. Analyses were obtained for copper, lead, zinc, molybdenum and silver.

8.23.5 Geology and Mineralization

The geology in this area is dominated by northwest trending Devonian phyllite, schist, limestone and siltstone and lower Mississippian dark gray phyllite (Kayak shale). A Cretaceous granitic body intrudes the Devonian rocks about one and one-half miles south of the examination area. The intrusive does not crop out in the examination area.

Pyrite was the only sulfide mineralization observed and weathering of the pyrite causes extensive iron staining throughout the area. A small amount of hematite is present along bedding planes in limestone, and a small amount of rhodochrosite was also seen in the limestone.

8.23.6 Geochemistry

Sample site locations are shown on Figure 27 and geochemical results accompany the figure.

Three soil samples were collected over a distance of about 500 feet on the ridge saddle separating the two drainages. These three samples analyzed in excess of 300 ppm zinc and 20 ppm molybdenum. Bedrock on this saddle consists of black graphite schist and phyllite, which contains disseminated pyrite. No base metal sulphide mineralization was observed and the seemingly high geochemical values are attributed to background concentrations of these metals.

Stream silt sample BM 1504 was collected from a stream draining the west side of the saddle and shows a zinc value in excess of 300 ppm and a molybdenum value of 35 ppm. These values are also attributed to background values.

8.23.7 Conclusions

Follow-up of reported anomalous lead and zinc geochemical values resulted in confirming the anomalous values, which are attributed to background metal content of the local bedrock. Anomalous lead, zinc and molybdenum values were obtained from the two drainages examined, however, pyrite, hematite and rhodochrosite were the only types of mineralization observed, and the high values obtained are attributed to background values.

No additional work is warranted.

8.23.8 Recommendations

Additional work is not recommended at this examination area. The reported granite-sedimentary rock contact zone about one-half mile to the south should be examined for possible tactite zones containing mineralization. The granitic body should also be examined and sampled.

TABLE 8.23.1

MT. PAPIOK AREA

GEOCHEMICAL SAMPLE RESULTS

(Values in ppm, unless noted)

Sample No.	Type	Cu	Mo	Pb	Zn	Ag
BM 1501	so	55	20	29	580	1.0
1502	so	70	28	28	660	1.0
1503	so	59	25	26	500	1.2
1504	ss	88	35	24	355	0.8
1505	ss	31	8	20	98	0.2
1506	ss	33	2	20	70	0.2
1507	ss	51	8	39	168	0.3
1508	ss	48	1	21	72	0.2
1509	rx	115	--	--	---	1.0
1651	ss	53	--	14	220	0.5
1652	ss	52	--	24	160	0.2
1653	ss	74	--	110	450	0.8
1654	ss	90	--	98	380	1.0
1655	ss	67	--	95	350	1.0
1656	ss	63	--	79	415	0.3

ss = stream silt sample
so = soil sample
rx = rock sample
- = not analyzed

Collected by: Stark
Beattie

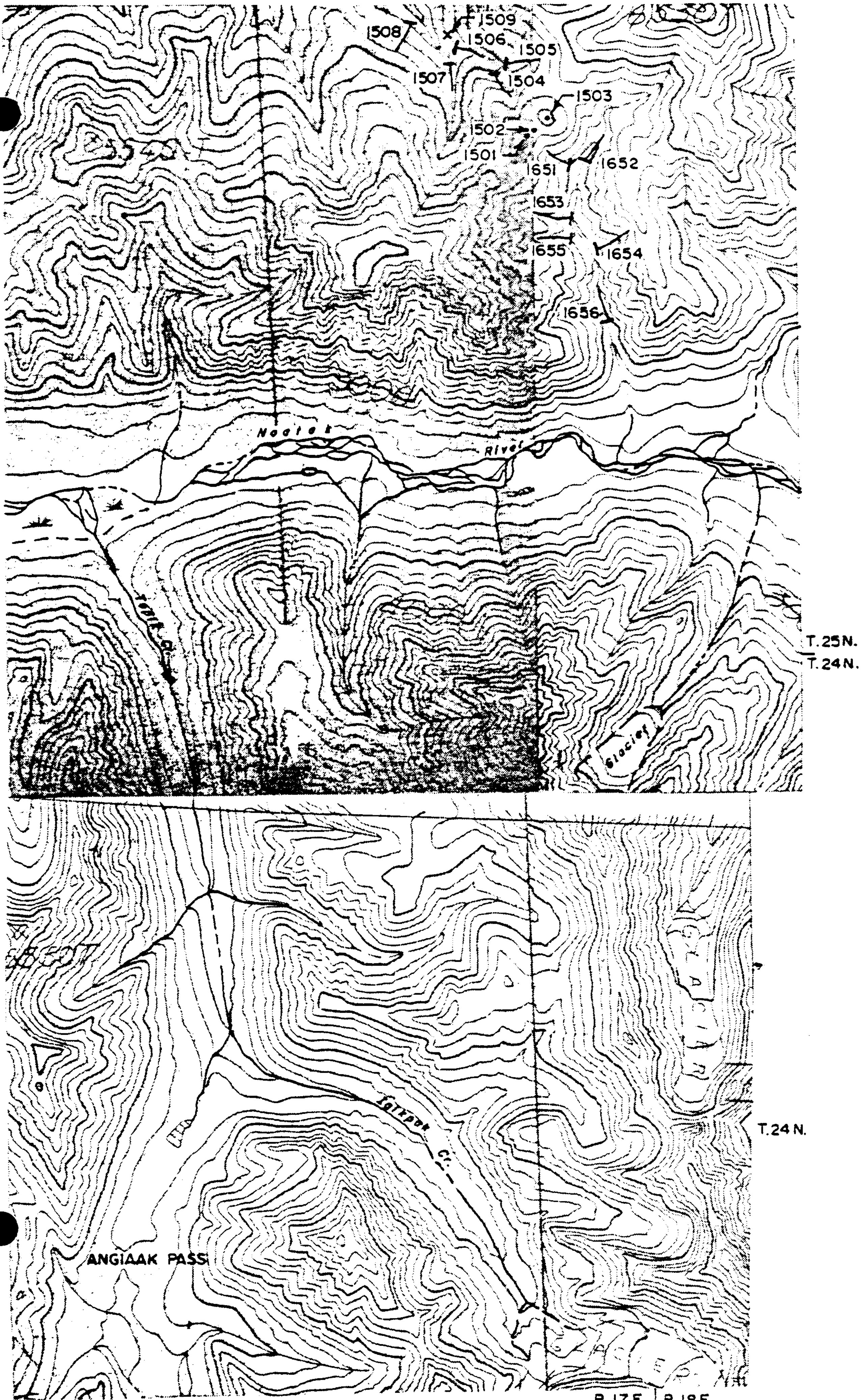


FIGURE 27 BM141

SAMPLE SITE LOCATIONS
MT. PAPIOK AREA
SURVEY PASS C-4, C-5 QUADRANGLES

DWN BY T.D.	REVISED
DATA BY WGM	
DATE 7/76	

WGM INC
MINING & GEOLOGICAL CONSULTANTS
ANCHORAGE, ALASKA

SCALE 1:63,360

8.24 WALKER LAKE AREA

8.24.1 Introduction

The geology of the Survey Pass quadrangle has been mapped by Federal and State agencies (Brosgė and Pessel, 1977). The State of Alaska, in conjunction with the U.S.G.S., has also conducted geochemical stream silt sampling throughout most of the quadrangle. Results of the geochemical sampling are available as State of Alaska open-file reports. Prior to their release, annual reports published by the State contained summaries of ongoing work in the quadrangle, including locations of apparently anomalous geochemical samples and observed mineral occurrences.

At least two private companies (Bear Creek Mining Co. and Alvenco) conducted first-pass geochemical stream silt sampling in the Walker Lake area prior to enactment of ANCSA. Neither of the two companies are believed to have followed up, in any detail, the anomalous values obtained during the course of their work. Results of the Alvenco work were made available for this study (General Crude Oil, private report).

Observations made during the course of the present investigation indicate that no work beyond first-pass or preliminary geochemical stream silt sampling was completed at any of the three areas examined.

On the basis of mapping by the government agencies and private and governmental geochemical survey results, WGM examined three drainage basins in the Walker Lake area. Figure 28 shows one of the areas, designated as Area 3, while Figure 28-A shows Areas 1 and 2.

Area 1 was selected because of a reported copper-zinc geochemical anomaly discovered by a previous investigator (Andrews, T.E., Bear Creek Mining Co., 1974 per. comm.). Area 2 was selected for inspection because a 200 ppm lead geochemical value was reportedly obtained in the drainage (State of Alaska OFR #67). Area 3 was picked for additional work based on a reported 280 ppm copper and 320 ppm zinc geochemical value obtained in the drainage (State of Alaska OFR #66). Geochemical stream silt values of this magnitude in a similar geologic environment receive aggressive follow-up work in the open to mineral entry lands to the west.

8.24.2 Summary

The Walker Lake area is underlain by the eastward extension of the schist belt, which hosts impressive base metal sulfide occurrences (Arctic, Sun, Smucker). Reconnaissance geochemical surveys, carried out by the U.S.G.S. and the State of Alaska, recorded anomalous base metal values at two areas designated as Areas 2 and 3. A third anomalous value was obtained by a member of the WGM staff while employed by a private company conducting reconnaissance in this area prior to enactment of ANCSA. This area is termed Area 1.

Prospecting in conjunction with geochemical sampling in Area 1 confirms the results of the earlier geochemical work.

Results of previous work in Area 2 were not duplicated and the previously reported lead anomaly remains unexplained.

In Area 3, the presence of favorable rock units and slightly anomalous copper and zinc values were confirmed.

Despite the failure to discover base metal mineralization in place, detailed geochemical stream silt sampling and prospecting is recommended in this geologic environment.

8.24.3 Location and Access

Two of the three drainage basins selected for follow-up work are located on the west side of Walker Lake (Fig. 28), while the third area is situated on the east side of the lake (Fig. 28-A).

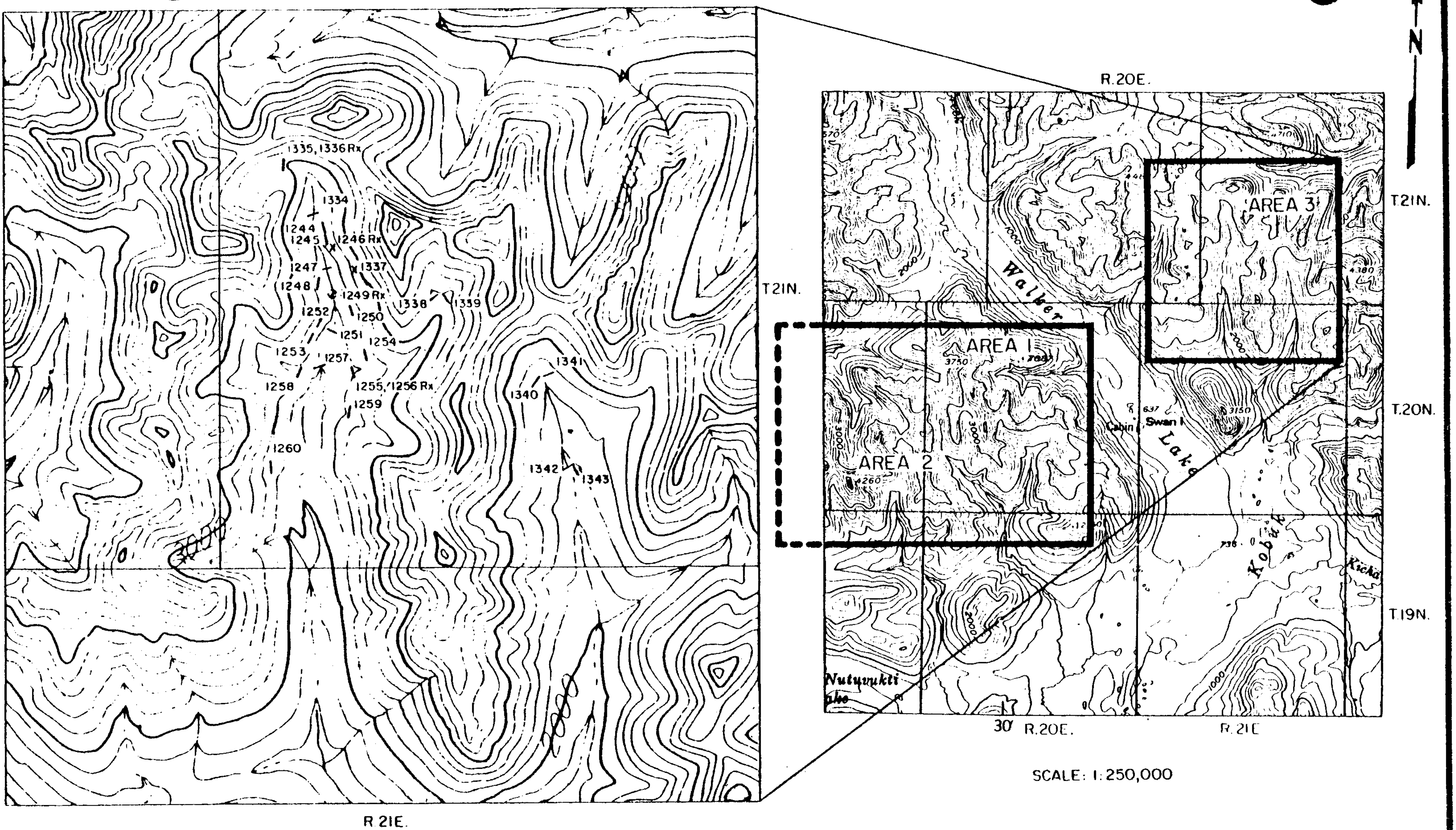
The three areas are located approximately 1.5 to 5 miles from Walker Lake, which is located in the southern part of the Survey Pass quadrangle in Tps. 19, 20, and 21N., Rs.19, 20, and 21E. The lake is about 13 miles long in a northwest-southeast direction and from 1/2 to 3 miles in width, and is the largest lake in the Brooks Range. Float-equipped aircraft can land on the lake during the summer, and ski-equipped aircraft landings are possible after freeze-up.

8.24.4 Work Accomplished

The present work consisted of foot traverses and prospecting in each of the three drainage basins, in conjunction with the collection of 52 geochemical samples. The results are shown on tables accompanying Figures 28 and 28-A.

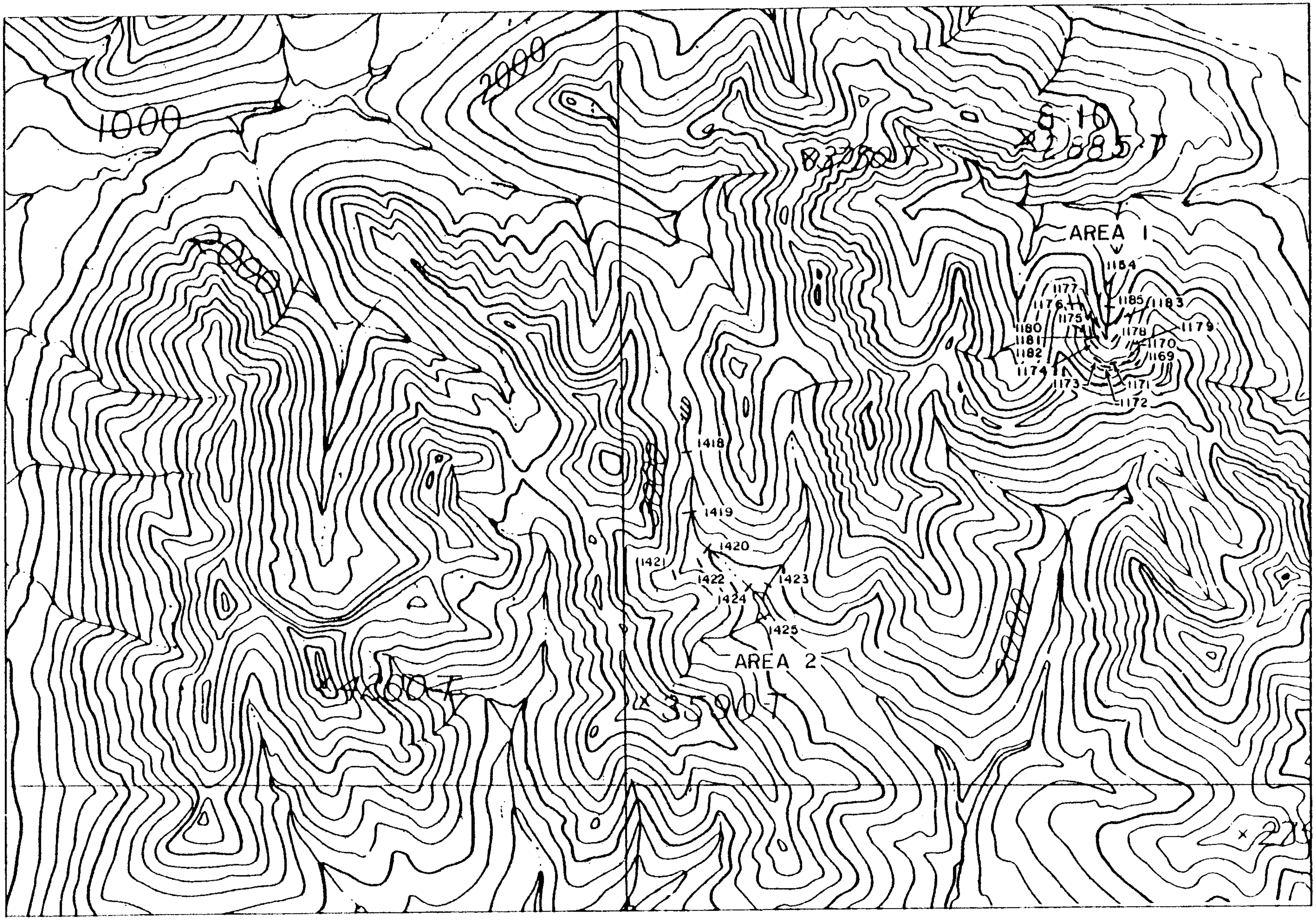
8.24.5 Geology

A review of the 1:250,000 scale geologic map (Brosgé and Pessel, 1977) of the Survey Pass quadrangle shows the bedrock in the three examination areas to be similar to, or a continuation of, rock units found along a distance of at



SEE FIGURE 28-A FOR AREAS 1 AND 2.

WGM INC	MINING & GEOLOGICAL CONSULTANTS ANCHORAGE, ALASKA	DWN BY: T.D. / DATA BY: WGM / DATE: 8/75	REVISED	**SAMPLE SITE LOCATIONS** WALKER LAKE AREA 3 SURVEY PASS A-3 QUADRANGLE
SCALE: AS SHOWN				FIGURE **28** BM142



WGM INC MINING & GEOLOGICAL CONSULTANTS ANCHORAGE, ALASKA	DWN BY: M.H.	REVISED	SAMPLE SITE LOCATIONS
	DATA BY: CB,WV		WALKER LAKE AREAS 1 & 2
SCALE: 1:63,360	DATE: 8/75		SURVEY PASS A-3, A-4 QUADRANGLES

FIGURE **28a**
BM110

least 60 miles to the west where these rock units contain large tonnages of high-grade base metal sulfides (Arctic, Sun, Smucker). Recent intensive exploration by several major companies along the schist belt has revealed additional base metal sulfide occurrences.

The dominant rock types mapped in the general area of the three examination sites consists of undifferentiated Paleozoic schists and Devonian Skajit Limestone. The schist units are, in part, massive and intensely folded. Quartz-mica schist is the predominant schist unit, although greenschist is also present.

Other rock units mapped in this area consist of Paleozoic orange- to green-weathering chloritic, clastic, and metamafic rocks; chloritic phyllite and sandstone; orange-weathering dolomite and impure marble; green phyllite and greenschist; and altered mafic igneous rocks, greenstone, greenschist and locally blueschist.

The rock units trend nearly east-west, however, local and regional scale folding and faulting causes variations in attitudes over short distances.

8.24.6 Geochemistry

A review of geochemical sample results from the three areas indicate that four samples collected by WGM may be considered anomalous in copper and/or zinc. Three of these samples were collected in Area 1 and the other sample was obtained from Area 3.

Area 1: Sample BM 1176 is a chip sample taken from a 2.5-foot thick rock outcrop. It analyzed 322 ppm zinc and was collected from highly iron-stained black pyritic quartz-mica schist.

Sample BM 1180 and 1181 are soil samples, which represent a combined length of approximately 27 feet along the trend of iron stain present on the soil. Sample BM 1180 shows 179 ppm copper and 280 ppm zinc, while sample BM 1181 assays 322 ppm copper and 840 ppm zinc.

The geochemical values obtained from the rock and soil samples suggest the presence of sulfide mineralization. The iron staining in the soil possibly marks the trace of a fault zone.

Area 2: Follow-up of a reported geochemical anomaly (OFR #67) of 200 ppm lead failed to reveal the source of the anomaly or to confirm it. Resampling of the stream silt from this drainage yielded a value of only 22 ppm lead.

Three explanations are offered for the large discrepancies in lead geochemical values between the two samples.

1. Error on behalf of one or both of the laboratories which analyzed the samples. This explanation is considered remote since both laboratories are presumed to check their work.

2. Past work in the schist belt indicates that geochemical values may be variable, depending upon the time of year of collection and runoff conditions. A sample collected after a period of heavy runoff is likely to show lower geochemical values than a sample collected at the same site following an extended period of normal or low stream flow.

3. Different sampling techniques by the collectors.

The drainage should be resampled and contingent upon results, additional follow-up work could be warranted.

Area 3: This area was chosen for additional work based on a reported geochemical anomaly of 280 ppm copper and 320 ppm zinc (OFR #66). Sample BM 1258, collected from the same drainage as the above sample, shows 146 ppm copper and 282 ppm zinc.

Although the latter values are lower, the drainage is considered slightly anomalous in these metals because of its relatively large size. No sulfide mineralization was noted in this basin during the follow-up work; stream float indicates that the basin is underlain by light gray quartz-mica schist and carbonate rocks. Stream float is coated with a bluish to white precipitate (hemimorphite?).

8.24.7 Conclusions

The three areas examined in the vicinity of Walker Lake are apparently underlain by rock units similar to those found to the west of Walker Lake, i.e. rocks which contain significant tonnages of base metal sulfides and numerous occurrences of mineralization which are undergoing extensive exploration.

No base metal sulfide mineralization was discovered during the course of prospecting near Walker Lake, however, geochemical sampling in Areas 1 and 3 yielded results which may indicate the presence of copper and zinc mineralization and therefore would normally be investigated further.

Detailed geochemical stream silt sampling is needed along the eastward continuation of the schist belt to determine if base metal sulfide occurrences are present. Geochemistry, however, can serve only as a useful tool in determining the presence of surface or near-surface occurrences of metals. Geophysical techniques and detailed geologic mapping in conjunction with geochemistry are being used along the schist belt to the west to establish drilling targets.

8.24.8 Recommendations

If the land were open to mineral entry it would be strongly recommended to industry that detailed geochemical stream silt sampling be conducted in all, or portions of Tps. 19, 20 and 21N, Rs. 19-23E to test the schist belt for the presence of base metal sulfide mineralization. Sampling should be carried out to test all drainages in the area, including small gullies.

Geochemical sampling would provide the first step in evaluating the eastward continuation of the schist belt. Contingent upon favorable results, additional exploration priorities could be assigned to the area.

TABLE 8.24.1

WALKER LAKE AREA

GEOCHEMICAL SAMPLE RESULTS

(Values in ppm, unless noted)

AREA 1

Sample No.	Type	Cu	Pb	Zn	Ag	(ppb) Au
BM 1169	ss	37	24	74	0.9	-
1170	ss	86	24	85	1.2	-
1171	ss	77	26	74	1.1	-
1172	ss	57	24	72	0.9	-
1173	ss	53	18	76	0.9	-
1174	ss	75	18	69	0.8	-
1175	ss	74	20	83	0.9	-
1176	rx	89	30	322	2.8	5
1177	ss	81	24	360	1.0	-
1178	ss	45	30	103	1.0	-
1179	ss	58	19	78	0.9	-
1180	so	178	30	380	1.1	-
1181	so	322	39	840	2.0	-
1182	rx	22	22	65	1.3	5
1183	ss	50	22	108	0.8	-
1184	ss	54	19	80	0.9	-
1185	ss	52	18	82	0.6	-

AREA 2

Sample No.	Type	Cu	Pb	Zn	Ag	(ppb) Au
1418	ss	60	28	150	1.2	-
1419	ss	45	18	100	0.6	-
1420	ss	64	16	84	0.6	-
1421	ss	50	21	85	0.8	-
1422	ss	60	20	83	1.1	-
1423	ss	47	16	82	1.0	-
1424	ss	52	22	76	1.6	-
1425	ss	25	10	38	0.7	-

AREA 3

Sample No.	Type	Cu	Pb	Zn	Ag	(ppb) Au
1244	ss	38	28	69	0.8	-
1245	ss	14	27	38	1.2	-

TABLE 8.24.1 (Cont.)

WALKER LAKE AREA

GEOCHEMICAL SAMPLE RESULTS

(Values in ppm, unless noted)

Sample No.	Type	Cu	Pb	Zn	Ag	(ppb) Au
BM 1246	rx	12	18	40	0.7	-
1247	ss	40	32	73	0.6	-
1248	ss	27	32	64	0.7	-
1249	rx	53	35	52	0.9	-
1250	ss	28	34	64	0.6	-
1251	ss	22	20	44	1.0	-
1252	ss	17	22	68	0.8	-
1253	ss	16	22	76	1.0	-
1254	ss	14	17	55	0.4	-
1255	ss	21	20	59	0.8	-
1256	rx	40	22	66	0.6	-
1257	ss	13	19	50	0.8	-
1258	ss	146	19	282	1.2	-
1259	ss	75	23	84	0.6	-
1260	ss	57	26	72	0.8	-
1334	ss	16	14	68	0.7	-
1335	ss	37	24	32	0.7	-
1336		Reference Sample				
1337		Reference Sample				
1338	ss	9	23	52	1.2	-
1339	ss	30	18	51	0.7	-
1340	ss	16	24	50	1.0	-
1341	ss	17	19	39	0.7	-
1342	ss	16	14	39	1.8	-
1343	ss	23	20	57	1.2	-

ss = stream silt sample
so = soil sample
rx = rock sample
\- = not analyzed

Collected by: Bigelow
Degenhart
Griffis
Via

8.25 ARRIGETCH PEAKS AREA

8.25.1 Introduction

Known work in this area consists of regional scale mapping by governmental agencies (Brosgė and Pessel, 1971) and a limited amount of geochemical stream silt sampling and prospecting be at least two private companies. The work by private concerns was conducted prior to enactment of ANCSA.

Attention was drawn to this area by the results of past geochemical stream silt sampling of several streams draining the Arrigetch Peaks and the report of minor copper-zinc-mineralization in a small tactite zone at one location (General Crude Oil Co., private report).

8.25.2 Summary

A portion of a granite-carbonate contact zone on the north side of the Arrigetch Peaks was examined to follow-up reported geochemical stream silt anomalies.

A minor amount of copper and zinc mineralization was observed as local occurrences in a magnetite-pyroxene zone of 450 feet in length and of variable width of less than 20 feet. Sample results indicate that minor tungsten mineralization is also present. A sample value of 4,500 ppm copper, 2,075 ppm zinc and 50 ppm tungsten was obtained from a 3-foot chip sample.

Additional geochemical stream silt sampling and prospecting is recommended along other granite-carbonate contact zones at the margin of the Arrigetch Peaks intrusive.

8.25.3 Location and Access

Arrigetch Creek is located in the Survey Pass B-3 quadrangle in T.23 and 24N., R.21 and 22E. (Figs. 1, 3 and 29). The area examined consists of Arrigetch Creek and three tributaries. Arrigetch Creek heads in the Arrigetch Peaks and flows northeastward into the Alatna River. The nearest settlement to the area is Bettles, about 79 miles southeast of the Arrigetch Peaks.

Access to the area is best gained by helicopter, although small, fixed-wing aircraft can land on gravel bars along the Alatna River, about 10 miles to the northeast.

8.25.4 Work Accomplished

During the present examination, 35 stream silt, rock and soil samples were collected in conjunction with prospecting and numerous foot traverses along the granite-limestone contact zone in four drainages (Fig. 29).

Certain areas along the granite-limestone contact zone were not examined where past geochemical sampling results were not encouraging. It was beyond the scope of this program to carry out reconnaissance activities in other nearby unexplored areas.

8.25.5 Geology and Mineralization

A granitic intrusive body measuring about 10 miles in a northwest/southeast direction by 20 miles in a northeast/ southwest direction dominates the geology of the area. The geologic map of the Survey Pass quadrangle (Brosgė and Pessel, 1977) shows that this Cretaceous-age granitic body is in contact with middle Devonian Skajit Limestone in the examination area.

In the Arrigetch Creek area localized thermally metamorphosed zones of less than 200 feet in thickness with lengths of several thousands of feet are present along the granite-limestone contact. Within these thermal contact zones, pods and lenses of magnetite and pyroxene containing minor copper, zinc, and tungsten are present. The widths of observed individual pods and lenses vary from 1 to 20 feet and reach up to about 450 feet in length. Very minor amounts of chalcopyrite, malachite and sphalerite are present locally within the magnetite-pyroxene pods. No tungsten mineral were identified, however, minor amounts of tungsten mineralization possibly are associated with small (< 1") zones of garnet found locally in the tactite zones as evidence by sample BM 1289, which shows 50 ppm tungsten.

Sample BM 1288, which shows 2,500 ppm copper, 640 ppm zinc, and 3 ppm tungsten, is a representative rock chip sample of a magnetite-pyroxene zone of about 450 feet in length and of variable widths of from 1 to 20 feet. The zone pinches and swells along strike and is bounded above and below by light gray to white, coarse-grained marble, which locally contains small bands of garnet.

Sample BM 1289 is a rock chip sample collected across a width of about 3 feet within the magnetite-pyroxene zone described above (BM 1288). This sample shows 4,500 ppm copper, 2,075 ppm zinc and 50 ppm tungsten and was collected from an area which appeared to contain the highest concentration of copper mineralization along the 450-foot strike length of the large zone described earlier.

Additional traverses made along the granite-limestone contact revealed no additional copper-zinc mineralization.

8.25.6 Geochemistry

Samples collected by WGM in the Arrigetch Creek area were routinely analyzed for copper, lead, zinc, molybdenum, silver and tungsten. Two samples were also analyzed for tin. Figure 29 shows the site locations and analytical results accompany the figure.

Geochemical analysis of stream sediments indicates that copper is apparently not an effective exploration tool in this local geologic-physiographic environment, unless samples are collected at a density of five or more per mile. For example, stream silt sample BM 1286, collected approximately 0.2 miles downstream from exposed copper mineralization, shows only 115 ppm copper. Sample BM 1292 collected about 0.5 miles downstream from the copper mineralization shows only 37 ppm copper.

Additional stream silt sampling is required to determine background and anomalous values for this area in order to assess the significance of 37 ppm copper in relationship to the amount and grade of exposed copper mineralization.

Stream silt sample BM 1549 which shows 380 ppm lead and 480 zinc was collected about one mile south of a granite-carbonate zone. Stream float and bedrock in the drainage consist entirely of granite. The lead value is the highest recorded from the sampling in this area and, except for three rock sample values, and one silt value, the zinc value exceeds all other values obtained. No mineralized rocks were observed in the drainage. The lead and zinc values indicate the presence of these metals in the granite. Follow-up work is required to determine the amount and mode of occurrence of the lead and zinc.

Other geochemical values which appear to be anomalous are attributed to mineralization associated with the thermal contact zone.

8.25.7 Conclusions

The presence of weak copper-zinc-tungsten mineralization in this granite-carbonate contact environment is demonstrated by the results of the field work.

The observed mineralization appears to be restricted to small pods and lenses exhibiting variable widths from 1 to 20 feet and a strike length of up to 450 feet. Additional prospecting and sampling along the granite-carbonate contact zone may lead to discovery of additional mineralization.

The grade of the sampled mineralization is not considered significant enough to warrant additional work; occurrences of higher grade mineralization may be present at other locations at or near the margin of the large intrusive body.

Copper geochemistry does not appear to be an effective exploration tool in this geologic environment unless samples are collected at a density of five or more per mile.

Geochemical sample results from sample BM 1549 indicate the presence of lead and zinc mineralization associated with the granitic body. The rugged topography in the Arrigetch Peaks prevents the accumulation of sufficient amounts of silt to allow collection of panned concentrates in most small drainages. This would hinder a systematic search for tungsten, however, analysis of stream silts may provide a fairly reliable method of exploration for tungsten.

The objective of any future work in the Arrigetch Peaks area should be directed toward discovery of significant amounts of high grade base metal sulfide mineralization and/or occurrences of tungsten mineralization.

8.25.8 Recommendations

Systematic prospecting, consisting of detailed geochemical stream silt sampling, in conjunction with foot traverses and float and talus mapping, is recommended around the margin of the large intrusive body where it is in contact with carbonate rocks.

The drainage from which sample BM 1549 was collected should be followed up to determine the source of the high lead and zinc geochemical values.

TABLE 8.25.1

ARRIGETCH CREEK AREA

GEOCHEMICAL SAMPLE RESULTS

(Values in ppm)

Sample No.	Type	Cu	Pb	Zn	Mo	Ag	W	Sn
BM 1198	ss	24	54	118	3	0.2	ND	24
1199	rx	106	24	22	ND	1.2	ND	1
1282	rx	34	23	76	4	0.2	ND	--
1283	ss	41	51	285	2	0.3	25	--
1284	rx	39	16	15	1	0.2	ND	--
1285	pc	19	63	96	3	0.2	5	--
1286	ss	115	167	570	2	0.9	10	--
1287	rx	3,500	12	1,120	ND	4.5	75	--
1288	rx	2,500	202	640	9	6.2	3	--
1289	rx	4,500	91	2,075	28	4.0	50	--
1290	rx	420	84	450	2	2.3	3	--
1291	ss	54	82	310	6	0.2	ND	--
1292	ss	37	48	228	3	0.2	ND	--
1360	ss	6	22	62	1	0.2	ND	--
1361	ss	74	114	360	5	1.0	3	--
1362	so	73	40	200	1	0.5	3	--
1363	ss	56	62	195	ND	0.3	ND	--
1364	ss	48	46	156	ND	0.2	ND	--
1365	ss	46	50	290	2	0.2	ND	--
1534	ss	43	97	410	2	0.3	ND	--
1535	ss	38	75	325	2	0.2	10	--
1536	ss	38	54	272	ND	0.5	ND	--
1537	rx	86	14	61	1	0.9	ND	--
1538	ss	64	48	380	1	0.2	ND	--
1539	ss	252	46	370	1	1.2	ND	--
1540	rx	120	15	24	1	1.3	ND	--
1542	rx	24	20	305	ND	0.2	ND	--
1543	ss	25	38	71	3	0.2	ND	--
1544	ss	43	83	255	2	0.2	ND	--
1545	ss	44	42	173	1	0.3	ND	--
1546	ss	60	66	330	2	0.6	ND	--
1547	ss	74	104	420	ND	0.9	ND	--
1548	ss	44	60	200	ND	0.3	ND	--
1549	ss	36	380	480	3	0.6	ND	--

ss = stream silt sample
rx = rock sample
so = soil sample
pc = panned concentrate sample
\- = not analyzed

Collected by: Degenhart
Stark
Stratman

LEGEND

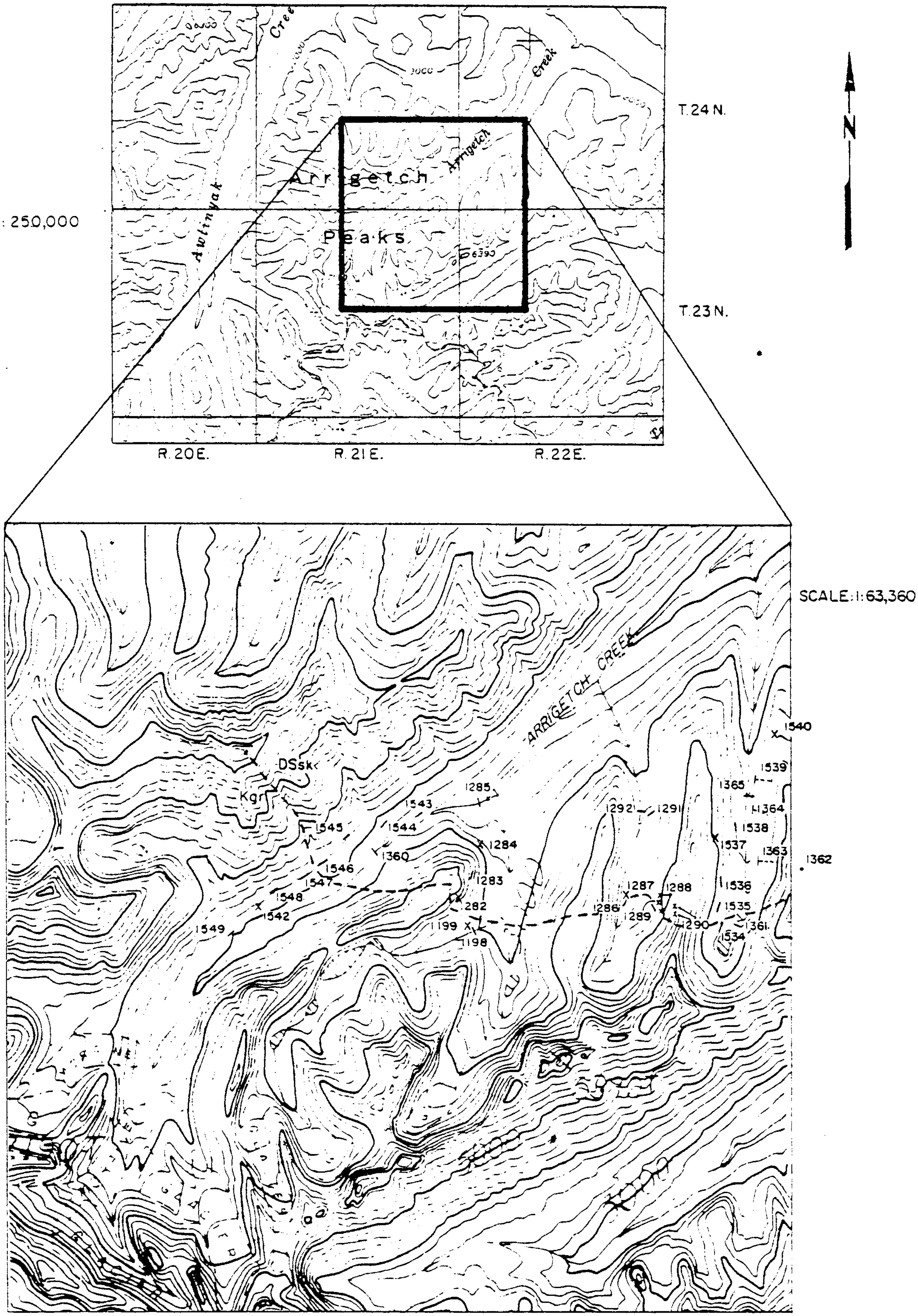
ARRIGETCH CREEK AREA FIGURE 29

Dssk: SKAJIT LIMESTONE --- mostly light gray, massive marble, locally, thermally metamorphosed.

Kgr: GRANITIC ROCKS --- mostly granite and quartz monzonite; probably Cretaceous (Fritts, 1971).

/ / : Geologic contact, approximate.

(Geology after Brosgé and Pessel, 1977)



WGM INC	MINING & GEOLOGICAL CONSULTANTS ANCHORAGE, ALASKA	DWN BY: M.H.	REVISED	SAMPLE SITE LOCATIONS ARRIGETCH CREEK AREA SURVEY PASS B-3 QUADRANGLE	FIGURE 29 8MI08
		DATA BY: WGM			
SCALE: AS SHOWN		DATE 6/76			

8.26 NAHTUK MOUNTAIN AREA

8.26.1 Introduction

The geology of the eastern Survey Pass 1:250,000 scale quadrangle is mapped (Brosgé and Reiser, 1971).

At least two private companies, Bear Creek Mining Company and Alvenco, conducted regional-scale exploration programs in portions of the Survey Pass quadrangle prior to enactment of ANCSA (Ruzicka, per. comm.). This work consisted of preliminary geochemical stream silt sampling and prospecting. The results of one of these programs were made available for this study (General Crude Oil, private report) however, this work did not cover the Nahtuk Mountain Area.

WGM's attention was drawn to this area by a reported occurrence of zinc-silver mineralization (Ruzicka, J.F., 1975, per. comm.). Mr. Ruzicka indicated that stream float assaying a few percent zinc and several ounces per ton silver had been discovered in the area during regional prospecting. A map showing the location of this mineralized float was not available to WGM.

8.26.2 Summary

Reported zinc-silver mineralization was not relocated and a limited amount of sampling failed to indicate the presence of mineralization in the area examined.

Analytical results from 22 samples indicate low geochemical values for copper, lead, zinc, silver, molybdenum, and gold.

No additional work is recommended for the area examined. If the reported zinc-silver mineralization is relocated, follow-up work is recommended.

8.26.3 Location and Access

The examination area is located in T.24N., R.26E. (Fig. 3) of the Survey Pass quadrangle and is situated about four miles northwest of Ernie Lake (Fig. 30). The area is drained by the southerly flowing Iniakuk River, which flows into the Malamute Fork of the Alatna River.

Bettles is the nearest settlement and is located about 59 miles southeast of the examination area.

Access is by helicopter, asthough float planes can land at Ernie Lake.

8.26.4 Work Accomplished

The 1976 field work consisted of foot traverses at the suspected location of the mineralization. In addition 22 samples were collected for analysis.

Our work failed to relocate the reported mineralization.

8.26.5 Geology and Mineralization

The geology in the area is dominated by northwest trending Devonian Skajit Limestone, chloritic phyllite, light gray quartzite, and sandstone intruded by a Cretaceous granitic body.

Graphitic schist was also noted which contains numerous small quartz stringers. Locally this schist is iron-stained from the weathering of small amounts of pyrite. A limited amount of pyrite (± 1%) is also present in a fine-grained, light-colored phase of the granitic intrusive.

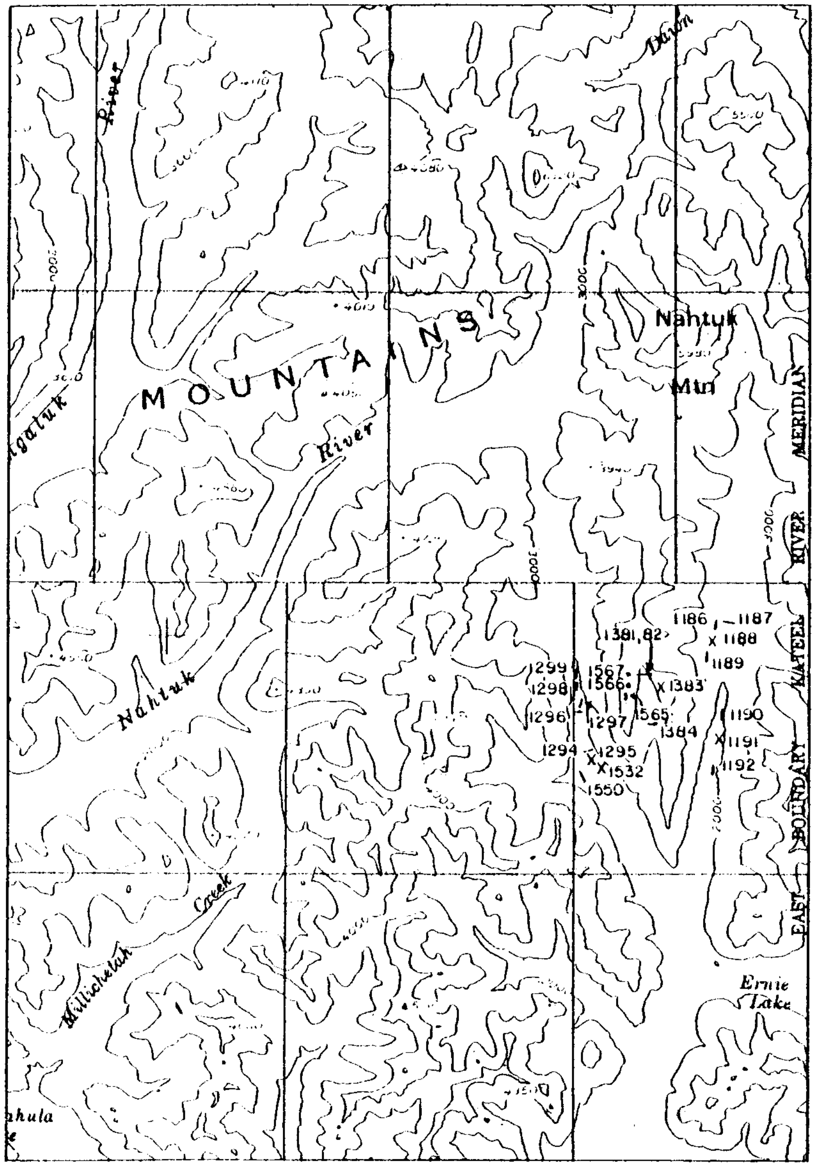
No mineralization of economic significance was noted during the course of the examination.

8.26.6 Geochemistry

Figure 30 shows sample site locations and a list of geochemical values accompanies the figure. All 22 samples were analyzed for copper, lead, zinc, molybdenum, and silver. In addition, 10 samples were checked for gold.

Analytical results show relatively low metal contents for all samples, however, two samples are considered weakly anomalous in one or more metals. Sample BM 1565 analyzed 156 ppm copper and 166 ppm lead and was collected from a small drainage underlain by chloritic phyllite and brown limestone. No mineralization was noted in hand specimens from the drainage. The metal values are attributed to background geochemical values in the small basin.

Sample BM 1384 shows 50 ppb gold. No bedrock exposures are present near the sample site; however, stream float is dominated by weakly pyritic, fine-grained, light-colored intrusive rock. The source of the gold is not known, but it is likely that trace amounts of gold may be associated with the pyrite.



LEGEND

1200	STREAM SILT SAMPLE SITE
• 1201	SOIL SAMPLE SITE
X 1202	ROCK SAMPLE SITE

N

WGM INC	MINING & GEOLOGICAL CONSULTANTS ANCHORAGE, ALASKA	DWN BY: M.H.	REVISED	SAMPLE SITE LOCATIONS
		DATA BY: WGM		NAHTUK MOUNTAIN AREA
SCALE: 1:250,000		DATE: 6/76		SURVEY PASS B-1, C-1 QUADRANGLES

FIGURE 30
BMI05

8.26.7 Conclusions

Reported zinc-silver mineralization in this Nahtuk Mountain area was not located and results from a limited amount of geochemical sampling do not suggest the presence of significant copper, lead, zinc, molybdenum, silver or gold mineralization.

The area examined is considered low in economic potential based on results from the present investigation. Rediscovery of the reported mineralization would enhance the economic potential.

8.26.8 Recommendations

No additional work is recommended in the area examined. Contingent upon relocation of the reported zinc-silver mineralization in this general area, additional follow-up work would be warranted.

TABLE 8.26.1

NAHTUK MOUNTAIN AREA

GEOCHEMICAL SAMPLE RESULTS

(Values in ppm, unless noted)

Sample No.	Type	Cu	Pb	Zn	Mo	Ag	ppb/Au
BM 1186	ss	36	19	93	2	0.4	--
1187	ss	27	18	57	1	0.2	--
1188	rx	85	29	48	6	1.2	20
1189	ss	38	21	109	1	0.2	--
1190	ss	12	8	33	ND	0.2	--
1191	rx	22	31	140	4	0.9	20
1192	ss	16	14	37	ND	0.2	--
1294	ss	36	21	88	1	0.2	--
1295	rx	108	22	110	2	1.1	--
1296	ss	35	18	84	ND	0.2	--
1297	ss	39	19	100	ND	0.2	--
1298	ss	45	16	88	ND	0.2	--
1299	ss	32	12	50	ND	0.2	--
1532	rx	28	21	42	1	0.4	10
1550	ss	28	37	90	2	0.2	--
1565	ss	156	166	96	ND	1.1	10
1566	so	42	23	60	1	0.2	5
1567	so	40	31	94	1	0.2	5
1381	ss	50	25	155	2	0.4	5
1382	rx	30	30	16	2	0.8	5
1383	rx	32	46	36	1	0.8	30
1384	ss	22	18	54	ND	0.2	50

ss = stream silt sample
so = soil sample
rx = rock sample
ND = not detected
\- = not analyzed

Collected by: Degenhart
Stark
Stratman

8.27 SHEEP CREEK (VABM ALLEN)

8.27.1 Introduction

The Wiseman quadrangle has been mapped at 1:250,000 scale (Brosgė and Reiser, 1971). Reconnaissance geochemical sampling and prospecting has also been conducted by at least four private companies in portions of the Wiseman quadrangle, including the Sheep Creek area. The companies are Bear Creek Mining Company, General Crude Oil Company, Alrenco, Inc., BP Alaska, and probably other comapnies. Results from past work were made available for review, but not for reproduction by General Crude Oil Company (Private report). The previous work was conducted prior to enactment of ANCSA and covered portions of the presently classified d-2 lands.

Attention was drawn to this area after review of a report covering past work in the area (General Crude Oil Company, private report). The report mentioned minor amounts of chalcopyrite, bornite, and malachite in metamorphosed reef limestone near survey monument (VABM Allen) and that minor copper mineralization in a similar geologic environment is present at two locations to the northeast from VABM Allen.

The two areas to the northeast were selected for field inspection since both areas are located in d-2 lands, while VABM Allen is located in d-1 lands.

8.27.2 Summary

An examination was made at Sheep Creek to check out reported copper mineralization associated with carbonate rocks. Copper mineralization to 5,700 ppm occurs in very small pods in limestone which overlies quartzose chlorite schist. The schist contains copper mineralization to 1,920 ppm at one location. It appears that the chloritic schist marks a thrust fault plane.

No additional work is recommended for the examined area.

8.27.3 Location and Access

This examination area is located in T.32N., R.20W. in the Wiseman quadrangle (Figs. 1, 2 and 31). Crevice Creek is located about 14 miles to the south of the work area.

Field work was conducted in the upper reaches of two drainage basins: Sheep Creek, which flows toward the southwest and drains into the John River, and an unnamed stream which flows in a southeastward direction and drains into the Allen River. Access is by helicopter.

8.27.4 Work Accomplished

Locations of 11 stream silt and two rock samples collected during an examination of the Sheep Creek area are shown on Figure 31. All samples were analyzed for copper, lead, zinc and silver. Six of the samples were analyzed for molybdenum and two for gold.

8.27.5 Geology and Mineralization

The geology at the Sheep Creek area is characterized by a fault which has thrust Middle Devonian Skajit Limestone over Upper Devonian rocks consisting of shale, phyllite and chloritic schist (Fig. 31).

Minor copper mineralization in the form of malachite, azurite and chalcopyrite is associated with quartzose-chlorite schist and limestone. Sparse disseminated copper mineralization occurs along planes of schistosity in quartzose-chlorite schist and along small fractures in overlying limestone.

The extent of the mineralization in the quartzose-chlorite schist appears to be limited to a few tens of feet along strike and to less than five feet in thickness. The mineralization observed in the limestone is restricted to small fractures in two small pods of less than five feet in diameter.

Sample BM 1197, which shows 1,920 ppm copper, represents selective sampling of a talus accumulation of the quartzose-chlorite schist. Numerous foot traverses failed to reveal a bedrock source; however, considering the distribution of the mineralized talus, the extent of the mineralized bedrock is apparently limited to no more than 20 feet along strike. Sample BM 1533 (5,700 ppm copper) is representative of the grade of copper mineralization associated with a five-foot diameter mineralized pod in the limestone.

Sample BM 1197 was collected approximately two miles southwest from sample BM 1533. At both locations, massive gray limestone overlies a five-foot thick unit of quartzose-chlorite schist.

The grade and apparent extent of the observed mineralization is not considered significant as regards to the specific occurrences, but the presence of mineralization in quartzose schist and carbonate environments is considered to be encouraging in the regional exploration sense.

8.27.6 Geochemistry

In addition to samples BM 1533 and BM 1197, which were discussed above, two stream silt samples were considered anomalous in copper. Samples BM 1354 and BM 1527 show 102 ppm and 170 ppm copper, respectively, Both samples were collected near the mapped fault plane and may indicate the presence of copper mineralization along the thrust, or in the overlying limestone. Normal or background values appear to be less than 50 ppm copper, based on results from the limited amount of sampling conducted. No other samples are considered anomalous.

8.27.7 Conclusions

Minor amounts of copper mineralization have been noted along a distance of at least five miles from VABM Allen in the southwest to sample BM 1533 in a northeast direction. Results from the field examination indicate that the extent of the individual mineral occurrences is limited to less than a few tens of feet along strike and to less than five feet in width. The grade of the observed mineralization is to 5,700 ppm copper and no more than a few tons are indicated. The mineralization is apparently stratabound, but additional work is required to determine the source and distribution pattern.

The mineralization is spatially related to a unit of chloritic schist near the base of the Skajit Limestone and to neraby overlying limestone. It is not known if the mineralization is indicative of the nearby presence of larger and higher grade base metal sulfide bodies in the schist and/or carbonate sections.

8.27.8 Recommendations

No work is recommended for the examined mineral shows since the potential for discovery of significant amounts of mineralization is considered low. Additional prospecting along the schist-limestone contact zone is recommended.

TABLE 8.27.1

SHEEP CREEK (VABM ALLEN)

GEOCHEMICAL SAMPLE RESULTS

(Values in ppm, unless noted)

Sample No.	Type	Cu	Pb	Zn	Mo	Ag	Au (ppb)
BM 1193	ss	25	29	66	2	0.2	-
1194	ss	14	42	60	4	0.2	-
1195	ss	41	25	84	ND	0.2	-
1196	ss	29	28	79	1	0.2	-
1197	rx	1,920	19	104	1	4.2	5
1354	ss	102	33	56	-	0.2	-
1355	ss	22	43	17	-	0.2	-
1356	ss	16	50	6	-	0.2	-
1357	ss	45	38	73	-	0.2	-
1358	ss	15	29	29	-	0.2	-
1359	ss	34	20	37	-	0.2	-
1527	ss	170	33	51	-	0.5	-
1533	rx	5,700	31	79	3	3.4	10

ss - stream sample
rx - rock sample
ND - not detected
\- - not analyzed

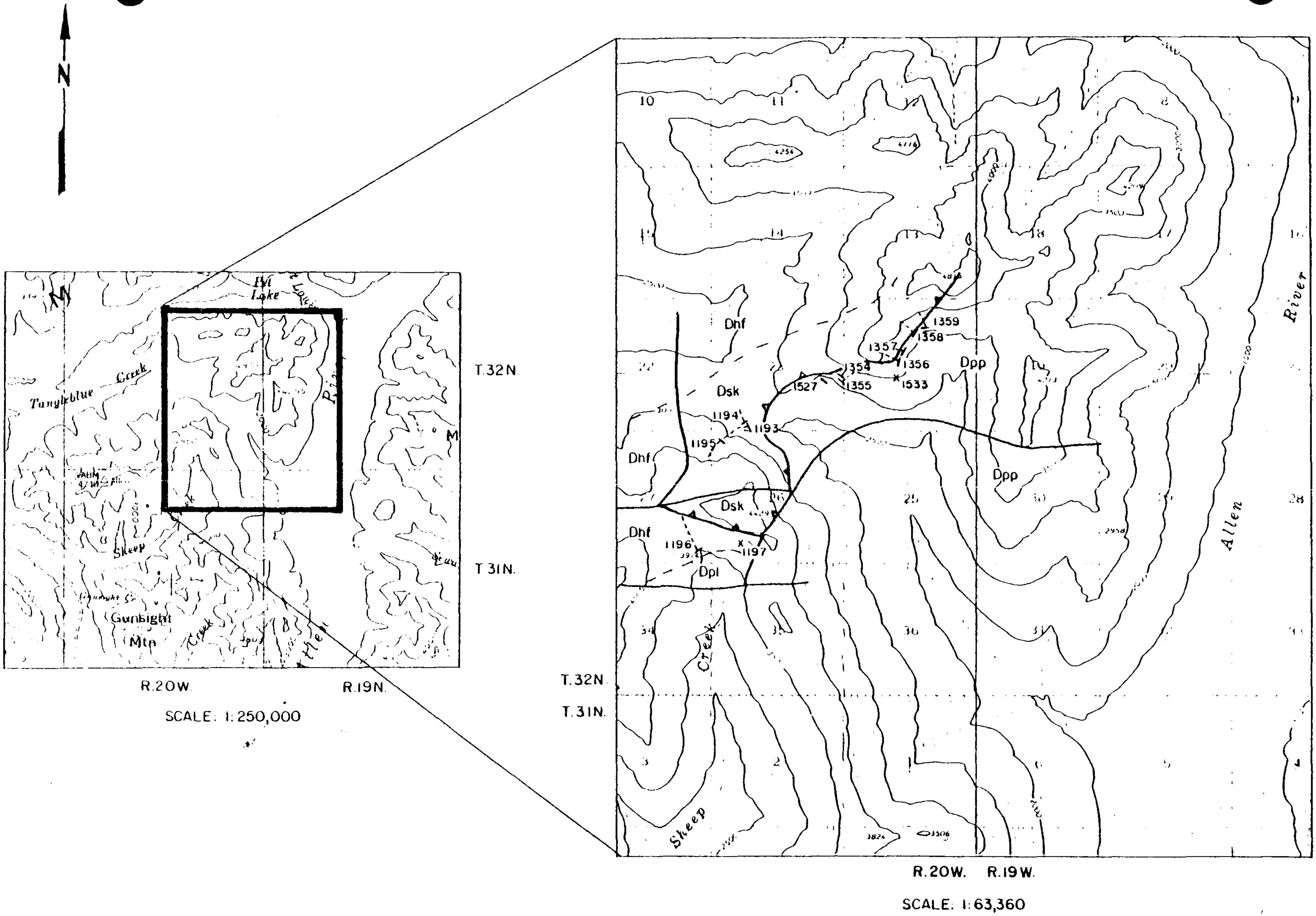
Collected by: Degenhart
Stratman
Stark

LEGEND

SHEEP CREEK AREA - FIGURE 31

Dhf:	HUNT FORK SHALE ... black shale, slate and phyllite; interbedded brown fine-grained sandstone and quartzite; lenses of brown muddy limestone.
Dpp:	PURPLE AND GREEN PHYLLITE ... purple, black and green phyllite; purple, green, gray and brown, partly calcareous, chloritic and limonitic siltstone.
Dpl:	Dark gray shaly limestone.
Dsk:	SKAJIT LIMESTONE ... gray thin-to-thick-bedded marble.
/	Contact
/	Fault
	Thrust Fault Sawteeth on Upper Plate

(Geology after Brosgé and Reiser, 1971)



WGM INC	MINING & GEOLOGICAL CONSULTANTS ANCHORAGE, ALASKA	DWN BY: M.H. DATA BY: WGM DATE: 6/76	REVISED	SAMPLE SITE LOCATIONS & GENERALIZED GEOLOGY SHEEP CREEK AREA WISEMAN C-4 QUADRANGLE	FIGURE 31 BM106
SCALE: AS SHOWN					

8.28 TOBIN MOUNTAIN

8.28.1 Introduction

The Wiseman quadrangle has been mapped at 1:250,000 scale (Brosgė and Reiser, 1971). At least two private companies conducted first-pass geochemical stream silt sampling in portions of the d-2 lands of the Wiseman quadrangle prior to enactment of ANCSA. Several geochemical anomalies obtained during these first-pass reconnaissance efforts were apparently not followed up by the companies involved.

The WGM field party conducted a limited amount of follow-up work at Tobin Mountain based on results obtained during one of the previous programs (Ruzicka, J.F., 1975, per. comm.).

8.28.2 Summary

A brief reconnaissance was carried out at Tobin Mountain to follow-up anomalous zinc geochemical values obtained during first-pass reconnaissance by a private company (Ruzicka, J.F., 1975, per. comm.). Maps showing locations of anomalous geochemical values were not available for this study.

A total of 20 silt samples were collected in conjunction with foot traverses and prospecting. Four samples show values in excess of 400 ppm zinc. The higher than normal zinc geochemical values obtained by WGM may be attributed to background values associated with the local bedrock, however, additional field work is required to confirm this.

Additional follow-up work is recommended at the Tobin Mountain area.

8.28.3 Location and Access

The portion of Tobin Mountain examined during the present investigation is situated in T.33 N., R.18 W. of the Wiseman 1:250,000 scale quadrangle (Figs. 1, 2 and 32). The area is located about 40 miles northeast from the village of Wiseman. Crevice Creek, a permanent residence of one family, is located about 23 miles to the southwest.

Streams draining Tobin Mountain flow to the north and west into the Allen River and to the north and east into the Tinayguk River and southward into the Wild River. Access is by helicopter.

8.28.4 Work Accomplished

A total of 20 stream silt samples were collected in conjunction with ridge and stream traverses during the present work. The samples were analyzed for copper, lead, zinc and silver.

8.28.5 Geology and Mineralization

Bedrock in the examination area consists of Upper Devonian gray and yellow shale and phyllite, black siliceous sandstone, and black graphitic limestone. The units strike nearly east-west and dip 20° to 40° to the north.

In the area traversed, most of the rocks observed contain variable amounts of disseminated pyrite. Several weakly pyritic quartz-carbonate lenses were observed in a phyllite host rock. Iron-staining due to weathering of pyrite is common near stream level and occasionally along ridgetops.

No sulfide mineralization except pyrite was noted.

8.28.6 Geochemistry

Sample site locations are shown on Figure 32 and geochemical values for these samples are listed on a table 8.28.1.

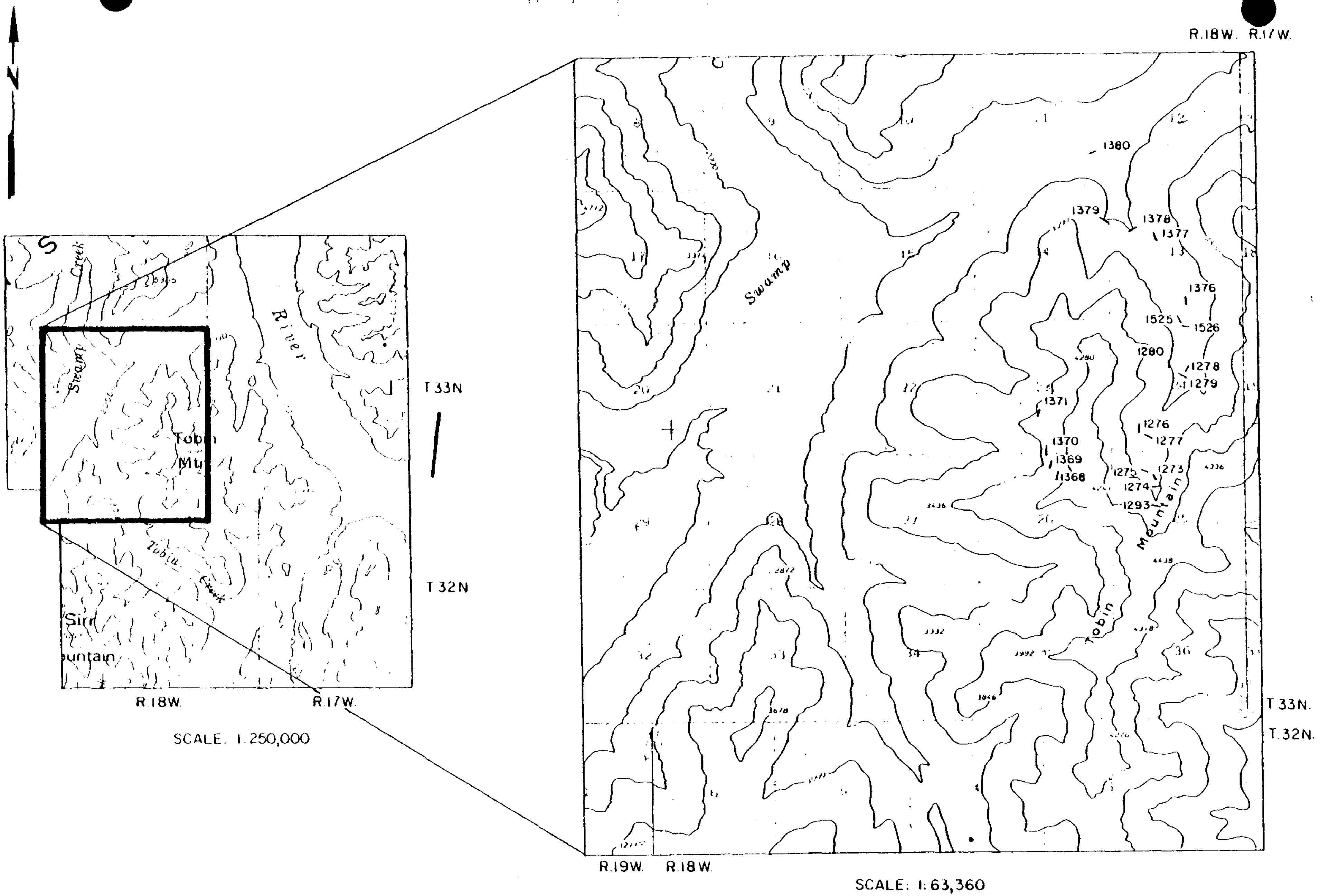
Four samples show zinc values ranging from 425 ppm to 480 ppm and are considered moderately anomalous. Bedrock and stream float observed in the vicinity of these four samples consists of weakly pyritic gray to black graphitic phyllite and schist. The source of the seemingly higher than normal values may be caused by a high background concentration of zinc in the local bedrock, however, additional field work is required to confirm this.

8.28.7 Conclusions

Follow-up work in an area reported to display anomalous zinc geochemical values failed to reveal the presence of significant amounts of base metal sulfides. The higher than normal zinc values may be caused by background amounts of zinc associated with the local bedrock, however, additional work is required to confirm this.

8.28.8 Recommendations

A limited amount of additional work is recommended for the part of Tobin Mountain examined during the present investigation. The work should be directed toward discovery of the source of the moderately high zinc geochemical values.



WGM INC MINING & GEOLOGICAL CONSULTANTS ANCHORAGE, ALASKA	DWN BY: M.H.	REVISED	SAMPLE SITE LOCATIONS	FIGURE
	DATA BY: WGM		TOBIN MOUNTAIN AREA	**32**
SCALE: AS SHOWN	DATE: 6/76		WISEMAN C-4 QUADRANGLE	BMI07

TABLE 8.28.1

TOBIN MOUNTAIN

GEOCHEMICAL SAMPLE RESULTS

(Values in ppm)

Sample No.	Type	Cu	Pb	Zn	Ag	Mo
BM 1273	ss	64	28	152	0.5	--
1274	ss	64	3	196	0.4	--
1275	ss	59	16	85	0.2	--
1276	ss	41	10	54	0.2	--
1277	ss	54	19	215	0.2	--
1278	ss	66	18	160	0.3	--
1279	ss	61	19	425	0.6	--
1280	ss	63	32	430	1.8	--
1293	ss	51	18	157	0.2	9
1368	ss	78	16	70	0.4	--
1369	ss	79	19	84	0.3	--
1370	ss	122	20	104	0.8	--
1371	ss	76	17	88	0.5	--
1376	ss	71	23	450	1.1	--
1377	ss	36	24	164	0.3	--
1378	ss	62	20	295	0.8	--
1379	ss	34	14	76	0.2	--
1380	ss	54	20	224	0.8	--
1525	ss	70	21	480	0.8	--
1526	ss	68	23	355	1.0	--

ss = stream silt samples
\- = not analyzed

Collected by: Degenhart
Stark
Stratman

9. MINERAL RESOURCES

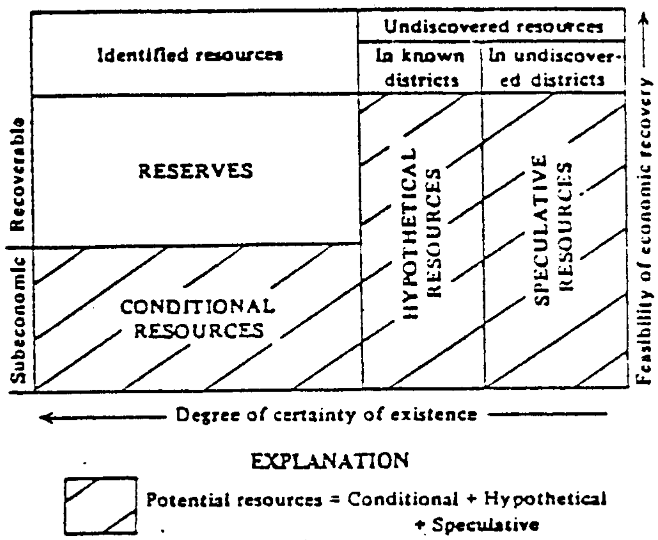
9.1 DEFINITION OF RESOURCES

A fundamental concept in the evaluation of mineral resources is the distribution between resources and reserves. Detailed definitions vary and thinking on the subject is still in a state of evolution.

McKelvey (1972) discussed the philosophy of resources and presented concepts which form a cornerstone for present thinking. Brobst and Pratt (1973) reprinted McKelvey's paper as the introductory chapter in U.S.G.S. Professional Paper 280 "United States Mineral Resources", but introduced certain modifications to McKelvey's classification.

It is apparent that different authors have found great difficulty in assigning various reserves, mineral districts or potential mineral districts to these categories, and we have met the same problem. The area of this study, 19.2 million acres, is large in terms of what can be accomplished by a single group in one or two field seasons. The concepts of classifying resources are based on the larger scene and our attempts to classify the resources of the study met with problems of definition when we considered specific mineral occurrences or specific environments within which we found mineralization.

We have, therefore, used the U.S.G.S. classification (shown below) as a basic framework, but have introduced several additional criteria.



The U.S.G.S. has defined <u>reserves</u> as known, identified deposits of mineral-bearing rock from which the mineral or minerals can be extracted profitably with existing technology and under present economic conditions; whereas <u>resources</u> include, not only reserves, but also other mineral deposits that may eventually become available - either known deposits that are not economically or technologically recoverable at present, or unknown deposits, rich or lean, that may be inferred to exist but have not yet been discovered.

Resources are then divided into three basic cagetories.

1. Identified resources are specific bodies of mineral bearing rock whose existence and location are known. They may or may not be evaluated as to extent and grade. Identified resources include reserves.

2. Hypothetical resources are defined as undiscovered resources that we may still reasonably expect to find in known districts.

3. Speculative resources are defined as undiscovered resources that may exist elsewhere - either conventional types of deposits in broad geologic terrains or unconventional types of resources that have only recently been recognized (or are yet to be recognized) as having some potential.

We are unable to regard any of the mineral occurrences examined during this study as having "reserves", although the

Red Dog prospect meets most of the criteria. Using the industry subdivision of the reserves into measured, indicated and inferred reserves, we could classify Red Dog in the inferred category.

The mineral prospects examined during this study are shown in Figure 3. We have categorized each of these occurrences in order to show the potential resources identified as a result of this study.

The following criteria, referred to earlier, are used to further define the U.S.G.S. categories:

Identified Resources are those which have, as a result of our examination, shown the following:

1. Current or historical production such as placer gold.

2. Assays of potentially ore grade material given the right combination of tons with a geological structure and/or host rock unit of sufficient potential size to contain a mineral deposit which would attract further exploration by industry.

3. Actual rock assays which would normally be considered "ore-grade" or either outcrop or suboutcrop associated with a geochemically anomalous area and/or structure. Sub-outcrop is used in the sense that near surface rock is indicated by frost heave fragments or detritus at surface.

Hypothetical Resources are undiscovered resources which may occur in rock units within the study area and are host to "identified resources" whether within or outside the study area. Known "identified resources" to which we will refer are the Ambler River district, the Red Dog prospect, the Omar and Frost prospects, and the Chandalar Copper District, even though these are not all "ore bodies" or "mines" which might result in defining "known district".

Speculative Resources are potential mineral resources which may occur within rock units examined by WGM and from which low grade assays were obtained from one or more small geological features, but which are still of sufficient interest to warrant further exploration of these geological environments. Some geological environments examined are similar in type or age to areas elsewhere in Alaska that are being explored for specific mineral commodities. Areas containing such environments are classified under speculative resources.

We have not included all mineral occurrences examined by us in the tabulation of resources, as some are too small to be of significance.

It must be emphasized that this appraisal of the resources of the study area is based only on those showings and/or environments actually examined, and can therefore be considered a minimum inventory. The positive results obtained from this modest program is surprising. Certainly, the Red Dog prospect and the geological environment in which it occurs, while noted by the U.S.G.S., had not been previously recognized as an outstanding base metal prospect. A review of exploration activity in the Red Dog area, subsequent to the U.S.B.M. news release, serves as an indication of the importance of this environment.

The discovery of the hitherto unknown Kav copper prospect further illustrates the lack of general and detailed knowledge of the entire area.

These, and other prospects, coupled with the presence of geological environments which, on nearby open lands, are being explored in detail at a cost of millions of dollars, in a region barely scratched by government agencies or industry, illustrates that our investigations and inventory can be described at best as preliminary.

Undoubtedly there will be readers who will find it difficult to accept that mineral deposits of the type found, to date, can be economically developed in this area. Such readers are referred to Section 9.2 on economic evaluation.

9.2 ECONOMIC EVALUATION

The definition of reserves incudes the provision that the reserve can be mined at a profit.

Insufficient work has been carried out on any of the mineral occurrences examined during this study to indicate economic viability. Further, there are no examples of mining operations in Alaska which can be cited to illustrate the criteria needed to establish a viable mining operation in the study area.

Fortunately, several examples of successful mines in Northern Canada and in Greenland establish criteria which show the importance of identified resources such as the Red Dog and Omar prospects. These cases also provide an understanding of economic mineral potential at the identified and hypothetical resources described herein.

Descriptions of successful mining operations in remote northern locations clearly illustrate a number of very important points:

1. A great deal of time, money, technology, and positive thinking is often required before a mineral deposit is found and developed (Pine Point).

2. Once a favorable geological environment has been defined, millions of dollars frequently are spent before a commercial deposit is developed into a mine (Pint Point, Nanisivik).

3. The first mine to achieve commercial operations in a district is often the second or third deposit to be discovered (the Anvil District).

4. After the first mine is in production, tens of millions of additional exploration dollars frequently are spent within a limited area and frequently this effort meets with success (Anvil District).

5. Both large and small operations can be profitably developed in remote locations.

With the foregoing in mind, it is concluded that the indicated grade and dimension of several of the mineral prospects examined (the identified resources) have mine-making

TABLE 9.1

MINERAL RESOURCES

EXAMINATON AREA	LOCATION	IDENTIFIED RESOURCES	HYPOTHETICAL RESOURCES	SPECULATIVE RESOURCES
8.1 Red Dog	T31N, R18W DeLong Mountains Quadrangle	LEAD-ZINC-SILVER-BARITE Mineralization is found over an area of 9,000 by 3,500'. Five types of mineralization have been identified: Chert + sulfides 7.6% combined lead-zinc; Massive sulfides 21.0% " " "; Siliceous rock 6.7% " " "; Breccia zone 29.0% " " "; Barite + sulfides 3.5% " " " + 83% barite. Drilling likely will lead to reclassifying the Red Dog into "Reserves"	LEAD-ZINC-SILVER-BARITE Geochemistry defines an area of 3.5 square miles (including the 9,000 by 3,500' area) which is anomalous in lead, zinc, silver and barium. This 3.5 square mile area is underlain by rock units which are the same as the mineralized 9,000 by 3,500' area. Therefore, this entire 3.5 square mile area is placed in the hypothetical category.	COPPER Known deposits which show similarities to the Red Dog commonly show vertical zonation within the ore body. Copper sulfides are normally stratigraphically lowest in these deposits. For this reason and the presence of weakly anomalous copper values at Red Dog, as yet undiscovered, copper sulfides are in the speculative category.
8.2 Delong Color Anomalies	D-1 Lands west and northwest Red Dog	NONE	LEAD-ZINC-SILVER-BARITE These color anomalies and associated geochemical anomalies are within the same rock units as the Red Dog prospect. Entire area included in the hypothetical category for Pb, Zn, Ba, Ag.	
8.3 Avan River	Tps. 31-34W Rs 13-16W DeLong Mountains Misheguk Mountain Quadrangles	NONE	NONE	CHROMITE No chromite of economic size or grade combination has been found, but chromite mineralization is widespread in parts of the ultramafic pluton examined. The entire 300 square mile pluton is assigned to the speculative resource category for chromite. Minor interest remains in nickel platinum and asbestos, but insufficient data exists to nominate these as even speculative resources.
8.4 Misheguk Mountain	T33N Rs 10,11W Misheguk Mountain Quadrangle	NONE	NONE	CHROMITE Same as 8.3 Avan River
8.5 Maiyumerak Mountains	Tps 27, 28N, Rs 14,15 16W Baird Mountains Quadrangle Noatak Quadrangle	NONE	NONE	COPPER-ZINC By definition, all ultramafic plutons in the DeLong Mountains could be classified as speculat[ive] resources. In the one area examined no significant minerali[za]zation, was found. One geochemic sample showed a significant zinc value and only marginal values were obtained for copper.
8.6 Omar Copper Prospect	T24, R10W Baird Mountains Quadrangle	COPPER Mineralization found intermittently over a length of 9,000' and widths of 30' or more. Grades of selected mineralized rubble samples assay up to 15% copper with several over 2%. Results from drilling conducted by a previous owner would greatly assist in evaluating this prospect.	COPPER-LEAD-ZINC-BARITE Apparently, only one regional prospecting and geochemical survey of this 500 square mile area has been made. As a result, the Omar and Frost prospect were located. It is believed that not all exposed mineralization has been discovered. Geochemical dispersion is very limited in carbonate terranes. Therefore, nominate this 500 square mile area of Devonian carbonate rocks as host to hypothetical resources. Lack of regional geological mapping prevents narrowly defining the host rocks. Nomination as hypothetical resources is reinforced by presence of other identified resources (Ruby Creek) in rocks of similar age elsewhere in the Brooks Range.	COPPER-LEAD-BARITE-ZINC See Hypothetical

EXAMINATION AREA	LOCATION	IDENTIFIED RESOURCES	HYPOTHETICAL RESOURCES	SPECULATIVE RESOURCES
8.7 Frost Prospect	T24N, R9W Sections 15,16 22 Baird Mountains Quadrangle	**BARITE** Mineralization has been found in discontinuous lenses and pods over a 5,000' strike length. Individual lenses up to 75' in length by 30' in width have been found at surface. Samples analyzed run rup to approximately 75% barite. **ZINC-COPPER** Two quartz-calcite-barite veins which contain zinc and copper; these are not large nor well exposed. The larger vein has an indicated width of 8' and a sample from it assayed 13.2% zinc, 0.49% copper and 20.7% barite. Metal resources identified are small but are encouraging.	At Frost, geochemical samples anomalous in zinc or copper were obtained from locations not associated with the showings or prospects. These suggest hypothetical resources could be present locally as well as reginnally.	
8.8 Klery Creek	T21N, R8W Baird Mountains Quadrangle	**GOLD** Because small quantities of gold have been produced at Klery Creek nearly every year between 1909 and 1973, it is necessary to include this by definition under identified resources. It was beyond the scope to evaluate the reserves of this and other alluvial deposits in the area. While reported production is small, the extent of the deposits was large enough to support a dredging operation at one time.	**GOLD** See Identified Resources	**COPPER-ZINC-GOLD** 1. Some of the rocks found in the Klery Creek area similar in appeerance and stratigraphic position to the schists in which the Arctic, Dead Creek, Sunshine Creek and Picnic Creek copper-zinc deposits are found. If this is subsequently confirmed then this unit would be designated as a host to hypothetical resources under our application of the term. 2. Since some of the gold in the area is coarse and commonly attached to country rock, we are tempted to nominate a speculative resource under lode gold, but have not done so. 3. Weakly(?) anomalous results for tungsten were obtained in several samples and while it could be argued these warrant inclusion under speculative resources it is not felt that results are significant enough with no clearly defined environment.
8.9 Temby Copper Prospect	T25N, R4W Baird Mountains Quadrangles	NONE OF SIGNIFICANCE	NONE	COPPER-URANIUM (?) 1. Minor amounts of copper were found in small quartz veins. 2. The presence of Paleozoic clastic sediments which are under study for uranium elsewhere could be construed as a speculative resource for uranium.
8.10 Hub Copper Prospects	T27N, R4W Baird Mountains Quadrangle	NONE	COPPER-LEAD-ZINC-BARITE See Hypothetical Resources for 8.6 Omar and 8.7 Frost. This property is located in the same 500 square mile area underlain by carbonate.	COPPER-LEAD-ZINC-BARITE Same as 8.6 Omar and 8.7 Frost
8.11 Chevron Copper Prospect	T29N, R5W Baird Mountains Quadrangle	NONE OF SIGNIFICANCE	NONE	URANIUM (?) Same as 8.9 Temby
8.12 Salmon River	Tps 26, 27N Rs 5, 6W Baird Mountains Quadrangle	NONE OF SIGNIFICANCE	NONE	URANIUM (?) Same as 8.9 Temby
13 Agashashok River	T26N, Rs 11, 12W Baird Mountains Quadrangles	NONE OF SIGNIFICANCE	COPPER-LEAD-ZINC-BARITE See 8.6, 8.7, 8.10 This prospect is located in the same geological unit.	See Hypothetical Resources

EXAMINATION AREA	LOCATION	IDENTIFIED RESOURCES	HYPOTHETICAL RESOURCES	SPECULATIVE RESOUR
8.22 Tupik Creek Area	Survey Pass Quadrangle	NONE	NONE	COPPER-ZINC-MOLYBDENUM Minor amounts of copper, zinc a molybdenum were found locally the contact zone between a gra and metasedimentary rocks and the granite. The contact zone should be examined further for local occurrences of mineraliza-tion.
8.23 Mt. Papiok Area	T25N, R17E Survey Pass Quadrangle	NONE	NONE	NONE While anomalous values in lead, zinc, and molybdenum wer obtain from analysis of stream silt a soil samples, they apparently characteristic of only metal buildup in the sedimentary roc found locally. Although not examined, the contact zone betw the sediments and an intrusive granitic body should be examin for tactite development known host elsewhere in northern Ala to copper and tungsten.
8.24 Walker Lake Area	Survey Pass Quadrangle	NONE	COPPER-ZINC-LEAD Rocks examined and mapped by WGM and the Government are the west-ward extension of rock units known to be host to several potentially economic deposits of copper, zinc, lead and silver. The deposits and the environments, where available to industry, are being subjected to exploration programs costing millions of dollars per annum. WGM work and Governmental geo-chemical surveys have not only confirmed the presence of the favorable units but have shown that locally, at least, the rocks contain anomalous values in copper, zinc and lead.	COPPER-ZINC-LEAD See Hypothetical Resources
8.25 Arrigetch Peaks	Survey Pass B-3 Quadrangle	NONE	NONE	COPPER-ZINC-TUNGSTEN Minor amounts of copper, zinc an tungsten mineralization were fou locally along the contact zone between a granite and Devonian Skajit Limestone (See 8.21 Speculative) in a magnetite-pyroxene zone.
8.26 Nahtuk Mountains Area	T24N, R26E Survey Pass Quadrangel	NONE	NONE	BASE METALS(?) No positive results were obtai from samples taken at the exam tion site. The presence of Sk Limestone(?(), which is host to base metal deposits currently under investigation elsewhere, suggests a permissive environme If confirmed as the same unit, limestone in the area could be nominated as a host for hypothet cal resources.

EXAMINATION AREA	LOCATION	IDENTIFIED RESOURCES	HYPOTHETICAL RESOURCES	SPECULATIVE RESOURCES
8.14 Kaluich Area	T25N, R3E Ambler River Quadrangle	NONE	NONE	LEAD-ZINC-TUNGSTEN(?), URANIUM(?) Geochemical sampling at the margins of the granitic pluton outlined an area of 4.9 square miles weakly anomalous in lead and zinc with weak tungsten anomalies elsewhere around the contact. Outcrop samples offered little or no encouragement. The granitic pluton is however mineralized and a dubious possibility exist for uranium in the granite and contact metamorphic deposits of tungsten at its margins.
8.15 Kav Copper Prospect	T28N, R9E Ambler River Quadrangle	NONE While high grade (18-33%) copper samples were taken and 4 previously unreported occurrences of copper with silver and minor antimony were found, insufficient data regarding geology, structural control and dimension are available. More work in the area of the mineralization and regional work is warranted - see speculative resources	NONE Had sufficient data been obtained to nominate the Kav prospect an an identified resource, the dolomite host and/or structural control would have been included as a host for hypothetical resources - copper.	COPPER Similarities (dolomite, breccia and quartz veining) between the Kav prospect and the Ruby Creek and Partner Hill copper deposits, allow inclusion of this prospect and nearby similar geologic environments into the speculative category for copper
8.16 Douglas Ningyoyak and Midas Creeks	Tps 28, 29N Rs 10,11,12E Ambler River Quadrangle	NONE While placer claims have been recorded and apparently some gold won, insufficient data is available to include as an identified resource.	GOLD A small but unknown amount of placer gold is likely present.	GOLD Fine placer gold has been reported in the area. At one time placer claims were recorded. Although very low grade copper was found in quartz-carbonate stringers, the dimension of these and the host rock are not considered indicative of significant potential.
8.17 Shishak-shinovik Pass	T24N, R11E Ambler River Quadrangle	NONE	NONE	BASE METALS A contact zone between an intrusive granite and surrounding meta-sedimentary rocks and/or the granite itself is geochemically anomalous in molybdenum, lead, zinc, silver and copper. Only limited interest in the potential is held. Any such mineralized granite could be of interest for uranium.
8.18 Kutarluk Creek Area	Tps 23,24N Rs 12,13E Ambler River Quadrangle	NONE	NONE	NONE While anomalous values in base metal were obtained, the geological environment does not appear favorable.
8.19 Nigikpalv-guruvak Creek	T27N, R13E Survey Pass Quadrangle	PLACER GOLD This is a very small (1-man) seasonal placer gold operation and, by definition it must be included as an identified resource. Brief inspection suggests that it is a small resource. This is believed to be the only current mining operation in the study area.	GOLD A small but unknown amount of placer gold reserves likely are present in various drainages in the area.	GOLD Source of the placer gold in the area is not known. This could be a speculative resource. No evidence for other speculative resources at the site examined, or in those rocks found at the site.
8.20 Igning River Area	Survey Pass Quadrangle	NONE	NONE	BASE METALS(?) High geochemical values for copper, zinc, silver, molybdenum, gold and lead were obtained from a "black shale" environment. Concentrations of significant mineralization may be present elsewhere in this environment. Detailed mapping and additional sampling required to confirm this.
8.21 Iyahuna Creek	Tps 24,25N R16E Survey Pass Quadrangle	NONE	NONE	BASE METALS(?) While moderately anomalous results were obtained from geochemical analyses of stream silt, soil and rock samples, they are not believed to reflect significant concentrations of metals owing to lack of favorability of the host environment. The Skajit Limestone noted here and at other sites examined in the area, is a very broad term, which, where better mapping available includes shales, etc. and is known host to attractive base metal (lead-zinc) prospects outside the study area. Were better geological data and information concenring these prospects available, a portion at least of this examination area and the Skajit Limestone elsewhere could possibly be under hypothetical resources.

EXAMINATION AREA	LOCATION	IDENTIFIED RESOURCES	HYPOTHETICAL RESOURCES	SPECULATIVE RESOURCES
8.27 Sheep Creek (VABM Allen)	T32N, R20W Wiseman Quadrangle	NONE	NONE	COPPER(?) Minor amount of copper wer[illegible] in association with a chlor[illegible] quartz schist and Devonian Skajit(?) Limestone. The low geochemical results and lack of good geological control prevente[illegible] determining if these schist rock[illegible] are the host to base metal deposi[illegible] or whether the Skajit Limestone i[illegible] the same unit as that being aggressively explored elsewhere.
8.28 Tobin Mountain	T33N, R18W Wiseman Quadrangle	NONE	NONE	NONE While moderately anomalous result[illegible] in zinc were obtained from stream silt samples, it is believed the[illegible] reflect only a local concentrati[illegible] or buildup of metals in graphiti[illegible] schists and phyllites.

potential. If the prospects were situated on open land, they would receive intensive exploration by industry.

In addition, it seems obvious that the hypothetical resources (extensive geological formations known to exist within the study areas which are host to the Red Dog, the Omar and the Ambler River deposits) would also receive intensive exploration by industry if entry to the lands were permitted.

9.3 MINING OPERATIONS IN NORTHERN CANADA AND GREENLAND

Asbestos Hills Mine - Asbestos Corporation Limited (McOuat, J.F., pers. comm.)

This asbestos mine is some 40 to 50 miles south of Hudson Strait in the Ungava region of the Province of Quebec, Canada.

The mine is 150 to 200 miles north of treeline and is underlain by permafrost to a depth of several hundred feet. The small village of Sugluk is the nearest point of permanent habitation 50 miles northwest of the mine.

Resupply by sea is generally from Montreal, 1,130 miles south, although ports in northern Europe or on the Atlantic seaboard are equally suitable.

Ocean navigation is restricted to approximately 100 days a year because of ice conditions and related marine insurance restrictions. This circumstance has a major impact upon inventories of supplies and products, marketing of products and working capital requirements.

The deposit was discovered in 1958 by Murray Mining Corporation, purchased by Asbestos Corporation in 1964, and brought into production in 1972. Several million dollars were spent on exploration, engineering and feasibility prior to a decision to place the property into production.

The cost of production facilities and all infrastructure was on the order of $C 80 million. An additional $20 million was spent for a finishing mill in Germany and $14 million was paid for the property. One unusual feature is that operations are conducted for only 8 to 9 months per year using "single" status personnel but little or no Eskimo labor. No government financial support was involved.

Infrastructure required included:

- a deep water terminal capable of berthing and loading 30,000-ton+ ore carriers, oil storage and warehousing, a power plant, and storage for 300,000 tons of asbestos concentrates.

- a 50-mile road south to the property capable of handling large tractor-trailers to haul ore concentrates outbound, and fuel and other supplies inbound.

- a townsite at the property for single-status personnel, a power plant, machine shops, warehouses, etc.

These facilities support an open pit mine producing 1,000,000 to 1,500,000 tons of ore and several times that amount of waste annually, and a treatment mill designed to produce a 40% fiber concentrate which is then shipped to the German plant for finishing to a marketable product.

Ore reserves of 19,000,000 tons were outlined prior to development, part available by open pit, the balance to be mined using underground methods.

The deposit is generally accepted as containing 10% Group 4 asbestos fiber. In 1964, at the time of acquisition, the ore value was $20 per ton; in 1972, at the commencement of production this had increased to approximately $25 per ton, and in 1975 would be roughly $40 per ton.

Nanisivik Mines Ltd.,

In the fall of 1976, production commenced from this lead-zinc mine located on Baffin Island some 475 miles north of the Arctic Circle, at latitude 73°N and longitude 84°25'W. From mid-November to mid-February the sun does not rise above the horizon.

The area is extremely remote and, as is the case with Asbestos Hill, resupply originates from the eastern seaboard and St. Lawrence River or western Europe. Montreal is 1,950 air miles south of the property.

The navigation season averages 60 days, with possible extensions if ice breakers or reinforced bulk carriers are utilized. Outbound concentrates (125,000 to 150,000 tons annually) and inbound operating supplies must be moved during this restricted season.

The Bernier Expedition first reported lead-zinc mineralization in the area in 1910-11. In 1937, claims were staked over at least a portion of the deposit, but were allowed to lapse.

In 1957, the first serious investigation of the property was undertaken by Texas Gulf Sulphur Co. (now Texasgulf Inc.)

following up a 1954 report by the Geological Survey of Canada. Between 1958 and 1972, Texasgulf investigated the deposit and surrounding area in detail, and completed nearly 90,000 feet of diamond drilling, 1,000 line-miles of air-borne geophysical surveys and an adit to obtain bulk samples from the ore zone for process testing.

In 1972, Texasgulf optioned the property to Mineral Resources International Limited, a junior Canadian company. MRI completed a further 10,000 feet of diamond drilling, obtained additional bulk samples and commissioned a detailed feasibility study.

In all, over the 15-year period, $4,000,000 was spent on exploration and engineering investigations.

The project was financed by Metallgesellschaft AG, Billiton B.V., Texasgulf Inc., Canadian, American and German Banks, and the Government of Canada.

The Canadian Government, through a variety of programs, provided financial assistance with a value of $17 million for which it earned an 18% equity interest in Nanisivik Mines Ltd., the operating company. This is believed to be the first-ever acquisition by the Canadian Government in return for providing financial assistance.

The total cost of the project is reported as $67,000,000.

Published proven and probable ore reserves are 6,970,000 tons averaging 14.1% zinc, 1.4% lead and 1.8 oz of silver which are sufficient to maintain the operating for a minimum life of 13 years.

Mining is underground, being developed initially from adits. The entire area is underlain by permafrost to a depth in excess of 1,000 feet with rock temperatures on the order of 11°F.

The process facilities are designed to treat 1,500 tons per day.

Infrastructure includes a deep-water marine terminal capable of handling ships up to 40,000 tons, an airport, roads, and townsite. In addition, concentrate storage facilities for one year's production were required, as well as a power plant, fuel storage for one year's consumption and major warehousing, repair and garage facilities, etc. While this mine has just commenced operation and no earnings or profit history is available, it is a reasonable assumption that with a 13-year life, the financiers would not have proceeded had they not been able to forecast a return of capital in 3 to 4 years and an overall return on the investment of 15% or more.

Black Angel Mine - Vestgron Mines Limited

This lead-zinc-silver deposit is located at Marmorilik on the west coast of Greenland at latitude 70°N, longitude 52°W. The mine is well north of the Arctic Circle in barren lands and in permafrost. Godthaab, the capital city of Greenland, is 650 miles south of the mine, while resupply is from Europe and North America.

While the deposit is located on the ocean, it outcrops in the face of a cliff about 1,500 feet above sea level. The cliff drops into the sea so abruptly that it was necessary to locate the town and mill on the opposite side of Marmorilik Fjord. Access to the mine is by an aerial tramway across the fjord and up to the mine entrance in the face of the cliff. Only primary crushing is carried out in the mine.

The "ice free" shipping season in this area is from early July to the middle or end of November. In 1975, this season was extended from early June to mid-December by the opening of a channel through the ice by use of an ice-strengthened tug and ice-strengthened bulk carriers.

The property, while known for a long time, received intensive exploration and investigation beginning only in 1965.

Commercial production from the Black Angel Mine started in October 1973.

Capital costs were approximately $44,000,000, exclusive of working capital.

The operation required town, power, water, shops, warehouses, major concentrate storage (120,000 tons) and ship-loading facilities, a marine terminal, and communications facilities. One interesting aspect of the Marmorilik operation is that there is no year-round supply of fresh water, consequently the company produces fresh water by desalination of sea-water and the concentrator utilizes sea-water in its flotation process.

This small mine employs 250 people and, in contrast with recent Canadian experience at remote mines, the labor force is reported to be remarkably stable. The company attributes this favorable experience to the fact that until very recently persons working in Greenland were exempt from Danish income tax for a minimum of two years. We understand that taxes are now payable, but at a fraction of the taxes paid in Denmark. Such was the success experienced in the recruitment and training of Greenlanders and Danes that the company was able to report in 1975 that all Canadian specialists on loan were withdrawn.

At the start of production, ore reserves were 4,440,000 metric tons averaging 14.9% zinc, 5.0% lead and 1.0 oz silver per ton. Since then, the Cover Zone, along the strike of the mineralized zone has been explored and as of 1976 additional reserves of 2,035,000 tons of ore had been outlined. New discoveries up to 20 miles away have also been reported.

Net earnings in the first two years of operation were over $26,000,000. Depreciation and depletion allowances of over $8,000,000 added materially to cash flow in this same period.

Mining is by underground methods utilizing both trackless mining and scraper techniques.

Production is 600,000 tons of ore per year. The mill treats about 2,000 tons per day and produces some 180,000 to 200,000 tons per year of concentrates.

Pine Point Mines Limited

This extremely successful 10,000 tons per day lead-zinc operation is located near the south shore of Great Slave Lake in the Northwest Territories of Canada, at latitude

61°N, longitude 114°W. The area is remote, being 510 air miles north of Edmonton, Alberta and 1,400 miles north of the smelter at Trail, British Columbia. It therefore faces high inland transportation costs for supplies and shipping concentrates.

Mining claims were first staked in 1898, but it was not until 67 years later that production was finally achieved.

No one knows when the Indians first found the mineral showings at Pine Point and, with the help of early fur traders, smelted galena into lead shot. The first mining claims were recorded in 1898, but were allowed to lapse because only minute amounts of gold and silver were found associated with the lead and zinc.

Between 1899 and 1930 sporadic claim staking, inspection by members of the Geological Survey of Canada, and exploration (test pitting, churn drilling, shaft sinking and diamond drilling) were conducted by various parties or companies including Cominco, the current controlling interest in Pine Point Mines.

Reports indicate that up to 1930, in excess of $300,000 (1930 dollars) had been spent. While some geologists had developed the idea of a general similarity between Pine Point and the Tri-State Mississippi Valley-type deposits, exploration efforts had only outlined about 500,000 tons averaging about 15% lead plus zinc. Widespread exploration, directed chiefly towards finding "sink-holes" since there are few outcrops, failed to find additional indications of ore.

No exploration beyond necessary claim assessment work was undertaken between 1930 and 1948.

At about this time Cominco geologists developed a new hypothesis as to the form the ore controls and development, and acquired a 500-square mile concession surrounding the known "ore" area.

By 1950, sufficient work had been done to confirm the theory and demonstrate the mine-making possibilities, and Pine Point Mines Limited was formed to acquire the 1,000 claims staked in the concession as well as the original claims in the area. A favorable belt some 22 miles long by two to four miles wide was included.

By the end of 1955, almost 180,000 feet of drilling plus limited underground work had developed 5 million tons of ore grading 4% lead and 7% zinc, with additional promising ore intersections to pursue. Work again came to a halt in 1955 since there was no prospect of adequate transportation facilities.

However, by late 1961, following the development of new reserves and hearings by two Royal Commissions, an agreement was reached between Pine Point Mines Limited (78% owned by Cominco), Cominco, the Federal Government, and the Canadian National Railway to build the Great Slave Lake Railway from northern Alberta to Hay River, N.W.T. with a branch line to Pine Point. In addition, the Federal Government, through the Northern Canada Power Commission, agreed to develop a 25,000 hp hydro power development and to assist with town-site services.

Development of this mine took time, 67 years from first staking to production, and several periods of high risk investment. The final key was a government policy which, in order to open up an undeveloped portion of Canada, initiated railroad construction when the established tonnage and grade could not alone justify construction, be it by private or public owners.

Major exploration programs by Pine Point Mines and others are continuing in the area at a cost of millions of dollars. For example, a joint venture between Western Mines and Dupont of Canada Exploration has spent $1,000,000 and plans a further $1,500,000 on expenditure on its Great Slave Reef Project. To date 2,800,000 tons have been indicated grading 4.1% lead and 11.9% zinc in the X25 deposit and other anomalies or occurrences are to be tested. Pine Point Mines continues to hold over 4,000 claims, most of which have yet to be explored in detail.

Capital costs for the project during the period 1960 to 1965 were:

Power plant and transmission line	$ 9,000,000
Mine and mill	22,000,000
Smelter facilities at Trail, B.C.	10,000,000
Great Slave Lake Railway	86,000,000

The power supply agreement with Northern Canada Power Commission called for Pine Point Mines to amortize the capital costs of most of the power on an annual basis. To date these charges have totalled $7,000,000.

The original railroad agreements called for Cominco to place the property into production at a rate which would ensure the shipment of at least 215,000 tons of concentrates per year for a period of at least 10 years. Pine Point Mines agreed during this period to pay normal freight rates plus a surcharge per ton of concentrates which would vary with the price of metals, but which could amount to $20,000,000 over the ten-year period. Since 1965 these surcharges have amounted to $15,000,000 in addition to $44,000,000 in freight revenues.

In the ten-year period 1965 to 1975, Pine Point Mines has paid $75,000,000 to all levels of government for royalties, municipal taxes, federal income tax, (even after enjoying a 3-year tax free period and for at least several years a 1/3 depletion allowance).

Pine Point Mines Limited has achieved an outstanding earnings record, as follows:

1964	$ 500,000
1965	27,000,000
1966	37,000,000
1967	37,000,000
1968	24,000,000
1969	24,000,000
1970	27,000,000
1971	16,000,000

1972	13,000,000
1973	27,000,000
1974	44,000,000
1975	23,000,000

At the time of the decision to commit the property into production, ore reserves were some 17,000,000 tons of 12% combined lead-zinc. As of December 31, 1975, ore reserves were 39,000,000 tons of 7.4% combined lead-zinc and the daily rate of mining and milling has risen from 5,000 tons per day to 10,000 tons per day.

As of December 1, 1975, the company reported it had found a new ore body which contained some 600,000 tons averaging 17% lead-zinc, and bought another deposit containing 1,414,600 tons averaging 11.5% lead-zinc.

Current reserves, while large, are not high grade and it is remarkable how relatively low grade ore can be successfully mined in a remote location.

Anvil Mine - Cyprus Anvil Mining Corporation

This mine is located in a very remote area, 125 air miles or 230 road miles northeast of Whitehorse in the Yukon Territory of Canada. The climate is like that of the Alaskan interior with warm summers and long cold winters. Supplies are delivered over 230 miles of road from Whitehorse. Up to 500,000 tons of lead and zinc concentrates are hauled by truck to Whitehorse and then 110 miles by the White Pass and Yukon Railway to Skagway. The concentrates are then shipped in bulk ore carriers, principally to Japan and West Germany.

Massive sulfide occurrences of pyrite, pyrrhotite and associated lead, zinc and copper (the Vangorda deposit) were first found by conventional prospecting methods in 1953. Over the next two years, Prospectors Airways, a highly experienced Canadian exploration company, outlined 9.4 million tons of 3.16% lead, 4.96% zinc, 0.27% copper, 1.76 oz. of silver and 0.02 oz. of gold per ton. Other smaller deposits and indications were also located. However, work was stopped because of low metal prices and the remoteness of the area.

In 1961 and 1962, Kerr Addison Mines, resumed prospecting in the area and based upon the results of an airborne magnetic survey, staked some 80 claims.

Other groups moved into the area and began staking claims and prospecting in 1963 and 1964.

In spring of 1964, Dynasty Explorations staked a number of properties and carried out an aggressive exploration program on a regional rather than on a restricted property basis, pursuing the host geological environment rather than restricting its activities to the area of the known prospects or mineralization.

By September 1964, following an aerial magnetometer survey over most of the favorable schist belt, Dynasty has staked some 800 claims and had drilled mineralized outcrops and associated geochemical, magnetic and gravity anomalies - with no success.

Early in 1965, Dynasty formed a joint venture with Cyprus Mining Corporation and began a major regional program including airborne electromagnetic and magnetic surveys, ground magnetic, gravity, electromagnetic surveys and widespread geological and geochemical reconnaissance. This work resulted in the discovery of gossanous zones, geochemical anomalies and other targets. These were staked to bring the total landholding to 2,500 claims.

In June of 1965, five geophysical targets were drilled and massive sulfides were discovered in the Faro No. 2 deposit.

Some $450,000 had been spent by Dynasty and the Dynasty-Cyprus joint venture to this point.

These discoveries triggered a massive staking and exploration boom by a number of large and small companies, and the area received saturation exploration.

By 1967, a production decision was made by Cyprus-Dynasty. Engineering design was begun, a sales contract was negotiated, a transportation agreement for concentrates was negotiated with the White Pass and Yukon Railway, and a $42 million loan from four banks was arranged. Proven ore reserves of about 63,000,000 tons averaging 3.4% lead, 5.7% zinc and 1.2 oz/ton silver had been developed in three closely related deposits - Faro No. 1, 2, and 3 - with the possibility of adding to reserves through additional drilling.

By September 1969, the concentrator started up and 5.5 million cubic yards of stripping had been completed. A power line was completed from Whitehorse; the new town of Faro for 300 employees and their dependents had been built; and transportation and storage improvements were completed at Skagway and elsewhere, including a major road construction program. In all, $100,000,000 was spent on the Anvil project. Some $64,000,000 of the financing was provided by the mining company, the balance by government, and transportation companies.

Since production start-up, through-put has been progressively increased from 5,500 tons per day to 6,600 to 8,000 and is currently 10,000 tons per day.

In the six full years of operation, earnings have totalled over $82,000,000, long-term debt has been reduced to slightly over $5,000,000, retained earnings have totalled in excess of $76,000,000, dividends have been paid, and the second largest community in the Yukon has been established (company annual reports).

In addition, mining royalties and income taxes of millions of dollars have been paid. A Yukon Mining Royalty payment for 1973 made in 1974 of $3,250,000 exceeded the total of all Yukon Mining Royalty payments collected by the Government since 1949.

The discovery of the Faro ore bodies resulted in the establishment of a major mine with 18 years of proven life, but this is not the end of the district. Since 1965, major exploration efforts have continued and additional success has been achieved both by Cyprus Anvil and other mining companies. These efforts have cost tens of millions of dollars and the following deposits have been outlined along a strike length of over 30 miles.

Grum deposit - over 30,000,000 tons of approximately 4% lead, 6.5% zinc, 1.8 oz/ton silver, discovered in 1974 by Canadian Natural Resources Ltd. and Kerr Addison Mines Ltd.

Vangorda deposit - 9,400,000 tons of 3.2% lead, 4.96% zinc, 1.76 oz/ton silver, 0.27% copper and 0.02 oz/ton gold. Discovered in 1953. Owned by Vangorda Mines Ltd. (69% Keer Addison). To 1956 over 56,000 feet of diamond drilling had been completed.

Swim deposit discovered in 1965 - 5,000,000 tons of 9.5% combined lead-zinc and 0.5 oz/ton silver - (Owned by Keer Addison Mines).

Dy prospect - as part of its long-term exploration program in the Anvil District, Cyprus Anvil embarked a major exploration program to test not only geochemical and geophysical targets, but also deep stratigraphic targets developed as a result of geological interpretation of regional geology and ore controls. In 1976 a deep drill hole intersected mineralization at a depth of 2,600 feet. The best section assayed 7.32% combined lead-zinc and 1.27 oz/ton silver. Although uneconomic, Cyprus Anvil has stated that the mineralization is typical of that seen on the edges of the Grum and Vangorda deposits. This discovery is some 12 miles southeast of the Faro ore bodies.

It is interesting to note that the first deposit found in the district has yet to be developed.

It is noteworthy also that in spite of nearly 25 years of exploration, costing tens of millions of dollars, millions are still being spent and new discoveries are still being made, and a stable employment base has been established in a region previously characterized by high unemployment.

<u>Clinton Mine - Cassiar Asbestos Corporation Ltd.</u>

This asbestos mine is located some 140 miles south of the Arctic Circle at latitude 64°28'N, 8 miles east of the Alaska-Yukon boundary and 50 miles northwest of Dawson.

It is remote and faces high costs.

The deposit was discovered by an Indian fur trapper in 1957 and was explored by Cassiar Asbestos Corporation through

1967. Production began in late 1967. Closure is scheduled for mid-1978 due to a reduction of economic reserves.

The area is underlain by permafrost and ground temperatures of 28 to 29°F are reported. A complete townsite was required for the 300 or so employees.

Crushed ore is transported from the mine to the mill via a one-mile tramway.

The operation is supported by truck transport from Whitehorse. Asbestos products are shipped through Dawson to Whitehorse by truck (some 400 miles), then via the White Pass and Yukon Railway to Skagway and then by ship to Vancouver. Sales are made from a warehouse in Vancouver.

The Canadian Federal Government assisted the development through contributions of approximately $2,800,000 for roads to the mine.

Specially designed trucks, equipped with large fuel tanks backhaul oil to the mine for power plant, heating and mine operation.

During summer the trucks are ferried across the Yukon River while in winter an ice bridge is constructed. An aerial tramway 1,460 feet long has been used during spring break-up and fall freeze-up.

At the commencement of operations, ore reserves were stated as 26,000,000 tons containing 8% chrysotile asbestos worth about $13 per ton of ore at the then prevailing prices.

The capital investment, including mine, processing plant, townsite, power plant and water supply, was reported as more than $26,000,000.

Initial mine production was at the rate of 3,300 tons per day and was increased in 1971 to 4,000 tons per day.

Since production commenced, annual sales of fiber increased from $8,000,000 in 1968 to over $23,000,000 in 1974.

LIST OF REFERENCES

Alaska Division of Geological and Geophysical Surveys, Annual Report, various years.

______________________________, Kardex Files, all quadrangles in project region.

______________________________, 1975. Aeromagnetic map, eastern two thirds of Baird Mountains quadrangle, Alaska: Alaska Div. Geol. Geophys. Surveys open-file map AOF-77, 3 p., 1 sheet scale 1:250,000.

Amstutz, G.C., Zimmerman, R.A., and Schot, E.H., 1971. The Devonian mineral belt of Western Germany (the mines of Meggen, Ramsbeck and Rammelsberg: Sedimentology of Parts of Central Europe Guidebook VIII. Int. Sediment. Congress 1971.

Anderson, Eskil, 1944. Brunton sketch map of region from Bear River, Trib. of Noatak to Kobuk River via Salmon River, Terr. of Alaska Dept. of Mines.

______________, 1945. Sketch map of part of the basin of the Eli River, a Left Limit Tributary of the Lower Noatak River Territory of Alaska, Dept. of Mines.

______________, 1947. Mineral occurrences other than gold deposits in northwestern Alaska: Alaska Dept. of Mines Pamph. 5-R, 48 p.

Barnes, D.F. and Tailleur, I.L., 1970. Preliminary Interpretation of Geophysical Data from the Lower Noatak River Basin, Alaska. U.S.G.S. open-file report no. 412, 24 p.

Barnes, F.F., 1967. Coal resources of the Cape Lisburne-Colville River region, Alaska: U.S. Geol. Survey Bull. 1242-E, 37 p.

Bastin, E.S., et al., 1939. Contributions to a knowledge of the lead and zinc deposits of the Mississippi Valley region: Geol. Soc. Amer. Spec. Paper 24, 156 p.

Beikman, H.M. and Lathram, E.H., 1976. Preliminary Geologic Map of Northern Alaska. Misc. Field Studies, Map MF 789, 2 sheets.

Bischoff, J.L. and Dickson, F.W., 1975. Seawater-basalt interaction at 200°C and 500 bars; implications for origin of seafloor heavy metal deposits and regulations of seawater geochemistry: Earth Planet. Sci. Letters, Vol. 25, pp. 385-397.

Bowsher, A.L., and Dutro, J.T. Jr., 1957. The Paleozoic section in the Shanin Lake area, central Brooks Range, Alaska: U.S. Geol. Survey Prof. Paper 303-A.

Boyle, R.W., 1963. Geology of the Barite, Gypsum, Manganese, and Lead-Zinc-Copper-Silver Deposits of the Walton-Cheverie Area, Nova Scotia; Geol. Surv., Canada, Paper 62-25.

Brathwaite, R.L.: The geology of the Rosebery ore deposits, Ph.D. Thesis, University of Tasmania, 1969.

Brobst, P.A. and Pratt, W.P., eds., 1973. United States mineral resources: U.S. Geol. Survey Prof. Paper 820, 722 p.

Brock, J.S., 1976. Selwyn-Mackenzie zinc-lead province, Yukon and Northwest Territories: Western Miner, March 1976, p. 9-16.

Brosgė, W.P., 1960. Metasedimentary rocks in the southcentral Brooks Range, Alaska, in Geological Survey Research 1960: U.S. Geol. Survey Prof. Paper 400-B, p. B351-B352.

Brosgė, W.P., Dutro, J.T. Jr., Mangus, M.D. and Reiser, H.N., 1962. Paleozoic Sequence in eastern Brooks Range, Alaska: Bull. Amer. Assoc. Petrol. Geol., Vol. 46, p. 2174-2198.

Brosgė, W.P. and Reiser, H.N., 1966. Draft Geologic Map, Baird Mountains Quadrangle, 1:200,000 scale.

______________________________, 1971. Preliminary Bedrock Geologic Map, Wiseman and Eastern Survey Pass Quadrangles, Alaska, U.S.G.S open-file report.

Brosgė, W.P., Reiser, H.N., Tailleur, I.L., 1967. Copper Analysis of Selected Samples, Southwest Brooks Range Alaska. U.S.G.S. open-file report 274, 1 sheet.

Brosgė, W.P. and Pessel, G.H., 1977. Preliminary Reconnaissance Geologic Map of Survey Pass Quadrangle: U.S. Geol. Sur. open-file map OF 77-27.

Cambell, R.H., 1967. Areal Geology in the vicinity of the Chariot Site, Lisburne Peninsula, northwestern Alaska: U.S. Geol. Survey Prof. Paper 395, 71 p.

Carne, R.C., 1976. Stratabound barite and lead-zinc-barite deposits in eastern Selwyn basin, Yukon Territory: Indian and Northern Affairs open-file report EGS 1976-16.

Chadwick, R.H.W., 1960. Copper deposits at the Ruby Creek area, Ambler River quadrangle, Alaska: Unpub. paper presented at Fifth Annual Alaskan A.I.M.E. conference, College, Alaska, Apr. 11-13, 10 p.

Churkin, M. Jr., 1973. Paleozoic and Precambrian rocks of Alaska and their role in its structural evolution: U.S. Geol. Survey Prof. Paper 740, 64 p.

Cobb, E.H., 1972. Metallic mineral resources map of the Ambler River quadrangle, Alaska: U.S. Geol. Survey Misc. Field Studies Map MF-454, 1 sheet, scale 1:250,000.

__________, 1972. Metallic mineral resources map of the Baird Mountains quadrangle, Alaska: U.S. Geol. Survey Misc. Field Studies Map MF-386, 1 sheet, scale 1:250,000.

__________, 1972. Metallic mineral resources map of the DeLong Mountains quadrangle, Alaska: U.S. Geol. Survey Misc. Field Studies Map MF-404, 1 sheet, scale 1:250,000.

__________, 1973. Placer deposits of Alaska: U.S. Geol. Survey Bull. 1374, 213 p.

Degenhart, C.E. and Bigelow, C.G., 1974. Preliminary minerals evaluation, NANA Regional Corporation selection lands, 1974: Unpub. report, WGM Inc., 84 p.

Detterman, R.L., 1970. Sedimentary history of the Sadlerochit and Shublik Formations in northeastern Alaska, in Adkinson, W.L., and Brosgé, W.P., (eds.), Proceedings of the Geological seminar on the North Slope of Alaska: Los Angeles, Pacific Sec., Am. Assoc. Petrol. Geol., P.01-013.

______________, 1973. Mesozoic Sequence in Arctic Alaska; in Pitcher, M.G., Arctic Geology: Amer. Assoc. Petroleum Geologists Memoir 19, p. 376-387.

Dewey, J.F. and Bird, J.M., 1970. Mountain Belts and The New Global tectonics, Journel of Geophysical Research, Vol. 75, No. 14 p. 2625-2647.

Dickinson, W.R., 1974. Plate Tectonics and Sedimentation, in Dickinson, W.R., (ed.), Tectonics and Sedimentation: Soc. Econ. Paleon. and Mineral., Spec. Pub. No. 22, pp. 1-27.

Flint, D.E., de Algear, J.F. and Guild, P.W., 1948. Geology and Chromite Deposits in Camaguay Province, Cuba: U.S. Geol. Survey Bull. 954-B, p. 39-63.

Forbes, R.B., Turner, D.L., Gilbert, W.G. and Carden, J.R., 1973. Ruby Ridge traverse, southwestern Brooks Range: Alaska Div. of Geol. and Geophys. Surveys, Annual Report, p. 34-36.

Fritts, C.E., 1969. Geology and geochemistry in the southeastern part of the Cosmos Hills, Shungnak D-2 quadrangle, Alaska: Alaska Div. of Mines & Geology, Geol. Report 37, 35 p.

____________, 1970. Geology and geochemistry of the Cosmos Hills, Ambler River and Shungnak quadrangles, Alaska: Alaska Div. of Mines & Geology, Geol. Report 39, 69 p.

Fritts, C.E., Eakins, G.R. and Garland, R.E., 1972. Geology and geochemistry near Walker Lake, southern Survey Pass quadrangle, Arctic Alaska, in Alaska Div. of Geol. Survey, Annual Report 1971: Anchorage, Alaska, p. 19-26.

Garland, R.E., Eakins, G.R., and Pessel, G.H., 1973. Preliminary maps of stream-sediment geochemical anomalies for southeastern Ambler River and part of Survey Pass quadrangles, Alaska: Alaska Div. Geol Geophys. Surveys open-file report 37, 2 sheets.

Garland, R.E., Eakins, G.R. and Trible, T.C., 1975. Geochemical analysis of stream-sediment samples from part of the Survey Pass A-2 quadrangle, Alaska: Alaska Div. Geol. Geophys. Surveys open-file report AOF-61, 2 p. plus index map and table.

______________________________________, 1975. Geochemical analysis of stream-sediment samples from part of the Survey Pass B-3 quadrangle, Alaska: Alaska Div. Geol. Geophys. Surveys open-file report AOF-72, 2 p. plus index map and table.

Garland, R.E., Eakins, G.R. and Trible, T.C., 1975. Geochemical analysis of rock and stream-sediment samples from part of the Survey Pass C-4 quadrangle, Alaska: Alaska Div. Geol. Geophys. Surveys open-file report AOF-63, 2 p. plus index map and table.

________________, 1975. Geochemical analysis of rock and stream-sediment samples from part of the Survey Pass C-5 quadrangle, Alaska: Alaska Div. Geol. Geophys. Surveys open-file report AOF-64, 2 p. plus index map and table.

________________, 1975. Geochemical analysis of stream-sediment sampples from part of the Survey Pass C-6 quadrangle, Alaska: Alaska Div. Geol. Geophys. Surveys open-file report AOF-65, 2 p. plus index map and table.

Garland, R.E., Eakins, G.R., Trible, T.C. and McClintock. W.W., 1975. Geochemical analysis of rock and stream-sediment samples from the Survey Pass A-3 quadrangle, Alaska: Alaska Div. Geol. Geophys. Surveys open-file report AOF-66, 2 p. plus index map and table.

________________, 1975. Geochemical analysis of rock and stream-sediment samples from the Survey Pass A-4, A-5, A-6, B-4, B-5, and B-6 quadrangles, Alaska: Alaska Div. Geol. Geophys. Surveys open-file report AOF-67, 2 p. plus index map and tables.

General Crude Oil Company, Company data and reports, various years.

Grybeck, D., Beikman, H.M., Brosgé, W.P., Tailleur, I.L. and Mull, C.G., 1977. Geologic map of the Brooks Range, Alaska: U.S. Geol. Survey open-file map 77-166B.

Hawkes, H.E. and Webb, J.S., 1962. Geochemistry in Mineral Exploration, Harper and Row, Publishers, Incorporated, 49 East 33rd Street, New York 16, N.Y.

Heiner, L.E. and Porter, Eve, 1972. A computer processable storage and retrieval program for Alaska mineral information; Mineral Industry Research Laborator No. 24, Vol. 2, 668 p.

Heiner, L.E. and Wolff, E.N., 1968. Mineral resources of Northern Alaska, Mineral Industry Research Laboratory, Report No. 16.

Jackson, S.A. and Beales, F.W., 1967. An aspect of sedimentary basin evolution: the concentration of Mississippi Valley-type ores during late stages of diagenesis: Canadian Petrol. Geol. Bull., Vol. 15, pp. 383-433.

Kanehira, K. and Tatsumi, T., 1970. Bedded cupriferous iron sulfide deposits in Japan, a review, in Tatsumi, T., (ed.), Volcanism and Ore Genesis, Univ. of Tokyo Press, Tokyo.

Krebs, W., 1976. Geology of European stratabound lead-zinc-copper deposits, Can. Soc. Pet. Geol. Seminar, Univ. Calgary.

Lin., W., 1969. A Model Study of the Crone Shootback EM Method, Univ. of Calif., College of Eng. Thesis.

Lowenstam, H.A., 1957. Niagran Reefs of the Great Lakes Area, in: Ladd, H.S. (ed.): Treatise of Marine Ecology and Paleoecology, Vol. 2, Paleoecology, Geol. Soc. Am. Mem. 67, pp. 215-248.

Lund, R.J., 1961. Future of Alaskan Mineral Industry: Mining Eng., Vol. 13, No. 12, p. 1351-1355.

Lutz, N., 1963. Copper deposit at Ruby Creek (Alaska): Unpub. paper presented at Northwest Mining Association convention, Spokane, Wash., Dec. 12, 7 p.

________, 1976. Talk presented to Alaska Geological Society Meeting in Anchorage, April 1976.

Martin, A.J., 1970. Structure and Tectonic History of the Western Brooks Range, DeLong Mountains and Lisburne Hills, Northern Alaska, Geological Society of America Bull., Vol. 81, No. 12, p. 3605-3622.

Matzko, J.J. and Freeman, V.L., 1963. Summary of reconnaissance for uranium in Alaska, 1955: U.S. Geol. Survey Bull. 1155, p. 33-49.

McKelvey, V.E., 1972. Mineral resource estimates and public policy, in United States Mineral Resources, Brobst, D.A., and Pratt, W.P., Editors, U.S. Geol. Survey Prof. Paper 820.

Mertie, J.B., 1969. Economic Geology of the Platinum Metals: U.S. Geol. Survey Prof. Paper 630, p. 1.

Mikami, H.M., 1975. Chromite: in industrial Minerals, AIME.

Miller, T.P., 1972. Potassium rich alkaline intrusive rocks of western Alaska: Geol. Soc. Am. Bull. Vol. 83, pp. 211-218.

Miller, T.P., 1976. Hardrock Uranium Potential in Alaska: U.S. Geol. Survey, open-file report, 76-246, 7 p.

Mills, J.W., Carlson, C.L., Gewkes, R.H., Handlen, L.W., Jayprakash, G.P., Johns, M.A., Morganti, J.M., Neitzel, T.W., Ream, L.R., Sanford, S.S. and Todd, S.G., 1972. "Bedded Barite Deposits of Stevens County, Washington," Economic Geology, Vol. 66, No. 8, pp. 1157-1163.

Mitchell, A.H. and Bell, J.D., 1973. Island Arc Evolution and Related Mineral Deposits: Jour. Geol., Vol. 8, No. 4, pp. 381-405.

Monseur, G. and Pel, J., 1973. Reef Environment and Stratiform Ore Deposits: in Ores in Sediments, G.C. Amstutz and A.J. Bernard, editors, Springer-Verlag Pub. Co., New York.

Newell, N.D., Rigby, J.K., Fischer, A.G., Whiteman, A.J., Hickox, J.E., Bradley, J.S.: The Permian Reef Complex of the Guadalupe Mountains Region, Texas and New Mexico, W.H. Freeman and Co., San Francisco, 236 p.

Ohle, E.L.,, 1959. Some considerations in determining the origin of ore deposits of the Mississippi Valley-type: Econ. Geol., 54: 769-789.

Oliver, W.A. Jr., 1976. Written communication.

Patton, W.W. Jr., 1973. Reconnaissance geology of the northern Yukon-Koyukuk province, Alaska: U.S. Geol. Survey Prof. Paper 774-A.

Patton, W.W. Jr. and Matzko, J.J., 1959. Phosphate deposits in northern Alaska: U.S. Geol. Survey Prof. Paper 302-A.

Patton, W.W. Jr., and Miller, T.P., 1966. Regional geologic map of the Hughes quadrangle, Alaska: U.S. Geol. Survey Misc. Geol. Inv. Map I-459, 1 sheet, scale 1:250,000.

Patton, W.W. Jr., Miller, T.P. and Tailleur, I.L., 1968. Regional geologic map of the Shungnak and southern part of the Ambler River quadrangles, Alaska: U.S. Geol. Survey Misc. Geol. Inv. Map I-554, 1 sheet, scale 1:250,000.

Pessel, G.H., Eakins, G.R. and Garland, R.E., 1972. Geology and geochemistry of the southeastern Ambler River quadrangle, in Alaska Div. Geol. and Geophys. Surveys, Annual Report.

Pessel, G.H., Garland, R.E., Tailleur, I.L. and Eakins, G.R. 1973. Preliminary geologic map of southeastern Ambler River and part of Survey pass quadrangle, Alaska: Alaska Div. of Geol. and Geophys. Surveys open-file report (28).

Pessel, G.H. and Brosgė, W.P., 1977. Preliminary Reconnaissance Geologic Map of Ambler River quadrangle, Alaska: U.S. Geol. Survey open-file map, OF 77-28.

Porter, S.C., 1966. Stratigraphy and deformation of Paleozoic section at Anaktuvuk Pass, central Brooks Range, Alaska: Bull. Amer. Assoc. Petrol. Geol., Vol. 50, p. 952-980.

Roeder, Dietrich, 1976. Tectonics of Paleozoic and Mesozoic ophiolites in the southwestern Brooks Range, Alaska: Geol. Soc. Amer., Abst. of 1976 Annual Mtg., p. 1073-74.

Runnells, D.D., 1963. The copper deposits of Ruby Creek, Cosmos Hills, Alaska: Cambridge, Mass., Harvard Univ., Ph.D. dissertation, 274 p; 1964, Univ. Microfilms, Ann Arbor, Michigan.

_______________, 1965. Anthraxolite derived from indigenous organic matter in Middle Devonian dolomite, Cosmos Hills, Alaska: Jour. Sed. Petrology, Vol. 35, No. 3, p. 599-603.

_______________, 1966. Mineralization of the Ruby Creek (Bornite) copper deposit, Cosmos Hills, Alaska: Econ. Geology, Vol. 61, No. 7, p. 1305.

Runnells, D.D., 1969. The Mineralogy and Sulfur Isotopes of the Ruby Creek Copper Prospect, Bornite, Alaska: Econ. Geol., Vol. 64, p. 75-90.

Sable, E.G. and Dutro, J.T. Jr., 1961. New Devonian and Mississippian formations in DeLong Mountains, Northern Alaska: Bull. Amer. Assoc. Petrol. Geol., Vol. 45, p. 585-593.

Sangster, B.J., 1972. Precambrian volcanogenic massive sulfide deposits of Canada; a review: Geol. Survey Can. Paper 72, 44 p.

Saunders, R.H., 1953. Report on the preliminary examination of the Berg prospect, Ruby Creek, Shungnak District, Alaska: Alaska Terr. Dept. Mines unpub. property-examination report PE 28-1, 10 p., February.

_______________, 1955. Report on the examination of the Kobuk copper prospect, Shungnak District, Alaska: Alaska Terr. Dept. Mines unpub. property-examination report PE 28-2, 9 p., October.

Saunders, R.H., 1956. Supplementary report on the Kobuk copper prospect, Shungnak District, Alaska: Alaska Terr. Dept. Mines unpub. property-examination report PE 28-3, 3 p., December.

Schot, E.H., 1971. The Rammelsberg Mine: A synposis; sedimentology of parts of Central Europe. Guidebook VIII. Int. Sediment. Congress 1971.

Shawe, D.R., 1969. "Newly Discovered Bedded Barite Deposits in East Northumberland Canyon, Nye County, Nevada, Economic Geology, Vol. 64, No. 3, p. 245-254.

Skall, H., 1975. The Paleoenvironment of the Pine Point Lead-Zinc District: Econ. Geol., Vol. 70, pp. 22-47.

Smith, P.S., 1911. Mineral Resources of Alaska, 1910 U.S.G.S. Bull. 480, p. 312-318.

__________, 1913. The Noatak-Kobuk region, Alaska: U.S. Geol. Survey Bull. 536, 160 p.

__________, 1930. Mineral industry of Alaska in 1927 and administration report: U.S. Geol. Survey Bull. 810-A, p. 1-85.

__________, 1930. Mineral industry of Alaska in 1928 and administration report: U.S. Geol. Survey Bull. 813-A, p. 1-96, 3 figs.

Smith, P.S. and Eakins, H.M., 1911. The Shungnak region, Kobuk Valley in Brooks, A.H., and others, Mineral resources of Alaska ... in 1910: U.S. Geol. Survey Bull. 480, p. 271-305 (of 333 p.).

Smith, P.S. and Mertie, J.B. Jr., 1930. Geology and mineral resources of northwestern Alaska: U.S. Geol. Survey Bull. 815, 351 p.

Stanton, R.L. "Ore Petrology" McGraw-Hill Book Company, New York, 1972.

Stoll, W.C., 1958. Geology and Petrology of the Masinloc Chromite Deposit, Rambales, Luzan, Philippine Islands: Geol. Soc. Amer. Bull., Vol. 69, p. 419-448.

Streckeisen, A.L., 1973. Plutonic Rocks: Geotimes, Oct. issue, p. 26-30.

Swanson, E.A. and Brown, R.L., 1962. Geology of the Buchans Orebodies: Transactions Canadian Institute of Mining and Metallurgy, Vol. 65, p. 288-296.

Tailleur, I.L., 1970. Lead, Zinc and Barite-Bearing samples from the Western Brooks Range, Alaska, open-file report, U.S.G.S., 19 p.

Tailleur, I.L., Brosgė, W.P. and Resier, H.N., 1967. Palinspastic Analysis of Devonian Rocks in Northwestern Alaska in Oswald, D.H., Editor, International Symposium on the Devonian System: Calgary, Alberta Soc. Petroleum Geologists, Vol. 2, p. 1345-1361.

Tailleur, I.L. and Sable, E.G., 1963. Nuka Formation of Late Mississippian to Late Permian age, new formation in northern Alaska: Bull. Amer. Assoc. Petrol. Geol., Vol. 47, p. 632-642.

Tailleur, I.L. and Snelson, S., 1966. Large-Scale Flat Thrusts in the Brooks Range Orogen, Northern Alaska (abstract). Geological Society of America Special Paper 101, p. 217.

______________________________, 1968. "Large-Scale Thrusting in Northwestern Alaska Possible Related to Rifting of the Arctic Ocean (abstract)," Geological Society of America Special Paper 121, p. 569.

Templeman-Kluit, D.J., 1972. Geology and origin of the Faro, Vangorda, and Swim concordant zinc-lead deposits, central Yukon Territory: Geol. Survey of Canada, Bull. 208, 73 p.

Thayer, T.P., 1964. Principal Features and Origin of Podiform Chromite Deposits and Some Observations in the Guleman-Soridag District, Turkey: Econ. Geol., Vol. 59, p. 1497-1524.

____________, 1967. Chemical and Structural Relations of Ultramafic and Feldspathic Rocks in Alpine Intrusive Complexes: In Ultramafic and Related Rocks, ed. P.J. Wyllie, John Wiley and Sons, Inc., New York, N.Y., p. 222-239.

Turner, D.L., 1974. Geochronology of southwestern Brooks Range metamorphic rocks: Alaska Div. of Geol. and Geophys. Surveys, Annual Report, 1973. p. 27-30.

U.S. Bureau of Mines, 1973. Alaska 1:250,000 scale quadrangle map overlays showing mineral deposit locations, principal minerals, and number and type of claims: U.S. Bureau of Mines open-file report 20-73.

Vokes, F.M., 1968. A Review of the Metamorphism of Sulfide Deposits: Earth Sci. Reviews, Vol. 5, pp. 99-143.

White, M.G., 1950. Examination for radioactivity in a copper-lode on Ruby Creek, Kobuk River valley, Alaska: U.S. Geol. Survey Trace Elements Inv. Report 76-A, unpub., 8 p.

Wilson, J.L., 1975. Carbonate facies in geologic history: Springer-Verlag, New York, 470 p.

Wiltse, M.A., 1975. Geology of the Arctic Camp prospect, Ambler River quadrangle, Alaska: AK Div. Geol. & Geophys. Surveys open-file report 60.

Wiltse, M.A. and Henning, M.W., 1976. Brooks Range Copper Belt, Southern Ambler River and Survey Pass quadrangles, in State of Alaska Dept. of Resources, Division of Geol. & Geophys. Surveys, Biennial Report 1974-1975.

Wood, G.V. and Armstrong, A.L., 1975. Diagenesis and stratigraphy of the Lisburne Group limestones of the Sadlerochit Mountains and adjacent areas, northeastern Alaska: U.S. Geol. Survey Prof. Paper 857, 47 p.

Zimmerman, R.A., 1969. "Stratabound Barite Deposits in Nevada," Mineralium Deposita, Berlin, Vol. 4, p. 401-409.

Zimmerman, R.A. and Amstutz, G.C., 1971. The Meggan Pyrite-Barite-Deposit; Sedimentology of parts of Central Europe. Guidebook VIII Int. Sediment. Congress 1971.