1978 MINERAL INVESTIGATIONS IN THE MISHEGUK MOUNTAIN AND HOWARD PASS QUADRANGLES, ALASKA

By: Uldis Jansons and Mary Ann Parke, Alaska Field Operations Center
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**********Open File Report
26-81

UNITED STATES DEPARTMENT OF THE INTERIOR
James Watt, Secretary
BUREAU OF MINES
Hermann Enzer, Acting Director

FOREWORD

In 1977 and 1978 a joint program devised by the U.S. Bureau of Mines (BOM) and the Geological Survey (USGS) initiated mineral resource appraisal field programs in the southern part of the National Petroleum Reserve in Alaska (NPR-A). These studies contributed to the land-use planning effort mandated by Congress under the Naval Petroleum Reserves Act of 1976.

The study area is primarily restricted to the Paleozoic rocks south of the Colville River between longitudes 156° and 162° W. Field work of the two agencies was assigned along the lines that field mapping and regional geochemical work would be done by the USGS and the known or suspected mineralized areas would be investigated by BOM.

This report presents the results of the work done in the 1978 field season by the BOM.

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BY

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and

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SUMMARY

Results of a regional geochemical stream sediment survey in the southern part of the National Petroleum Reserve in Alaska and adjacent lands were used to select areas for prospecting and further sampling. That survey defined regional geochemical trends and identified areas which contain anomalous concentrations of base metals and other elements. Twenty-one of these areas and four other areas were cursorily prospected. This report reviews the results of the prospecting and evaluates the use of the geochemical data as an indicator of potentially mineralized ground.

Base metal sulfide mineralization was found in five of twenty-five prospected areas. High-grade zinc and lead mineralization occurs at Whoopee Creek, Story Creek, and Kivliktort Mountain; minor amounts of lead and zinc mineralization were found at Koiyaktot Mountain and Isikut Mountain.

Geochemically anomalous base metal concentrations were found in eleven of the twenty-five areas. Anomalously high base metal concentrations occur in stream sediments at Sphinx Mountain, Kagvik Creek, Sharp Peak, Twistem Creek, Memorial Creek, and Safari Creek. Lesser, yet still anomalous, concentrations of base metals occur in stream sediments from the Spike Creek, Anisak River, and Ignisirok areas. The Mechanic Creek and Nuka River areas contain anomalous base metal concentrations in soils and rocks.

Nonmetallic minerals and commodities occur within the study area. Fluorite, phosphate, and oil shale occur at Mount Bupto. Coal, presumably of

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Paleozoic age, occurs near Story Creek. The Nuka Ridge oil sand contains minor amounts of tasmanite(?). Anomalously high barium concentrations occur in stream sediments from the Kagvik Creek and Ignisirok areas.

A regional lead-zinc geochemical anomaly, which extends from the Kuna River to Koiyaktot Mountain, is spatially closely related to the contact zone between the Devonian Kayak Shale and the Mississippian-Devonian Kanayut Conglomerate. The five sulfide-bearing zones and two of the geochemically anomalous areas, Memorial Creek and Safari Creek, are within this anomally. The regional continuity of geology, geochemistry, and high-grade sulfide mineralization suggests this geologic setting is highly favorable for the occurrence of base metal mineralization.

INTRODUCTION

Public Law 94-258 (94th Congress, H. R. 49, April 5, 1976), referred to as the Naval Petroleum Reserves Production Act of 1976, transferred the administration of the Naval Petroleum Reserve Number 4 (NPR-4) from the U. S. Navy to the Department of the Interior on June 1, 1977. All lands within NPR-4 were redesignated as the National Petroleum Reserve in Alaska (NPR-A). Under Section 105(c) of that Act, the Secretary of Interior was mandated to determine and inventory the resources contained within those lands and to determine the best uses of the lands within the reserve. To effect this mandate, a task force was formed from Department of the Interior agencies including the Bureau of Mines, Bureau of Outdoor Recreation, Bureau of Indian Affairs, Geological Survey, National Park Service, Fish and Wildlife Service, and the Bureau of Land Management. The State of Alaska, North Slope Borough, and Arctic Slope Regional Corporation were also represented on the task force. The task force, assisted by the NPR-A Planning Team which consists of seven work groups formed from the Department of the Interior agencies, will present recommendations for a land use plan. The work groups will compile information such as recreation, scenery, wilderness, fish and wildlife populations and habitat, anthropology, archaeology, geology, hydrology, public facilities and communities, minerals, and Native livelihood and dependence.

In 1977 and 1978 the Bureau of Mines (BOM) and the U. S. Geological Survey (USGS) formed study teams to investigate mineralization and geology related to mineralization in the NPR-A. This work was helicopter supported and based out

of an established river bar airstrip, located north of the confluence of Driftwood Creek and the Utukok River, in the southwestern part of the NPR-A. The 1977 field work consisted of geological mapping (1)[3], geochemical sampling (2), aerial geologic reconnaissance, and site specific investigations and sampling (1). During the 44 day 1978 field season, 2 to 3 BOM professionals prospected and sampled areas where results of the 1977 geochemical survey indicated the presence of anomalously high metal concentrations. The prospecting consisted primarily of creek traverses in search for mineralized rock that could account for the geochemical anomalies. Stream sediment samples were collected from tributaries of the geochemically anomalous drainages. This report summarizes the 1978 BOM field work and presents analytical results.

Location

The study area covers the southern NPR-A and immediately adjacent lands. It is covered by the Misheguk Mountain and Howard Pass 1:250,000 quadrangle map sheets of the National Topographic Map Series. The boundaries of the NPR-A and the map quadrangles are shown on Figure 1. Locations of investigated areas are shown on Figure 2 and on figures accompanying corresponding sections in the text.

Physical Setting

The study area is within the Arctic Foothills and the Arctic Mountains Physiographic Provinces (4). Elevations in the southern section of the Arctic Foothills province, which is located north of the Arctic Mountains province, range from about 2,000 to 3,000 feet. This area is characterized by scattered groups of irregularly shaped ridges and knobs that are separated by extensive tracts of gently rolling uplands. Northward-flowing rivers cross the foothills through broad mature valleys and most drain into the Colville River. The major river valleys are mantled with glacial debris which produces an uneven, hummocky, morainal topography with hundreds of small lakes. The foothills are cloaked by a heavy growth of moss, lichen, grass, and sedge; the ridgetops are

[3]Underlined numbers in parentheses refer to items in the list of references at the end of this report.

barren. Trees are not present, but patches of stunted willows grow along some creeks.

Elevations in the Arctic Mountains province rise to about 5,000 feet. The headwaters of the larger rivers are near the center of the Brooks Range from which they meander northward through deep, flat-floored, glaciated valleys. The headwaters of the smaller streams are along the north flank of the Brooks Range. The north flank is rugged and notably barren of vegetation. Tundra growth extends a few hundred feet up the mountain slopes and then gives way to barren talus and bedrock.

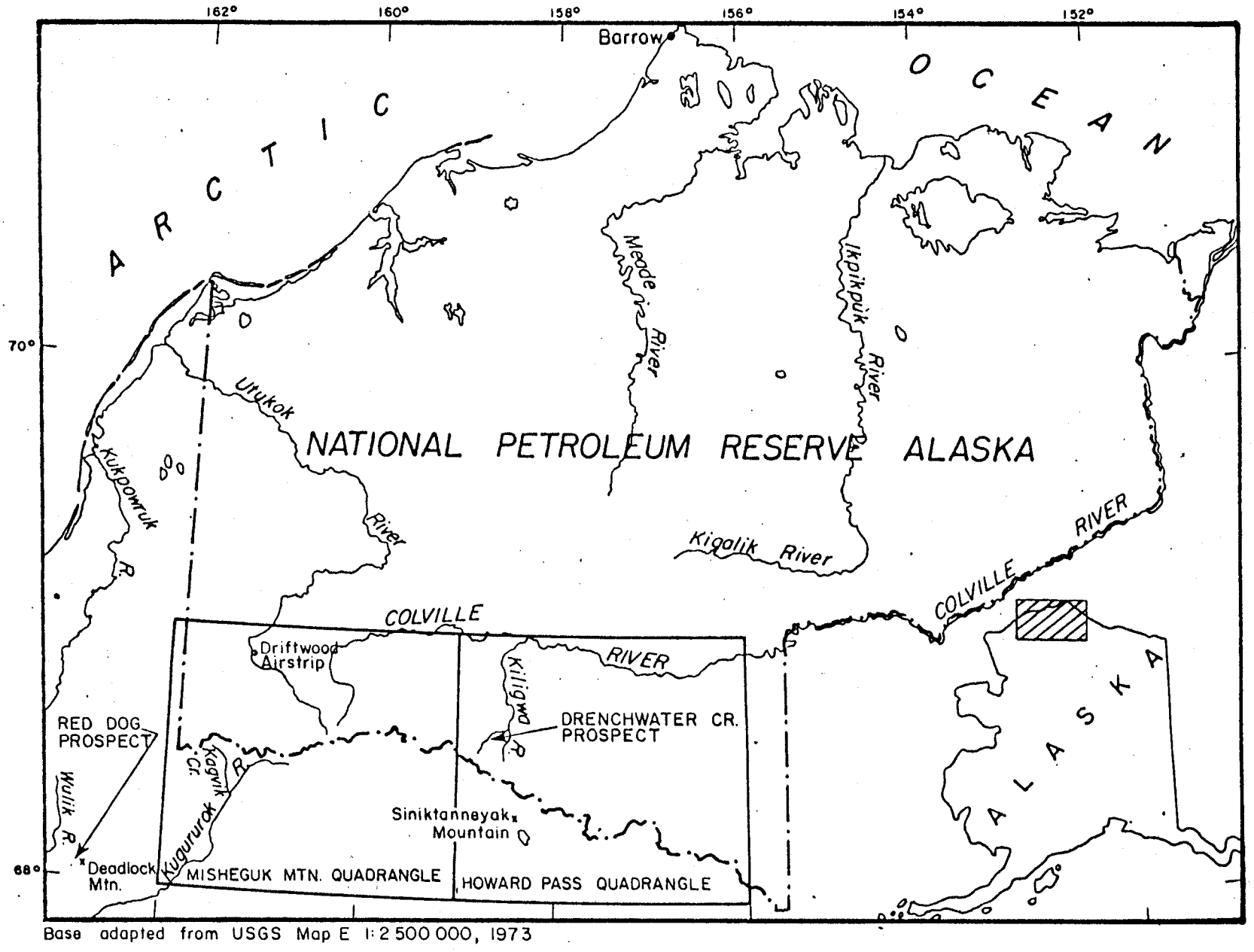
Geologic Setting

For the purpose of this report, the geology of the NPR-A can be subdivided into a northern and a southern terrane based on sedimentologic, stratigraphic, and structural differences. The northern terrane consists of structurally simple, late Mesozoic and younger, sandstone, shale, and conglomerate units of marine and non-marine origin. Extensive coal deposits occur in these rocks. The southern terrane, which includes the Brooks Range and Northern Foothills thrust sequences, is structurally and stratigraphically complex(1). Rocks of the southern terrane include shale, siltstone, sandstone, radiolarian chert, submarine volcanics, and limestone. Base metal sulfide deposits occur within the southern terrane.

Mineralization

Both metallic and non-metallic mineral resources are present in the NPR-A. The work to date, which has been of a reconnaissance nature, has identified occurrences of coal, phosphate, oil shale, barite, fluorite, and base and precious metals.

Late Mesozoic and younger coal occurrences are widespread in the NPR-A(10). Large minable economic deposits may be present, but to date only outcrop occurrences and some drill hole intercepts have been sampled. Preliminary estimates of a potential coal reserve in excess of 4 trillion tons have been inferred on the basis of optimistic assumptions of geologic continuity(7, 10). The extent, nature, and quality of most of this coal is not known. Some recently acquired analyses are listed in Appendices A and B.



Base adapted from USGS Map E 1:2 500 000, 1973

Figure 1. Index map of Northern Alaska showing location of the National Petroleum Reserve in Alaska and the 1978 study area.

Phosphate occurrences in the NPR-A have been identified in Early Mesozoic and Paleozoic stratigraphic horizons(8). The data on the phosphate occurrences are based on analyses of rock samples collected during regional geologic work and not specifically for the evaluation of the phosphate potential. Great lateral extent has been shown for the phosphatic horizons, but systematic measurements of continuity, thickness, and grade have not been made. In addition to the phosphate potential, these rocks generally contain uranium and other commonly associated, potentially exploitable, elements.

Oil shale occurrences are present in the NPR-A, but the quality and distribution of this commodity are undetermined(9). Some samples, collected from scattered localities, yield as much as 144 gallons of oil per ton of shale. In addition to the presence of oil, chemical analyses indicate high concentrations of molybdenum, vanadium, rare earths, and other elements that may be recoverable from the oil shale.

Barite and fluorite occur in the NPR-A, however, their resource potential is unknown. Massive bedded barite deposits occur in the Brooks Range outside the NPR-A(11); equivalent rock units occur in the NPR-A. Anomalously high barium concentrations in stream sediments from the NPR-A suggest that barite deposits may be present.

Only one base metal sulfide mineral occurrence, located at Drenchwater Creek, was known in the NPR-A before 1978. Results of a study of this deposit have been published(3, 5).

Previous Work

Minerals exploration has not been undertaken in the NPR-A by professional groups because the area has been closed to mineral entry and land acquisition since the creation of the NPR-4 in 1923. The present mineral resource assessment of the NPR-A was initiated in 1977 by the BOM and the USGS. The program included regional geological mapping (1, 5, 6), a geochemical survey (2), and prospecting in areas of reported mineralization and "color" anomalies (3). The prospecting lead to identification of base metal mineralization in the Drenchwater Creek area (3, 5). The gecchemical survey revealed anomalous concentrations of elements in samples from numerous drainages. The geological mapping suggests that the base metal mineralization at Red Dog and at Drenchwater Creeks (Figure 1) are in similar rock units (1, 6).

NATIONAL PETROLEUM RESERVE IN ALASKA

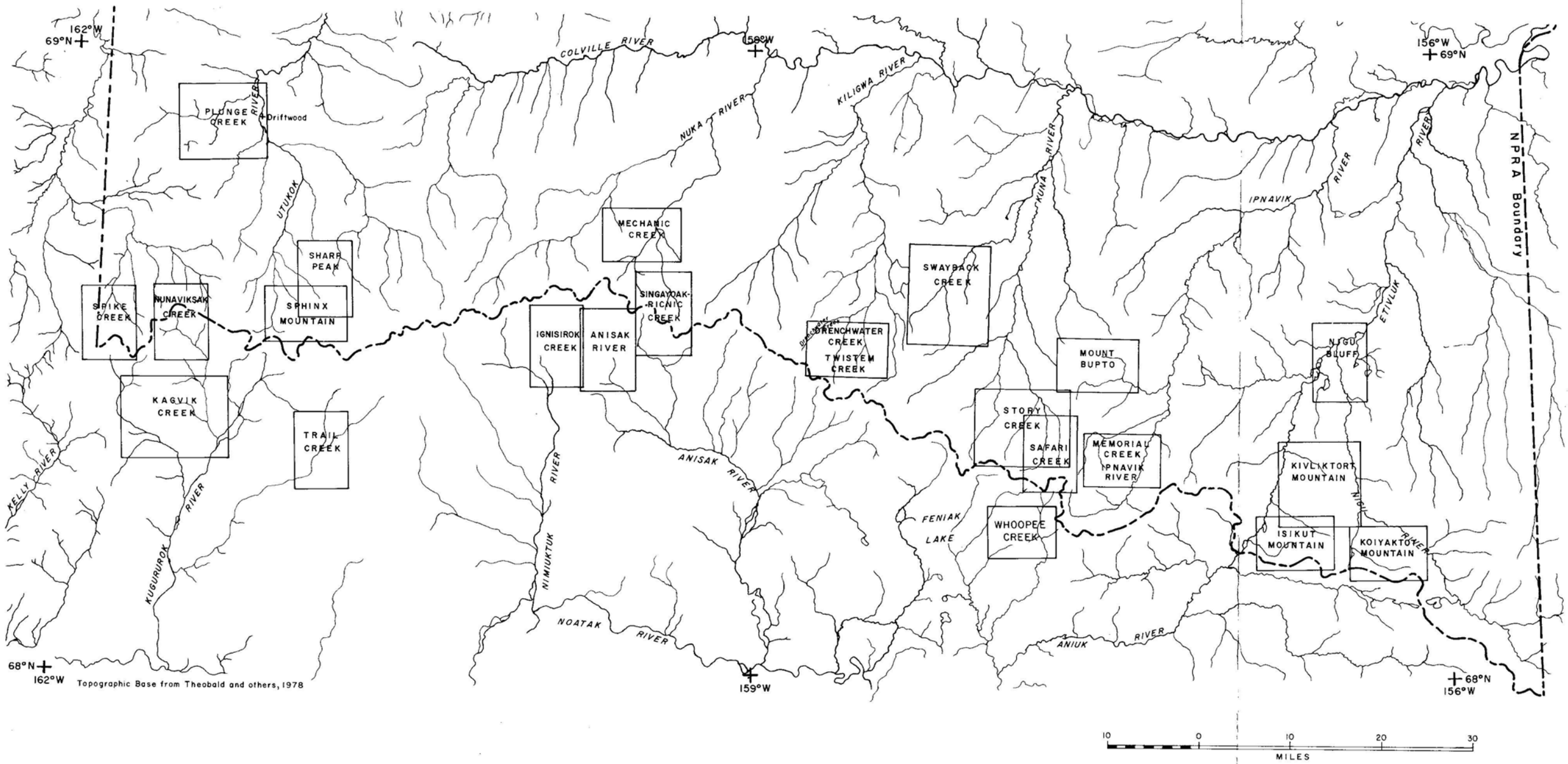


Figure 2. INDEX MAP SHOWING 1978 U.S. BUREAU OF MINES FIELD STUDY AREAS, MISHEGUK MOUNTAIN AND HOWARD PASS QUADRANGLES, ALASKA

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The 1977 USGS Regional Geochemical Survey

In 1977 the USGS conducted a regional reconnaissance geochemical survey in the southern NPR-A and adjacent areas(2, 6). Three types of samples were obtained at each sample station: (1) minus 30-mesh stream sediment, (2) pan-concentrate of the nonmagnetic heavy minerals in the stream sediment, and (3) stream bank materials. Semiquantitative emission spectrographic techniques were used to determine the concentration of 31 elements in the stream sediment samples and their heavy-mineral concentrates. These data were used to detemine regional geochemical variations and identify areas of potential outcropping and subcropping mineralization.

Only part of the near-surface mineral potential within the study area was evaluated due to sampling density. In the Arctic Mountains Physiographic Province the sample density is higher than that in the Arctic Foothills Physiographic Province. This sampling density variation is a function of the difference of stream development and distribution in the two areas. Most of the drainage basins were sampled, however, many small drainages which are large enough to contain potentially significant mineralized zones were not sampled.

An evaluation of the available data suggests five distinct geochemical and geologic associations occur within the study area(6). These are: (1) barium associated with concretionary and/or bedded barite deposits, (2) zinc and silver related to zinc-rich stratiform sulfide deposits which occur within the area of geochemically abundant barium, (3) lead, zinc, and silver, without barium, related to an unknown bedrock source; and (4) arsenic, lead, and silver related to an unknown bedrock source, (5) a broad distribution of chromium derived principally from ultramafic rocks south of the NPR-A.

The 1978 Bureau of Mines Investigations

The 1978 BOM field work consisted of prospecting and rock and stream sediment sampling along drainages which in 1977 yielded samples containing anomalous concentration of barium, copper, lead, zinc, silver and other elements. Prospecting was aimed at locating mineralization. Stream sediment sampling was to delineate areas for further prospecting.

Drainage basins were selected for examination primarily on the basis of geochemical data and partly on knowledge of the geologic terrane. Areas under-

lain by Triassic and Paleozoic bedrock were given higher priority than areas underlain by Cretaceous and younger rocks.

The BOM samples were analyzed at a commercial laboratory using standard techniques. Atomic absorption spectrophotometric methods were used to determine the content of elements in all stream sediment, soil, and selected rock samples. Semiquantitative emission spectrographic techniques were used to determine the contentrations of 31 elements in rock samples. Government laboratories were used to analyze hydrocarbon samples.

Total-count radiometric readings were taken along most traverses and at sample stations. In general the readings averaged near 50 counts per second (cps). Higher readings are listed on tables showing analytical results.

Selection of Geochemically Anomalous Samples

Eight elements were selected as being potential indicators of mineralization. These elements and their defined threshold values are: Ag = 1 ppm, Ba = 20,000 ppm, Co = 100 ppm, Cu = 300 ppm, Mn = 5,000 ppm, Mo = 6 ppm, Pb = 100 ppm, and Zn = 300 ppm.

The 1977 geochemical data identified more than 80 drainages worthy of prospecting. Time constraints precluded the investigation of all anomalous areas and, therefore, data screening was required. Highest priority was assigned to areas from which both the stream sediment and pan-concentrate contained anomalous concentrations of several elements. High priority was assigned to drainages from which either the sediment or pan-concentrate contained anomalously high concentrations of several elements. Lower priority was assigned to drainages from which samples contained high, erratic element values but were from areas of similar geology.

The content of selected elements in stream sediment samples collected from areas of extensive lead-zinc mineralization, at Red Dog and Drenchwater Creeks, are presented here for comparison.

	Red Dog	Drenchwater	
Ag	10 ppm		
Ba	20,000 ppm	7,000 ppm	10,000 ppm
Cu	150 ppm	100 ppm	70 ppm
Pb	10,000 ppm	50 ppm	30 ppm
Sr	1,000 ppm	100 ppm	100 ppm
Zn	3,000 ppm	500 ppm	700 ppm

Data Presentation

The investigated areas are presented by quadrangle. Those in the Misheguk Mountain quadrangle are discussed first and those in the Howard Pass quadrangle follow. The location and distribution of these study areas are shown on Figure 2.

Each study area is identified by reference to a nearby topographic feature and by the sample number from the 1977 USGS geochemical survey. Unnamed drainages are referred to by the USGS corresponding stream sediment sample number (e.g. M-262 or H-537). The location and physical and geological setting of each area are described. The results of the 1977 geochemical survey, used for selecting areas for prospecting, are summarized. The 1978 Bureau of Mines work, including geologic observations, chemical analyses, and sample descriptions, follow.

MINERALS INVESTIGATIONS IN THE MISHEGUK MOUNTAIN QUADRANGLE

Thirteen widely separated areas were investigated in the Misheguk Mountain quadrangle. Each area is discussed separately in the following sections.

Plunge Creek Area (M-105)

The heavy-mineral concentrate of sediment sample M-105 contains anomalously high lead and zinc concentrations. The sample site is within the regional "Driftwood" multi-element geochemical anomaly that was evaluated in detail by the USGS in 1978(13). Anomalous lead and zinc concentrations were not found in the BOM stream sediments from this area.

Location and Physical Setting

The area of the 1978 sampling centers near 68° 53' 30"N latitude, 161° 23'W longitude, and is in the northern half of T 7S, R 40W, and the southeastern quarter of T 6S, R 39W, Umiat Base and Meridian. It is approximately 3.5 miles east of the western NPR-A boundary.

The Plunge Creek area is within the southern subprovince of the Arctic Foothills Physiographic Province(4). It is characterized by a swampy, tussock covered, undulating tundra surface that is cut by meandering streams. Well drained, east-west trending, whale-back ridges cross these tundra lowlands. Elevations in the area range from 1,100 to 2,900 feet.

Plunge Creek is a 9.5-mile long, north-flowing tributary of Tupikchak Creek, which is a 17.5-mile long, northeast-flowing tributary of the Utukok River (Figure 3). The creeks meander and have gradients of approximately 50 feet per mile. Stream beds are composed primarily of cobbles. The surface area of the Plunge Creek drainage basin is approximately 48 square miles; that of Tupikchak Creek is approximately 150 square miles.

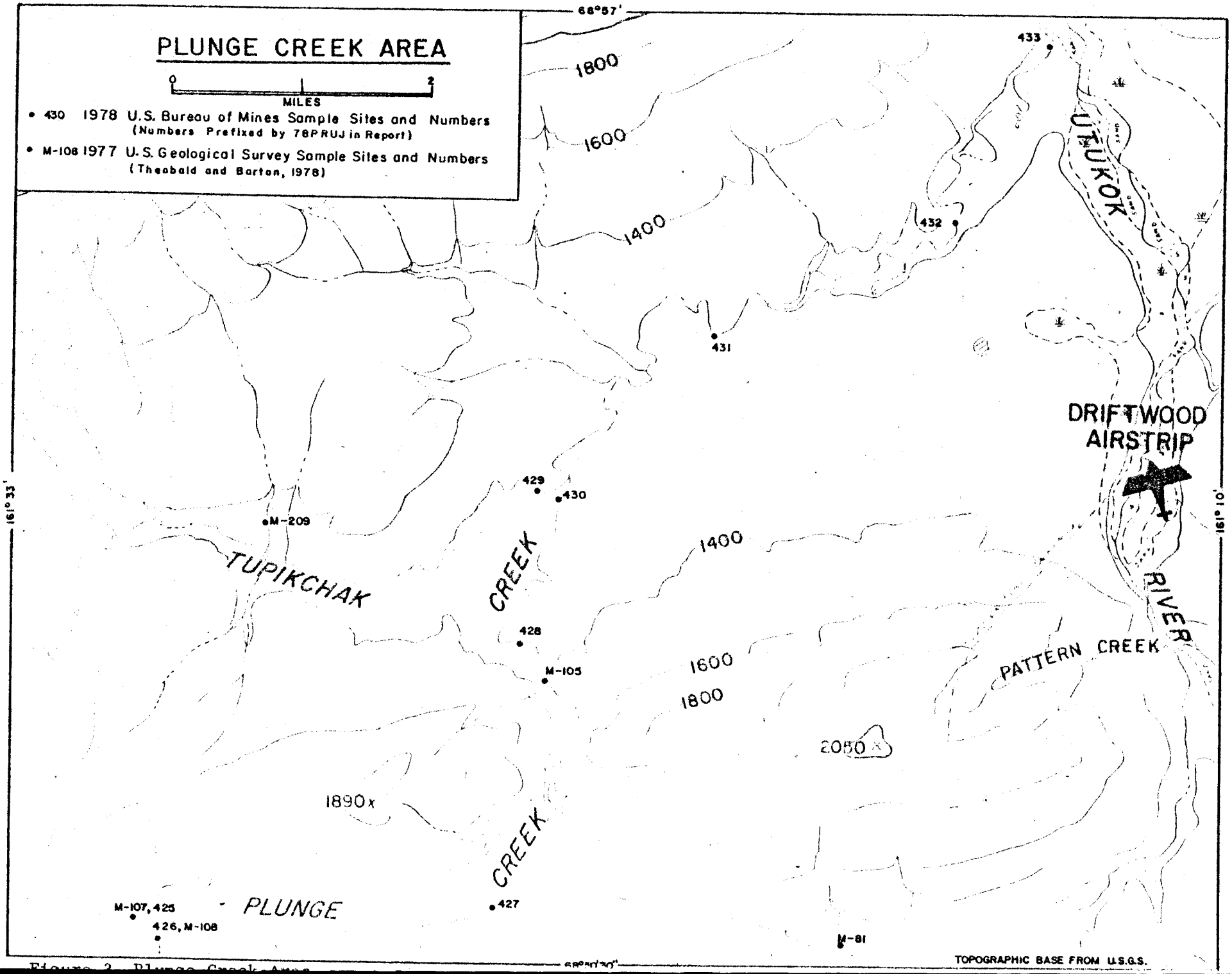


Figure 2. Plunge Creek Area

Regional Geology

The Lower Cretaceous Torok, Fortress Mountain, and Kukpowrok Formations underlie the study area(14). Plunge Creek is underlain predominantly by clastic rocks of the Torok Formation. The Fortress Mountain Formation, which consists largely of flyschoid wacke, conglomerate, and mudstone, is exposed to the south along the West Driftwood Anticline. The Kukpowruk Formation is exposed to the north along the Flintchip Syncline.

Results of the 1977 Geochemical Survey

An anomalous lead (100 ppm) concentration occurs in the stream sediment and anomalous lead (700 ppm) and zinc (1,500 ppm) concentrations occur in the heavy-mineral concentrate of sample M-105(2). Silver (7.0 ppm), arsenic (10,000 ppm), and other elements are also present in anomalous concentrations in the heavy-mineral concentrate.

Bureau of Mines Work in 1978

Nine stream sediment samples, collected from Plunge Creek and lower Tupikchak Creek, were analyzed to determine their copper, lead, and zinc content (Table 1). The area was not prospected. Sandstone outcrops were noted but not sampled.

The average metal contents of the 1978 stream sediment samples, with the standard deviations shown in parentheses, are: copper 21 ppm (4.2 ppm), lead 17 ppm (2.6 ppm), and zinc 120 ppm (23 ppm). The results for all but one of the samples (78 PRUJ 426) are within two standard deviations of the average. Sample 78 PRUJ 426, collected from a small tributary of Plunge Creek, contains 180 ppm zinc which is 14 ppm higher than the average plus two standard deviations.

Table 1. - Analytical results of Plunge Creek area samples
[Values in parts per million]

Sample Number	Elements Analyzed			CPS	Sample Type
	Cu	Pb	Zn		
78 PRUJ 425	25	15	125	x	Stream sediment
78 PRUJ 426	25	20	180	x	Stream sediment
78 PRUJ 427	20	20	130	x	Stream sediment
78 PRUJ 428	15	15	110	x	Stream sediment
78 PRUJ 429	20	20	105	x	Stream sediment
78 PRUJ 430	25	15	120	x	Stream sediment
78 PRUJ 431	25	15	125	x	Stream sediment
78 PRUJ 432	15	15	100	x	Stream sediment
78 PRUJ 433	20	20	115	x	Stream sediment

x - Within range of background values

Spike Creek Area (M-6, M-9, M-10)

Stream sediment samples M-6, M-9, and M-10 from the Spike Creek area, which is located at the southwestern corner of the NPR-A, contain anomalously high concentrations of copper, molybdenum, lead, zinc, barium, and silver(2). The three creeks contain different combinations of anomalous element concentrations. The element content of samples from streams M-6 and M-9 is similar to that of the bedrock along the drainages. The element content of samples from stream M-10 is higher than that of the analyzed rocks.

Location and Physical Setting

The Spike Creek area, located between Inaccessible Ridge and Sulungataak Ridge, is in the southwestern part of the NPR-A. Spike Creek is a north-flowing tributary of Iligluruk Creek, a tributary of the Kokolik River.

The Spike Creek area is within the DeLong Mountains section of the Arctic Mountains Physiographic Province(4). Prospected areas in the upper Spike Creek drainage are characterized by high, steep, barren to alpine tundra covered mountains that are cut by wide, deeply incised stream valleys. Elevations in the area range from 1,900 feet to 3,700 feet.

Regional Geology

The Spike Creek area is underlain by three east-west trending time-stratigraphic units(1). Lower Cretaceous to Upper Jurassic flyschoid wacke, mudstone, and conglomerate units crop out between the 1,600 and 1,800 foot elevations along Spike Creek. Lower Cretaceous-Mississippian undifferentiated wacke, mudstone, chert, and shale crop out between the 1,800 foot elevation along Spike Creek and the base of Inaccessible Ridge. The rocks of these two units make up part of the Northwestern Brooks Range thrust sequence. Mississippian Lisburne Group rocks, which include crinoidal and sandy limestones, crop out along Inaccessible Ridge. They are mapped as a part of the Kelly River thrust sequence.

Spike Creek (M-6)

Location and Physical Setting

Stream M-6 is a northeast-flowing tributary of the eastern branch of Spike Creek (Figure 4). The prospected area centers near 68° 33' 45"N latitude, 161° 45' 30"W longitude, and is in sections 16 and 21 of T 10S, R 42W, Umiat Base and Meridian.

Stream M-6 is 1.8 miles long and originates on the north side of the 3,700 foot high, barren Inaccessible Ridge. In the prospected area, the stream is relatively straight, has a gradient of approximately 200 feet per mile, and occupies a wide, gently sloping, alpine tundra covered valley. The stream bed consists primarily of coarse pebbles. The surface area of the drainage basin is approximately 1.4 square miles.

Geologic Setting

Mississippian Lisburne Group carbonates and Lower Cretaceous-Mississippian undifferentiated wacke, mudstone, chert, and shale underlie the prospected area(1). Mississippian Lisburne Group carbonates, which are mapped as part of the Kelly River thrust sequence, are cut by stream M-6 above the 2,200 foot elevation. Below this elevation, this thrust sequence overlies the mainly clastic, Lower Cretaceous-Mississippian, sedimentary rocks of the Northwestern Brooks Range thrust sequence.

Results of the 1977 Geochemical Survey

Anomalously high zinc (500 ppm), anomalous silver (2.0 ppm), and high barium (20,000 ppm) concentrations are present in stream sediment sample M-6(2).

Bureau of Mines Work in 1978

Stream M-6 was prospected and rock and stream sediment samples were collected between the 2,200 and the 1,900 foot elevations. Geology was not mapped; rock types and their distribution were noted. Sediments were collected from tributary streams at their confluence with stream M-6.

Black calcareous and carbonaceous shales crop out along the upper reaches of the drainage; limestones crop out along the lower segment. Tight, overturned folds and rapid changes in bedding attitudes indicate local structural complexities.

Nine stream sediment and two rock samples were collected to determine their copper, lead, and zinc content (Table 2). The average metal contents of the stream sediment samples, with the standard deviations shown in parentheses, are: copper 62 ppm (12 ppm), lead 18 ppm (4.4 ppm), and zinc 400 ppm (100 ppm). Two carbonaceous shale samples, 78 PRUJ 288 and 78 PRUJ 294, contain 110 and 35 ppm copper, 20 and 5 ppm lead, and 300 and 120 ppm zinc, respectively. Semiquantitative emission spectrographic analyses of the these shale samples show the presence of zinc, barium, and detectable amounts of silver (Table 3). The element concentrations in the stream sediments and shales are similar. The shale may be the source rock of the elements in the stream sediments.

A qualitative zinc-oxide field test was used extensively during the traverse but positive indications of zinc were not obtained.

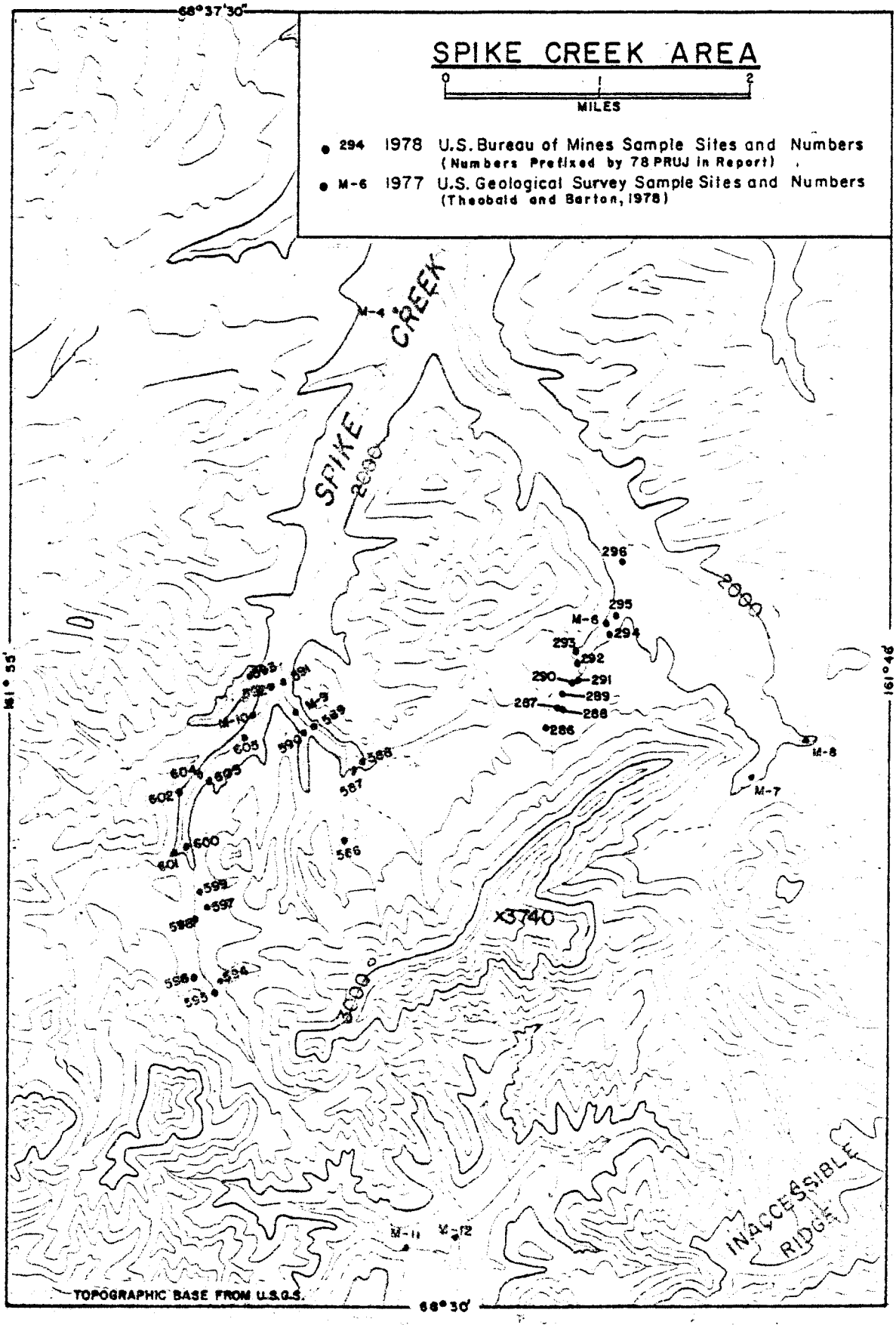


Figure 4. Sample sites along Stream M-6.

Spike Creek (M-9)

Location and Physical Setting

The prospected area centers near 68° 33' 15"N latitude, 161° 50'W longitude, and is in sections 19 and 30, T 10S, R 42W, Umiat Base and Meridian.

Stream M-9 is a 2.2-mile long, northwest-flowing tributary of the west branch of Spike Creek (Figure 5). It originates on the north side of Inaccessible Ridge and flows north through a wide, gently sloping, alpine tundra covered valley. The stream is relatively straight and has a gradient of approximately 150 feet per mile. The creek bed consists primarily of cobbles. The surface area of the drainage basin is approximately 2.3 square miles.

Geologic Setting

Mississippian Lisburne Group carbonates and Lower Cretaceous-Mississippian undifferentiated wacke, mudstone, chert, and shale underlie stream M-9(1). Mississippian Lisburne carbonate rocks, which are mapped as part of the Kelly River thrust sequence, are cut by stream M-9 above the 2,200 foot elevation. Below this elevation clastic, Lower Cretaceous-Mississippian, sedimentary rocks of the Northwestern Brooks Range thrust sequence crop out.

Results of the 1977 Geochemical Survey

High lead (50 ppm) and detectable zinc (200 ppm) concentrations are present in stream sediment sample M-9(2).

Bureau of Mines Work in 1978

Stream M-9 was prospected between the 2,200 and 1,900 foot elevations. Sediment samples were collected from the main stream and its tributaries. Geology was not mapped, but rock types, their distribution, and attitudes were noted.

Fossiliferous limestone and minor amounts of chert crop out on Inaccessible Ridge at the headwaters of stream M-9. North of Inaccessible Ridge, the bedrock includes (from south to north): (1) green chloritic(?) sandy limestone,

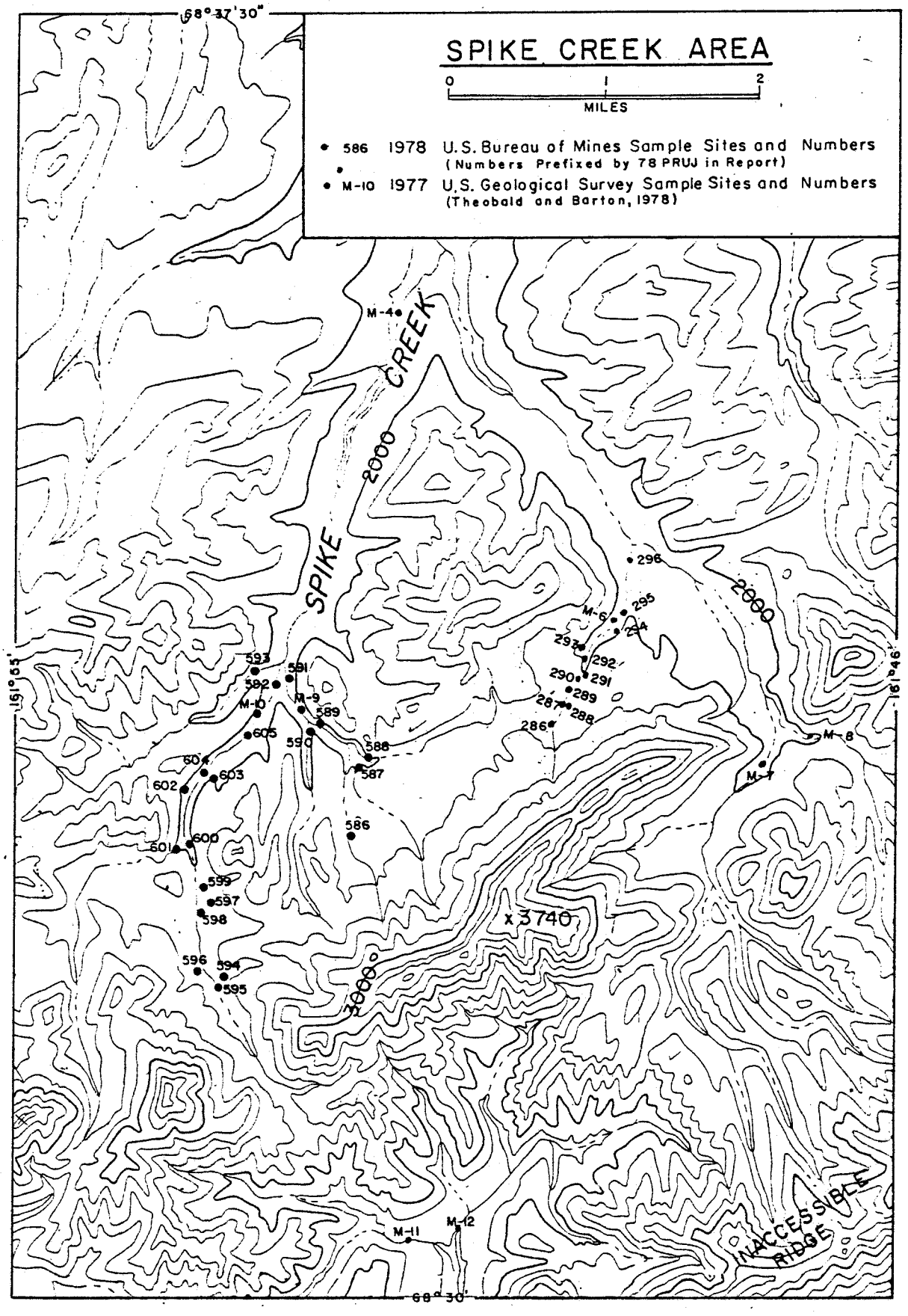


Figure 5. Sample sites along Streams M-9 and M-10.

(2) black carbonaceous limestone, (3) light-grey to black pyritiferous limestone, (4) orange and yellow weathering thin-bedded pyritiferous chert, and (5) green chloritic(?) sandy limestone. The latter carbonates, which outcrop near the confluence of stream M-9 and Spike Creek, are very similar in appearance to those found at the foot of Inaccessible Ridge and may represent a repeat of the section.

Six stream sediment samples were analyzed to determine their copper, lead, zinc, and barium contents (Table 2). The average element contents of the samples, with standard deviations shown in parentheses, are: copper 55 ppm (13 ppm), lead 13 ppm (2.6 ppm), zinc 320 ppm (86 ppm), and barium 5,900 ppm (4,100 ppm). These concentrations are similar to values obtained from carbonaceous shale and sediment samples collected elsewhere in the Spike Creek area.

Spike Creek (M-10)

Location and Physical Setting

The drainage basin of stream M-10 centers near 68° 33' 10"N latitude, 161° 51'W longitude, and is in sections 24, 25, and 36 of T 10S, R 43W, Umiat Base and Meridian (Figure 5).

Stream M-10 is 3.5 miles long and originates on the 3,700 foot high, barren slopes of Inaccessible Ridge. It flows northward from the 2,300 foot divide, between Spike and Kagvik Creeks, through a wide, gently sloping, alpine tundra covered valley. The stream gradient is approximately 100 feet per mile between the 1,900 and 2,100 foot elevations. The stream bed consists primarily of cobbles. The surface area of the drainage basin is approximately 6.6 square miles.

Geologic Setting

Mississippian Lisburne Group carbonates and Lower Cretaceous-Mississippian undifferentiated wacke, mudstone, chert, and shale underlie stream M-10(1). Mississippian Lisburne carbonates, which are mapped as part of the Kelly River thrust sequence, crop out along the stream above the 2,100 foot elevation.

Below this elevation clastic, Lower Cretaceous-Mississippian, sedimentary rocks of the Northwestern Brooks Range thrust sequence crop out.

Results of the 1977 Geochemical Survey

High lead(30 ppm), silver(1.0 ppm), and barium(20,000 ppm) concentrations occur in stream sediment sample M-10(2).

Bureau of Mines Work in 1978

Sediment samples were collected from tributaries of stream M-10 to determine a source of elements found in anomalous concentrations. Pyritiferous chert and secondary iron-oxides were noted in two easterly-flowing tributaries of stream M-10. Samples 78 PRUJ 603 and 604 were collected from these drainages.

Fourteen stream sediment samples were collected and analyzed to determine their copper, lead, zinc, and barium content (Table 2). The average element contents, with standard deviations shown in parentheses, are: copper 77 ppm (38 ppm), lead 15 ppm (2.0 ppm), zinc 380 ppm (250 ppm), and barium 5,700 ppm (6,400 ppm). These values are similar to the average values of all samples from the Spike Creek area. Highly anomalous zinc concentrations, 1,100 ppm and 640 ppm, were found in samples 78 PRUJ 599 and 78 PRUJ 602, respectively. Indications of mineralization, such as alteration or iron-oxide staining, were not noted along these two drainages.

The radiometric reading taken during the traverse ranged between 25 and 80 cps. These are within regional background values. Minor variations in the radiometric readings appear to reflect changes in bedrock.

Summary

The element content of stream sediments and carbonaceous shales is similar in two (M-6, M-9) of the three prospected drainages. The zinc values in sediments from stream M-10 are significantly higher than in any of the analyzed rocks. This drainage should be studied further.

Table 2. - Analytical results of Spike Creek area samples
[Values in parts per million]

Sample Number	Elements analyzed Cu	Pb	Zn	Ba	CPS	Sample Type
M-6 Creek						
78 PRUJ 286	50	25	145	NA	x	Stream sediment
78 PRUJ 287	70	15	490	NA	x	Stream sediment
78 PRUJ 288	110	20	300	NA	x	Carbonaceous shale
78 PRUJ 289	50	15	460	NA	x	Stream sediment
78 PRUJ 290	70	15	375	NA	x	Stream sediment
78 PRUJ 291	45	15	450	NA	x	Stream sediment
78 PRUJ 292	60	15	395	NA	x	Stream sediment
78 PRUJ 293	85	20	450	NA	x	Stream sediment
78 PRUJ 294	35	5	120	NA	x	Carbonaceous shale
78 PRUJ 295	65	15	450	NA	x	Stream sediment
78 PRUJ 296	65	25	415	NA	x	Stream sediment
M-9 Creek						
78 PRUJ 586	35	15	155	650	x	Stream sediment
78 PRUJ 587	50	15	340	2,300	x	Stream sediment
78 PRUJ 588	50	10	400	3,500	x	Stream sediment
78 PRUJ 589	70	15	370	6,800	x	Stream sediment
78 PRUJ 590	60	15	320	14,000	x	Stream sediment
78 PRUJ 591	65	10	345	8,300	x	Stream sediment
M-10 Creek						
78 PRUJ 592	65	15	290	8,200	x	Stream sediment
78 PRUJ 593	65	15	185	8,000	x	Stream sediment
78 PRUJ 594	65	15	280	2,150	x	Stream sediment
78 PRUJ 595	125	20	470	4,300	60	Stream sediment
78 PRUJ 596	45	15	145	800	x	Stream sediment
78 PRUJ 597	25	15	500	1,200	x	Stream sediment
78 PRUJ 598	45	15	195	1,350	35-40	Stream sediment
78 PRUJ 599	110	10	1,100	1,500	40	Stream sediment
78 PRUJ 600	50	15	280	1,200	60-70	Stream sediment
78 PRUJ 601	45	15	260	2,000	x	Stream sediment
78 PRUJ 602	140	15	640	5,600	60-70	Stream sediment
78 PRUJ 603	90	15	245	13,000	75-85	Stream sediment
78 PRUJ 604	65	15	300	6,000	75-85	Stream sediment
78 PRUJ 605	140	15	430	24,000	20-30	Stream sediment

NA - Not analyzed
x - Within range of background values

Table 3. - Emission spectrographic results of Spike Creek area samples
[Values in parts per million unless otherwise noted]

Element	Sample numbers	
	78 PRUJ 288 carbonaceous shale	78 PRUJ 294 carbonaceous shale
Fe	0.5%	0.5%
Ca	5%	1.5%
Mg	0.1%	0.5%
Ag	2	1
As	<500	<500
B	30	50
Ba	700	2,000
Be	<2	<2
Bi	<10	<10
Cd	<50	<50
Co	<5	<5
Cr	200	100
Cu	100	30
Ga	<10	<10
Ge	<20	<20
La	20	20
Mn	50	70
Mo	3	3
Nb	<20	<20
Ni	150	50
Pb	15	10
Sb	<100	<100
Sc	<10	<10
Sn	<10	<10
Sr	300	300
Ti	500	1,000
V	150	150
W	<50	<50
Y	10	<10
Zn	200	<200
Zr	20	20

Anisak River Area (M-260, M-261, M-262, M-263, M-264)

In 1977, anomalous zinc values were found in sediment samples from five tributaries of the Anisak River(2). In 1978, three of the streams were prospected and sampled; two were sampled but not prospected.

Sediment samples from streams M-260 and M-263 contain anomalously high copper concentrates; those from streams M-261, M-262, and M-264 contain anomalously high copper and zinc ocncentrations. Base metal sulfide occurrences were not found. The Anisak River area is located approximately 5 miles south of the NPR-A, an area centered near 68° 34'N latitude, 159° 40'W longitude, and in T 10 and 11S, R 33W, Umiat Base and Meridian. The investigated areas are within the DeLong Mountains section of the Arctic Mountains Physiographic Province(4), an area characterized by wide, gently sloping, glaciated valleys. Elevations in this area range from 1,600 to 3,800 feet. Steeply-dipping, northwest-striking, interbedded shales, cherts, sandstones and limestones underlie the major portion of the area; diabase sills crop out in the northern portion.

Stream M-260

Location and Physical Setting

Stream M-260, a west-flowing tributary of Anisak River, is centered near 68° 34' 40"N latitude, 159° 38' 30"W longitude, and is in sections 16 and 17 of T 10S, R 33W, Umiat Base and Meridian (Figure 6). It is 1.5 miles long, relatively straight, and has a gradient of approximately 550 feet per mile. The stream bed is composed primarily of angular cobbles. The drainage basin has a surface area of approximately 1.4 square miles. Its elevations range from 2,000 to 3,400 feet. The valley floor is alpine tundra covered; valley slopes and adjacent ridge tops are barren of vegetation.

Geologic Setting

Geologic maps of the prospected area have not been published. Geologic observations, made while prospecting, are discussed in the 1978 BOM work section.

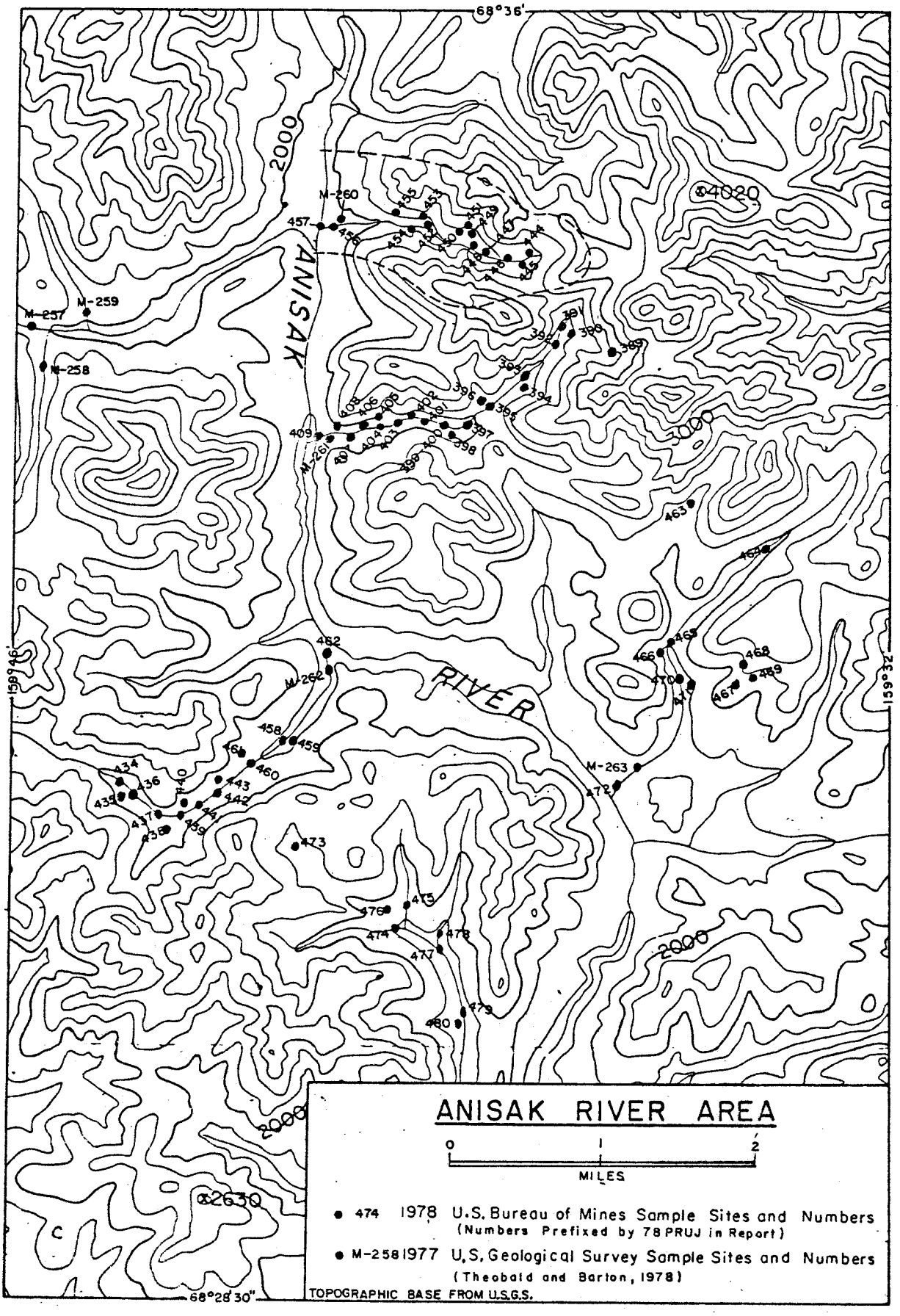


Figure 6. Sample sites along Stream M-260.

Results of the 1977 Geochemical Survey

Anomalously high silver (5.0 ppm), copper (100 ppm), and lead (70 ppm) concentrations are present in the heavy-mineral concentrate of sample M-260(2).

Bureau of Mines Work in 1978

Stream M-260 was prospected and geologic relationships were noted between the 2,500 foot elevation and the Anisak River. Rock and sediment samples were collected.

A northwest-striking, north-dipping sequence of limestones, shales, and cherts outcrop in the drainage. A brown-weathering limestone predominates along the stream above the 2,500 foot elevation. Cobbles of clastic limestone, chert, and diabase occur in float rock at this elevation. Downstream from the brown-weathering limestone, the stream flows between a N 80° W trending, 60° N dipping, white crystalline fossiliferous limestone on the north and a black chert with interbedded black shales on the south. Near its confluence with the Anisak River, stream M-260 cross-cuts interbedded shales and brown limestones. Local deformation of these units is evident in outcrops.

Several rocks were sampled to determine their base metal content. These include: 1) a 6-foot long sample of a red-orange stained, pyritiferous black shale (78 PRUJ 451) which is interbedded with black chert, 2) a 5-foot long sample of a pale green-yellow stained, pyritiferous chert bed (78 PRUJ 455) located along the north side of the stream at the 2,100 foot elevation, and 3) a 5-foot long sample of shale (78 PRUJ 446) which is interbedded with brown limestone. Float rock samples of pyritiferous chert (78 PRUJ 446) and brown-stained pyritiferous dolomite (78 PRUJ 447) were collected. Emission spectrographic analyses of these rocks show that none contain anomalous concentrations of base metals (Table 5). The pyritiferous chert (78 PRUJ 446) contains an anomalous concentration of barium (5,000 ppm).

Nine stream sediment samples were collected from stream M-260 and its tributaries to determine their copper, lead, and zinc content (Table 4). The average element contents, with the standard deviations shown in parentheses, are: 54 ppm (26 ppm) copper, 17 ppm (2.5 ppm) lead, and 180 ppm (23 ppm) zinc. Sample 78 PRUJ 444 contains 110 ppm copper; this is greater than the average plus two standard deviations. The lead and zinc contents are very low and

show little variation between samples. The element concentrations of the stream sediments and rocks are similar.

Stream M-261

Location and Physical Setting

Stream M-261, a west-flowing tributary of Anisak River (Figure 7), is located near 68° 33' 30"N latitude, 159° 39'W longitude, and is in sections 15, 20, 21, and 22 of T 10S, R 33W, Umiat Base and Meridian. It is 2.5 miles long, relatively straight, and has a gradient of approximately 290 feet per mile. The stream bed is composed primarily of cobbles and boulders. The drainage basin has a surface area of approximately 2.0 square miles. Its elevations range from 1,800 to 3,800 feet. The drainage is nearly barren of vegetation.

Geologic Setting

Geologic maps of the prospected area have not been published. Geologic observations, made while prospecting, are discussed in the Bureau of Mines 1978 work section.

Results of the 1977 Geochemical Survey

Anomalously high copper (100 ppm), zinc (300 ppm), and high lead (30 ppm) concentrations occur in stream sediment sample M-261(2).

Bureau of Mines Work in 1978

Stream M-261 was prospected and the geologic relationships were noted from the 3,300-foot col, at the stream's headwaters, to the stream's confluence with the Anisak River. Stream sediment and rock samples were collected.

A northwest-striking, north-dipping sequence of limestones, shales, cherts, and calcarenites crops out in the drainage. Cross-bedding in calcarenite indicates the top of this unit is to the north. A light-grey sucrosic limestone, cut by several thick, N 70° W trending, 60°N dipping diabase sills, predominates

at the headwaters. Shaly chert cobbles occur as float just below the 3,300-foot col. Brown fossiliferous limestone with interbedded black shale is exposed downstream and down-section(?). A thick cross-bedded calcarenite sequence underlies these units. Interbedded calcareous shales and muddy and clean cherts crop out below the calcarenite, between the 2,000-foot elevation of the stream and its confluence with Anisak River. Minor local folding is visible in outcrop along the stream.

Pyrite is the only sulfide mineral found in the drainage. Trace amounts occur as disseminations in the diabase; moderate amounts occur as coarse-grained disseminations, as fine-fracture fillings, and as very fine-grained disseminations, in both the muddy and clean cherts. Large (up to 12-inch diameter) pyrite nodules occur in the calcareous shale. Pyritiferous rock types were sampled for analysis to determine their base metal content (Tables 4 and 5). They include: (1) diabase (78 PRUJ 392), (2) chert (78 PRUJ 403), (3) pyrite nodules (78 PRUJ 400), (4) calcareous shale hosting the nodules (78 PRUJ 399), and (5) shale (78 PRUJ 408) located one-mile downstream from the pyrite nodules. Semiquantitative emission spectrographic analyses of these samples detected 200 ppm copper and 2,000 ppm barium in the diabase (Table 5). Other samples contain less than 20 ppm copper, 10 ppm lead, less than 200 ppm zinc, and 1,000 ppm barium.

Sixteen sediment samples were collected from stream M-261 and from several of its tributaries to determine their copper, lead, and zinc content (Table 4). Average element contents, with standard deviations shown in parentheses, are: 59 ppm (30 ppm) copper, 14 ppm (3.6 ppm) lead, and 310 ppm (240 ppm) zinc. Sample 78 PRUJ 402 contains the highest amount of copper (125 ppm); the other samples contain less than 70 ppm copper. The highest zinc content (1,100 ppm), in sample 78 PRUJ 397, is more than the average value plus two standard deviations. Four of the other samples contain more than 300 ppm zinc. The zinc and copper concentrations in stream sediments are much higher than those in the pyritiferous rocks. The source of these metals remains undetermined.

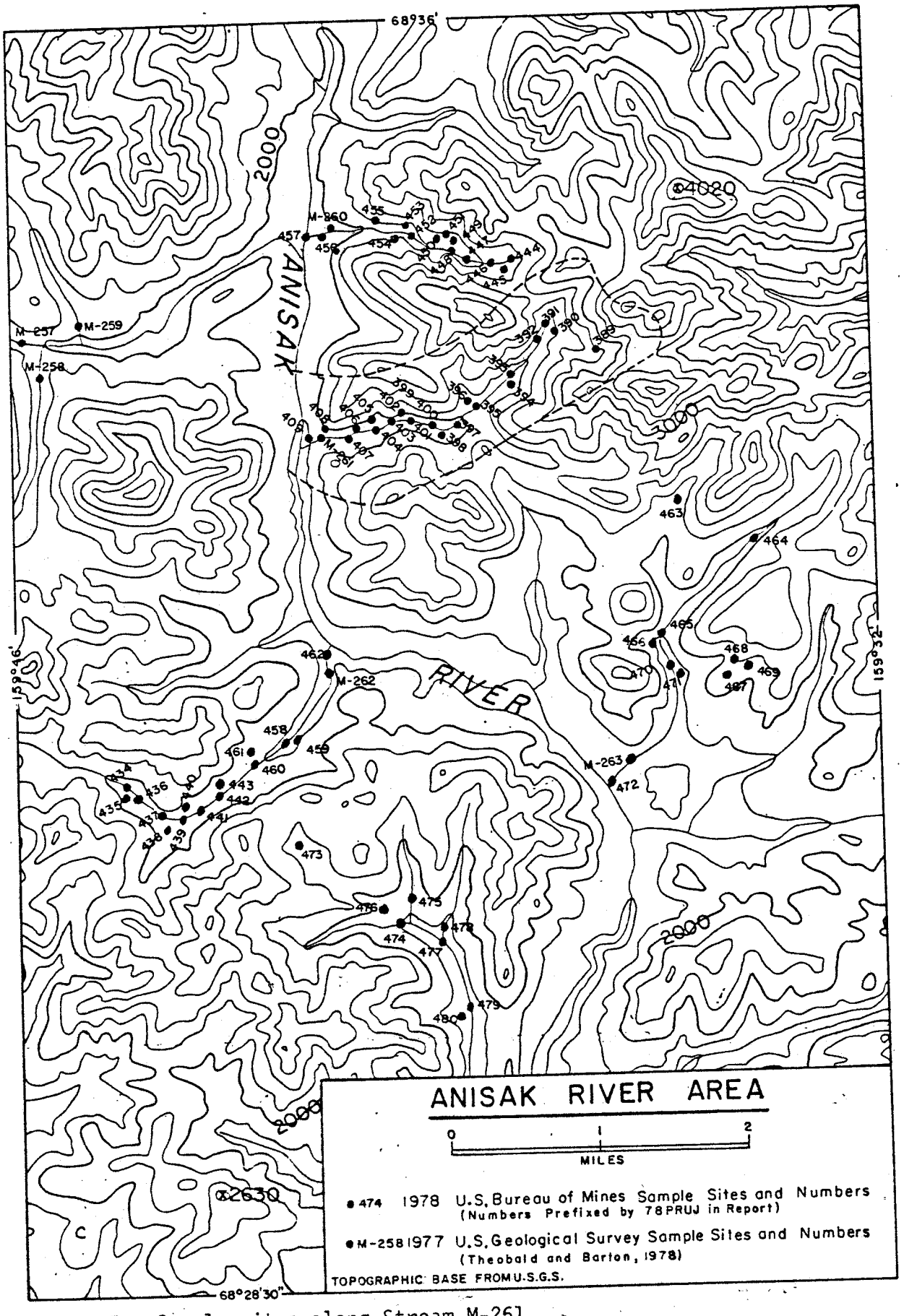


Figure 7. Sample sites along Stream M-261.

Stream M-262

Location and Physical Setting

Stream M-262, a northeast-flowing tributary of Anisak River (Figure 8), is located near 68° 31' 30"N latitude, 159° 43'W longitude, and is in sections 31 and 32 of T 10S, R 33W; section 6 of T 11S, R 33W; section 1 of T 11S, R 34W; and section 36 of T 10S, R 34W, Umiat Base and Meridian. It is 3.5 miles long, relatively straight, and has a gradient of approximately 140 feet per mile. The stream bed is composed primarily of cobbles. The drainage basin has a surface area of approximately 3.5 square miles. Its elevations range from 1,700 to 3,000 feet. The drainage basin is moderately wide, has gentle slopes, and is alpine tundra covered.

Geologic Setting

Geologic maps have not been published for this area. Geologic observations, made while prospecting, are discussed in the 1978 Bureau of Mines work section.

Results of the 1977 Geochemical Survey

Anomalously high copper (100 ppm) and detectable zinc (200 ppm) concentrations are present in stream sediment sample M-262(2).

Bureau of Mines Work in 1978

Stream M-262 was prospected and geologic relationships were noted between the 2,000 and 1,850 foot elevations; stream sediment and rock samples were collected along this segment. Stream sediments were collected from the 1,850 foot elevation to the Anisak River.

A northwest-striking, steeply-dipping sequence of shale and chert crop out along stream M-262. Interbedded black shale and calcareous shale, trending N 70° W and dipping 55° south, outcrop along the stream between the 1,900 to 2,000 foot elevations. Calcareous shale, black chert, pyritiferous muddy chert, and black shale crop out between the 1,800 and 1,900 foot elevations.

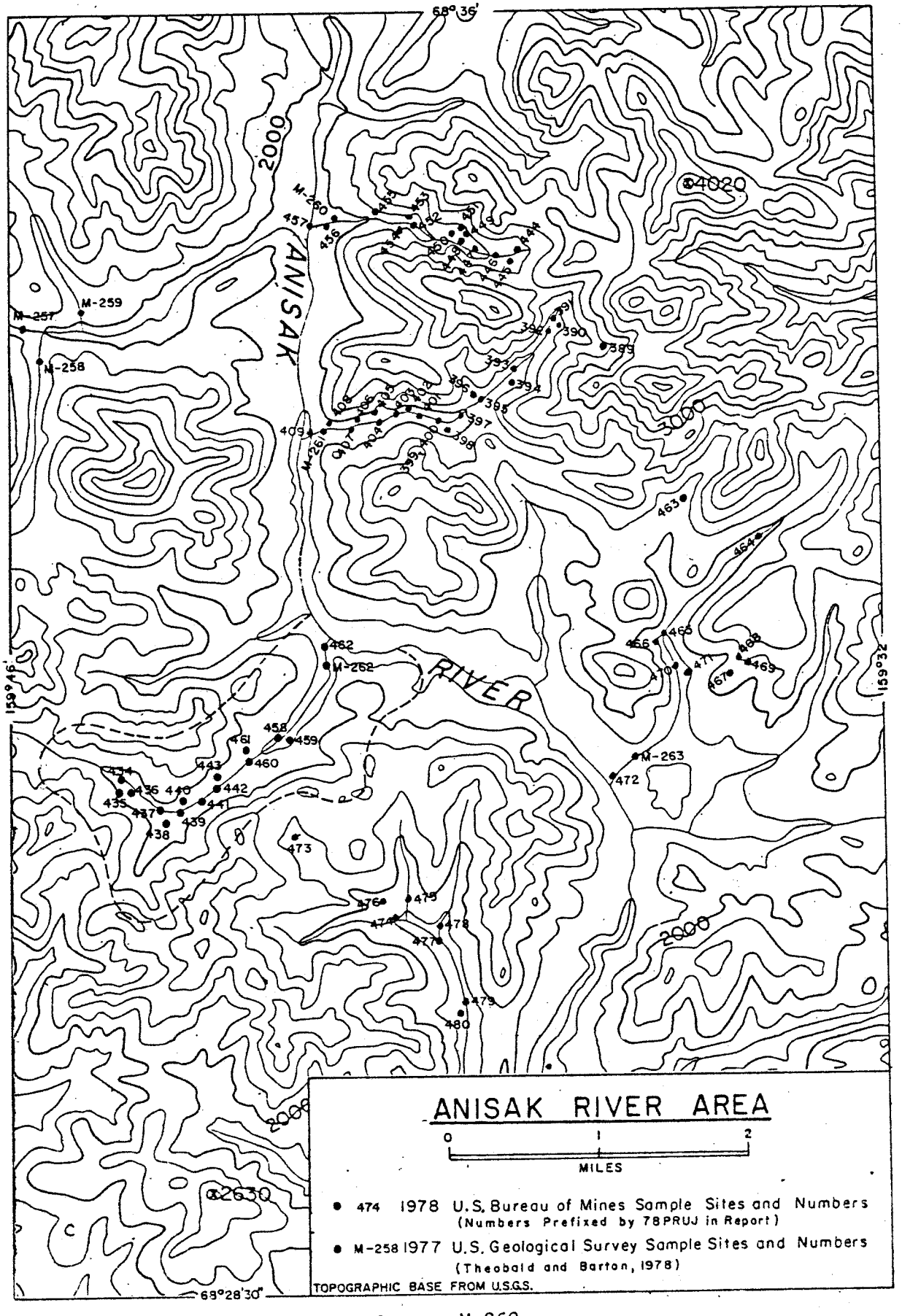


Figure 8. Sample sites along Stream M-262.

Pyrite in the clean and muddy cherts occurs as fine- to coarse-grained disseminations and as fillings in fine fractures.

Black shale (78 PRUJ 435) and pyritiferous muddy chert (78 PRUJ 441) were collected for analysis. The black shale outcrops at the 2,000 foot elevation along the stream. The chert is from a 60-foot thick bed of red-stained pyritiferous muddy chert located at 1,900 feet elevation. Emission spectrographic analyses of these samples (Table 5) show neither contains anomalous copper, lead, or zinc concentrations. The pyritiferous chert contains 5,000 ppm barium.

Thirteen sediment samples were collected from stream M-262 and its tributaries to determine their copper, lead, and zinc content (Table 4). The average element contents, with the standard deviation shown in parentheses, are: 96 ppm (52 ppm) copper, 17 ppm (2.5 ppm) lead, and 420 ppm (230 ppm) zinc. Anomalously high concentrations of zinc (910 ppm) and copper (245 ppm) occur in sediment sample 78 PRUJ 461 which was collected form a small tributary of the main stream. Lower, but still anomalously high, zinc (700 ppm) and copper (105 ppm) concentrations occur in the uppermost sediment sample (78 PRUJ 434) collected from stream M-262. The anomalous tributary and the south-flowing tributaries of stream M-262, above the 2,000 foot elevation, cut the same units. These units may be the source of the copper and zinc. Anomalous concentrations of copper and zinc were not found in float rock or outcrop. The source of the metals remains unknown.

Stream M-263

Location and Physical Setting

Stream M-263, a south-flowing tributary of Anisak River (Figure 9), is located near 68° 32' 30"N latitude, 159° 35'W longitude, and is in sections 23, 24, 26, 27, 34, and 35 of T 10S, R 33W, Umiat Base and Meridian. It is 3 miles long, relatively straight, and has a gradient of about 220 feet per mile. The drainage basin has a surface area of approximately 3.5 square miles. Its elevations range from 1,650 to 3,400 feet. The drainage basin is wide, gently sloping, and alpine tundra covered.

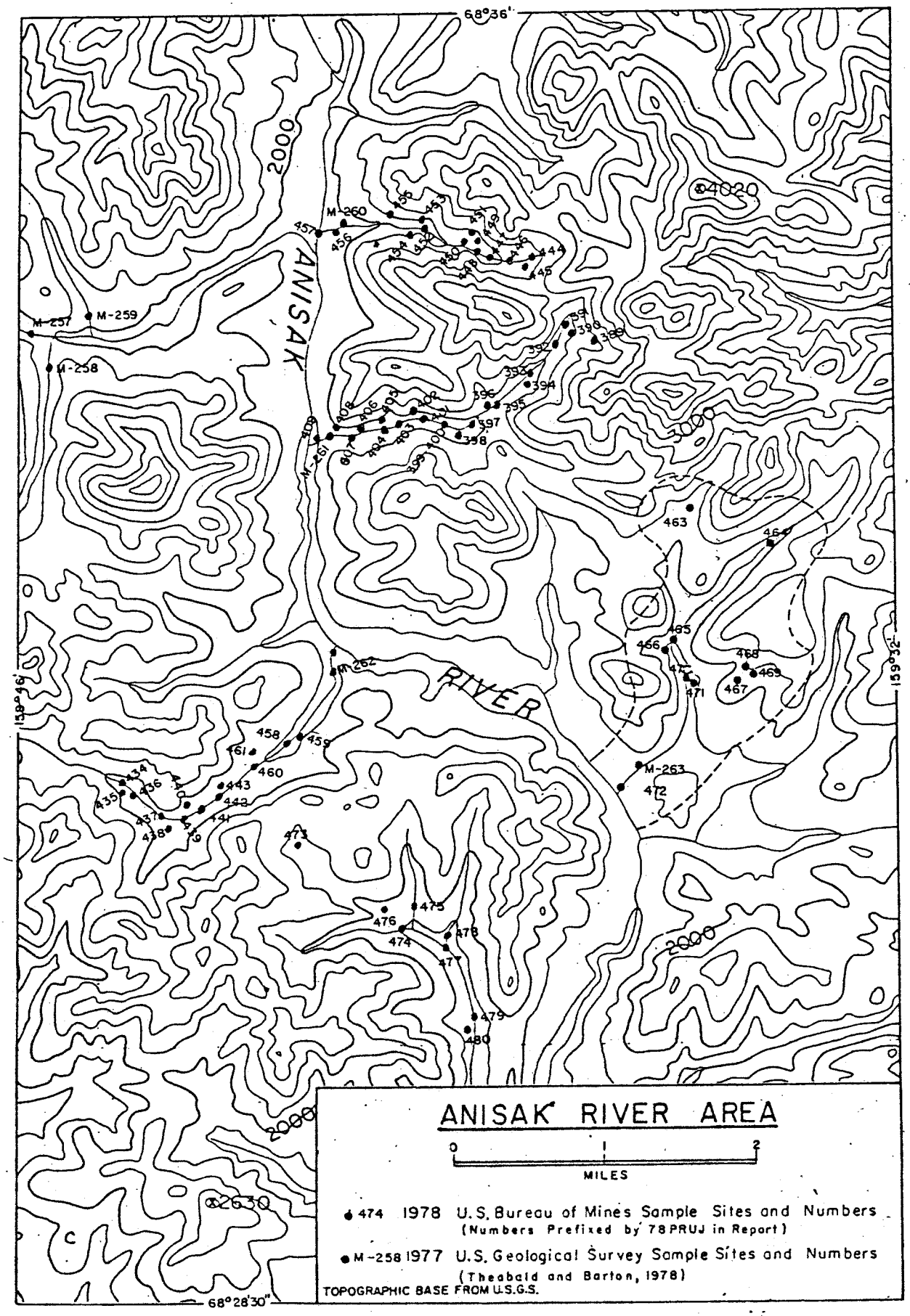


Figure 9. Sample sites along Stream M-263.

Geologic Setting

Geologic maps have not been published for the area. Brief geologic observations, made while sediment sampling, are described in the 1978 Bureau of Mines work section.

Results of the 1977 Geochemical Survey

Detectable zinc (200 ppm) and lead (20 ppm) concentrations are present in the sediment sample M-263(2). An anomalously high zinc (1,500 ppm) concentration is present in the heavy-mineral concentrate of this sample.

Bureau of Mines Work in 1978

Stream sediments were collected from this drainage and geologic relationships were briefly noted from the 2,200 foot elevation of the stream to its confluence with Anisak River. A color anomaly, located on the east side of the drainage basin, was examined and associated soil and rock were sampled.

The northwest-striking, steeply south-dipping, stratigraphic sequence of shale, chert, sandstone, and limestone, which comprise the terrane of the Anisak River area, crops out in this drainage basin. Rock types in the area of the investigated color anomaly are shale, chert, and sandstone. These units trend N 55° W and dip 45° S. The chert and sandstone contain minor amounts of disseminated pyrite. Samples of red-orange (78 PRUJ 468) and yellow-orange (78 PRUJ 467) soil overlying the chert horizon and manganese-oxide coated sandstone (78 PRUJ 469) were collected from the color anomaly. The analytical results (Tables 4 and 5) show soil and rock samples contain lower base metal concentrations than stream sediments from this drainage. The sandstone contains more than 10,000 ppm manganese.

Nine sediment samples were collected from stream M-263 and several of its tributaries to determine their copper, lead, and zinc content (Table 4). The average element contents, with the standard deviations shown in parentheses, are: 41 ppm (16 ppm) copper, 14 ppm (1.7 ppm) lead, and 200 ppm (77 ppm) zinc. Zinc and copper values are low but highly variable. Sample 78 PRUJ 464, the upper most sample collected from the east branch of stream M-263, contains 300 ppm zinc.

Stream M-264

Location and Physical Setting

Stream M-264, an east-flowing tributary of the Anisak River (Figure 10), is located near 68° 30' 30"N latitude, 159° 38'W longitude, and is in the northwestern quarter of T 11S, R 33W, Umiat Base and Meridian. It is 3 miles long, relatively straight, and has a gradient of approximately 100 feet per mile. The drainage basin has a surface area of approximately 5.5 square miles. Its elevations range from 1,600 to 2,800 feet. The drainage occupies a moderately wide, gently sloping, alpine tundra and tussock covered valley. Willow brush is present along the main stream.

Geologic Setting

Geologic maps are not available for the area drained by stream M-264. Observations of rock types and regional structures, made while sediment sampling, are presented in the 1978 Bureau of Mines work section.

Results of the 1977 Geochemical Survey

Anomalously high concentrations of copper (100 ppm) and lead (30 ppm) and detectable zinc (200 ppm) are present in stream sediment sample M-264(2).

Bureau of Mines Work in 1978

Sediment samples were collected from the 2,200 foot elevation of stream M-264 and its confluence with the Anisak River. Geologic relationships were observed while sampling.

The northwest striking, steeply-dipping, stratigraphic sequence of shales, cherts, sandstone, and limestones, that underlie the Anisak River area, is cut by stream M-264.

Eleven sediment samples were collected from stream M-264 and its tributaries to determine their copper, lead, zinc, and barium content (Table 4). The average element contents, with the standard deviation shown in parentheses, are: 78 ppm (25 ppm) copper, 17 ppm (2.6 ppm) lead, 340 ppm (97 ppm) zinc,

and 7,600 ppm (4,800 ppm) barium. High zinc and anomalous copper concentration occur in sediment samples 78 PRUJ 474 and 478, collected from tributaries of the main stream. Zinc content of the sediment samples collected downstream from these tributaries decreases with distance. The source of the zinc and copper remains unidentified.

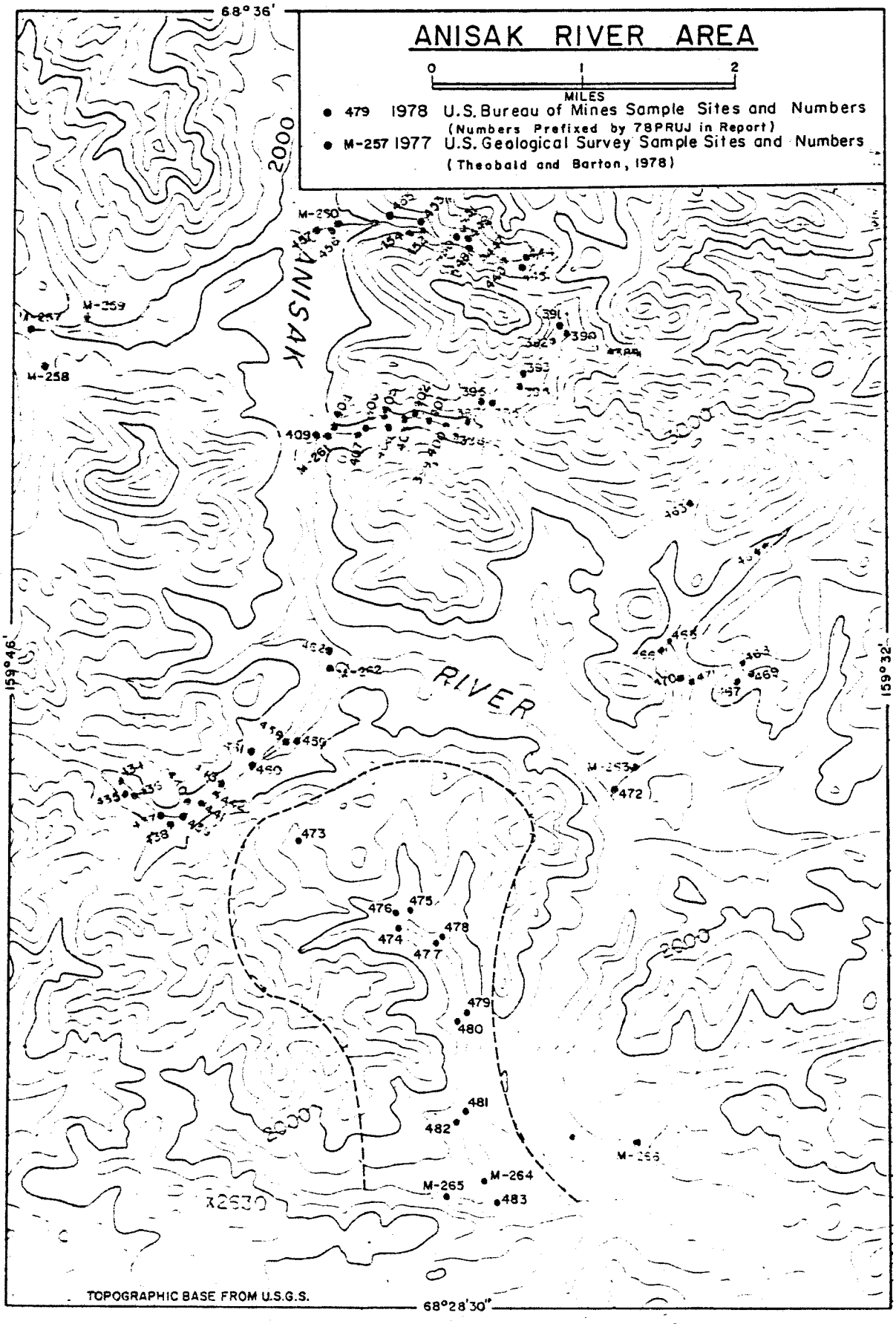


Figure 10. Sample sites along Stream M-264.

Table 4. - Analytical results of the Anisak River area samples
[Values in parts per million]

Sample Number	Elements analyzed Cu	Pb	Zn	Ba	CPS	Sample Type
Stream M-260						
78 PRUJ 444	110	25	155	NA	x	Stream sediment
78 PRUJ 445	50	15	170	NA	x	Stream sediment
78 PRUJ 446	NA	NA	NA	NA	x	Pyritiferous chert
78 PRUJ 447	NA	NA	NA	NA	x	Pyritiferous dolomite
78 PRUJ 448	55	20	210	NA	x	Stream sediment
78 PRUJ 449	65	20	200	NA	x	Stream sediment
78 PRUJ 450	60	20	155	NA	x	Stream sediment
78 PRUJ 451	NA	NA	NA	NA	x	Shale
78 PRUJ 452	40	15	170	NA	x	Stream sediment
78 PRUJ 453	60	15	220	NA	x	Stream sediment
78 PRUJ 454	20	5	180	NA	x	Stream sediment
78 PRUJ 455	NA	NA	NA	NA	x	Pyritiferous chert
78 PRUJ 456	NA	NA	NA	NA	x	Shale
78 PRUJ 457	30	15	190	NA	x	Stream sediment
Stream M-261						
78 PRUJ 389	15	10	145	NA	x	Stream sediment
78 PRUJ 390	35	10	170	NA	x	Stream sediment
78 PRUJ 391	70	15	220	NA	x	Stream sediment
78 PRUJ 392	NA	NA	NA	NA	x	Diabase
78 PRUJ 393	45	10	180	NA	x	Stream sediment
78 PRUJ 394	30	15	120	NA	x	Stream sediment
78 PRUJ 395	40	15	180	NA	x	Stream sediment
78 PRUJ 396	90	15	260	NA	x	Stream sediment
78 PRUJ 397	65	20	1,100	NA	x	Stream sediment
78 PRUJ 398	35	20	200	NA	x	Stream sediment
78 PRUJ 399	NA	NA	NA	NA	x	Pyritiferous shale
78 PRUJ 400	NA	NA	NA	NA	x	Pyrite nodule
78 PRUJ 401	60	15	540	NA	x	Stream sediment
78 PRUJ 402	125	15	285	NA	x	Stream sediment
78 PRUJ 403	NA	NA	NA	NA	x	Pyritiferous chert
78 PRUJ 404	55	15	430	NA	x	Stream sediment
78 PRUJ 405	115	10	130	NA	x	Stream sediment
78 PRUJ 406	60	15	460	NA	x	Stream sediment
78 PRUJ 407	60	20	190	NA	x	Stream sediment
78 PRUJ 408	NA	NA	NA	NA	x	Calcareous shale
78 PRUJ 409	45	10	355	NA	x	Stream sediment

NA - Not analyzed
x - Within range of background values

Table 4. - Analytical results of the Anisak River area samples - Continued
[Values in parts per million]

Sample Number	Elements Analyzed Cu	Pb	Zn	Ba	CPS	Sample Type
Stream M-262						
78 PRUJ 434	105	15	700	NA	x	Stream sediment
78 PRUJ 435	60	20	215	NA	x	Stream sediment
78 PRUJ 436	NA	NA	NA	NA	x	Black shale
78 PRUJ 437	105	15	630	NA	x	Stream sediment
78 PRUJ 438	85	15	235	NA	x	Stream sediment
78 PRUJ 439	95	15	525	NA	x	Stream sediment
78 PRUJ 440	55	20	140	NA	x	Stream sediment
78 PRUJ 441	NA	NA	NA	NA	x	Pyritiferous chert
78 PRUJ 442	95	15	495	NA	x	Stream sediment
78 PRUJ 443	150	20	375	NA	x	Stream sediment
78 PRUJ 458	70	15	365	NA	x	Stream sediment
78 PRUJ 459	60	20	150	NA	x	Stream sediment
78 PRUJ 460	55	15	345	NA	x	Stream sediment
78 PRUJ 461	245	20	910	NA	x	Stream sediment
78 PRUJ 462	75	15	330	NA	x	Stream sediment
Stream M-263						
78 PRUJ 463	60	10	215	NA	x	Stream sediment
78 PRUJ 464	50	15	300	NA	x	Stream sediment
78 PRUJ 465	45	15	215	NA	x	Stream sediment
78 PRUJ 466	15	15	190	NA	x	Stream sediment
78 PRUJ 467	35	15	115	NA	x	Soil
78 PRUJ 468	20	15	45	NA	x	Soil
78 PRUJ 469	NA	NA	NA	NA	x	Pyritiferous sandstone, Mn coated
78 PRUJ 470	45	15	215	NA	x	Stream sediment
78 PRUJ 471	60	15	270	NA	x	Stream sediment
78 PRUJ 472	35	15	230	NA	x	Stream sediment
Stream M-264						
78 PRUJ 473	35	15	230	1,300	x	Stream sediment
78 PRUJ 474	60	15	400	16,000	x	Stream sediment
78 PRUJ 475	110	20	325	5,000	x	Stream sediment
78 PRUJ 476	85	20	300	7,000	x	Stream sediment
78 PRUJ 477	65	15	300	13,000	x	Stream sediment
78 PRUJ 478	100	15	600	3,200	x	Stream sediment
78 PRUJ 479	65	15	330	14,000	x	Stream sediment
78 PRUJ 480	95	20	320	7,000	x	Stream sediment
78 PRUJ 481	70	15	320	8,500	x	Stream sediment
78 PRUJ 482	60	20	300	2,600	x	Stream sediment
78 PRUJ 483	110	20	270	6,100	x	Stream sediment

NA - Not analyzed
x - Within range of background values

Table 5. - Emission spectrographic results of Anisak River area samples
[Values in parts per million unless otherwise noted]

Element	Sample numbers		
	78 PRUJ 392 Diabase	78 PRUJ 399 Calcareous shale	78 PRUJ 400 Pyrite nodule
Fe	10%	5%	10%
Ca	5%	0.03%	0.15%
Mg	5%	1%	0.1 %
Ag	<1	<1	<1
As	<500	<500	<500
B	10	50	15
Ba	2,000	1,000	20
Be	<2	<2	<2
Bi	<10	<10	<10
Cd	<50	<50	<50
Co	20	<5	<5
Cr	70	30	<10
Cu	200	20	5
Ga	10	10	<10
Ge	<20	<20	<20
La	<20	30	<20
Mn	2,000	50	1,500
Mo	<2	2	2
Nb	20	20	<20
Ni	50	20	5
Pb	<10	10	<10
Sb	<100	<100	<100
Sc	20	10	<10
Sn	<10	<10	<10
Sr	200	100	100
Ti	5,000	2,000	20
V	200	150	<10
W	<50	<50	<50
Y	10	10	<10
Zn	<200	<200	<200
Zr	<20	50	<20

Table 5. - Emission spectrographic results of Anisak River area samples - Continued
[Values in parts per million unless otherwise noted]

Element	Sample numbers		
	78 PRUJ 403 Pyritiferous chert	78 PRUJ 408 Calcareous shale	78 PRUJ 436 Black Shale
Fe	1%	3%	7%
Ca	0.05%	5%	0.05%
Mg	0.2 %	0.5%	0.5%
Ag	1	<1	<1
As	<500	<500	<500
B	20	30	50
Ba	1,000	300	700
Be	<2	<2	2
Bi	<10	<10	<10
Cd	<50	<50	<50
Co	<5	5	5
Cr	10	10	30
Cu	20	5	20
Ga	<10	<10	10
Ge	<20	<20	<20
La	20	20	20
Mn	50	200	500
Mo	2	<2	2
Nb	<20	20	20
Ni	10	20	50
Pb	<10	10	10
Sb	<100	<100	<100
Sc	<10	<10	10
Sn	<10	<10	<10
Sr	100	300	100
Ti	1,000	3,000	5,000
V	100	50	100
W	<50	<50	<50
Y	<10	10	10
Zn	<200	<200	<200
Zr	20	100	100

Table 5. - Emission spectrographic results of Anisak River area samples - Continued
[Values in parts per million unless otherwise noted]

Element	Sample numbers		
	78 PRUJ 441 Pyritiferous chert	78 PRUJ 446 Pyritiferous chert	78 PRUJ 447 Pyritiferous dolomite
Fe	2%	2%	20%
Ca	0.02%	0.1%	0.2%
Mg	0.5%	0.7%	1%
Ag	<1	<1	<1
As	<500	<500	<500
B	50	10	20
Ba	5,000	5,000	500
Be	<2	<2	<2
Bi	<10	<10	<10
Cd	<50	<50	<50
Co	<5	5	<5
Cr	20	15	<10
Cu	15	50	2
Ga	<10	<10	10
Ge	<20	<20	<20
La	20	50	<20
Mn	150	1,000	2,000
Mo	2	2	10
Nb	20	20	20
Ni	50	50	5
Pb	<10	<10	<10
Sb	<100	<100	<100
Sc	10	10	<10
Sn	<10	<10	20
Sr	100	100	<100
Ti	3,000	1,500	100
V	100	100	10
W	<50	<50	<50
Y	<10	<10	<10
Zn	<200	<200	<200
Zr	50	50	<20

Table 5. - Emission spectrographic results of Anisak River area samples - Continued
[Values in parts per million unless otherwise noted]

Elements	Sample numbers			
	78 PRUJ 451 Shale	78 PRUJ 455 Pyritiferous chert	78 PRUJ 456 Shale	78 PRUJ 469 Pyritiferous sandstone
Fe	5%	1%	5%	7%
Ca	0.05%	0.15%	1%	10%
Mg	0.7%	0.1%	0.5%	2%
Ag	<1	1	<1	<1
As	<500	<500	<500	<500
B	50	10	50	<10
Ba	2,000	2,000	500	500
Be	2	<2	2	<2
Bi	<10	<10	<10	<10
Cd	<50	<50	<50	<50
Co	<5	<5	5	5
Cr	20	10	20	10
Cu	20	20	10	10
Ga	10	<10	<10	<10
Ge	<20	<20	<20	<20
La	20	20	50	<20
Mn	100	1,000	100	>10,000
Mo	2	7	<2	5
Nb	20	<20	20	20
Ni	30	20	30	30
Pb	10	<10	<10	<10
Sb	<100	<100	<100	<100
Sc	10	<10	10	<10
Sn	<10	<10	<10	<10
Sr	100	200	100	500
Ti	2,000	500	2,000	1,000
V	150	70	100	50
W	<50	<50	<50	<50
Y	<10	<10	10	10
Zn	<200	<200	<200	<200
Zr	100	20	100	30

Trail Creek Area (M-124)

Stream sediment sample M-124 contains detectable silver and zinc concentrations(2). This drainage was prospected and sampled between the 1,750 foot elevation and the stream mouth.

Location and Physical Setting

Stream M-124 is located near 68° 22' 30"N latitude, 160° 58'W longitude, in sections 25 and 26 of T 12S, R 39W, Umiat Base and Meridian, and in section 10 of T 34N, R 9W, Kateel River Base and Meridian. This location, between Trail Creek and Kugururok River, is 10 miles south of the NPR-A.

The prospected area is within the DeLong Mountains section of the Arctic Mountains Physiographic Province(4). Stream M-124 drains a 2-mile long box canyon (Figure 11). The canyon walls are nearly vertical, rise approximately 2,100 feet above the stream bed, and are barren of vegetation. Elevations in the area range from 1,400 to 3,700 feet.

Stream M-124 is a 2-mile long, southeast-flowing tributary of a southwest-flowing tributary of Trail Creek. The stream is relatively straight and has a gradient of approximately 430 feet per mile. The stream bed is comprised of angular boulders at the upper end of the canyon and cobbles at the lower end. The surface area of the drainage basin is approximately 2.6 square miles. Dense willow brush, alpine tundra vegetation, and tussocks grow along the valley floor near the stream mouth.

Regional Geology

Published geologic maps are not available for the Trail Creek area. Geologic relationships, noted while prospecting, are discussed in the 1978 Bureau of Mines work section.

Results of the 1977 Geochemical Survey

Anomalous silver (1.0 ppm) and detectable zinc (200 ppm) concentrations are present in stream sediment sample M-124(2).

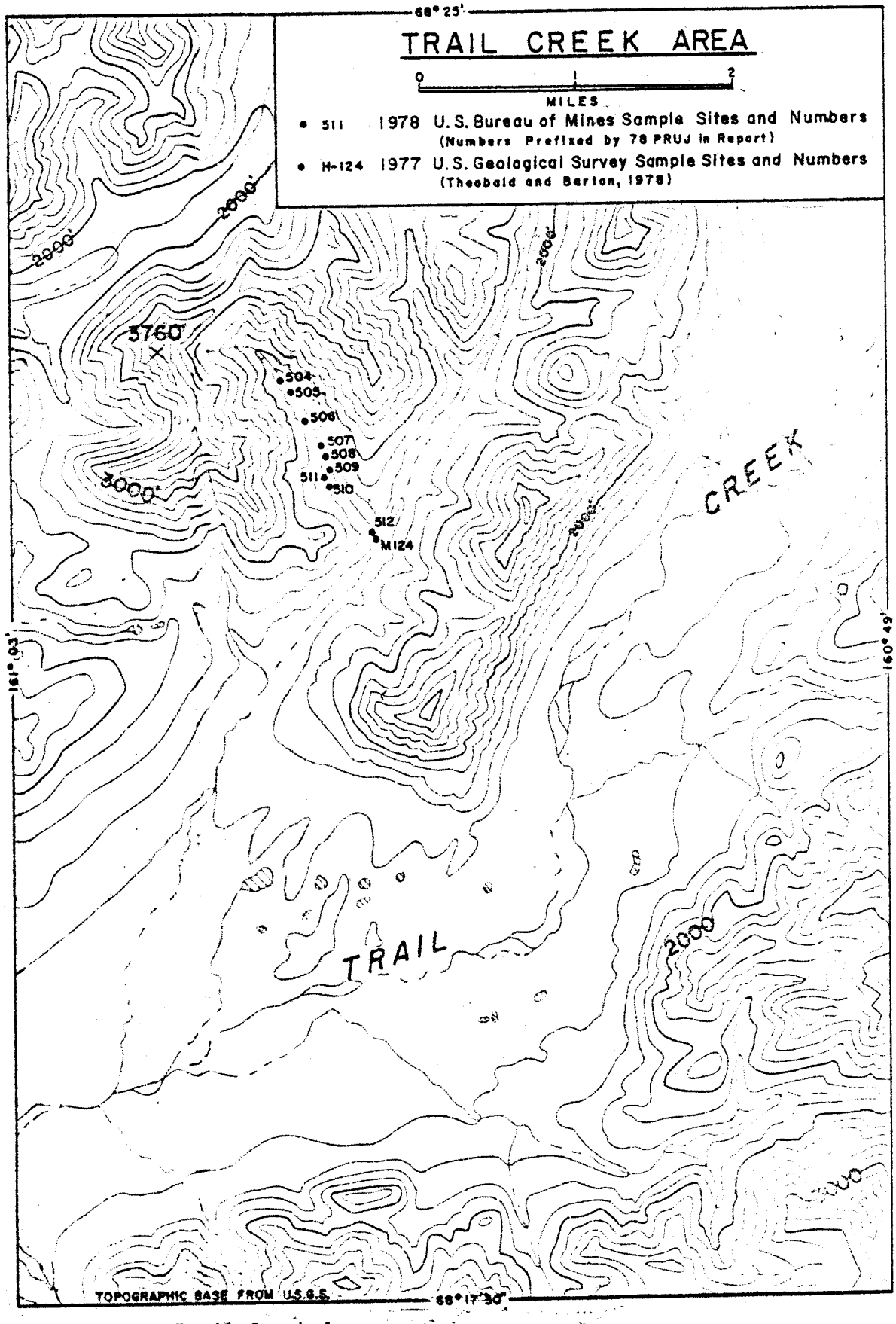


Figure 11. Trail Creek Area

Stream M-124 was prospected, geologic relationships noted, and stream sediment and rock samples collected.

The stream cuts a thick, nearly undeformed, northeast-striking, shallowly north-dipping sequence of interbedded fossiliferous limestone, dolomite, calcareous shale, and minor chert. A calcareous shale (78 PRUJ 506) was sampled to determine its metal content.

Fine- to coarse-grained disseminated pyrite occurs in both limestone and chert. Pyrite nodules, up to 1 inch in diameter, are common in chert float rock. Fine-grained disseminated pyrite was also found in the matrix of a piece of conglomerate float rock. Pyritiferous chert and limestone are common; the conglomerate is rare.

Five stream sediment and four rock samples were collected for analysis to determine their copper, lead, zinc, silver, and barium content (Table 6 and 7). The average element contents in the stream sediments, with the standard deviations shown in parentheses, are: copper 54 ppm (6.5 ppm), lead 16 ppm (4.2 ppm), zinc 230 ppm (38 ppm), silver 0.7 ppm (0.4 ppm), and barium 1,600 ppm (830 ppm). The element contents, and standard deviations, of the rock samples are: copper 11 ppm (8.1 ppm), lead <10 ppm, zinc <200 ppm, silver <1 ppm, and barium 450 ppm (400 ppm). The manganese content of these samples is highly variable; the maximum content is 5,000 ppm. The element concentrations of the sediment samples are similar. Anomalous element concentrations do not occur in sediment or rock samples.

Table 6. - Analytical results of Trail Creek area samples
[Values in parts per million]

Sample Number	Elements analyzed						
	Cu	Pb	Zn	Ba	Ag	CPS	Sample Type
78 PRUJ 504	50	15	295	900	1.4	x	Stream sediment
78 PRUJ 505	NA	NA	NA	NA	NA	x	Pyritiferous dolomite
78 PRUJ 506	NA	NA	NA	NA	NA	x	Calcareous shale
78 PRUJ 507	NA	NA	NA	NA	NA	x	Limestone conglomerate
78 PRUJ 508	NA	NA	NA	NA	NA	x	Pyritiferous chert
78 PRUJ 509	50	15	220	1,300	.6	x	Stream sediment
78 PRUJ 510	65	20	245	3,000	.6	x	Stream sediment
78 PRUJ 511	55	20	210	1,600	.2	x	Stream sediment
78 PRUJ 512	50	10	215	1,100	.6	x	Stream sediment

NA - Not analyzed
x - Within background range of values

Table 7. - Emission spectrographic results of Trail Creek area samples
[Values in parts per million unless otherwise noted]

Element	Sample numbers			
	78 PRUJ 505 Pyritiferous dolomite	78 PRUJ 506 Calcareous shale	78 PRUJ 507 Limestone	78 PRUJ 508 Pyritiferous chert
Fe	7%	7%	15%	2%
Ca	15%	1%	5%	0.5%
Mg	0.5%	1%	2%	0.5%
Ag	<1	<1	<1	<1
As	<500	<500	<500	<500
B	10	30	20	10
Ba	100	1,000	200	500
Be	<2	<2	<2	<2
Bi	<10	<10	<10	<10
Cd	<50	<50	<50	<50
Co	<5	10	5	<5
Cr	<10	50	15	<10
Cu	3	20	5	15
Ga	<10	10	<10	<10
Ge	<20	<20	<20	<20
La	<20	<20	<20	20
Mn	1,500	1,000	5,000	200
Mo	2	2	3	5
Nb	<20	20	20	<20
Ni	10	30	20	20
Pb	10	10	<10	<10
Sb	<100	<100	<100	<100
Sc	<10	15	<10	<10
Sn	<10	<10	<10	<10
Sr	300	100	100	300
Ti	1,000	3,000	1,000	700
V	10	150	20	70
W	<50	<50	<50	<50
Y	<10	10	50	<10
Zn	<200	<200	<200	<200
Zr	20	100	20	50

Nunaviksak Creek Area (M-33)

A high copper content occurs in stream sediment sample M-33(2). The headwaters of the sampled creek are in the NPR-A; the prospected section of the stream is south of the NPR-A. Anomalous element concentrations were not found in samples collected in 1978.

Location and Physical Setting

Stream M-33 is located near 68° 33' 40"N latitude, 161° 27'W longitude, and is in sections 14, 15, 22, 23, 26, and 27 of T 10S, R 41W, Umiat Base and Meridian. The prospected area is between the southern NPR-A boundary and Nunaviksak Creek.

Stream M-33 is within the DeLong Mountains section of the Arctic Mountains Physiographic Province(4). This area is characterized by deeply incised, steep-walled canyons (Figure 12). Elevations in the area range from 1,650 to 4,100 feet.

Stream M-33 is an approximately 4-mile long, south-flowing tributary of Nunaviksak Creek. The prospected stream is relatively straight, occupies a deep, steep-walled narrow canyon and has a gradient of approximately 220 feet per mile. The stream bed consists primarily of cobbles and boulders. The surface area of the drainage basin is approximately 4.5 square miles.

Regional Geology

Stream M-33 is underlain entirely by Mississippian Lisburne Group sedimentary rocks(1). The rock types include beds of crinoidal limestone, with local black chert nodules and beds, and sandy limestone, with local sandstone and shale members. These rocks are mapped as part of the Kelly River thrust sequence.

Results of the 1977 Geochemical Survey

Sample M-33 contains 300 ppm copper; this is the highest copper concentration found by the 1977 survey. The copper content in the pan-concentrate is

30 ppm. The stream sediment also contains detectable zinc (200 ppm) and high lead (50 ppm) concentrations.

Bureau of Mines Work in 1978

Stream M-33 was prospected and geologic relationships noted from near its headwaters to its confluence with Nunaviksak Creek. Rock and stream sediment samples were collected from the main drainage and its tributaries.

Orange- and grey-weathering carbonates and minor shales and chert outcrop along the prospected drainage. Chert is common in a greengrey limestone and a grey-weathering fossiliferous limestone. The float rock in the tributaries is primarily orange-weathering fossiliferous limestone. Systematic changes in attitudes of rock strata and a repeat of rock types along the creek indicate a large anticlinal structure.

Fourteen stream sediment samples and a calcareous shale (78 PRUJ 414) sample were collected for analysis to detemine their copper, lead, and zinc content (Tables 8 and 9). The average element contents of the stream sediments, with the standard deviations shown in parentheses, are: copper 14 ppm (9.4 ppm), lead 8.2 ppm (2.5 ppm), and zinc 77 ppm (23 ppm). Higher zinc concentrations are present in samples collected near the headwaters of the stream. The zinc content is lower than the regional average. The calcareous shale and stream sediments contain similar element concentrations.

The source of the copper in the 1977 sample is not known. Site M-33 was resampled but high copper values were not reproduced.

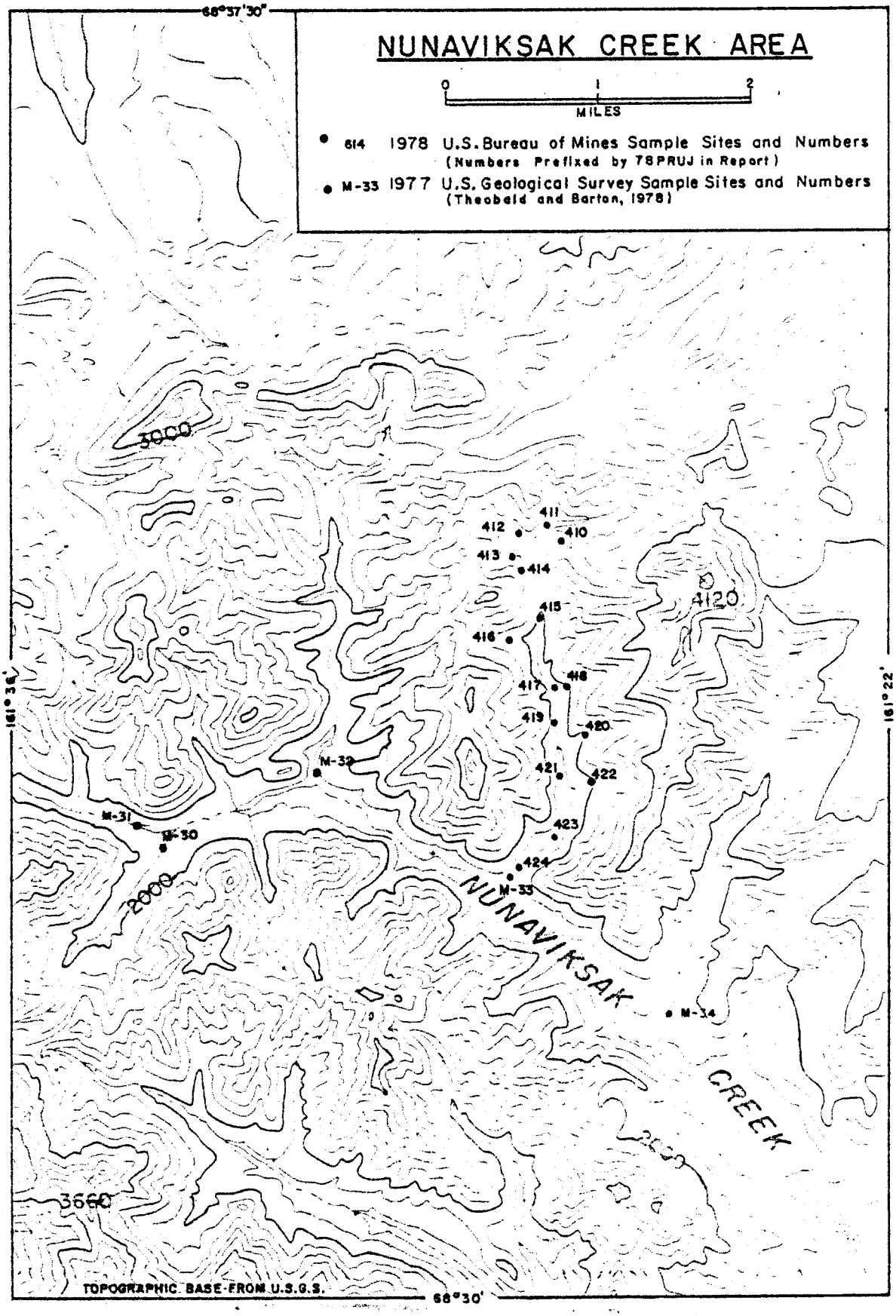


Figure 12. Nunaviksak Creek Area

Table 8. - Analytical results of Nunaviksak Creek area samples
[Values in parts per million]

Sample Number	Elements Analyzed Cu	Pb	Zn	CPS	Sample Type
78 PRUJ 410	15	10	115	x	Stream sediment
78 PRUJ 411	20	10	80	x	Stream sediment
78 PRUJ 412	35	10	100	x	Stream sediment
78 PRUJ 413	30	10	120	x	Stream sediment
78 PRUJ 414	NA	NA	NA	x	Calcareous shale
78 PRUJ 415	20	10	85	x	Stream sediment
78 PRUJ 416	5	10	65	x	Stream sediment
78 PRUJ 417	10	10	75	x	Stream sediment
78 PRUJ 418	5	5	40	x	Stream sediment
78 PRUJ 419	15	10	70	x	Stream sediment
78 PRUJ 420	5	5	40	x	Stream sediment
78 PRUJ 421	15	10	75	x	Stream sediment
78 PRUJ 422	5	5	80	x	Stream sediment
78 PRUJ 423	10	5	65	x	Stream sediment
78 PRUJ 424	10	5	65	x	Stream sediment

NA - Not analyzed
x - Within background range of values

Table 9. - Emission spectrographic results of Nunaviksak Creek area sample
[Values in parts per million unless otherwise noted]

Element	Sample Number
	78 PRUJ 414 Calcareous shale
Fe	5%
Ca	1%
Mg	2%
Ag	<1
As	<500
B	15
Ba	500
Be	<2
Bi	<10
Cd	<50
Co	5
Cr	150
Cu	20
Ga	<10
Ge	<20
La	20
Mn	700
Mo	<2
Nb	<20
Ni	70
Pb	<10
Sb	<100
Sc	10
Sn	<10
Sr	100
Ti	2,000
V	70
W	<50
Y	<10
Zn	<200
Zr	200

Ignisirok Creek Area (M-202)

Anomalously high zinc, barium, and high lead concentrations occur in stream sediment sample M-202(2). Prospecting and geochemical sampling were conducted along this tributary of Ignisirok Creek. Anomalous copper and zinc concentrations occur in the 1978 stream sediment samples. The source of these elements was not identified.

Location and Physical Setting

Stream M-202 is located between Ignisirok Creek and Anisak River. The prospected area centers near 68° 33' 30"N latitude, 159° 52'W longitude, and is in sections 21, 22, 28, 29, and 32 of T 10S, R 34W, Umiat Base and Meridian. The prospected area is approximately 6 miles south of the NPR-A.

The Ignisirok area is within the DeLong Mountains section of the Arctic Mountains Physiographic Province(4). Steep barren mountain slopes characterize the upper elevations along the stream. Elevations in the area range from 1,400 to 3,600 feet (Figure 13).

Stream M-202 is a 4-mile long southwest-flowing tributary of Ignisirok Creek. The stream is relatively straight and has a gradient of about 240 feet per mile. The stream bed is composed primarily of cobbles. The surface area of the drainage basin is approximately 7.6 square miles. Dense willow brush grows along the stream.

Results of the 1977 Geochemical Survey

Anomalously high zinc (300 ppm), barium (20,000 ppm) and high lead (30 ppm) concentrations are present in stream sediment sample M-202(2).

Bureau of Mines Work in 1978

Stream M-202 was prospected, geologic relationships noted, and rock, soil, and sediment samples were collected from its headwaters to its confluence with Ignisirok Creek. Sediment samples were also collected from tributary streams.

Sedimentary rocks outcrop along the traversed drainage. Carbonaceous and graphitic shale, siliceous mudstone, and pyritiferous chert crop out along the

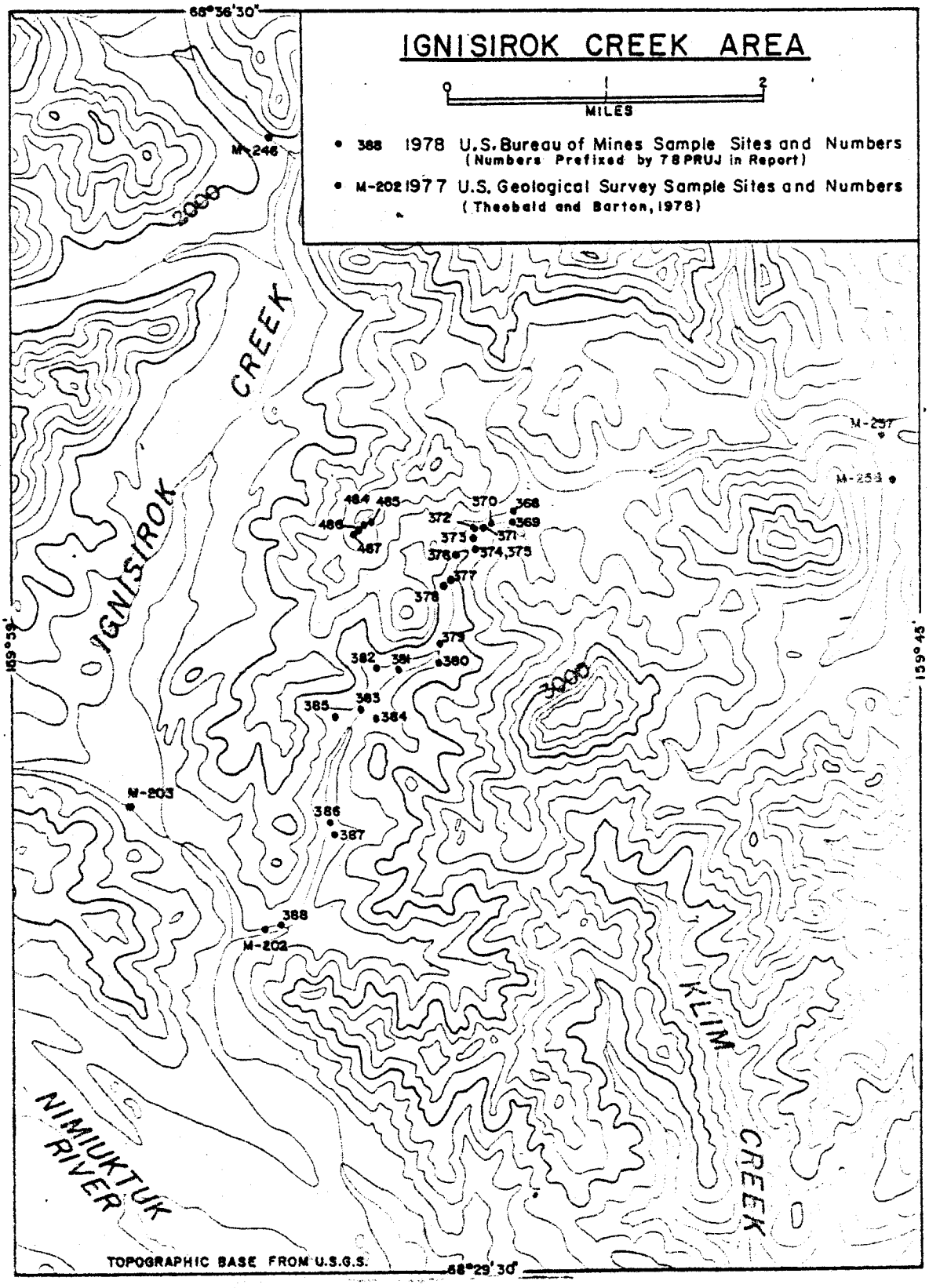


Figure 13. Ignisirok Creek Area

headwaters segment of the drainage. Some float cobbles of this material contain up to 50 percent pyrite. Tan-weathering grey fossiliferous limestone crops out downstream from the shale. Iron-oxide precipitate forms ferruginous breccia immediately downstream from this limestone. Highly pyritiferous (estimated 30 percent pyrite) siliceous rocks and limestone (78 PRUJ 375) containing pyritized fossil corals(?) (78 PRUJ 373) crop out downstream from this limestone. Numerous limestone (78 PRUJ 376) and chert fragments, containing an unidentified green mineral, are present in the area downstream from the pyritiferous rock. Grey fossiliferous limestone crops out along the lower segment of the creek; minor amounts of carbonaceous graphitic shale and orange-weathering fossiliferous and nonfossiliferous limestone are also present.

The pyrite content of the bedrock changes noticeably along this drainage. Rocks along the upper third of the drainage are much more pyritiferous than those from the lower segment of the drainage. A marked decrease in the pyrite content of the bedrock occurs downstream from the pyritiferous grey carbonate beds.

A brightly stained, yellow-orange colored, slope, located near the crest of a ridge on the northwest side of stream M-202 at 68° 33' 40"N latitude, 159° 53"W longitude, in section 21 of T 10S, R 34W, Umiat Base and Meridian, was examined for base metal mineralization. Yellow-orange (78 PRUJ 485), red-orange (78 PRUJ 487), and brown (78 PRUJ 486) stained soils were sampled for chemical analysis. Pyritiferous chert float (78 PRUJ 484) is present in the stained area and may comprise bedrock. Fossiliferous limestone occurs adjacent to the stain zone. Base metal sulfides were not found.

Sixteen stream sediment, five soil, and four rock samples were collected for analysis (Table 10 and 11). The sediment samples are from the main drainage and its tributaries. The average element contents of the stream sediments, with the standard deviations shown in parentheses, are: copper 66 ppm (43 ppm), lead 13 ppm (6.6 ppm), zinc 350 ppm (89 ppm), and barium 4,500 ppm (3,500 ppm). For soil samples the values are: copper 58 ppm (35 ppm), lead 16 ppm (6.5 ppm), zinc 170 ppm (120 ppm), and barium 3,000 ppm (2,300 ppm). The most noticeable difference between the stream sediment and soil samples is the lower zinc and barium content in the soil samples. Three of the four soil samples from the "color" anomaly yield low zinc and barium values. Soil samples 78 PRUJ 370 and 374, outside the "color" anomaly, contain element values similar to those of the stream sediments. Emission spectrographic analyses of the rocks show

that the pyritiferous chert (78 PRUJ 484) contains 10,000 ppm barium but no unusual concentrations of base metals.

A zinc-oxide colorimetric test solution was used extensively but no positive reactions were observed.

Table 10. - Analytical results of the Ignisirok Creek area samples
[Values in parts per million]

Sample Number	Elements Analyzed					Sample Type
	Cu	Pb	Zn	Ba	CPS	
78 PRUJ 368	90	25	195	5,000	x	Stream sediment
78 PRUJ 369	35	5	265	1,000	x	Stream sediment
78 PRUJ 370	95	25	370	7,000	x	Soil
78 PRUJ 371	40	5	265	1,200	x	Stream sediment
78 PRUJ 372	75	15	305	3,600	x	Stream sediment
78 PRUJ 373	NA	NA	NA	NA	x	Pyrite
78 PRUJ 374	15	10	175	1,100	x	Soil
78 PRUJ 375	NA	NA	NA	NA	x	Pyritiferous limestone
78 PRUJ 376	NA	NA	NA	NA	x	Limestone with unidentified green mineral
78 PRUJ 377	50	10	355	1,800	x	Stream sediment
78 PRUJ 378	55	15	210	3,200	x	Stream sediment
78 PRUJ 379	55	10	475	2,200	x	Stream sediment
78 PRUJ 380	215	30	415	14,000	x	Stream sediment
78 PRUJ 381	50	10	350	3,000	x	Stream sediment
78 PRUJ 382	30	15	365	1,900	x	Stream sediment
78 PRUJ 383	50	10	380	2,500	x	Stream sediment
78 PRUJ 384	90	15	370	10,000	x	Stream sediment
78 PRUJ 385	50	10	440	2,600	x	Stream sediment
78 PRUJ 386	65	10	500	6,000	x	Stream sediment
78 PRUJ 387	45	15	315	6,400	x	Stream sediment
78 PRUJ 388	65	10	430	8,000	x	Stream sediment
78 PRUJ 484	NA	NA	NA	NA	x	Pyritiferous chert
78 PRUJ 485	60	15	135	2,300	x	Soil
78 PRUJ 486	90	20	100	2,500	x	Soil
78 PRUJ 487	30	10	55	2,000	x	Soil

NA - Not analyzed
x - Within background range of values

Table 11. - Emission spectrographic analyses of Ignisirok Creek area samples
[Values in parts per million unless otherwise noted]

Element	Sample numbers			
	78 PRUJ 373 Pyrite	78 PRUJ 375 Pyritiferous limestone	78 PRUJ 376 Limestone	78 PRUJ 484 Pyritiferous chert
Fe	15%	15%	5%	1%
Ca	0.15%	15%	10%	0.03%
Mg	0.1%	0.5%	2%	0.2%
Ag	<1	<1	<1	<1
As	<500	<500	<500	<500
B	15	10	<10	20
Ba	10	30	20	>10,000
Be	<2	<2	<2	<2
Bi	<10	<10	<10	<10
Cd	<50	<50	<50	<50
Co	<5	<5	50	<5
Cr	20	<10	1,500	10
Cu	10	2	3	30
Ga	<10	<10	<10	<10
Ge	<20	<20	<20	<20
La	<20	<20	<20	30
Mn	100	1,000	1,500	100
Mo	7	20	2	2
Nb	20	20	<20	<20
Ni	10	10	700	10
Pb	<10	<10	<10	<10
Sb	<100	<100	<100	<100
Sc	<10	<10	<10	<10
Sn	<10	<10	<10	<10
Sr	<100	<100	200	200
Ti	100	100	150	1,000
V	10	10	30	50
W	<50	<50	<50	<50
Y	<10	<10	<10	<10
Zn	<200	<200	<200	<200
Zr	<20	<20	<20	70

Sphinx Mountain Area (M-79, M-115, M-116)

Prospecting and geochemical sampling were conducted along three drainages in the Sphinx Mountain area. Results of the 1977 geochemical survey identified anomalously high concentrations of molybdenum in stream M-116, high zinc and manganese in stream M-115, and barium and molybdenum in stream M-79(2). Anomalously high copper and zinc concentrations occur in sediments from streams M-115 and M-116. Sources of these elements were not found. Further prospecting is recommended.

The Sphinx Mountain area is on the north flank of the DeLong Mountains, immediately north of Kogruk Creek and approximately one-half mile north of the NPR-A's southern boundary. The area is within the DeLong Mountains section of the Arctic Mountains Physiographic Province(4).

Two major rock sequences are recognized in the area(1). Mississippian Lisburne Group limestone, with local black chert nodules and beds, and sandy limestone, with local sandstone and shale, underlie the study area. These rock units are part of the Kelly River sequence which has been thrust over an undifferentiated sequence of Lower Cretaceous-Mississippian wacke, mudstone, chert, and shale of the Northwestern Brooks Range thrust sequence. The latter thrust sequence is exposed in an east-west trending belt on the north side of Sphinx Mountain.

Three drainages, from which the 1977 samples contained anomalous element concentrations, were prospected and sampled in 1978. The streams were traversed from their headwaters to the 1977 sample sites. Stream sediment samples were collected from the main streams and tributaries. Geology was not mapped; rock types, their distribution, and attitudes were noted. Drainages from which highly anomalous sediment samples were collected in 1978 were prospected subsequently. The three prospected drainages are discussed separately in sections titled East (M-116), Central (M-115), and West (M-79) Sphinx Mountain.

East Sphinx Mountain Area (M-116)

Location and Physical Setting

Stream M-116 on the western flank of Sphinx Mountain (Figure 14) is located near 68° 34'N latitude, 160° 54'W longitude, and is in sections 18 and 19, T 10S, R 38W, Umiat Base and Meridian.

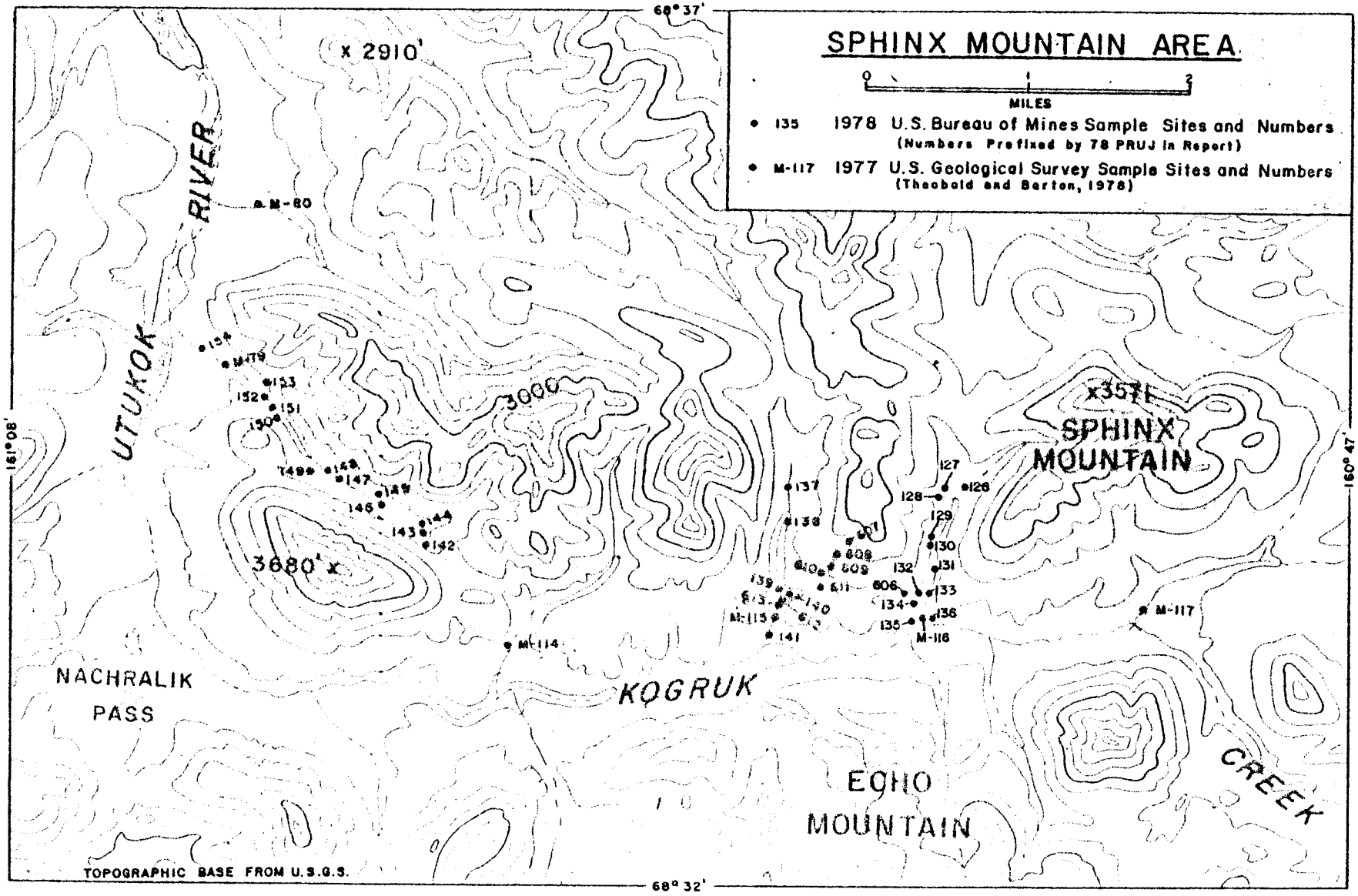


Figure 14. Sample sites along Stream M-116.

Stream M-116 is a 2-mile long south-flowing tributary of Kogruk Creek. It is relatively straight and has a gradient of about 100 feet per mile. The stream bed is composed primarily of cobbles and boulders. The surface area of the drainage basin is approximately 2 square miles.

The drainage is characterized by high, steep-sided, barren limestone mountains which give way at lower elevations to gentle, alpine tundra covered slopes. Elevations range from 2,300 to 3,600 feet.

Local Geologic Setting

Generally east-west striking black carbonaceous shale (78 PRUJ 130), pyritiferous chert (78 PRUJ 132), and light-grey to greenish-grey shale (78 PRUJ 135) crop out in the drainage. Diabase was found as float rock; its apparent source is from near the tops of the ridges of Sphinx Mountain.

Results of the 1977 Geochemical Survey

High lead (50 ppm) and molybdenum (7 ppm) and detectable zinc (<200 ppm) concentrations are present in stream sediment sample M-116(2).

Analytical Results of the 1978 Samples

Seven stream sediment and five rock samples were collected to determine their copper, lead, zinc, and molybdenum content (Tables 12 and 13). The average element contents of stream sediments, with standard deviations shown in parentheses, are: copper 88 ppm (91 ppm), lead 14 ppm (7.3 ppm), zinc 180 ppm (150 ppm), and molybdenum 5.7 ppm (5.2 ppm). Sample 78 PRUJ 134, from an east-flowing tributary, contains anomalously high copper (285 ppm), zinc (500 ppm), and molybdenum (14 ppm). If values from this sample are excluded, the average values and standard deviations are: copper 55 ppm (29 ppm) and zinc 120 ppm (37 ppm). Analyses of rock samples show the copper content ranges from 50 to 200 ppm and is highly variable; the lead content ranges from 10 to 25 ppm and is nearly uniform; the zinc content in one sample is 300 ppm and less than 200 ppm in four samples. Shale sample 78 PRUJ 135 contains up to 10,000 ppm manganese. The stream sediment and rock samples generally contain similar element concentrations.

Central Sphinx Mountain Area (M-115)

Location and Physical Setting

Stream M-115 is located approximately 2.5 miles west of Sphinx Mountain. The prospected area centers near 68° 33' 30"N latitude, 160° 56' W longitude, and is in sections 13 and 24, T 10S, R 39W, Umiat Base and Meridian.

The study area is in a west trending belt of high, barren, limestone mountains (Figure 15). Elevations in the area range from 2,300 to 3,600 feet.

Stream M-115 is a 1.8-mile long, south-flowing tributary of Kogruk Creek which is a west-flowing tributary of the Utukok River. The sampled creek is relatively straight and has a gradient of about 190 feet per mile. The stream bed is composed primarily of cobbles and boulders. The surface area of the drainage basin is approximately 2.8 square miles.

Local Geologic Setting

Black pyritiferous shale, chert, shaly chert, and highly fossiliferous limestone crop out in the Central Sphinx Mountain drainage. Black shales are present in the upper segment of the drainage; limestones are present in the central section; grey shales and siliceous shales are present in the lower section. Jasper crops out near the confluence of this drainage and Kogruk Creek.

Results of the 1977 Geochemical Survey

Anomalously high zinc (500 ppm) and manganese (5,000 ppm) concentrations are present in stream sediment sample M-115(2); an anomalous manganese (1,500 ppm) concentration is present in the heavy-mineral concentrate. The sediment sample contains 30 ppm lead.

Analytical Results of the 1978 Samples

Seven stream sediment and four rock samples were collected to determine their copper, lead, zinc, and manganese content (Tables 12 and 13). The average element contents of the stream sediment samples, with the standard devia-

tions shown in parentheses, are: copper 350 ppm (410 ppm), lead 17 ppm (3.9 ppm), and zinc 690 ppm (640 ppm). Very high copper, zinc, and manganese concentrations are present in samples 78 PRUJ 140 and 78 PRUJ 141. Sample 78 PRUJ 140, collected from a small west-flowing tributary of stream M-115, contains 650 ppm copper, 1,300 ppm zinc, and 29,000 ppm manganese. Sample 78 PRUJ 141, collected downstream from 78 PRUJ 140 and near the mouth of stream M-115, contains 280 ppm copper, 1,300 ppm zinc, and 7,200 ppm manganese. Rock samples from the main drainage contain from 15 to 70 ppm copper, 10 ppm or less lead, and 300 ppm or less zinc.

West Sphinx Mountain Area (M-79)

Location and Physical Setting

Stream M-79 is located 3 miles east of Tupik Mountain, near the confluence of Kogruk Creek and the Utukok River. It is located near 68° 34' 30"N latitude, 161° 03'W longitude, and is in sections 8, 16, 17 and 22 of T 10S, R 39W, Umiat Base and Meridian.

The prospected part of stream M-79 is at the western end of a belt of steep-sided, high, barren, limestone mountains that extend westward from Sphinx Mountain (Figure 16). Elevations in the area range from 2,100 to 3,600 feet.

Stream M-79 is a 2.5-mile long northwest-flowing tributary of the Utukok River. The stream is relatively straight and has a gradient of about 140 feet per mile. The stream bed is composed primarily of cobbles and boulders. The surface area of the drainage basin is approximately 3.5 square miles.

Local Geologic Setting

Black and brown pyritiferous shale, green dolomitic(?) sandstone, calcareous shale, pyritiferous dolomitic black shale, and sandy shale crop out along the creek. These units are believed to be part of the Mississippian Lisburne Group which is mapped as part of the Kelly River thrust sequence(1).

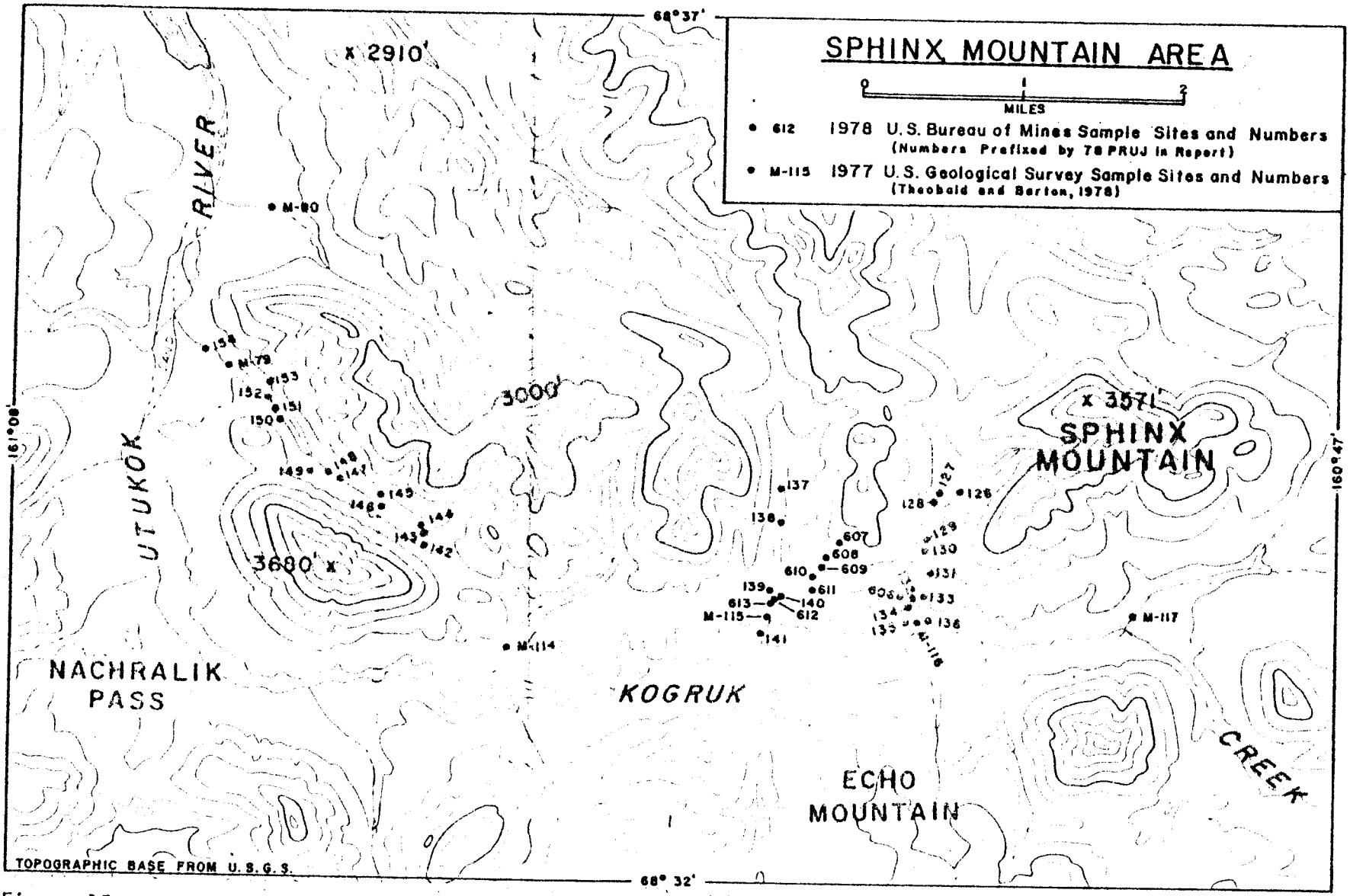


Figure 15. Sample sites along Stream M-115.

Results of the 1977 Geochemical Survey

Anomalously high barium (>20,000 ppm), molybdenum (10 ppm), chromium (1,000 ppm), and lead (50 ppm) and detectable zinc (<200 ppm) concentrations are present in sediment sample M-79(2).

Analytical Results of the 1978 Samples

Ten stream sediment samples and three rock samples were collected and analyzed to detemine their copper, lead, zinc, molybdenum, and barium content (Tables 12 and 13). The average element contents of the stream sediments, with the standard deviations shown in parentheses, are: copper 59 ppm (79 ppm), lead 14 ppm (3.2 ppm), zinc 110 ppm (16 ppm), molybdenum 2 ppm, and barium 2,200 ppm (1,600 ppm). Sample 78 PRUJ 142 contains anomalously high copper (280 ppm). The barium content of the stream sediment samples is anomalously high. Emission spectrographic analyses of rock samples indicate the presence of up to 500 ppm barium, 50 ppm copper, 10 ppm lead, and less than 200 ppm zinc. These values are considered normal for this rock type.

Summary

Interest for prospecting in the Sphinx Mountain area was aroused by the presence of anomalously high molybdenum, zinc and manganese, and barium and molybdenum concentrations in three samples of the 1977 survey. Prospecting in these drainages did not lead to the discovery of zones of mineralization, but sediment sampling indicated anomalously high copper and zinc in samples 78 PRUJ 134 and 140 which are from two creeks that drain a central zone. The source of the metals was not found, however, an area of potential mineralization is indicated.

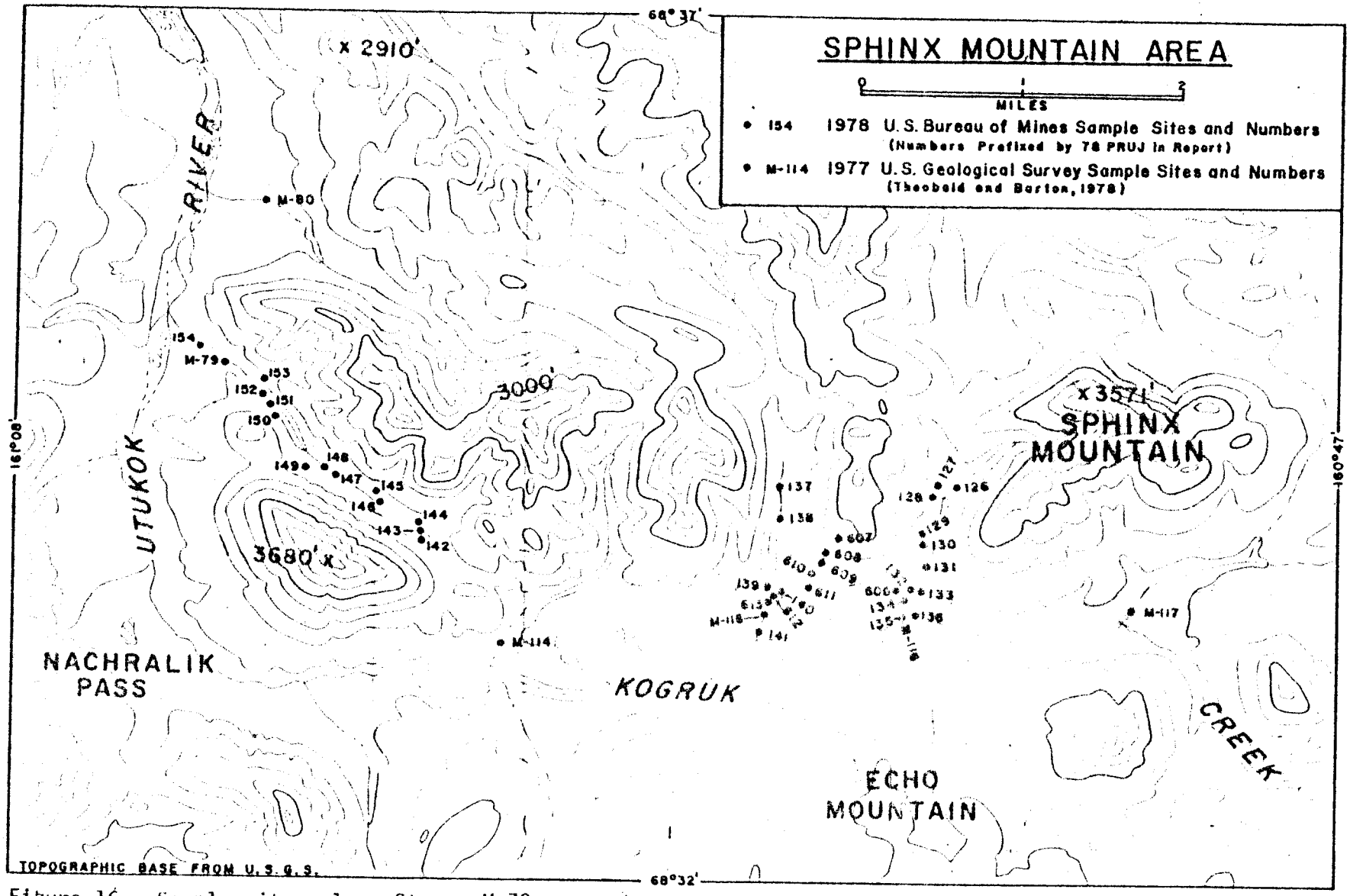


Figure 16. Sample sites along Stream M-79.

Table 12. - Analytical results of Sphinx Mountain area samples
[Values in parts per million]

Sample Number	Elements analyzed						CPS	Sample Type
	Cu	Pb	Zn	Mo	Ba	Mn		
Sphinx Mountain (M-116)								
78 PRUJ 126	30	10	85	<2	NA	NA	x	Stream sediment
78 PRUJ 127	45	15	120	2	NA	NA	x	Stream sediment
78 PRUJ 128	105	15	195	6	NA	NA	x	Stream sediment
78 PRUJ 129	75	10	110	12	NA	NA	x	Stream sediment
78 PRUJ 130	NA	NA	NA	NA	NA	NA	x	Carbonaceous shale
78 PRUJ 131	35	10	110	2	NA	NA	x	Stream sediment
78 PRUJ 132	NA	NA	NA	NA	NA	NA	x	Pyritiferous chert
78 PRUJ 133	40	10	125	2	NA	NA	x	Stream sediment
78 PRUJ 134	285	30	500	14	NA	NA	x	Stream sediment
78 PRUJ 135	NA	NA	NA	NA	NA	NA	x	Shale
78 PRUJ 136	NA	NA	NA	NA	NA	NA	x	Black shale
78 PRUJ 606	NA	NA	NA	NA	NA	NA	x	Shale
Sphinx Mountain (M-115)								
78 PRUJ 137	50	20	150	NA	NA	1,200	x	Stream sediment
78 PRUJ 138	NA	NA	NA	NA	NA	NA	x	Black shale
78 PRUJ 139	60	20	235	NA	NA	1,100	x	Stream sediment
78 PRUJ 140	650	20	1,300	NA	NA	29,000	x	Stream sediment
78 PRUJ 141	280	20	1,300	NA	NA	7,200	20-30	Stream sediment
78 PRUJ 607	NA	NA	NA	NA	NA	NA	x	Black siliceous shale
78 PRUJ 608	90	10	130	8	NA	NA	x	Stream sediment
78 PRUJ 609	NA	NA	NA	NA	NA	NA	x	Green shale
78 PRUJ 610	190	15	210	10	NA	NA	x	Stream sediment
78 PRUJ 611	NA	NA	NA	NA	NA	NA	x	Shale
78 PRUJ 612	1,550	15	1,500	8	NA	NA	x	Stream sediment
78 PRUJ 613	NA	NA	NA	NA	NA	NA	50-60	White precipitate

NA - Not analyzed
x - Within range of background values

Table 12. - Analytical results of Sphinx Mountain area samples - Continued
[Values in parts per million]

Sample Number	Elements Analyzed						CPS	Sample Type
	Cu	Pb	Zn	Mo	Ba	Mn		
Sphinx Mountain (M-79)								
78 PRUJ 142	280	10	105	2	1,200	NA	40	Stream sediment
78 PRUJ 143	NA	NA	NA	NA	NA	NA	120	Black pyritiferous shale
78 PRUJ 144	15	10	110	2	1,250	NA	x	Stream sediment
78 PRUJ 145	15	15	110	<2	1,200	NA	x	Stream sediment
78 PRUJ 146	30	10	125	2	1,700	NA	x	Stream sediment
78 PRUJ 147	35	15	130	2	1,950	NA	60	Stream sediment
78 PRUJ 148	30	15	130	2	2,900	NA	x	Stream sediment
78 PRUJ 149	50	20	105	2	850	NA	62	Stream sediment
78 PRUJ 150	NA	NA	NA	NA	NA	NA	90	Black shale
78 PRUJ 151	NA	NA	NA	NA	NA	NA	x	Dolomitic black shale
78 PRUJ 152	50	15	80	2	850	NA	x	Stream sediment
78 PRUJ 153	50	15	135	<2	5,300	NA	x	Stream sediment
78 PRUJ 154	35	15	115	<2	4,200	NA	x	Stream sediment

NA - Not analyzed
x - Within range of background values

Table 13. - Emission spectrographic analyses of Sphinx Mountain area samples
[Values in parts per million unless otherwise noted]

Element	Sample numbers		
	78 PRUJ 130 Carbonaceous shale	78 PRUJ 132 Pyritifereous Chert	78 PRUJ 135 Shale
Fe	2%	2%	7%
Ca	0.03%	0.07%	0.2%
Mg	0.15%	0.15%	0.5%
Ag	1	1	<1
As	<500	<500	<500
B	20	15	100
Ba	7,000	1,000	2,000
Be	<2	<2	2
Bi	<10	<10	<10
Cd	<50	<50	<50
Co	<5	<5	50
Cr	100	70	20
Cu	50	70	100
Ga	<10	<10	10
Ge	<20	<20	<20
La	30	20	50
Mn	10	100	10,000
Mo	<2	<2	<2
Nb	<20	<20	30
Ni	10	20	200
Pb	10	10	10
Sb	<100	<100	<100
Sc	<10	<10	10
Sn	<10	<10	<10
Sr	300	200	200
Ti	1,000	1,000	5,000
V	200	200	100
W	<50	<50	<50
Y	<10	<10	10
Zn	<200	<200	200
Zr	30	30	100

Table 13. - Emission spectrographic analyses of Sphinx Mountain area samples - Continued
[Values in parts per million unless otherwise noted]

Element	Sample numbers		
	78 PRUJ 136 Black shale	78 PRUJ 138 Black shale	78 PRUJ 143 Black pyritiferous shale
Fe	7%	0.5%	5%
Ca	0.1%	0.03%	0.07%
Mg	0.5%	0.1%	0.5%
Ag	<1	1	<1
As	<500	<500	<500
B	50	20	30
Ba	1,000	500	300
Be	2	<2	<2
Bi	<10	<10	<10
Cd	<50	<50	<50
Co	20	<5	5
Cr	50	100	20
Cu	150	30	20
Ga	10	<10	<10
Ge	<20	<20	<20
La	50	20	50
Mn	1,500	150	150
Mo	<2	<2	<2
Nb	50	<20	20
Ni	150	20	30
Pb	20	10	<10
Sb	<100	<100	<100
Sc	15	<10	10
Sn	<10	<10	<10
Sr	100	100	100
Ti	5,000	700	3,000
V	150	150	150
W	<50	<50	<50
Y	10	<10	<10
Zn	200	<200	<200
Zr	100	20	50

Table 13. - Emission spectrographic analyses of Sphinx Mountain area samples - Continued
[Values in parts per million unless otherwise noted]

Element	Sample numbers		
	78 PRUJ 150 Black shale	78 PRUJ 151 Dolomitic black shale	78 PRUJ 606 Shale
Fe	7%	5%	10%
Ca	0.2%	0.5%	0.15%
Mg	1%	0.5%	1%
Ag	<1	<1	<1
As	<500	<500	<500
B	20	30	100
Ba	200	500	5,000
Be	<2	<2	2
Bi	<10	<10	<10
Cd	<50	<50	<50
Co	10	5	50
Cr	70	70	20
Cu	50	50	200
Ga	10	10	10
Ge	<20	<20	20
La	20	30	<20
Mn	200	300	>10,000
Mo	<2	<2	700
Nb	20	20	20
Ni	50	30	150
Pb	10	10	15
Sb	<100	<100	<100
Sc	10	10	15
Sn	<10	<10	<10
Sr	100	100	200
Ti	5,000	3,000	2,000
V	150	100	100
W	<50	<50	<50
Y	10	<10	10
Zn	<200	<200	300
Zr	100	70	100

Table 13. - Emission spectrographic analyses of Sphinx Mountain area samples - Continued
[Values in parts per million unless otherwise noted]

Element	Sample numbers		
	78 PRUJ 607 Black shale	78 PRUJ 609 Green shale	78 PRUJ 611 Shale
Fe	1%	7%	7%
Ca	0.02%	0.05%	0.1%
Mg	0.2%	0.7%	1%
Ag	<1	<1	<1
As	<500	<500	<500
B	20	50	70
Ba	5,000	5,000	2,000
Be	<2	2	3
Bi	<10	<10	<10
Cd	<50	<50	<50
Co	<5	50	20
Cr	30	15	15
Cu	15	50	70
Ga	<10	10	10
Ge	20	20	20
La	30	30	20
Mn	100	10,000	>10,000
Mo	150	500	500
Nb	<20	20	20
Ni	5	150	100
Pb	<10	10	<10
Sb	<100	<100	<100
Sc	<10	20	15
Sn	<10	<10	<10
Sr	200	200	200
Ti	1,000	2,000	3,000
V	100	100	100
W	<50	<50	<50
Y	<10	15	10
Zn	<200	300	200
Zr	20	100	100

Kagvik Creek Area (M-42, M-45 through M-49, and M-67)

Anomalously high concentrations of barium, zinc, cobalt, nickel, copper, and manganese are present in sediment samples collected from streams which drain an east-west trending ridge located near the headwaters of Kagvik Creek. Seven streams were prospected and/or sampled. Zones of iron-oxide staining were noted in several creek beds.

Location and Regional Physical Setting

The Kagvik Creek area, on the southern flank of the DeLong Mountains, is approximately 12 miles south of the NPR-A. The study area is bounded on the south by Kagvik Creek and on the north by Nunaviksak Creek(Figure 17). It centers at approximately 68° 20'N latitude, 161° 30'W longitude, and is in T 12S, R 41W, the eastern half of T 12S, R 42W, the southeastern quarter of T 11S, R 41W, Umiat Base and Meridian, and in the northern half of T 34N, R 12W, Kateel River Base and Meridian.

The Kagvik Creek area is within the DeLong Mountains section of the Arctic Mountains Physiographic Province(4). It is characterized by rugged, steep, barren mountains that are dissected by narrow, deeply incised, steep-walled canyons. Rolling foothills surround the rugged peaks. Elevations in the area range from 1,000 to 3,600 feet.

Regional Geology

Two geologic terranes, a southern and a northern, are defined in the Kagvik Creek area(1). In the southern terrane, of Lower Cretaceous to Mississippian undifferentiated wacke, mudstone, chert and shale, underlies a region of relatively gentle topography. The northern, more rugged half of the area, is underlain by Mississippian Lisburne Group crinoidal and sandy limestone. The Lisburne Group is part of the Kelly River thrust sequence which overlies the undifferentiated wacke, mudstone, chert, and shale of the Northwestern Brooks Range thrust sequence.

Bureau of Mines Work in 1978

The Kagvik Creek area was prospected and rock and stream sediment samples were collected for analysis. The Eastern Kagvik Creek (M-67) and Southeastern Kagvik Creek (M-49) areas were prospected and sampled from their headwaters to the 1977 sample sites. Sediment samples were collected for chemical analysis from five streams M-42, M-45 to M-48; these streams were not prospected. Results of the two traverses are discussed separately; results of the sediment sampling of the five drainages are discussed in one section.

Eastern Kagvik Creek Area (M-67)

Anomalously high zinc, barium, cobalt, nickel, copper and manganese concentrations are present in sample M-67. Helicopter reconnaissance of this area revealed iron-oxide staining along sections of the creek bed.

Location and Physical Setting

Stream M-67 drains the eastern portion of the Kagvik Creek area (Figure 17). It is located near 68° 24' 00"N latitude, 161° 25'W longitude, and is in sections 13, 14 and 23 of T 12S, R 41W, Umiat Base and Meridian.

The drainage is characterized by moderately sloping, rounded, alpine tundra covered hills. Elevations in the area range from 1,000 to 3,600 feet.

Stream M-67 is a 2-mile long, easterly-flowing tributary of Nunaviksak Creek, which is a south-flowing tributary of the Kugururok River. The prospected stream is relatively straight and has a gradient of about 450 feet per mile. The stream bed consists primarily of cobbles. The surface area of the drainage basin is approximately 3.0 square miles. Willow brush and tussocks are prevalent along the creek at lower elevations.

Geologic Setting

The terrane in the area is Lower Cretaceous to Mississippian undifferentiated wacke, mudstone, shale and chert(1).

Results of the 1977 Geochemical Survey

Anomalous concentrations of several elements were found in the stream sediment and in the heavy-mineral concentrate of sample M-67(2). Anomalously high concentrations of barium (20,000 ppm), manganese (5,000 ppm), zinc (1,000 ppm), cobalt (100 ppm), nickel (500 ppm), and copper (200 ppm) occur in the stream sediment. Anomalously high manganese (3,000 ppm) and zinc (500 ppm) concentrations occur in the heavy-mineral concentrate. The reported lead values are 30 ppm in the stream sediment; none was detected in the heavy-mineral concentrate.

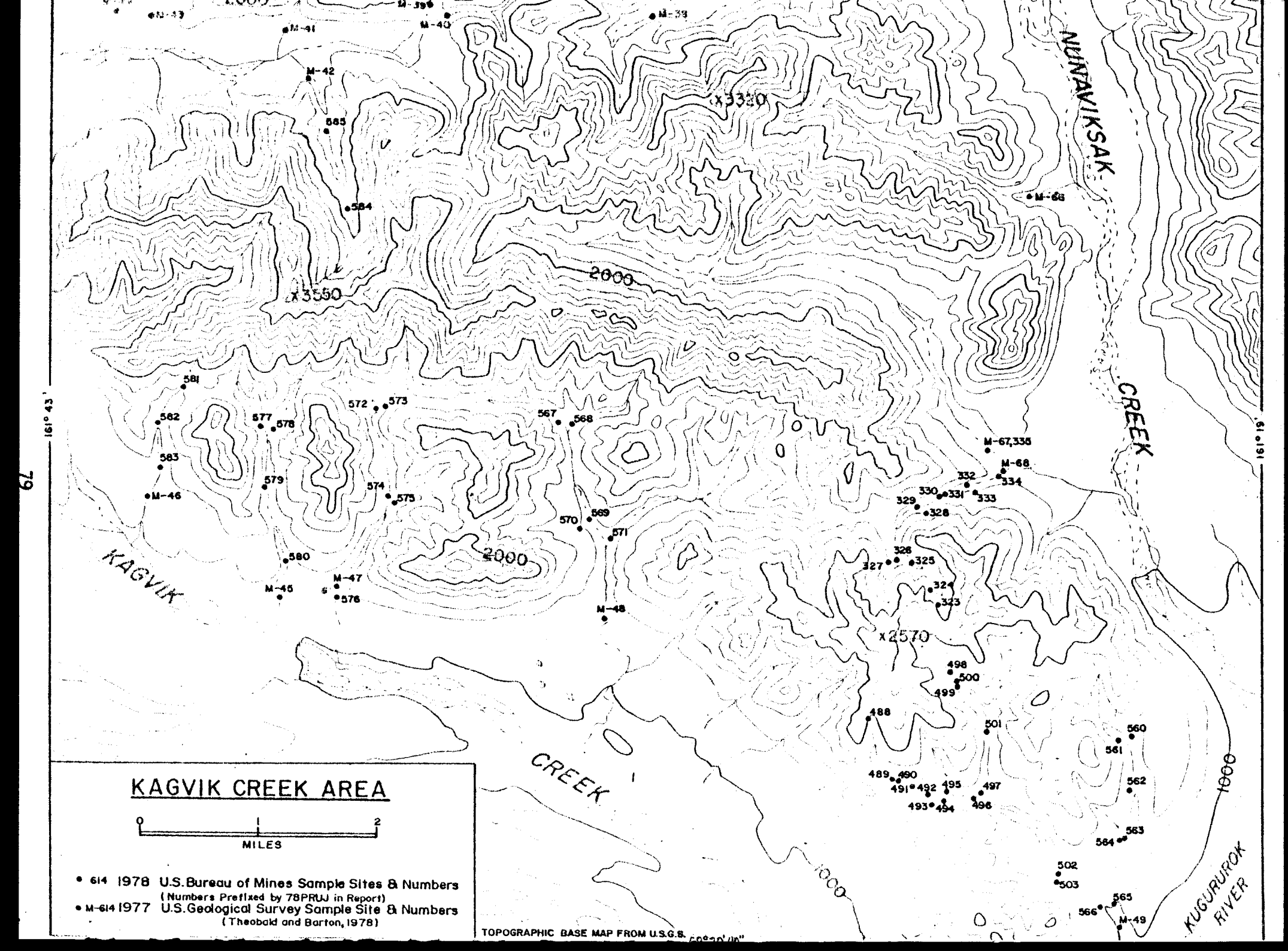
Bureau of Mines Work in 1978

The area was prospected, geologic relationships noted, and rock and stream sediment samples collected.

Rock types, their distribution, and their attitudes were noted while prospecting. Black shale bedrock and chert float occur in the upper reaches of the drainage. Light-grey argillite and grey chert crop out downstream from the black shale. The argillite contains characteristic spherical molds of unknown origin. Thin-bedded cherts and minor shales, which outcrop downstream from the argillites, persist nearly to the creek mouth where shale and calcareous shales dominate.

Iron-oxide precipitate was noted in two areas along stream M-67. An iron-oxide precipitate, in the form of ferruginous breccia, has formed in the headwaters area and persists downstream for a distance of about 5,000 feet. In addition to this breccia in the streams, a 2-foot thick surface coating of ferruginous breccia occurs on some of the side slopes. The extent of this thick iron-oxide precipitate was not determined. The source of the iron was not identified. A second, but by comparison minor, zone of iron-oxide precipitation occurs where stream M-67 has eroded the chert and shale section. Bright orange iron-oxide has precipitated on carbonate float rock. Pyritiferous chert and barite nodules (78 PRUJ 331) were found immediately to the east of this zone.

Eleven stream sediment and two rock samples were collected from the main drainage; sediment samples were collected from several tributaries. These samples were analyzed to determine their copper, lead, zinc, and barium content


KAGVIK CREEK AREA
0
1
2
MILES
• 614 1978 U.S.Bureau of Mines Sample Sites & Numbers
(Numbers Prefixed by 78PRUJ in Report)
• M-614 1977 U.S.Geological Survey Sample Site & Numbers
(Theobald and Barton, 1978)
TOPOGRAPHIC BASE MAP FROM U.S.G.S.
NUNAVIKSAK CREEK
KAGVIK CREEK
KUGURUROK RIVER
X3330
X3550
X2570
2000
1000
M-39
M-40
M-41
M-42
M-43
M-44
M-45
M-46
M-47
M-48
M-49
M-67,335
M-68
565
584
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(Tables 14 and 15). The average element contents in the sediment samples, with standard deviations shown in parentheses, are: copper 200 ppm (140 ppm), lead 14 ppm (6.7 ppm), zinc 800 ppm (830 ppm), and barium 17,000 ppm (9,800 ppm). Five samples (78 PRUJ 327, 328, 330, 332, 334) contain anomalously high copper (up to 425 ppm) and zinc (up to 2,400 ppm). Two distinct sample populations are present and account for the large standard deviations.

Two rock samples, 78 PRUJ 325 (a shale) and 78 PRUJ 331 (barite float), contain 150 and 10 ppm copper, 10 ppm and less lead, less than 200 ppm zinc, 5,000 ppm and more than 10,000 ppm barium, respectively.

Southeastern Kagvik Creek Area (M-49)

Location and Physical Setting

Stream M-49, at the southeastern end of the Kagvik Creek area, is located near 68° 22' 00"N latitude, 161° 25' 00"W longitude, and is in sections 23, 25, and 26 of T 12S, R 41W, and section 30 of T 12S, R 40W, Umiat Base and Meridian, and in sections 10, 11, 12 and 13 of T 34N, R 12W, Kateel River Base and Meridian.

Moderately sloping, rounded, alpine tundra covered hills characterize the prospected area drained by stream M-49. Elevations in the area range from 1,000 to 2,600 feet.

Stream M-49 is a 3.8-mile long, southeast-flowing tributary of Nunaviksak Creek which flows south into the Kugururok River (Figure 17). The prospected stream is relatively straight and has a gradient of approximately 570 feet per mile. The stream bed is composed primarily of cobbles. The surface area of the drainage is approximately 8.0 square miles. Willow brush and tussocks are prevalent at lower elevations along the stream.

Geologic Setting

The terrane in the area is Lower Cretaceous to Mississippian undifferentiated wacke, sandstone, shale, and chert(1).

Results of the 1977 Geochemical Survey

High barium (>20,000 ppm), zinc (300 ppm), and lead (30 ppm) concentrations occur in stream sediment sample M-49(2).

Bureau of Mines Work in 1978

Two tributaries of the western branch of stream M-49 were prospected and sampled to locate the source of the zinc found in anomalous concentrations by the 1977 survey. Geologic relationships were noted. A third stream, the eastern branch of stream M-49, was sampled but not prospected.

Chert, carbonate, and shale crop out in the M-49 drainage. Grey chert, with minor brown-weathering limestone, predominates from the headwaters of the western drainage to its 1,300 foot elevation. Calcareous shale (78 PRUJ 494) predominates below this elevation. These rock units also crop out in the centrally located drainage. Black shale (78 PRUJ 498), striking N 80° E and dipping 65° S, crops out at the 1,450 foot elevation along the central drainage, red-brown shale (78 PRUJ 499) crops out at the 1,340 foot elevation, and chert-shale couplets crop out at the 1,320 foot elevation.

Ferruginous breccia and iron-oxide strain zones are present in both the western and central branches of stream M-49. Ferruginous breccia crops out at the 1,900 foot elevation (sample 78 PRUJ 488) at the headwaters of the western stream and at the 1,350 foot elevation along the central stream. The iron-oxide stain zones occur between the 1,575 and 1,300 foot elevations of the western stream and between the 1,340 and 1,320 foot elevations of the central stream. They are restricted to the stream beds and are comprised of a red-orange colloidal material. The stain zones are spatially related to different rock types, a grey chert in the western stream and a red-brown shale (78 PRUJ 499) in the central stream. Ferrugineous breccia crops out upstream from the strain zones.

Sediment samples collected from the western, central, and eastern branches of stream M-49 contain anomalously high concentrations of zinc and barium and high concentrations of copper (Table 14). The average copper, lead, zinc, and barium contents of the samples, with the standard deviations shown in parentheses, are: 110 ppm (93 ppm) copper, 21 ppm (3.8 ppm) lead, 840 ppm (960 ppm) zinc, and 7,900 ppm (11,000 ppm) barium. Anomalously high zinc and copper

concentrations occur in all sediment samples (78 PRUJ 497, 500, and 501) collected from the central stream and in samples 78 PRUJ 561, 562, and 563 from the eastern branch. Copper and zinc concentrations in sediment samples decrease downstream from sample 78 PRUJ 500 in the central branch and sample 78 PRUJ 561 in the eastern branch. Black (78 PRUJ 498) and red-brown (78 PRUJ 499) shale, which outcrop in the central drainage, contain significantly lower copper and zinc concentrations than the stream sediments.

The ferruginous breccia (78 PRUJ 488) and the sediment from the stain zone (78 PRUJ 490 and 491), in the western branch of stream M-49, do not contain anomalous element concentrations. Calcareous shale (78 PRUJ 494) which crops out downstream from the stained zone contains 700 ppm zinc. Sediment samples (78 PRUJ 492 and 496), collected in the area of the calcareous shale outcrop, contain anomalous zinc concentrations.

Stream sediments from the western branch of stream M-49 containing highly anomalous barium concentrations (to 47,000 ppm barium). The concentrations in these samples are significantly higher than in other samples from drainage M-49.

Southwestern and Northern Kagvik Creek Area (M-42, M-45 through M-48)

Stream sediment samples were collected from five drainages. Four of these drainages, M-45 through M-48, are in the southwestern part of the Kagvik Creek area; one stream, M-42, is on the north side (Figure 17). These creeks drain an area underlain by limestone and black carbonaceous(?) shale.

Southwestern Kagvik Creek Area (M-45, M-46, M-47, M-48)

Location and Physical Setting

Streams M-45, M-46, M-47, and M-48 originate on the 3,600-foot high, steep, barren, east-west trending ridge in the central Kagvik Creek area (Figure 17). Below the 1,800 foot elevations the south flowing streams cut moderately sloping, rounded, alpine tundra and tussock covered hills. Elevations in the area range from 1,000 to 3,550 feet.

Streams M-45, M-46, M-47, and M-48 are 2.6 miles, 1.7 miles, 3.3 miles, and 3.0 miles long, respectively. All are south-flowing tributaries of Kagvik

Creek. The creek beds consist primarily of cobbles. Stream gradients are 330 feet per mile for stream M-45, 330 feet per mile for stream M-46, 200 feet per mile for stream M-47, and 170 feet per mile for stream M-48. The surface areas of the drainage basins are 2.25 square miles, 1.0 square mile, 3.75 square miles, and 8.5 square miles, respectively. Willow brush is prevalent along the creeks at lower elevations.

Geologic Setting

Two geologic terranes are mapped in the sampled area(1). Lower Cretaceous to Mississippian undifferentiated wacke, mudstone, shale, and chert underlie the streams below the 2,000 foot elevation. Mississippian Lisburne Group rocks, which include crinoidal limestone, with local black chert nodules and beds, and sandy limestone, containing minor sandstone and shale beds, underlie the streams above the 2,000 foot elevation.

Results of the 1977 Geochemical Survey

A variety of elements occur in anomalously high concentrations in the stream sediments(2). Sample M-45 contains anomalous barium (20,000 ppm) and silver (1.0 ppm) and detectable zinc concentrations. Sample M-46 contains anomalous barium (20,000 ppm), silver (.5 ppm), and molybdenum (5 ppm) and detectable zinc concentrations. Sample M-47 contains an anomalous barium (>20,000 ppm) concentration. Sample M-48 contains anomalous barium (>20,000 ppm) and detectable zinc concentrations.

Northwestern Kagvik Creek Area (M-42)

Location and Physical Setting

Stream M-42 is located near 68° 26' 30"N latitude, 161° 37' 30"W longitude, and is in section 36 of T 11S, R 42W and in section 1 of T 12S, R 42W, Umiat Base and Meridian.

Stream M-42 drains the high barren ridge in the northern Kagvik Creek area. Elevations range from 1,600 to more than 3,500 feet.

Stream M-42 is a 2-mile long, north-flowing tributary of Kagvik Creek (Figure 17). The stream occupies a straight, narrow, steep-sided, barren, talus covered canyon. The stream gradient is approximately 350 feet per mile. The stream bed consists primarily of angular limestone boulders. The surface area of the drainage basin is approximately 1.7 square miles.

Geologic Setting

Stream M-42 is underlain entirely by Mississippian Lisburne Group carbonate rocks which includes crinoidal limestone, with local black chert nodules and chert beds, and sandy limestone, with local sandstone and shale(2).

Results of the 1977 Geochemical Survey

Anomalously high silver (2.0 ppm) and detectable zinc concentrations are present in stream sediment sample M-42; anomalous silver (1.5 ppm) and molybdenum (50 ppm) concentrations are present in the heavy-mineral concentrate of sample M-42(2).

Analytical Results of the 1978 Samples

Nineteen sediment samples were collected from five streams (M-42, M-45 through M-48) in the Kagvik Creek area for analysis to determine their copper, lead, zinc, and barium content (Table 14). The average element concentrations in the stream sediments, with the standard deviations shown in parentheses, are: copper 40 ppm (38 ppm), lead 11 ppm (3.6 ppm), zinc 200 ppm (95 ppm), and barium 11,000 ppm (16,000 ppm). Two of the 19 samples contain more than 100 ppm copper. The lead content is low and uniform. The highest zinc content is 400 ppm; three samples contain more than 300 ppm zinc. The barium concentration is high and highly variable. Sample 78 PRUJ 579, from stream M-47, contains 72,000 ppm barium. In general, the barium content of samples from stream M-47 are considerably higher than that in samples from other drainages. The silver content was determined in samples from streams M-46 and M-47; the maximum value is 0.2 ppm silver.

Summary

Two drainages were prospected and five were sampled to determine the source of anomalously high concentrations of barium, cobalt, copper, manganese, nickel, silver(?), and zinc found in 1977(2).

Limonite staining occurs in several creeks. Extensive zones of ferruginous breccia occur in some stream beds and on some hillsides. Regional geochemical sampling has identified drainages that contain anomalously high element concentrations. The drainages merit further prospecting to determine the nature and source of the elements.

Table 14. - Analytical results of Kagvik Creek area samples
[Values in parts per million]

Sample Number	Elements Analyzed						Sample Type
	Cu	Pb	Zn	Ba	Ag	CPS	
Stream M-42							
78 PRUJ 584	5	<5	55	NA	NA	x	Stream sediment
78 PRUJ 585	15	5	135	NA	NA	x	Stream sediment
Stream M-46							
78 PRUJ 581	10	10	90	1,000	<.2	45-50	Stream sediment
78 PRUJ 582	45	10	205	3,700	<.2	50	Stream sediment
78 PRUJ 583	130	20	290	13,000	<.2	60	Stream sediment
Stream M-47							
78 PRUJ 572	25	15	120	5,500	NA	45	Stream sediment
78 PRUJ 573	15	10	90	2,400	NA	x	Stream sediment
78 PRUJ 574	15	10	105	8,500	NA	50	Stream sediment
78 PRUJ 575	40	15	200	8,500	NA	x	Stream sediment
78 PRUJ 576	20	10	130	6,300	NA	30	Stream sediment
78 PRUJ 577	55	10	250	5,500	<.2	45	Stream sediment
78 PRUJ 578	60	10	260	14,000	.2	x	Stream sediment
78 PRUJ 579	50	10	325	72,000	<.2	55-65	Stream sediment
78 PRUJ 580	55	10	400	12,500	.2	40	Stream sediment
Stream M-48							
78 PRUJ 567	25	10	150	1,850	NA	x	Stream sediment
78 PRUJ 568	40	10	230	5,300	NA	x	Stream sediment
78 PRUJ 569	40	10	290	13,000	NA	40-50	Stream sediment
78 PRUJ 570	45	15	170	3,500	NA	20(?)	Stream sediment
78 PRUJ 571	65	15	300	5,000	NA	60-70	Stream sediment
Stream M-49							
78 PRUJ 488	NA	NA	NA	NA	NA	x	Ferruginous breccia
78 PRUJ 489	70	20	160	17,000	NA	x	Stream sediment
78 PRUJ 490	75	25	165	11,000	NA	x	Stream sediment
78 PRUJ 491	75	25	155	20,000	NA	x	Stream sediment
78 PRUJ 492	90	20	435	47,000	NA	x	Stream sediment
78 PRUJ 493	75	15	255	15,000	NA	x	Stream sediment

NA - Not analyzed
x - Within range of background values

Table 14. - Analytical results of Kagvik Creek area samples - Continued
[Values in parts per million]

Sample Number	Elements Analyzed						Sample Type
	Cu	Pb	Zn	Ba	Ag	CPS	
Stream M-49 - Continued							
78 PRUJ 494	NA	NA	NA	NA	NA	x	Shale
78 PRUJ 495	45	20	120	3,050	NA	x	Stream sediment
78 PRUJ 496	90	25	360	5,000	NA	x	Stream sediment
78 PRUJ 497	125	15	1,350	9,000	NA	x	Stream sediment
78 PRUJ 498	NA	NA	NA	NA	NA	x	Black shale
78 PRUJ 499	NA	NA	NA	NA	NA	x	Red shale
78 PRUJ 500	345	25	3,600	7,000	NA	x	Stream sediment
78 PRUJ 501	375	20	3,000	4,600	NA	x	Stream sediment
78 PRUJ 502	95	20	1,000	5,000	NA	x	Stream sediment
78 PRUJ 503	95	15	355	NA	NA	x	Stream sediment
78 PRUJ 560	50	30	195	3,300	NA	x	Stream sediment
78 PRUJ 561	170	20	1,400	2,450	NA	x	Stream sediment
78 PRUJ 562	75	20	960	1,650	NA	x	Stream sediment
78 PRUJ 563	55	20	770	2,100	NA	x	Stream sediment
78 PRUJ 564	45	20	270	4,500	NA	x	Stream sediment
78 PRUJ 565	75	20	800	17,000	NA	x	Stream sediment
78 PRUJ 566	50	20	700	2,050	NA	x	Stream sediment
Stream M-67							
78 PRUJ 323	80	5	115	11,000	NA	x	Stream sediment
78 PRUJ 324	90	10	95	10,000	NA	x	Stream sediment
78 PRUJ 325	NA	NA	NA	NA	NA	x	Shales
78 PRUJ 326	145	10	135	27,000	NA	x	Stream sediment
78 PRUJ 327	255	20	640	25,000	NA	x	Stream sediment
78 PRUJ 328	425	10	1,650	32,000	NA	x	Stream sediment
78 PRUJ 329	100	30	270	7,750	NA	x	Stream sediment
78 PRUJ 330	345	15	1,350	26,000	NA	x	Stream sediment
78 PRUJ 331	NA	NA	NA	NA	NA	x	Barite float
78 PRUJ 332	300	15	1,750	21,000	NA	x	Stream sediment
78 PRUJ 333	75	15	240	10,000	NA	x	Stream sediment
78 PRUJ 334	365	10	2,400	16,000	NA	x	Stream sediment
78 PRUJ 335	45	10	170	1,250	NA	x	Stream sediment

NA - Not analyzed
x - Within range of background values

Table 15. - Emission spectrographic results of Kagvik Creek area samples
[Values in parts per million unless otherwise noted]

Element	Sample numbers		
	78 PRUJ 325 Shale	78 PRUJ 331 Barite	78 PRUJ 488 Ferruginous breccia
Fe	5%	1.5%	15%
Ca	0.03%	<.02%	0.03%
Mg	0.5%	0.2%	0.1%
Ag	<1	<1	<1
As	<500	<500	<500
B	30	<10	30
Ba	5,000	>10,000	5,000
Be	2	<2	<2
Bi	<10	<10	<10
Cd	<50	<50	<50
Co	<5	<5	<5
Cr	20	<10	10
Cu	150	10	20
Ga	<10	<10	<10
Ge	<20	<20	<20
La	30	30	<20
Mn	100	20	100
Mo	5	3	5
Nb	20	<20	20
Ni	50	7	20
Pb	10	<10	10
Sb	<100	<100	<100
Sc	10	<10	<10
Sn	<10	<10	<10
Sr	200	1,000	200
Ti	3,000	200	2,000
V	200	20	100
W	<50	<50	<50
Y	10	<10	<10
Zn	<200	<200	<200
Zr	100	<20	50

Table 15. - Emission spectrographic results of Kagvik Creek area samples - Continued
[Values in parts per million unless otherwise noted]

Element	Sample numbers		
	78 PRUJ 494 Calcareous shale	78 PRUJ 498 Black shale	78 PRUJ 499 Red shale
Fe	15%	1%	10%
Ca	0.1%	0.05%	0.05%
Mg	0.5%	0.1%	1%
Ag	<1	3	<1
As	<500	<500	<500
B	20	20	50
Ba	700	2,000	5,000
Be	2	3	2
Bi	<10	<10	<10
Cd	<50	<50	<50
Co	10	<5	20
Cr	20	200	20
Cu	30	15	150
Ga	<10	<10	15
Ge	<20	<20	<20
La	<20	100	20
Mn	500	10	2,000
Mo	3	3	10
Nb	20	<20	20
Ni	100	50	100
Pb	10	<10	20
Sb	<100	<100	<100
Sc	10	<10	20
Sn	<10	<10	<10
Sr	100	200	100
Ti	2,000	1,500	2,000
V	70	200	150
W	<50	<50	<50
Y	15	<10	10
Zn	700	<200	200
Zr	70	70	100

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Sharp Peak Area (M-139)

Prospecting and stream sediment sampling were undertaken to locate the source of barium, manganese, and zinc found in anomalously high concentrations in stream sediment sample M-139(2). Anomalously high copper, zinc, and barium concentrations occur in sediment samples collected in 1978. The source of these metals was not found.

Location and Physical Setting

The prospected area centers near 68° 38' 30"N latitude, 160° 55'W longitude, and is in section 19 of T 9S, R 38W, and sections 24 and 25 of T 9S, R 39W, Umiat Base and Meridian. This area, located between Elbow Creek and the Utukok River, is approximately nine miles north of the southern NPR-A boundary.

The Sharp Peak area is within the DeLong Mountains section of the Arctic Mountains Physiographic Province(4). It is characterized by steep-sloped, barren, rugged mountains (Figure 18). Topographic relief in the area is approximately 3,400 feet.

Stream M-139, the major drainage on the south side of Sharp Peak, is a 2-mile long, southwest-flowing tributary of an unnamed northwest-flowing tributary of the Utukok River. It is relatively straight and has a gradient of about 220 feet per mile. The stream bed is composed primarily of cobbles. The surface area of the drainage basin is approximately 2.5 square miles. The valley is alpine tundra covered and contains willow brush at lower elevations.

Regional Geology

Two rock units are mapped in the area(1). Lower Cretaceous to Mississippian undifferentiated wacke, mudstone, chert, and shale underlie Sharp Peak and stream M-139. Lower Cretaceous to Upper Jurassic flyschoid wacke, mudstone, and conglomerate, with local quartzitic sandstone, crop out on the south side of stream M-139. The two rock sequences are mapped as a part of the Northwestern Brooks Range thrust sequence.

Results of the 1977 Geochemical Survey

Regional geochemical work identified the presence of anomalously high barium (>20,000 ppm), high copper (200 ppm), high molybdenum (5 ppm), and detectable zinc (200 ppm) concentrations in stream sediment sample M-139(2). The reported lead content of the stream sediment is 30ppm.

Bureau of Mines Work in 1978

Stream M-139 was prospected and sediment samples were collected from the main drainage and its tributaries. Geology was not mapped but the rock types, their distribution and attitude, were noted. A tributary basin was prospected and sampled from sample site 78 PRUJ 125 to stream M-139.

Limestone underlies the upper segment of stream M-139; chert underlies the lower segment. Grey to black cherts are interbedded with the limestones. Thin-bedded, steeply dipping, pyritiferous chert beds outcrop along the lower portion of the drainage.

Pyrite, malachite, and manganese-oxide were found. Pyrite occurs as fine-grained disseminations and as aggregates in cherts. Bands or layers of pyrite were found in a white float rock. Similar rock, tentatively identified as a pyritiferous tuff, was found in outcrop in 1977 on top of the ridge to the north of stream M-139. Float material found in 1978 may be from this same area. A trace amount of malachite was found along a small fracture in chert. This was the only malachite-bearing sample found in the NPR-A. Manganese-oxide (pyrolousite?) coated limestone boulders are common in this drainage.

The stream bed of a small south flowing tributary of stream M-139 is coated with a white precipitate. This precipitate persists in stream M-139 downstream from the confluence of this tributary. Some of the white precipitate effervesced on the application of dilute hydrochloric acid.

Nine stream sediment samples were collected for analysis to determine their copper, lead, zinc, and barium content (Table 16). The average element contents of the stream sediment samples, with standard deviations shown in parentheses, are: copper 110 ppm (35 ppm), lead 16 ppm (3.3 ppm), zinc 310 ppm (190 ppm), and barium 9,000 ppm (6,200 ppm). The highest concentrations are 195 ppm copper, 20 ppm lead, 680 ppm zinc, and 21,500 ppm barium. There are no radical variations in the copper and lead concentrations, but five of the zinc values

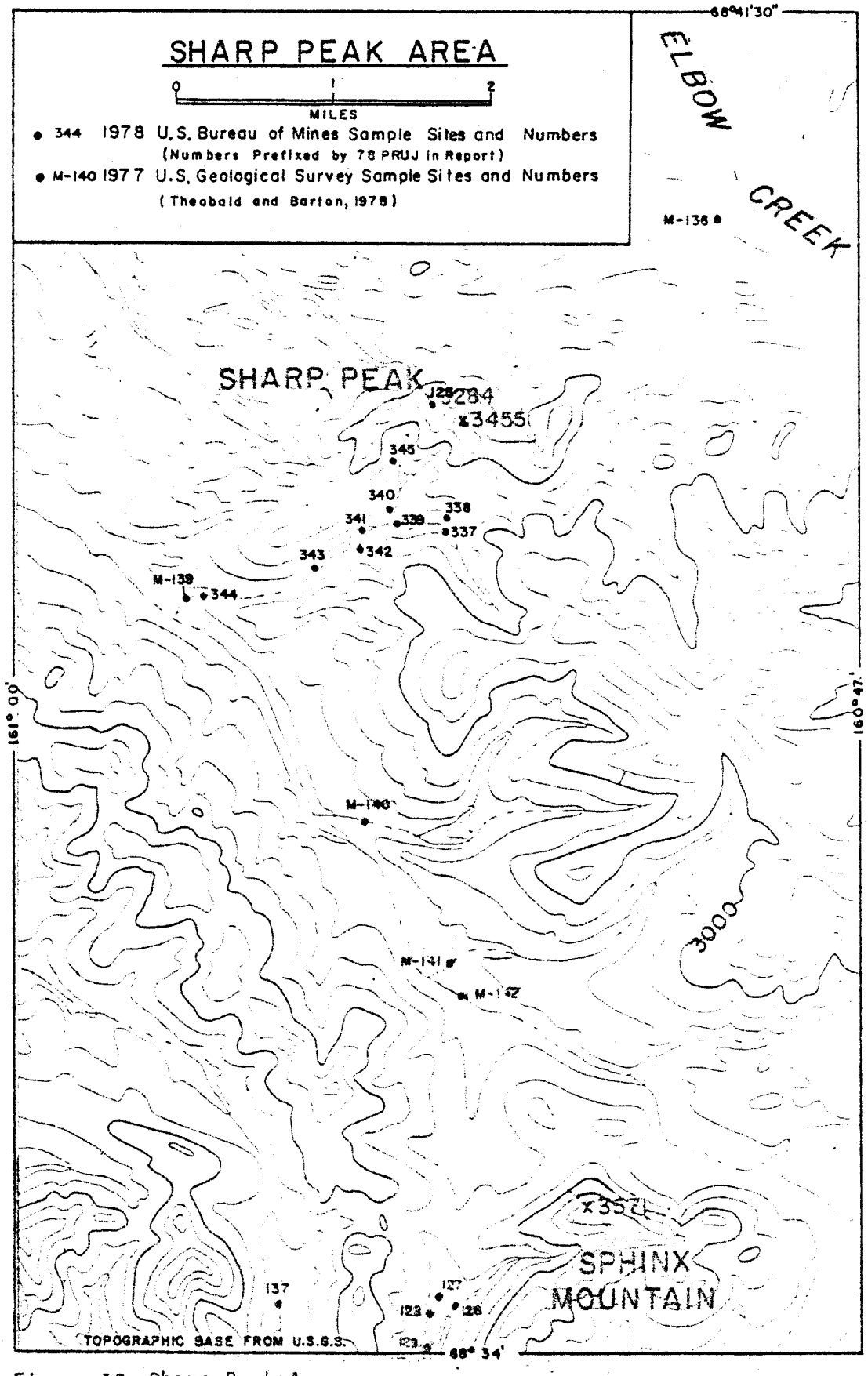


Figure 18. Sharp Peak Area

are higher than 300 ppm. Barium values are uniform, but three samples contain radically high concentrations (e.g. sample 78 PRUJ 338 contains 21,500 ppm barium). Further work is required to determine the source and significance of the anomalously high metal concentrations.

Table 16. - Analytical results of Sharp Peak area samples
[Values in parts per million]

Sample Number	Elements Analyzed					
	Cu	Pb	Zn	Ba	CPS	Sample Type
78 PRUJ 125	NA	NA	NA	NA	x	Clay
78 PRUJ 337	90	20	170	4,600	x	Stream sediment
78 PRUJ 338	115	10	140	21,500	x	Stream sediment
78 PRUJ 339	100	15	435	7,500	x	Stream sediment
78 PRUJ 340	195	15	380	13,500	x	Stream sediment
78 PRUJ 341	115	15	680	5,800	x	Stream sediment
78 PRUJ 342	55	20	165	2,700	x	Stream sediment
78 PRUJ 343	95	15	405	5,000	x	Stream sediment
78 PRUJ 344	80	15	300	5,800	x	Stream sediment
78 PRUJ 345	135	20	100	15,000	x	Stream sediment

NA - Not analyzed
x - Within range of background values

Nuka Ridge "Oil" Sands Area

Oil-bearing sands were reported to occur in Lisburne Group rocks in the south-central part of the NPR-A(15, 16). The area of this occurrence was traversed and three rock samples yielding an "asphaltic" odor were collected. Trace amounts of tasmanite(?) occur in the arkose.

Location and Physical Setting

The prospected area is on a small ridge between Mechanic Creek and Nuka Ridge at 68° 42' 45"N latitude, 159° 34'W longitude, in sections 31 and 32 of T 8S, R 32W, Umiat Base and Meridian. It is 6 miles north of the southern NPR-A boundary.

The area is within the DeLong Mountains section of the Arctic Mountains Physiographic Province(4). Elevations in the area range from 2,200 to 3,200 feet. Rock samples were collected along the western end of a 1.5-mile long northeast-trending ridge (Figure 19). The ridge rises approximately 800 feet above the surrounding tundra plain and has moderately steep slopes. The ridge is barren of vegetation along the crest and covered by alpine tundra at lower elevations.

Regional Geology

The Permian to Mississippian Nuka Formation, which consists of arkose, arkosic limestone, and glauconitic limestone, underlies the prospected ridge(1). This unit is mapped as part of the Ipnavik River thrust sequence.

Bureau of Mines Work in 1978

Limited surface prospecting was conducted in the area of the reported oil-bearing sands and three rock samples were collected. Two are arkose (78 PRUJ 103 and 105); one is a shale (78 PRUJ 104). These samples were not analyzed. An "asphaltic" odor could be detected from freshly broken surfaces of these samples. Arkose (sample 78 PRUJ 103) contains trace amounts of a soft black material that has tentatively been identified as tasmanite. This mineral has been identified previously in samples from this area.

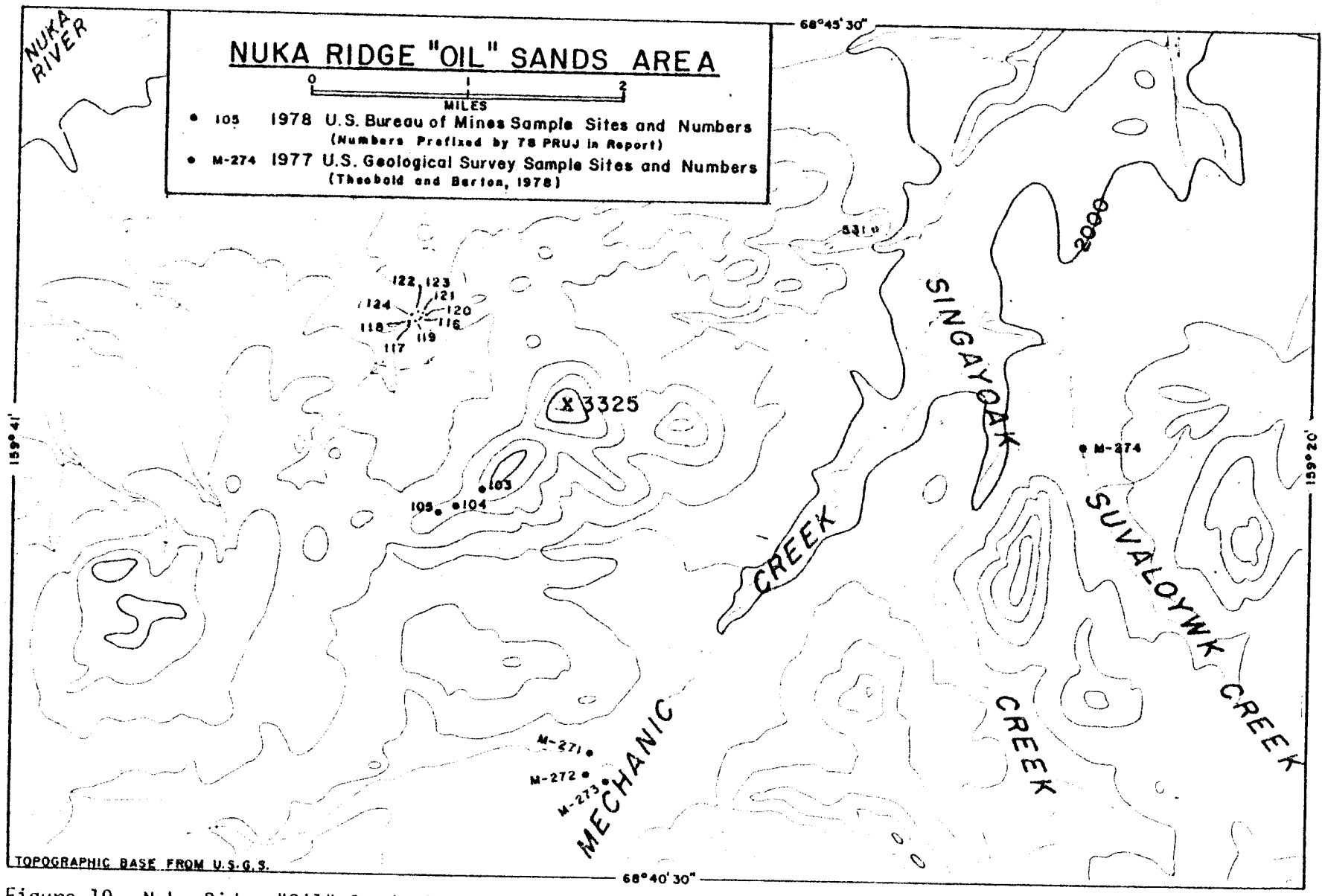


Figure 19. Nuka Ridge "Oil" Sands Area

Nuka River Pyritiferous Chert Zone

A prominent zone of limonite staining, which is related to pyritiferous chert, occurs north of Nuka Ridge. Rock and stream sediment samples were collected and analyzed. High barium and copper concentrations occur in the chert.

Location and Physical Setting

Limonite stained cherts outcrop along a small stream located near 68° 43' 55"N latitude, 159° 34'W longitude, in section 20 of T 8S, R 32W, Umiat Base and Meridian. The site, located between the Nuka River and Mechanic Creek, is approximately 7 miles north of the southern NPR-A boundary.

The sampled area is within the DeLong Mountains section of the Arctic Mountains Physiographic Province(4). It is characterized by rolling, tussock and alpine tundra covered plains with knobs, buttes, and long, low ridges (Figure 20). Elevations in the area range from 2,100 to 2,400 feet.

Regional Geology

The rock units in the area of the chert outcrop include: (1) Lower Cretaceous to Upper Jurassic wacke and mudstone of the Okpikruak Formation, (2) Triassic to Permian chert and shale of the Shublik and Siksikpuk Formations, and (3) Mississippian black chert and shale of the Lisburne Group(1). These rock units are mapped as part of the Northwestern Brooks Range thrust sequence.

Bureau of Mines Work in 1978

The area was prospected, geologic relationships were noted, and rock and stream sediment samples were collected.

A pyritiferous chert and chert agglomerate(?) unit overlies(?) carbonaceous pyritiferous shales and mudstone (Figure 21). A thin limestone bed, or lens, occurs in the cherts. One piece of banded pyritiferous shale float was found in the drainage.

Chip samples of the cherts (78 PRUJ 118, 119, 121, 122, 124), a shale and chert (78 PRUJ 120), and the calcareous unit (78 PRUJ 123) were collected and analyzed to determine their base metal content (Table 17 and 18). Sample sites

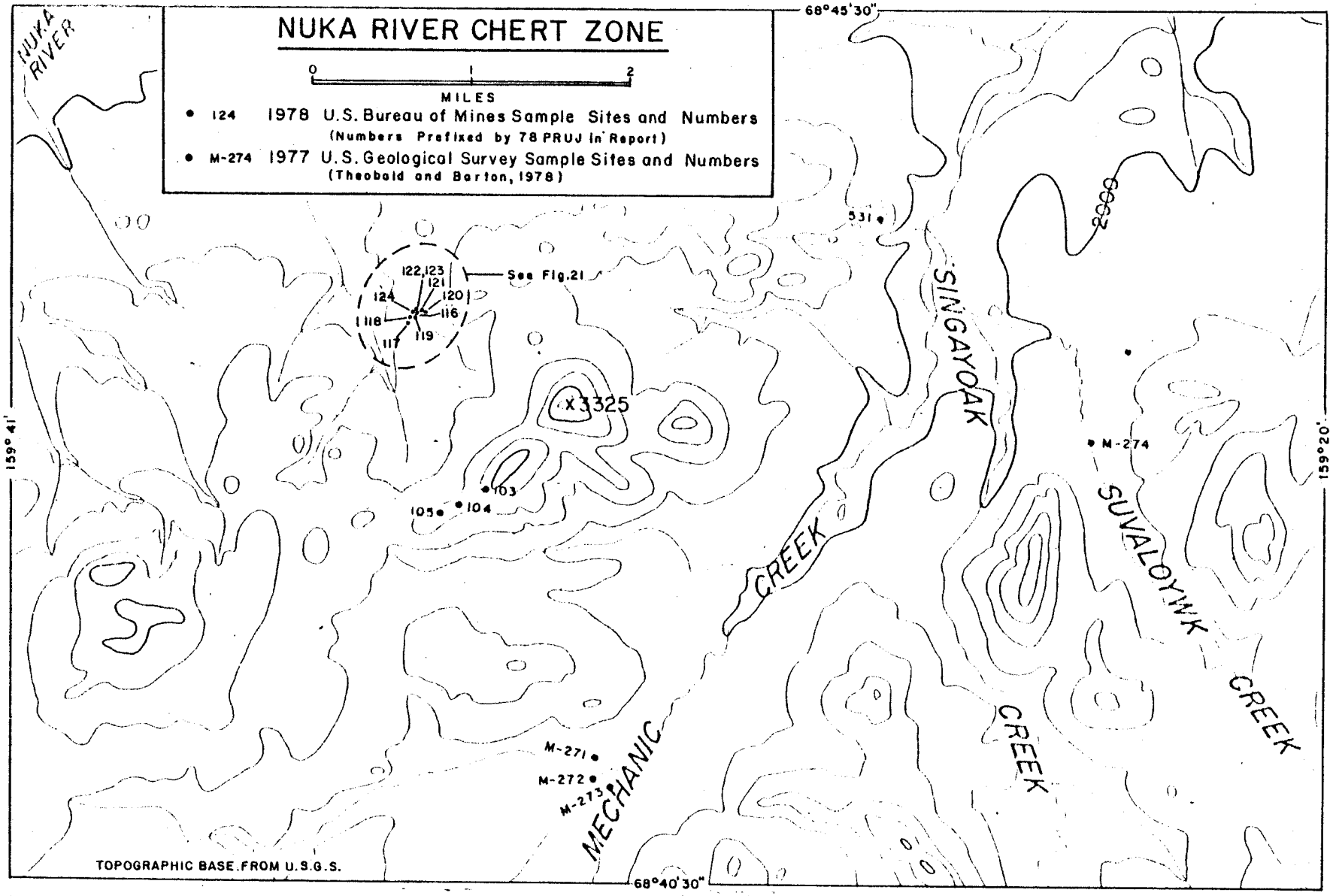


Figure 20. Nuka River Chert Zone

and sample lengths are shown on Figure 21. Chert samples 78 PRUJ 118 and 124 contain 10,000 ppm or more barium; samples 78 PRUJ 119 and 121 contain 5,000 ppm and 3,000 ppm respectively. Samples 78 PRUJ 119 and 124 contain 200 ppm copper. Stream sediment samples were collected immediately upstream (78 PRUJ 116) and downstream (78 PRUJ 117) from the chert outcrop. The downstream sample contains slightly higher concentrations of copper and zinc than the upstream sample; neither of these concentrations is anomalously high.

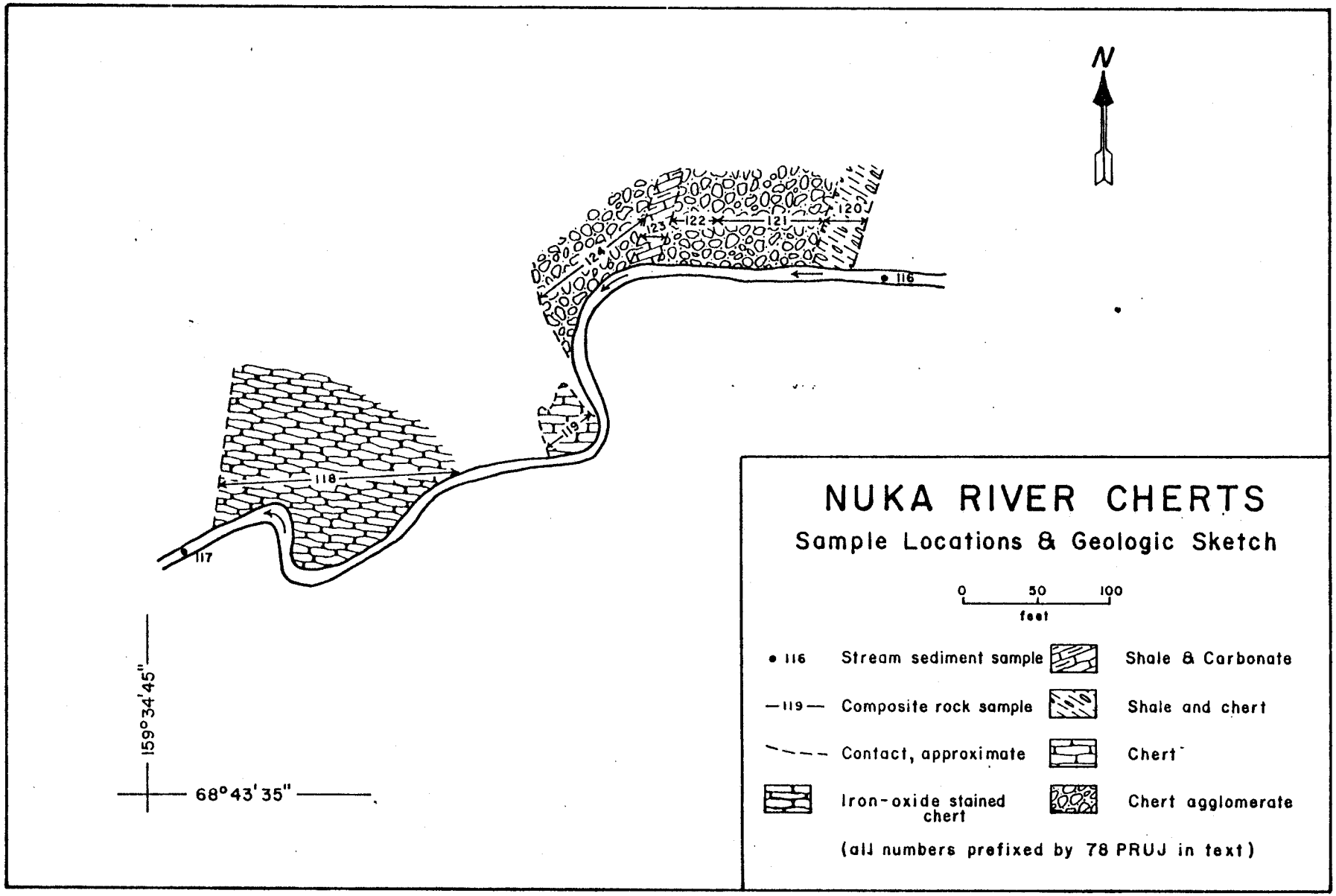


Figure 21. Generalized geology and sample sites of the Nuka River pyritiferous chert zone

Table 17. - Analytical results of Nuka River Chert area samples
[Values in parts per million]

Sample Number	Elements Analyzed				Sample Type
	Cu	Pb	Zn	CPS	
78 PRUJ 116	55	30	120	x	Stream sediment
78 PRUJ 117	80	30	170	x	Stream sediment
78 PRUJ 118	NA	NA	NA	x	Chert
78 PRUJ 119	NA	NA	NA	x	Chert
78 PRUJ 120	NA	NA	NA	x	Shale and chert
78 PRUJ 121	NA	NA	NA	x	Chert agglomerate
78 PRUJ 122	NA	NA	NA	x	Chert agglomerate
78 PRUJ 123	NA	NA	NA	x	Shale and carbonate
78 PRUJ 124	NA	NA	NA	x	Chert agglomerate

NA - Not analyzed
x - Within range of background values

Table 18. - Emission spectrographic results of Nuka River Chert area samples
[Values in parts per million unless otherwise noted]

Element	Sample numbers			
	78 PRUJ 118 Chert	78 PRUJ 119 Chert	78 PRUJ 121 Chert agglomerate	78 PRUJ 124 Chert agglomerate
Fe	0.7%	1.5%	1%	3%
Ca	0.1%	0.07%	0.07%	0.1%
Mg	0.15%	0.2%	0.1%	0.2%
Ag	<1	<1	<1	<1
As	<500	<500	<500	<500
B	15	20	20	20
Ba	10,000	5,000	3,000	>10,000
Be	<2	<2	<2	<2
Bi	<10	<10	<10	<10
Cd	<50	<50	<50	<50
Co	<5	<5	<5	<5
Cr	10	20	20	30
Cu	50	200	30	200
Ga	<10	<10	<10	<10
Ge	<20	<20	<20	<20
La	20	20	20	20
Mn	150	100	200	200
Mo	<2	<2	<2	2
Nb	<20	<20	<20	<20
Ni	5	10	15	50
Pb	<10	20	<10	10
Sb	<100	<100	<100	<100
Sc	<10	<10	<10	<10
Sn	<10	10	<10	<10
Sr	100	100	100	200
Ti	500	1,000	1,000	1,500
V	50	100	100	200
W	<50	<50	<50	<50
Y	<10	<10	<10	10
Zn	<200	<200	<200	<200
Zr	20	30	50	70

Singayoak (M-275) - Picnic Creek (M-267) Area

Two drainages, one north-flowing and the other south-flowing from an unnamed divide, were sampled to determine the source of lead found in anomalously high concentrations in a sample from the 1977 regional geochemical survey(2). Sediment sample M-275 from the north flowing creek contained 100 ppm lead; the south-flowing creek contained detectable lead and zinc. The anomalous metal concentrations were not reproduced by the 1978 sampling.

Location and Physical Setting

Stream sediment samples were collected from the western branch of upper Singayoak Creek and from the eastern branch of upper Picnic Creek, both are located south of Nuka Ridge near the southern NPR-A boundary (Figure 22). Sample sites are near 68° 34"N latitude, 159° 23'W longitude, and in sections 27 and 34 of T 9S, R 32W, and sections 3, 4, 9, 15, 19, 20, 21, 22, and 28 of T 10S, R 32W, Umiat Base and Meridian.

The Singayoak-Picnic Creek area is within the DeLong Mountains section of the Arctic Mountains Physiographic Province(4). Elevations in the area range from 2,000 to 4,000 feet.

Stream M-267 is a 5-mile long west-flowing tributary of Picnic Creek which is a south-flowing tributary of Anisak River. The stream is relatively straight and occupies a steep-walled narrow canyon. The stream gradient is 150 feet per mile. The surface area of the drainage basin is approximately 8.0 square miles.

Stream M-275 is a 3.5-mile long north-flowing branch of Singayoak Creek which is a north-flowing tributary of the Nuka River. The stream is relatively straight and occupies a gently sloping, alpine tundra covered valley. The stream gradient is about 100 feet per mile. The surface area of the drainage basin is approximately 5.25 square miles.

Regional Geology

The Jurassic-Cretaceous Okpikruak Formation, which contains wacke and mudstone couplets, conglomerate, layers of carbonaceous detritus and oil shale clasts, crops out on the west side of stream M-275(12). These wackes and mud-

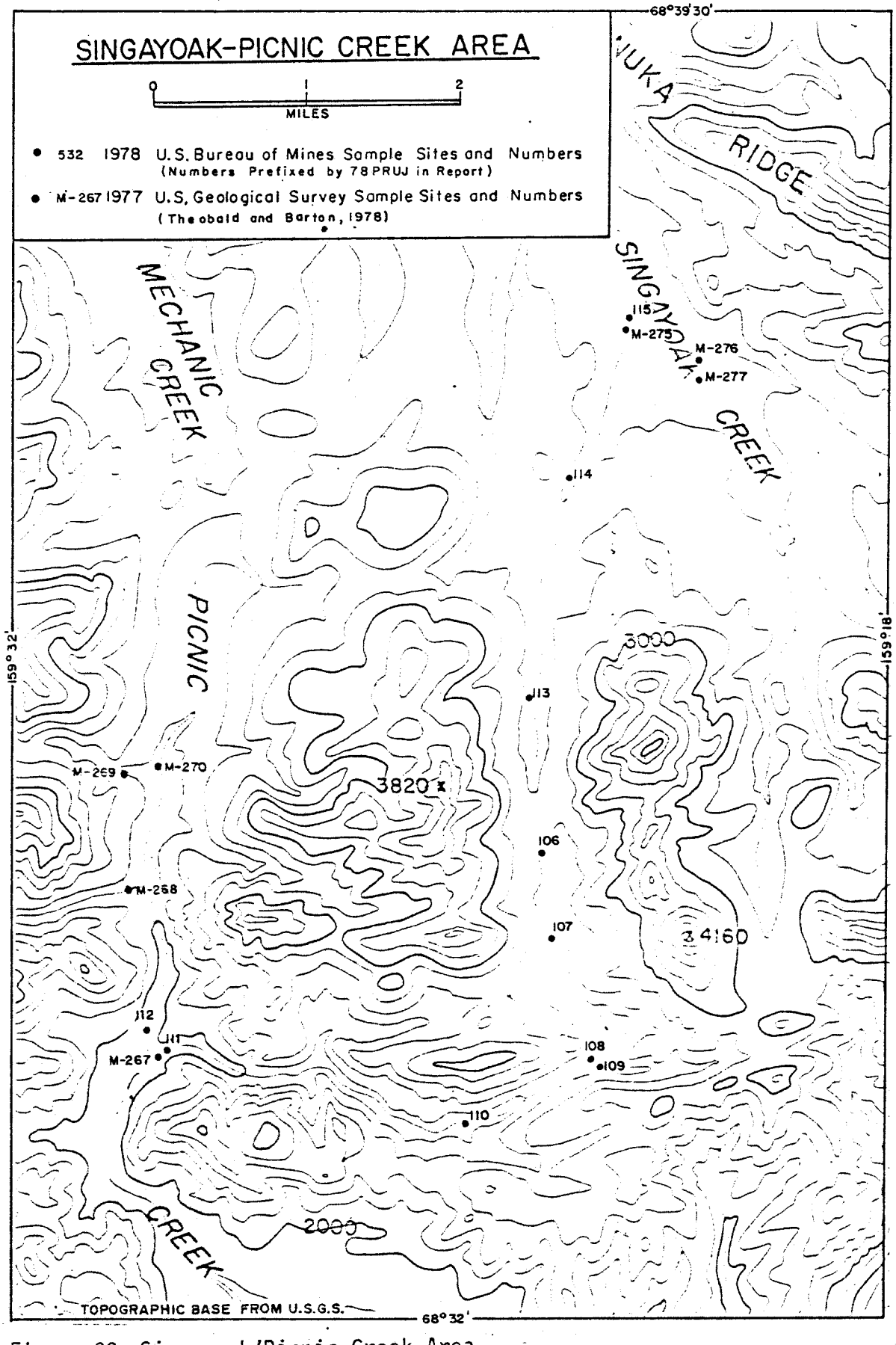


Figure 22. Singayoak/Picnic Creek Area

stones underlie stream M-275 above the 2,600 foot elevation; Mississippian Lisburne Group rocks, which include well-bedded black chert, grey limestone, with black chert nodules, and diabase sills, underlie the stream below the elevations. The upper portion of stream M-267 is underlain by Lower Cretaceous flyschoid wacke and mudstone, with localized conglomerate, of the Okpikruak Formation(1). These units are mapped as part of the Ipnavik River thrust sequence.

Results of the 1977 Geochemical Survey

Anomalously high lead (100 ppm) and detectable zinc (<200 ppm) concentrations are reported in stream sediment sample M-275(2). Stream sediment sample M-267 contains 20 ppm lead and low, but detectable (<200 ppm), zinc concentrations. The heavy-mineral concentrate of neither sample contains detectable lead or zinc.

Analytical Results from the 1978 Samples

Ten stream sediment samples were collected for analysis to determine their barium, copper, lead, and zinc content (Table 19). Average element contents of the samples, with standard deviations shown in parentheses, are: barium 2,600 ppm (1,300 ppm), copper 52 ppm (16 ppm), lead 25 ppm (6.2 ppm), and zinc 150 ppm (42 ppm). The copper, lead, and zinc concentrations are nearly uniform; barium concentrations have a very large standard deviation.

Radiometric readings in the area averaged about 50 cps and had a variation of about 10 cps. These values are within the normal range for the NPR-A.

Table 19. - Analytical results of Singayoak-Picnic Creek area samples
[Values in parts per million]

Sample Number	Elements Analyzed				CPS	Sample Type
	Cu	Pb	Zn	Ba		
78 PRUJ 106	65	30	260	1,600	x	Stream sediment
78 PRUJ 107	30	10	110	1,950	55	Stream sediment
78 PRUJ 108	55	25	135	1,400	65	Stream sediment
78 PRUJ 109	30	30	125	3,500	65	Stream sediment
78 PRUJ 110	55	30	170	1,500	65	Stream sediment
78 PRUJ 111	50	30	165	4,900	45-50	Stream sediment
78 PRUJ 112	40	25	150	3,600	40-50	Stream sediment
78 PRUJ 113	60	20	140	2,700	45	Stream sediment
78 PRUJ 114	80	25	155	NA	40	Stream sediment
78 PRUJ 115	60	25	120	NA	30	Stream sediment

NA - Not analyzed
x - Within range of background values

Mechanic Creek Area

A surface sample was collected from an area of limonite staining on a knob located on the west side of Mechanic Creek. This area was prospected briefly for potential base metal sulfide mineralization. Anomalously high copper and zinc concentrations occur in the soils.

Location and Physical Setting

A limonite stained stream bed occurs near the top of a small knob on the west side of Mechanic Creek. This knob is located one-half mile below the confluence of Singayoak and Mechanic Creeks and is near 68° 44' 30"N latitude, 159° 27'W longitude, and in section 23 of T 8S, R 32W, Umiat Base and Meridian.

The knob, which rises approximately 400 feet above the surrounding rolling tundra plain, is within the DeLong Mountains section of the Arctic Mountains Physiographic Province(4). It is steep-sided, barren of vegetation, and consists of outcrop surrounded by talus-covered slopes (Figure 23).

General Geology

Lower Cretaceous to Upper Jurassic wacke and mudstone of the Okpikruak Formation, Triassic to Permian chert and shale of the Shublik and Siksikpuk Formations, and Mississippian black chert and shale of the Lisburne Group outcrop in the area(1). The units are mapped as part of the Northwestern Brooks Range thrust sequence.

Rock types at the knob are grey to black cherts and limestone. The sampled material is a ferruginous calcareous clay. Iron-oxide coated aragonite crystals are present in the surface materials.

Analytical Results of the 1978 Samples

Soil sample 78 PRUJ 531 contains anomalously high copper (155 ppm) and zinc (420 ppm) concentrations (Table 20).

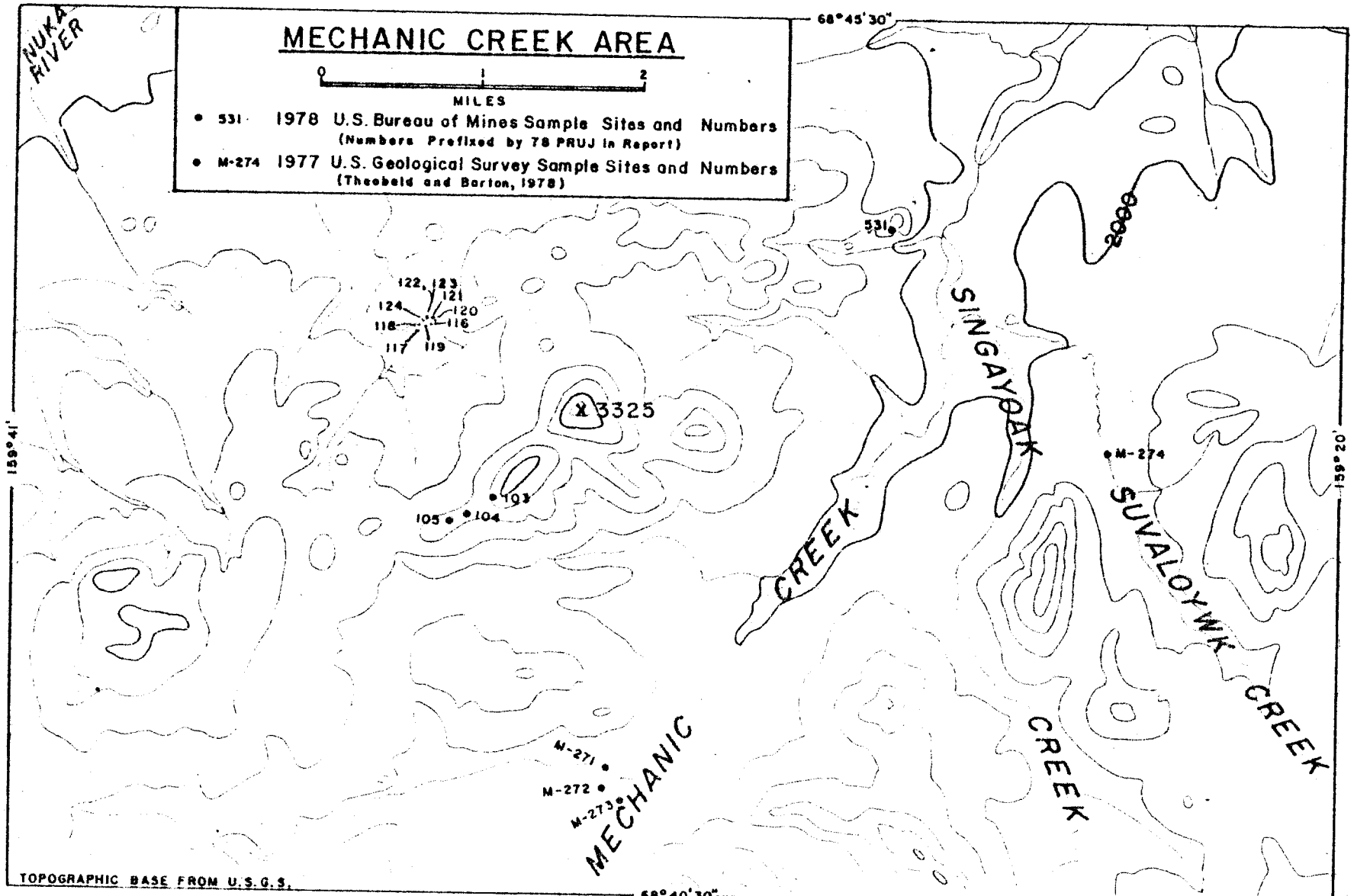


Figure 23. Mechanic Creek Area

Table 20. - Analytical results of the Mechanic Creek area sample
[Values in parts per million]

	Elements Analyzed				
Sample No.	Cu	Pb	Zn	CPS	Sample Type
78 PRUJ 531	155	5	420	x	Soil

x - Within range of background values

MINERALS INVESTIGATIONS IN THE HOWARD PASS QUADRANGLE

Eleven widely separated areas were investigated in the Howard Pass Quadrangle. Eight of these occur within a regional lead-zinc anomaly defined by the 1977 survey. Each is discussed separately.

Twistem Creek Area (H-330)

The Twistem Creek area is located about 6 miles southeast of the high-grade zinc and lead sulfide mineralization at Drenchwater Creek. Anomalously high lead and zinc concentrations were found in samples collected from the Twistem Creek area in 1977(2) and 1978.

Location and Physical Setting

The prospected area centers near 68° 31' 10"N latitude, 158° 32'W longitude, and is in section 6, T 11S, R 38W, Umiat Base and Meridian. This site is approximately three miles north of the southern NPR-A boundary.

The Twistem Creek area is in the Southern Foothills subprovince of the Arctic Foothills Physiographic Province(4). It is characterized by gently rolling tundra covered hills. Elevations in the area range from 2,100 to 2,400 feet.

Twistem Creek (H-330) is a 4-mile long, northwest-flowing tributary of the Kiligwa River (Figure 24). The half-mile long prospected segment of Twistem Creek is 20 to 30 feet wide and has a gradient of approximately 200 feet per mile. The stream bed is composed mainly of cobbles. The area of the Twistem Creek drainage basin is approximately 3.2 square miles. A limonite stained creek, which yields high zinc values, is a .8 mile long, ten-foot wide, shallow, northwest-flowing tributary of Twistem Creek. Its gradient is approximately 250 feet per mile. Its stream bed is composed mainly of cobbles. The area of this drainage basin is approximately .32 square miles.

Regional Geology

Rocks of the Lisburne Group (interbedded black chert and black shale), Siksikpuk Formation (red, green, and grey chert, argillite, shale), and Shublik

Formation (calcilutite, dark chert, and bituminous "paper" shale) underlie the region(12). These rocks are mapped as part of the Northwestern Brooks Range thrust sequence. The rock units strike nearly east-west and dip to the south.

Results of the 1977 Geochemical Survey

Anomalously high barium (20,000 ppm), and zinc (700 ppm) and low lead (20 ppm) concentrations occur in the stream sediment sample H-330(2); no zinc and minor lead (70 ppm) concentrations occur in the heavy-mineral concentrate.

Bureau of Mines Work in 1978

A limonite stained tributary and another unnamed tributary of Twistem Creek were prospected and sampled during two visits to this area. A limonite stained drainage, located 2.3 miles upstream from sample site H-330, was prospected and stream sediment and black shale samples were collected. Later the limonite stained area was prospected further because samples from this area contained anomalously high zinc, barium, copper, and manganese concentrations. Geology was not mapped, but the rock types, their distribution and attitudes, were noted.

A generalized stratigraphic section, striking aproximately N 70° E and dipping 20° S, crops out at the limonite stained creek. This section, from top to bottom, includes thin (tens of feet) beds of: carbonaceous/calcareous shale, limestone, pyritiferous carbonaceous shale, and diabase. The prospected tributary occupies a strike valley that has been eroded into the shale.

Eleven stream sediment and six rock samples were collected for chemical analysis; radiometric reading were taken at most of the sample sites (Tables 21 and 22). The stream sediments contain high concentrations of zinc (to 1,150 ppm), barium (to 19,000 ppm), copper (to 130 ppm), and manganese (to 2,800 ppm). The average element contents of the stream sediments, with the standard deviations shown in parentheses, are: copper 92 ppm (28 ppm), lead 37 ppm (26 ppm), zinc 420 ppm (380 ppm), barium 11,000 ppm (6,500 ppm), and manganese 2,700 ppm (470 ppm). The samples containing high barium and manganese concentrations are from one tributary. Rock samples contain barium (to 3,000 ppm), copper (to 150 ppm), manganese (to 3,000 ppm), lead (10 ppm) and silver (to 2 ppm), but no detectable zinc.

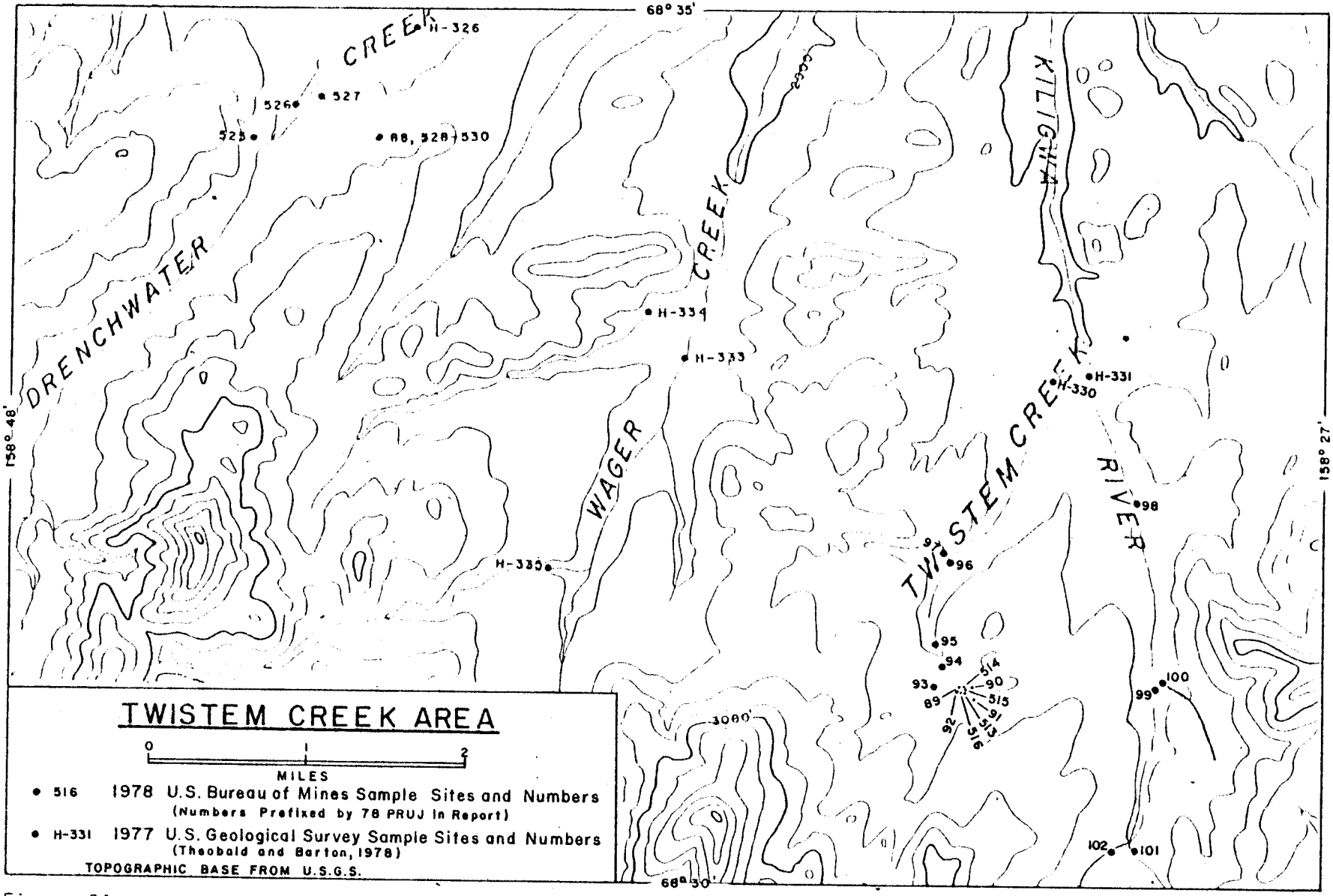


Figure 24. Twistem Creek Area

Except for zinc, the element concentrations in the stream sediment and rock samples are similar. Stream sediment samples downstream from the outcrop contain anomalously high zinc concentration; those collected upstream from the out crop did not have a high zinc content.

Radiometric readings of 220-240 cps were obtained over parts of the black shale outcrops. These readings were the highest radiometric values noted in the NPR-A and are more than 4 to 5 times background. Uraniferous phosphatic black shales may be present in the area.

Table 21. - Analytical results of Twistem Creek area samples
[Values in parts per million]

Sample Number	Elements Analyzed						
	Cu	Pb	Zn	Ba	Mn	CPS	Sample Type
78 PRUJ 89	NA	NA	NA	NA	NA	160	Carbonaceous shale
78 PRUJ 90	NA	NA	NA	NA	NA	220-240	Black shale
78 PRUJ 91	65	110	100	NA	NA	60	Stream sediment
78 PRUJ 92	70	45	1,150	NA	NA	x	Stream sediment
78 PRUJ 93	70	30	280	NA	NA	70	Stream sediment
78 PRUJ 94	75	45	1,150	NA	NA	x	Stream sediment
78 PRUJ 95	NA	NA	NA	NA	NA	x	Carbonaceous mudstone
78 PRUJ 96	135	20	30	NA	NA	x	Stream sediment
78 PRUJ 97	55	25	475	NA	NA	x	Stream sediment
78 PRUJ 98	130	30	440	6,500	2,200	x	Stream sediment
78 PRUJ 99	90	25	285	17,000	2,350	x	Stream sediment
78 PRUJ 100	90	20	210	19,000	2,800	x	Stream sediment
78 PRUJ 101	105	25	300	11,000	3,400	x	Stream sediment
78 PRUJ 102	125	30	220	3,900	2,550	x	Stream sediment
78 PRUJ 513	NA	NA	NA	NA	NA	x	Black shale
78 PRUJ 514	NA	NA	NA	NA	NA	x	Calcareous sandstone
78 PRUJ 515	NA	NA	NA	NA	NA	x	Diabase

NA - Not analyzed
x - Within range of background values

Table 22. - Emission spectrographic analyses of Twistem Creek area samples
[Values in parts per million unless otherwise noted]

Element	Sample numbers			
	78 PRUJ 95 Carbonaceous mudstone	78 PRUJ 513 Black Shale	78 PRUJ 514 Calcareous sandstone	78 PRUJ 515 Diabase
Fe	0.5%	1.5%	1%	10%
Ca	0.05%	0.2%	15%	5%
Mg	0.1%	0.1%	10%	7%
Ag	2	1	<1	<1
As	<500	<500	<500	<500
B	20	20	<10	<10
Ba	3,000	200	20	300
Be	<2	2	<2	<2
Bi	<10	<10	<10	<10
Cd	<50	<50	<50	<50
Co	<5	<5	<5	20
Cr	70	50	10	150
Cu	100	15	2	150
Ga	<10	<10	<10	10
Ge	<20	<20	<20	<20
La	20	200	50	<20
Mn	20	50	3,000	1,000
Mo	20	5	5	3
Nb	<20	50	20	<20
Ni	100	20	5	50
Pb	<10	10	10	<10
Sb	<100	<100	<100	<100
Sc	<10	<10	<10	30
Sn	<10	<10	<10	<10
Sr	100	1,000	200	100
Ti	1,500	2,000	500	3,000
V	200	100	20	200
W	<50	<50	<50	<50
Y	<10	20	<10	10
Zn	<200	<200	<200	<200
Zr	70	300	50	<20

Isikut Mountain Area (H-536)

A minor amount of lead is present in the stream sediment sample, and its heavy-mineral concentrate, collected from the Isikut Mountain area(2). The geologic setting at Isikut Mountain appears to be similar to that at Kivliktort and Koiyaktot Mountains where high-grade zinc and lead sulfide mineralization occurs. A sphalerite bearing cobble was found about 3.5 miles upstream from sample site H-536.

Location and Physical Setting

Isikut Mountain, which is located between Howard Pass and Inyorurak Pass, is on the southern NPR-A boundary. The headwaters of stream H-536 are on the southwestern side of Isikut Mountain near 68° 13' 15"N latitude, 156° 38'W longitude and in section 31 of T 33N, R 10E, Kateel River Base and Meridian.

Isikut Mountain is within the Central Brooks Range section of the Arctic Mountains Physiographic Province(4). Elevations in the area range from 1,700 to 4,300 feet (Figure 25). The mountain slopes are steep and barren of vegetation above the 3,000 foot elevation. Below the 3,000 foot elevation the slopes are gently rolling and alpine tundra covered.

Stream H-536 is a 3.8-mile long southwest-flowing tributary of a northwest-flowing stream which flows into Nigtun Lake, the headwaters of the Etivluk River. The prospected and sampled streams occupy a westerly-trending U-shaped valley which opens into the Howard Pass area near the headwaters of the Aniuk River. The stream bed consists primarily of cobbles and boulders. The stream gradient is about 600 feet per mile. The surface area of the drainage basin is approximately 5.3 square miles.

Regional Geology

The Lower Mississippian-Upper Devonian Kanayut Conglomerate, which consists of quartz and chert pebble conglomerate and clean white sandstone, underlies the northern and eastern slopes of Isikut Mountain(1). Mississippian Kayak Shale, which consists of siltstone, sandstone, and shale, underlies the southern foothills and western portion of the mountain. The prospected segment of stream H-536 is underlain by the Kanayut Conglomerate. At the lower elevations the

stream cuts Quaternary surficial deposits which are inferred to be underlain by Kayak Shale. Isikut Mountain was covered by the Pleistocene Itkillik and Anaktuvuk glaciations below approximately the 2,500 foot elevation(17).

Results of the 1977 Geochemical Survey

Stream sediment sample H-536 contains 15 ppm lead; the heavy-mineral fraction contains 70 ppm lead(2). Zinc was not detected.

Bureau of Mines Work in 1978

Stream H-536 was prospected and sediment and rock samples were collected. A colorimetric zinc-oxide indicator test was used extensively.

Sixteen stream sediment and three rock samples were analyzed to determine their copper, lead, and zinc content (Tables 23 and 24). The average element contents of the stream sediments, with the standard deviations shown in parentheses, are: copper 36 ppm (7.7 ppm), lead 15 ppm (2.9 ppm), and zinc 110 ppm (16 ppm). The emission spectrographic analyses of the rock samples indicate the presence of moderate amounts of barium (700 ppm), manganese (to 3,000 ppm), and molybdenum (to 5 ppm).

The element content of the rock and sediment samples is similar. The analytical results do not reflect the presence of zones of significant mineralization. Minor amounts of zinc-oxide were noted on a fracture surface in a conglomerate (78 PRUJ 195) collected from the headwaters of the drainage. This sample contains 50 ppm zinc. Minor amounts of galena were identified in a dolomite (78 PRUJ 200) which contains 10 ppm lead.

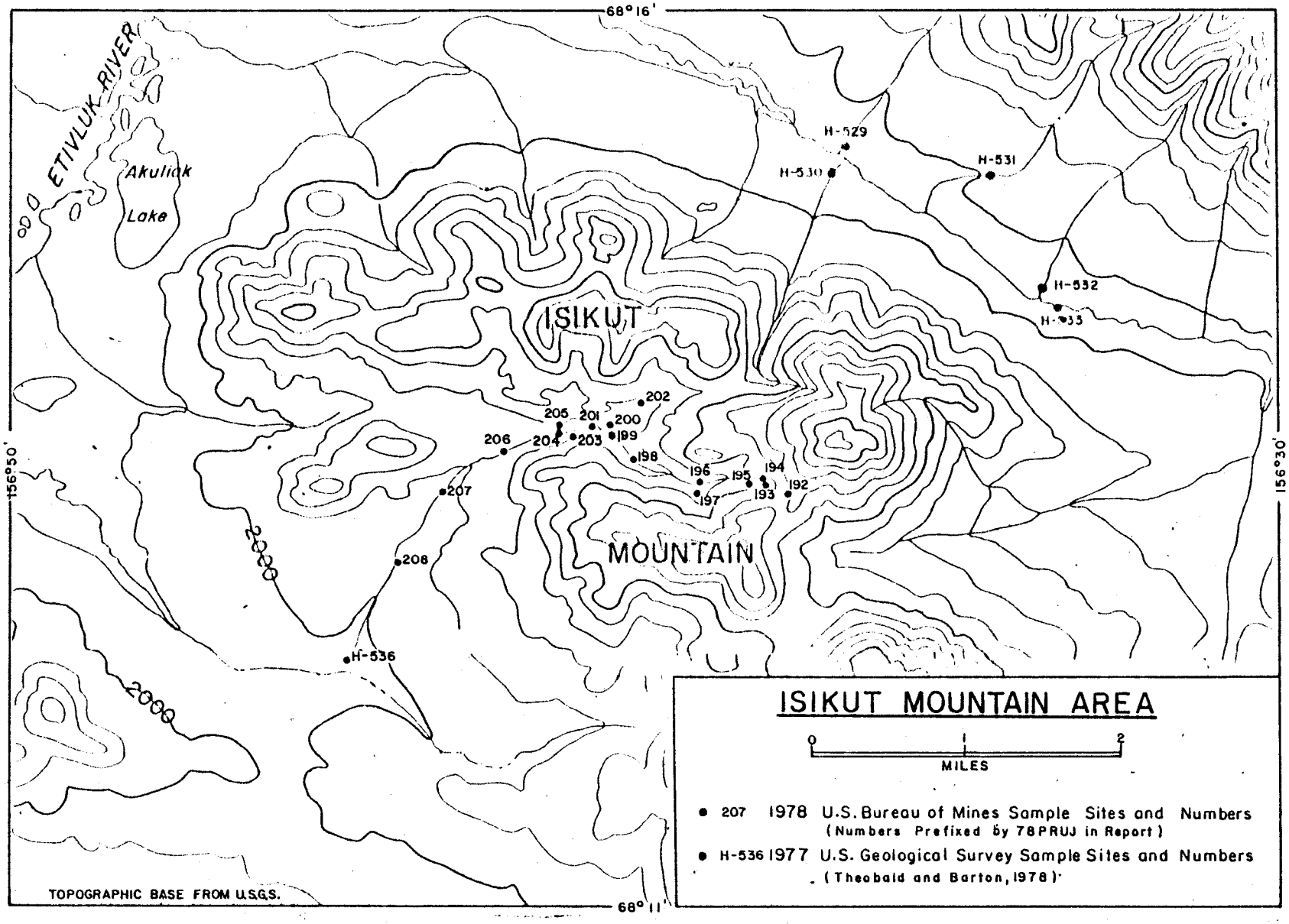


Figure 25. Isikut Mountain Area

Table 23. - Analytical results of Isikut Mountain area samples
[Values in parts per million]

Sample Number	Elements Analyzed			CPS	Sample Type
	Cu	Pb	Zn		
78 PRUJ 192	40	15	75	x	Stream sediment
78 PRUJ 193	45	15	105	x	Stream sediment
78 PRUJ 194	45	15	100	x	Stream sediment
78 PRUJ 195	70	55	50	x	Conglomerate with zinc oxide
78 PRUJ 196	25	15	90	x	Stream sediment
78 PRUJ 197	50	20	120	x	Stream sediment
78 PRUJ 198	25	10	110	x	Stream sediment
78 PRUJ 199	40	20	110	x	Stream sediment
78 PRUJ 200	60	10	135	x	Dolomite with galena
78 PRUJ 201	30	15	110	x	Stream sediment
78 PRUJ 202	35	15	135	x	Stream sediment
78 PRUJ 203	65	15	110	x	Shale
78 PRUJ 204	30	15	115	x	Stream sediment
78 PRUJ 205	35	10	105	x	Stream sediment
78 PRUJ 206	35	15	105	x	Stream sediment
78 PRUJ 207	I	I	I	x	Stream sediment
78 PRUJ 208	40	15	135	x	Stream sediment

I - Insufficient sample
x - Within range of background values

Table 24. - Emission spectrographic analyses of Isikut Mountain area samples
[Values in parts per million unless otherwise noted]

Element	Sample numbers		
	78 PRUJ 195 Conglomerate	78 PRUJ 200 Dolomite	78 PRUJ 203 Shale
Fe	15%	7%	1%
Ca	0.2%	5%	0.05%
Mg	0.5%	0.7%	0.15%
Ag	<1	<1	<1
As	<500	<500	<500
B	30	20	30
Ba	700	10	50
Be	<2	<2	2
Bi	<10	<10	<10
Cd	<50	<50	<50
Co	5	10	<5
Cr	<10	50	10
Cu	20	30	20
Ga	10	<10	10
Ge	<20	<20	<20
La	<20	20	50
Mn	3,000	1,500	500
Mo	5	2	<2
Nb	20	20	<20
Ni	20	50	10
Pb	10	<10	10
Sb	<100	<100	<100
Sc	15	10	<10
Sn	15	<10	<10
Sr	<100	100	100
Ti	200	2,000	1,000
V	50	100	100
W	<50	<50	<50
Y	<10	15	10
Zn	<200	<200	<200
Zr	<20	200	30

Koiyaktot Mountain Area (H-558, H-563)

Anomalously high lead and zinc concentrations were found in several sediment samples collected in 1977 from the Koiyaktot Mountain area(2). These samples form part of an extensive regional lead-zinc geochemical anomaly. Detailed prospecting and geochemical sampling along two streams led to the discovery of lead and zinc sulfide bearing cobbles. Similar mineralized float has been reported to occur in other drainages in the Koiyaktot Mountain area(13). The two prospected areas are designated as Koiyaktot Mountain-East and Koiyaktot Mountain-West.

Location and Physical Setting

Koiyaktot Mountain is located between Nigu River and Inyorurak Lake on the north slope of the central part of the Brooks Range. It is located at latitude 68° 13'N and longitude 156° 15'W and is four miles north of the southern NPR-A boundary.

Koiyaktot Mountain is within the Central Brooks Range section of the Arctic Mountains Physiographic Province(4). Elevations in the area range from 1,900 to 4,300 feet. Steep-sided, barren slopes, which are cut by many deeply-incised streams, characterize the mountain. The surrounding alpine tundra covered foothills are dissected by many streams.

Regional Geology

Koiyaktot Mountain is underlain by two sequences of Lower to Upper Devonian clastic sedimentary rock(1). The Kanayut Conglomerate, comprised of quartz and chert pebble conglomerate and clean white sandstone, makes up the overlying sequence. An unnamed sequence of sandstone, siltstone, and shale underlies the coarse clastic sequence. These units are mapped as part of the North Central Brooks Range thrust sequence. Pleistocene Itkillik and Anaktuvuk glaciations covered Koiyaktot Mountain below approximately 2,600 feet(17).

Koiyaktot Mountain-East (H-558)

Galena-bearing float rock was found in the stream at the 2,500 foot elevation at a site 0.9 miles upstream from sample H-558. Sediment samples from this stream contain up to 1,000 ppm lead and 820 ppm zinc.

Location and Physical Setting

Stream H-558 is located near latitude 68° 11' 25"N, longitude 156° 08'W, and is in section 9, T 34N, R 12E, Kateel River Base and Meridian.

The headwaters region of stream H-558, that above the 2,400 foot elevation, is characterized by steep slopes of barren talus and bedrock. Gently sloping, alpine tundra covered, rolling hills, which are cut by many small streams originating on Koiyaktot Mountain, characterize the topography below the 2,400 foot elevation. Elevations range from 1,900 to 4,300 feet.

Stream H-558 is a 1.8-mile long, northeast-flowing tributary of the Nigu River (Figure 26). It is relatively straight and has a gradient of approximately 1,000 feet per mile. The stream bed consists primarily of cobbles and boulders. The surface area of the drainage basin is approximately 2.5 square miles.

Geologic Setting

Two Lower Mississippian-Lower Devonian rock units underlie stream H-558(1). Kanayut Conglomerate, which consists of quartz and chert pebble conglomerate and clean white sandstone, crops out above the 2,400 foot elevation. An unnamed sandstone, siltstone, and shale unit underlies the lower segment of the stream.

Results of the 1977 Geochemical Survey

An anomalously high lead (150 ppm) concentration occurs in the stream sediment and heavy-mineral concentrate of sample H-558; an anomalous zinc (300 ppm) concentration occurs in the stream sediment but not in the heavy-mineral concentrate(2).

Bureau of Mines Work in 1978

Stream H-558 was prospected, general geologic relationships were noted, and stream sediment and rock samples were collected between its headwaters and its confluence with the Nigu River.

Sandstone and chloritic shale constitute the float rock in this drainage. Galena, as disseminations and fracture fillings, was found in sandstone (78 PRUJ 169) at a site about 0.9 miles upstream from sample site H-558. Highly pyritiferous chert-pebble conglomerate float rock was found along the lower reaches of the drainage.

Seven stream sediment and three rock samples were collected for analysis to determine their copper, lead, and zinc content (Tables 25 and 26). The average element contents in the stream sediments, with standard deviations shown in parentheses, are: copper 34 ppm (6.3 ppm), lead 220 ppm (360 ppm), and zinc 420 ppm (250 ppm). Sediment sample 78 PRUJ 173 contains 1,000 ppm lead and 820 ppm zinc; sediment sample 78 PRUJ 177 contains 330 ppm lead and 700 ppm zinc. Both samples are from the main drainage. The average base metal content of the rock samples is similar to that of the stream sediment samples when the two anomalous values are excluded. The source of the metals was not found.

Koiyaktot Mountain-West (H-563)

Galena-bearing float rock was found at two sites about 1.2 and 1.8 miles upstream from sample site H-563. Anomalously high concentrations of lead (to 510 ppm) and zinc (to 2,400 ppm) occur in stream sediment samples.

Location and Physical Setting

Stream H-563 is located near 68° 12' 50"N latitude, 156° 18' 30"W longitude, and is in section 34, T 33N, R 11E, Kateel River Base and Meridian.

The major segment of this stream traverses gently sloping, alpine tundra covered, rolling foothills on the southwest side of Koiyaktot Mountain. The uppermost segment of the stream, that above the 3,000 foot elevation, drains the steep, barren slopes of Koiyaktot Mountain (Figure 27). Elevations in the area range from 2,000 to 3,600 feet.

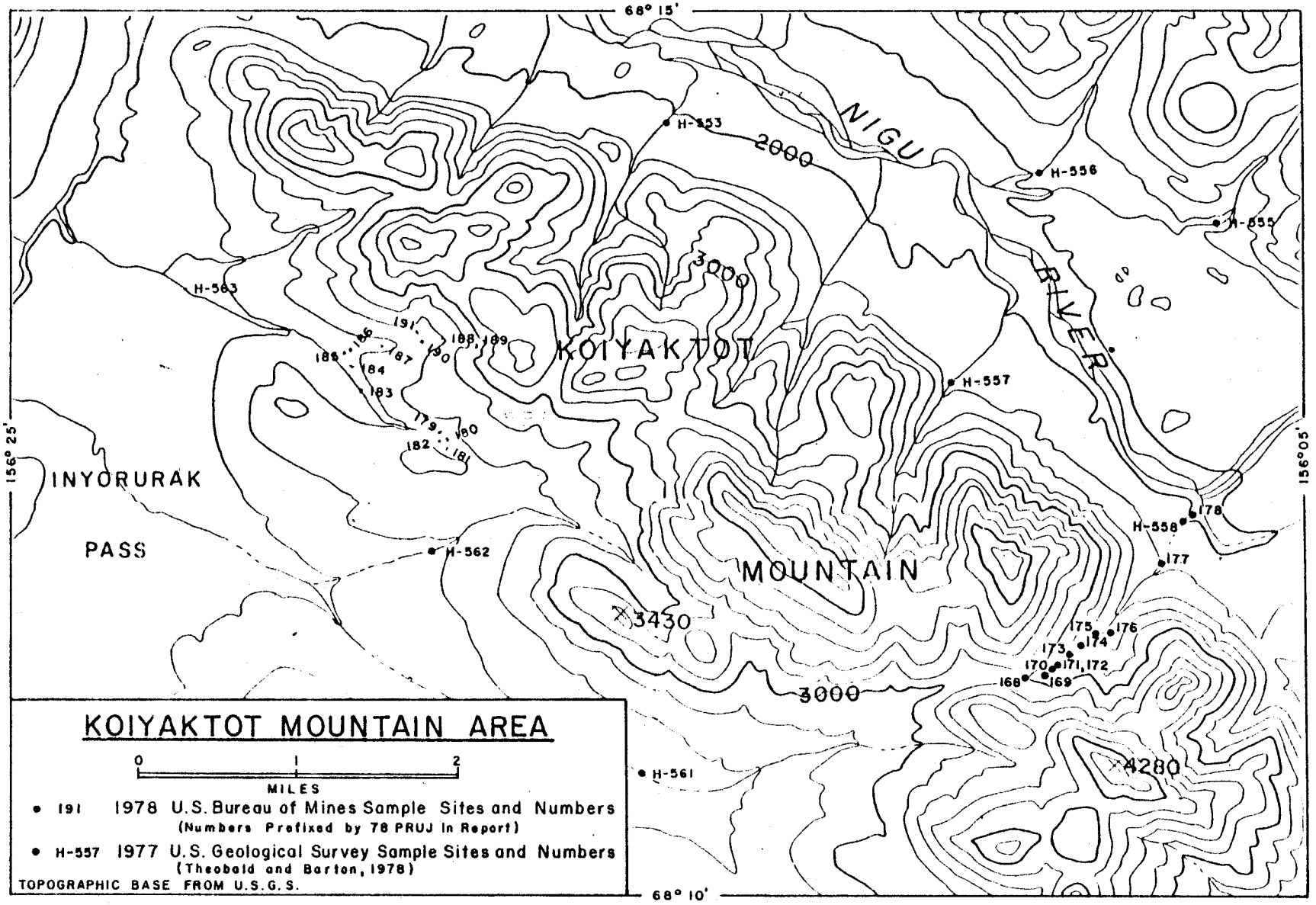


Figure 26. Sample sites in the eastern Koiyaktot Mountain area

Stream H-563 is a 3.2-mile long, west-flowing tributary of the west branch of the Nigu River. It branches approximately .8 miles upstream from sample site H-563. The prospected creeks are relatively straight and have gradients ranging from 230 to 400 feet per mile. The stream bed consists primarily of cobbles. The surface area of the drainage basin is approximately 3.8 square miles.

Geologic Setting

Two Lower Mississippian-Upper Devonian rock units underlie stream H-563(1). The Kanayut Conglomerate, which consists of quartz and chert pebble conglomerate and clean white sandstone, crops out below the 3,000 foot elevation. An unnamed sandstone, siltstone, and shale unit crops out above the 3,000 foot elevation.

Results of the 1977 Geochemical Survey

Anomalously high zinc (300 ppm) and lead (70 ppm) concentrations occur in stream sediment sample H-563(2). The heavy-mineral concentrate contains 20 ppm lead; zinc was not detected.

Bureau of Mines Work in 1978

Stream H-563 and one of its tributaries were prospected and rock and stream sediment samples were collected. Nearly all sampled materials are from the creek bed, but several outcrops were sampled to determine their metal content. Disseminated galena and galena-filled fractures were found in sandstone boulders and cobbles (78 PRUJ 182, 186, 189) in the northern branch of stream H-563.

Eight sediment and four rock samples were analyzed to determine their copper, lead, and zinc content (Tables 25 and 26). The average element contents of the stream sediment samples, with standard deviations shown in parentheses, are: copper 30 ppm (9.3 ppm), lead 160 ppm (160 ppm), and zinc 800 ppm (790 ppm). Galena and sphalerite bearing sandstone samples contain up to 14,000 ppm lead (78 PRUJ 189) and 4,500 zinc (78 PRUJ 186).

Emission spectrographic analyses of rock samples show element concentrations up to 70 ppm copper, 7,000 ppm lead, 7,000 ppm zinc, and 1,500 ppm manganese. The data suggest the metal contents of the stream sediment and rock samples are similar. The metal concentrations are very high. Further work is

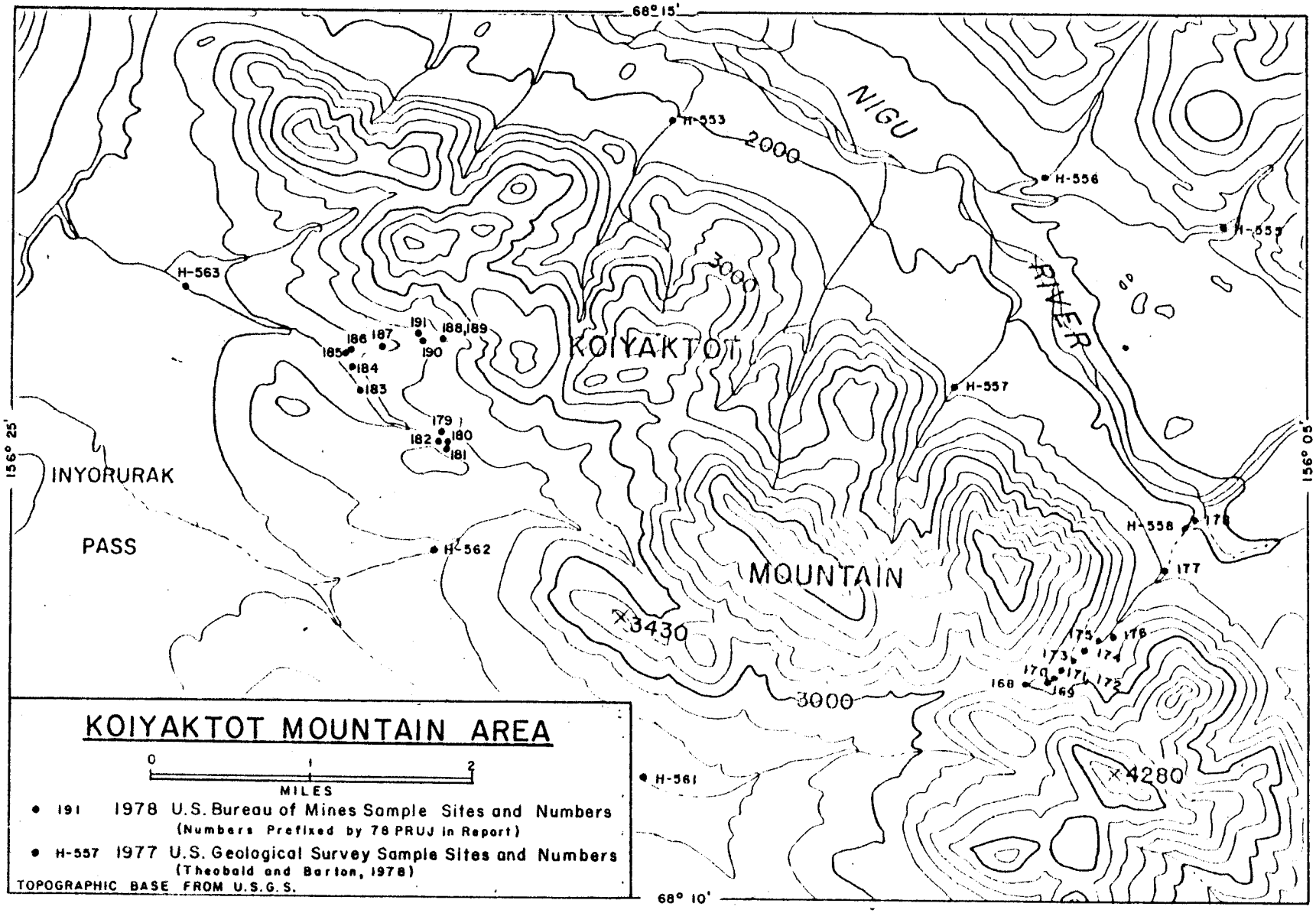


Figure 27. Sample sites in the western Koiyaktot Mountain area

necessary to determine the in-place location, nature, and extent of mineralization.

Table 25. - Analytical results of Koiyaktot Mountain area samples
[Values in parts per million]

Sample Number	Elements Analyzed Cu	Pb	Zn	CPS	Sample Type
Koiyaktot Mountain - East (H-558)					
78 PRUJ 168	35	50	300	x	Stream sediment
78 PRUJ 169	15	185	135	x	Conglomerate with sandstone
78 PRUJ 170	35	40	235	x	Stream sediment
78 PRUJ 171	10	15	20	x	Pyritiferous chert pebble conglomerate
78 PRUJ 172	35	50	450	x	Stream sediment
78 PRUJ 173	35	1,000	820	x	Stream sediment
78 PRUJ 174	10	10	15	x	Pyritiferous sandstone
78 PRUJ 175	NA	NA	NA	x	Conglomerate with galena and sphalerite
78 PRUJ 176	40	40	190	x	Stream sediment
78 PRUJ 177	35	330	700	x	Stream sediment
78 PRUJ 178	20	60	230	x	Stream sediment
Koiyaktot Mountain - West (H-563)					
78 PRUJ 179	NA	NA	NA	100	Sandstone
78 PRUJ 180	35	110	295	x	Stream sediment
78 PRUJ 181	10	20	75	x	Stream sediment
78 PRUJ 182	15	5	15	x	Sandstone
78 PRUJ 183	30	30	225	100	Stream sediment
78 PRUJ 184	35	20	100	100	Shale
78 PRUJ 185	30	175	1,200	80	Stream sediment
78 PRUJ 186	15	4,000	4,500	80	Sandstone with galena
78 PRUJ 187	25	150	950	80	Stream sediment
78 PRUJ 188	35	510	2,400	100-110	Stream sediment
78 PRUJ 189	80	14,000	1,800	x	Sandstone with galena
78 PRUJ 190	40	250	1,150	100-110	Stream sediment
78 PRUJ 191	35	50	150	x	Stream sediment

NA - Not analyzed
x - Within range of background values

Table 26. - Emission spectrographic analyses of Koiyaktot Mountain area samples
[Values in parts per million unless otherwise noted]

Element	Sample Numbers			
	78 PRUJ 169 Conglomerate	78 PRUJ 171 Pyritiferous conglomerate	78 PRUJ 174 Pyritiferous sandstone	78 PRUJ 182 Sandstone
Fe	3%	7%	1%	1%
Ca	0.07%	0.5%	0.03%	0.07%
Mg	0.05%	0.07%	0.05%	0.07%
Ag	<1	1	<1	<1
As	<500	<500	<500	<500
B	10	15	15	10
Ba	<10	<10	10	<10
Be	<2	<2	<2	<2
Bi	<10	<10	<10	<10
Cd	<50	<50	<50	<50
Co	10	10	5	<5
Cr	20	10	50	10
Cu	10	20	10	10
Ga	<10	<10	<10	<10
Ge	<20	<20	<20	<20
La	50	20	100	50
Mn	1,000	700	10	100
Mo	<2	2	<2	<2
Nb	<20	20	<20	<20
Ni	20	50	<5	15
Pb	100	10	<10	<10
Sb	<100	<100	<100	<100
Sc	<10	<10	<10	<10
Sn	<10	<10	<10	<10
Sr	200	200	200	200
Ti	1,000	1,000	3,000	500
V	30	50	50	50
W	<50	<50	<50	<50
Y	<10	20	<10	<10
Zn	<200	<200	<200	<200
Zr	100	20	200	30

Table 26. - Emission spectrographic analyses of Koiyaktot Mountain area samples - Continued
[Values in parts per million unless otherwise noted]

Element	Sample numbers		
	78 PRUJ 184 Shale	78 PRUJ 186 Sandstone	78 PRUJ 189 Sandstone
Fe	7%	5%	2%
Ca	0.05%	0.03%	0.05%
Mg	0.2%	0.05%	0.1%
Ag	<1	5	10
As	<500	<500	<500
B	50	10	20
Ba	50	10	20
Be	2	<2	2
Bi	<10	<10	<10
Cd	<50	<50	<50
Co	10	<5	<5
Cr	50	<10	20
Cu	50	20	70
Ga	10	<10	<10
Ge	<20	<20	<20
La	20	20	50
Mn	500	1,500	100
Mo	<2	<2	2
Nb	20	20	20
Ni	50	5	30
Pb	20	2,000	7,000
Sb	<100	<100	300
Sc	20	<10	10
Sn	<10	<10	<10
Sr	200	200	200
Ti	5,000	700	3,000
V	200	70	100
W	<50	<50	<50
Y	15	<10	10
Zn	<200	7,000	2,000
Zr	200	30	200

Kivliktort Mountain Area (H-521, H-527)

Geochemical work in 1977 revealed the presence of anomalously high concentrations of lead and zinc in two drainages in the Kivliktort Mountain area. These drainages were prospected and sampled. This area is within an extensive regional lead-zinc geochemical anomaly. Pyritiferous quartzites and sandstones were found in creek H-521; high-grade zinc sulfide, lead sulfide, and barite were found in creek H-527. The 1978 work is discussed in sections titled East Kivliktort Area (H-521) and West Kivliktort Area (H-527).

Location and Physical Setting

Kivliktort Mountain is located at 68° 17'N latitude, 156° 30'W longitude, between the Nigu and Etivluk Rivers, and is approximately seven miles north of the southern NPR-A boundary.

Kivliktort Mountain is within the Central Brooks Range section of the Arctic Mountains Physiographic Province(4). The mountain rises about 3,000 feet above the adjacent valleys. Elevations in the area range from 1,600 to 4,600 feet. Above the 2,200-foot elevation, steep-sided barren mountain slopes are cut by deeply incised drainages. Below this elevation, gently sloping, alpine tundra covered, rolling foothills are cut by drainages originating on Kivliktort Mountain.

Regional Geology

Three rock sequences are present in the Kivliktort Mountain area. These include the Lower Mississippian-Upper Devonian Kanayut Conglomerate, an unnamed sandstone, siltstone, and shale unit of the same age, and the Mississippian Kayak Shale(1). The unnamed sandstone, siltstone, and shale section may be the Hunt Fork Shale(17). All the units are mapped as part of the North Central Brooks Range thrust sequence. Pleistocene Itkillik and Anaktuvuk glaciations covered Kivliktort Mountain below the 3,000 foot elevation(17).

East Kivliktort Area (H-521)

Anomalously high concentrations of lead (7,000 ppm) are present in the heavy-mineral concentrate of sample H-521. Sandstones and shales containing about 15 percent pyrite were found in the drainage. The source of the lead in the concentrate was not identified.

Location and Physical Setting

Stream H-521, on the southeastern side of Kivliktort Mountain, is located at 68° 15' 45"N latitude, 156° 25'W longitude and in section 18, T 33N, R 11E, Kateel River Base and Meridian. It occupies a deeply incised, V-shaped valley. Elevations in the area range from 1,900 to 4,000 feet. The stream was prospected and sampled between the 1,900 and 2,300 foot elevations (Figure 28).

Stream H-521 is a 2.7-mile long, northeast-flowing tributary of the Nigu River. It is relatively straight and its gradient varies from 400 to 700 feet per mile. The stream bed consists primarily of cobbles and boulders. The surface area of the drainage basin is approximately 2.6 square miles.

Geologic Setting

Two terranes are mapped in the area(1). Mississippian Kayak Shale, which includes siltstone, shale, and sandstone, is cut by the northeast-flowing upper branch of stream H-521 above the 3,000 foot elevation. An unnamed Lower Mississippian-Upper Devonian sandstone, siltstone, and shale unit crops out below the 3,000 foot elevation.

An abrupt change from sandstone to carbonaceous shale occurs along creek H-521. This change is reflected in the topography. Rugged slopes are underlain by sandstones; areas of gentle slopes are underlain by shale. Predominantly siliceous sandstone crops out upstream from sample site H-521; carbonaceous pyritiferous shale crops out downstream from this site. Rocks in the eastern half of the traversed drainage include cross-bedded, locally hematitic, siliceous sandstone. Disseminated pyrite, up to an estimated 15% by volume, was found in one sandstone boulder and several smaller fragments of this rock type. Black to grey carbonaceous shale underlies much of the main valley floor.

It is limonite stained and assumed to be pyritiferous. These rocks are thought to be part of the Endicott Group(18).

Results of the 1977 Geochemical Survey

Anomalous lead (100 ppm) and low, but detectable, zinc (<200 ppm) concentrations occur in the stream sediment sample H-521; anomalous lead (7,000 ppm) and silver (7 ppm) concentrations occur in the heavy-mineral concentrate(2).

Analytical Results of the 1978 Bureau of Mines Samples

Ten stream sediment samples and one rock sample were collected for analysis to determine their copper, lead, and zinc content (Tables 27 and 28). The average element contents of the stream sediments, with the standard deviations shown in parentheses, are: copper 25 ppm (7.6 ppm), lead 44 ppm (26 ppm), and zinc 170 ppm (69 ppm). The lead values of these samples are higher than the defined threshold values of the 1977 analyses. The copper and zinc values are not anomalous and show little variation. The analytical results show no highly anomalous element concentrations in the pyritiferous graphitic quartzite (78 PRUJ 161).

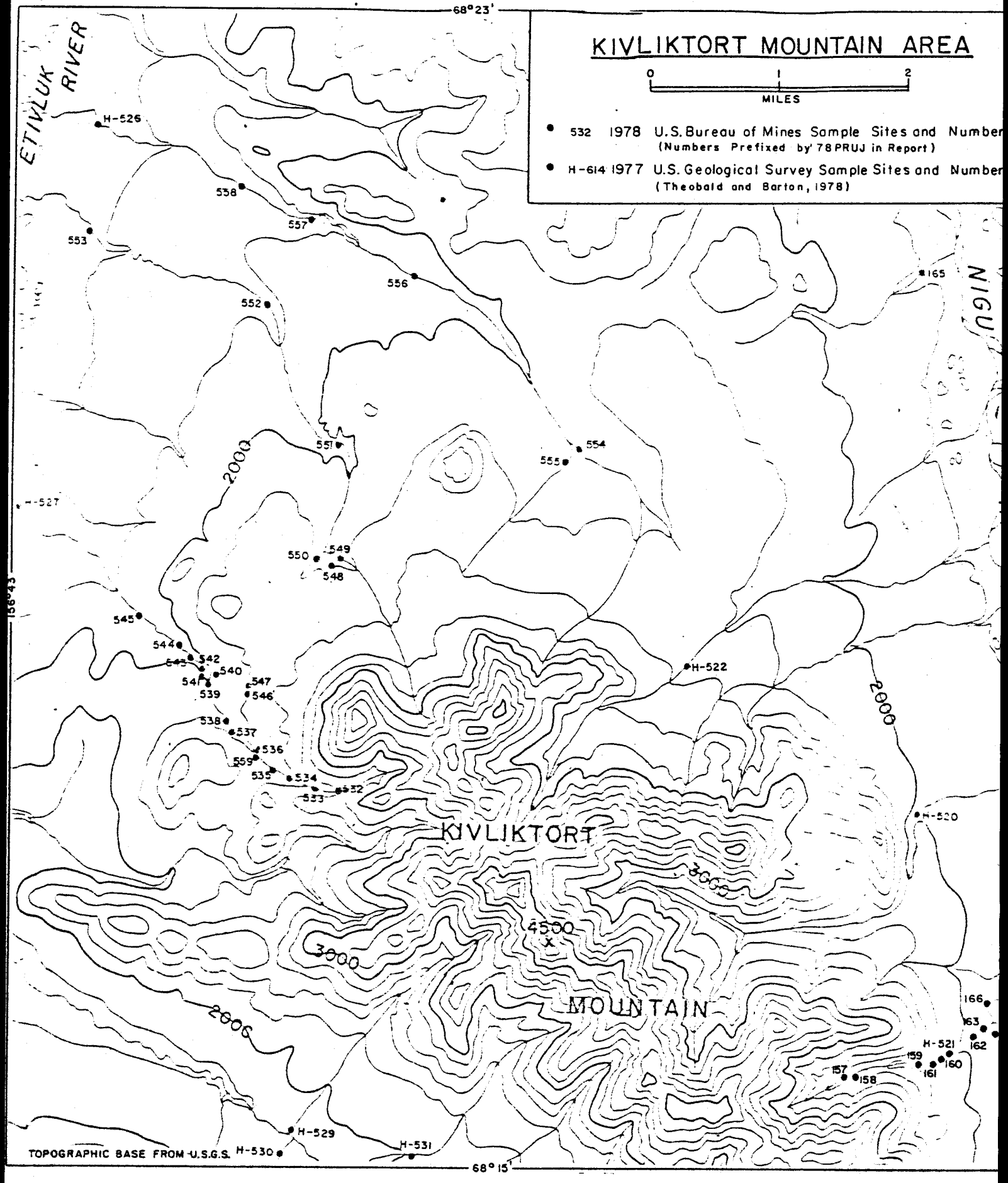


Figure 28. Sample sites in the eastern Kivliktort Mountain area

Table 27. - Analytical results of East Kivliktort Mountain area samples
[Values in parts per million]

Sample Number	Elements Analyzed					CPS	Sample Type
	Cu	Pb	Zn	Au	Ag		
78 PRUJ 157	30	80	200	NA	NA	90	Stream sediment
78 PRUJ 158	25	10	35	NA	NA	x	Stream sediment
78 PRUJ 159	25	70	140	NA	NA	x	Stream sediment
78 PRUJ 160	30	70	130	NA	NA	x	Stream sediment
78 PRUJ 161	NA	NA	NA	<.02	<.2	x	Pyritiferous graphitic quartzite
78 PRUJ 162	25	60	130	NA	NA	x	Stream sediment
78 PRUJ 163	25	50	115	NA	NA	x	Stream sediment
78 PRUJ 164	30	40	240	NA	NA	x	Stream sediment
78 PRUJ 165	20	20	224	NA	NA	x	Stream sediment
78 PRUJ 166	5	10	245	NA	NA	50-60	Stream sediment
78 PRUJ 167	30	35	230	NA	NA	x	Stream sediment

NA - Not analyzed
x - Within range of background values

Table 28. - Emission spectrographic analysis of East Kivliktort Mountain area sample
[Values in parts per million unless otherwise noted]

Element	Sample number
	78 PRUJ 161 Quartzite
Fe	5%
Ca	0.7%
Mg	0.15%
Ag	<1
As	<500
B	10
Ba	10
Be	<2
Bi	<10
Cd	<50
Co	5
Cr	10
Cu	20
Ga	<10
Ge	<20
La	30
Mn	500
Mo	<2
Nb	20
Ni	30
Pb	30
Sb	<100
Sc	<10
Sn	<10
Sr	100
Ti	1,000
V	50
W	<50
Y	15
Zn	<200
Zr	30

West Kivliktort Area (H-527)

High-grade sphalerite bearing float rock was found 2 miles upstream from sample site H-527 and in a small, 0.4-mile long, west-flowing tributary of stream H-527. This area is within the regional lead-zinc geochemical anomaly which extends from the Kuna River to Koiyaktot Mountain. The bedrock source and extent of mineralization have not been determined.

Location and Physical Setting

Stream H-527 is a 5-mile long, northwest-flowing tributary of the Etivluk River. It is located on the southwestern side of Kivliktort Mountain, near 68° 17' 53"N latitude, 156° 37'W longitude, and is in section 32, T 34N., R 10E, Kateel River Base and Meridian.

The area is characterized by gently sloping, rolling foothills which are cut by small drainages. Elevations in the area range from 1,900 to 2,200 feet (Figure 29). The stream gradients range from 240 to 430 feet per mile. The stream beds consist primarily of cobbles and boulders. The surface area of the drainage basin is approximately 5 square miles.

Geologic Setting

Two rock units are mapped in the area(1). The Lower Mississippian-Upper Devonian Kanayut Conglomerate, which is comprised of quartz and chert pebble conglomerate and clean white sandstone, underlies stream H-527. The Mississippian Kayak Shale, which is comprised of siltstone, shale, and sandstone, crops out southwest of the prospected creek at approximately the 2,200 foot elevation.

Results of the 1977 Geochemical Survey

Anomalously high zinc (300 ppm) and high lead (50 ppm) concentrations occur in stream sediment sample H-527; high lead (150 ppm) and zinc (1,000 ppm) concentrations occur in the heavy-mineral concentrate(2).

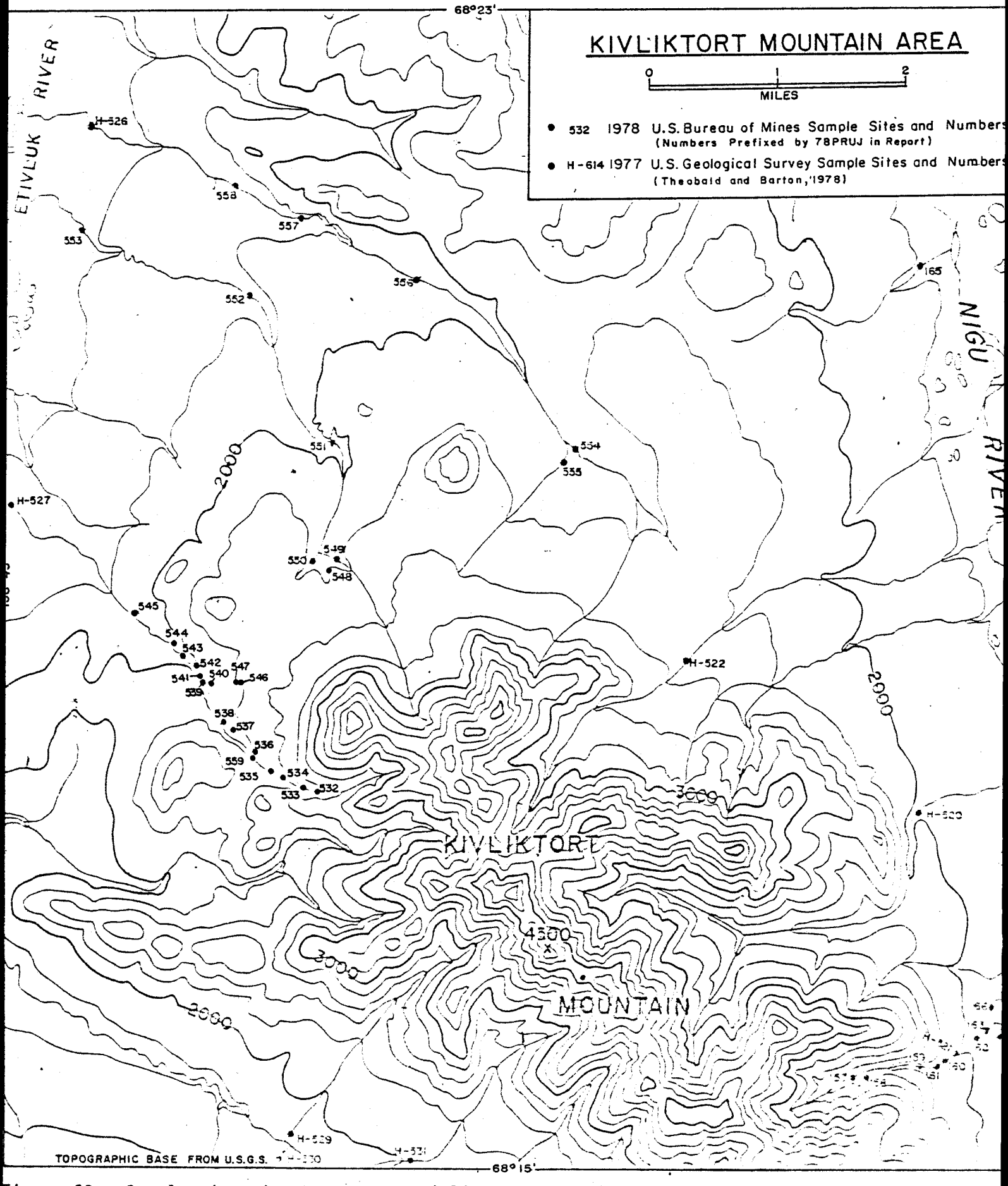


Figure 29. Sample sites in the western Kivliktort Mountain area

Bureau of Mines Work in 1978

A short segment of stream H-527 was prospected, local geologic relationships were noted, and sediment samples were collected. Highly mineralized cobbles and boulders, containing up to 30.5 percent zinc, were found in the creek bed about 2 miles upstream from the H-527 sample site and in a small tributary upstream from this location. The bedrock source of this mineralized material was not identified. Other nearby drainages, slopes, and ridges were prospected briefly.

Chert pebble conglomerate, ferruginous chert pebble conglomerate, chert and calcarenite, and shale underlie the area. The steep slopes along the west flank of Kivliktort Mountain are underlain by coarse grained siliceous clastics; areas of low relief are underlain by shale. Shale crops out in and along the stream drainages, but the float material in the creeks consists principally of sandstone, chert pebble conglomerate, and minor amounts of chloritic shale.

The attitude of the rocks appears to be conformable and continuous. Where measured, the shale bed strikes east-west and dips 30° S. The general stratigraphic sequence, from top to bottom, along the stream is: (1) ferruginous chert arenite and ferruginous calcarenite, (2) chert pebble congomerate, (3) chert arenite, (4) quartzite, (5) fissile shale, (6) ferruginous chert pebble conglomerate and chert arenite, and (7) shale. Massive sulfide mineralization, found only as float rock, appears to be spatially related to the contact zone between units 6 and 7.

Twenty-one stream sediment samples, four rock, and five mineralized rock samples were collected for analysis (Tables 29 and 30). The average element contents in the stream sediments, with the standard deviations shown in parentheses, are: copper 23 ppm (9.0 ppm), lead 59 ppm (81 ppm), and zinc 410 ppm (470 ppm). Very high lead and zinc concentrations occur in stream sediments collected downstream from the small tributary where the mineralized samples 78 PRUJ 546 and 547 were collected. Sediment samples from creeks on the west side of Kivliktort Mountain contain less than 35 ppm lead and 310 ppm zinc.

Mineralized rock samples (78 PRUJ 539, 544, 547) contain up to 30.5 percent zinc and less than 0.5 percent lead. Minor amounts of galena and abundant barite (23 percent barium) were found in shale sample 78 PRUJ 542.

Rock samples contain variable element contents. Sample 78 PRUJ 559, a sphalerite- and galena-bearing siliceous breccia, contains more than 10,000 ppm

barium, 1,000 ppm lead, and 10,000 ppm zinc. Shale (78 PRUJ 537) contains no anomalous lead or zinc. Sphalerite- and chert-pebble conglomerate (78 PRUJ 538) contains 500 ppm zinc.

High-grade sphalerite float (78 PRUJ 539) was found in the main drainage. Minor amounts of sphalerite and galena were found in outcrops of the Kanayut Conglomerate (78 PRUJ 538), and minor amounts of galena were found associated with barite in shale (78 PRUJ 542). To date, 1978, mineralization has been found only in one drainage basin.

Table 29. - Analytical results of West Kivliktort Mountain area samples
[Values in parts per million unless otherwise noted]

Sample Number	Elements Analyzed						Sample Type
	Cu	Pb	Zn	Ag	Au	CPS	
78 PRUJ 532	35	15	105	NA	NA	x	Stream sediment
78 PRUJ 533	30	10	60	NA	NA	x	Stream sediment
78 PRUJ 534	30	10	70	NA	NA	x	Stream sediment
78 PRUJ 535	25	25	140	NA	NA	x	Stream sediment
78 PRUJ 536	5	25	20	NA	NA	x	Stream sediment
78 PRUJ 537	NA	NA	NA	NA	NA	x	Fissile shale
78 PRUJ 538	NA	NA	NA	NA	NA	x	Chert-pebble conglomerate
78 PRUJ 539	NA	0.13%	30.5%	180	0.29	x	Breccia with sphalerite
78 PRUJ 540	35	220	1,700	NA	NA	x	Stream sediment
78 PRUJ 541	30	180	1,150	NA	NA	x	Stream sediment
78 PRUJ 542	NA	NA	NA	NA	NA	x	Siltstone with barite and galena
78 PRUJ 543	30	100	1,150	NA	NA	x	Stream sediment
78 PRUJ 544	NA	0.03%	30.5%	NA	NA	x	Breccia with sphalerite
78 PRUJ 545	25	100	890	NA	NA	x	Stream sediment
78 PRUJ 546	20	310	1,000	NA	NA	x	Stream sediment
78 PRUJ 547	NA	0.33%	8.5%	NA	NA	x	Breccia with sphalerite
78 PRUJ 548	35	25	270	NA	NA	x	Stream sediment
78 PRUJ 549	20	20	195	NA	NA	x	Stream sediment
78 PRUJ 550	10	20	85	NA	NA	x	Stream sediment
78 PRUJ 551	25	25	260	NA	NA	x	Stream sediment
78 PRUJ 552	25	30	300	NA	NA	x	Stream sediment
78 PRUJ 553	20	20	235	NA	NA	x	Stream sediment
78 PRUJ 554	5	20	165	NA	NA	x	Stream sediment
78 PRUJ 555	15	15	280	NA	NA	x	Stream sediment
78 PRUJ 556	15	35	310	NA	NA	x	Stream sediment
78 PRUJ 557	25	15	190	NA	NA	x	Stream sediment
78 PRUJ 558	20	15	135	NA	NA	x	Stream sediment
78 PRUJ 559	NA	NA	NA	NA	NA	x	Breccia with galena and sphalerite

NA - Not analyzed
x - Within range of background values

Table 30. - Emission spectrographic analyses of West Kivliktort Mountain area samples
[Values in parts per million unless otherwise noted]

Element	Sample numbers			
	78 PRUJ 537 Shale	78 PRUJ 538 Conglomerate	78 PRUJ 542 Siltstone	78 PRUJ 559 Sulfide breccia
Fe	7%	10%	0.05%	0.2%
Ca	0.07%	0.1%	0.02%	0.02%
Mg	0.5%	0.1%	0.03%	0.05%
Ag	<1	<1	<1	5
As	<500	<500	<500	<500
B	50	10	10	<10
Ba	300	500	>10,000	>10,000
Be	2	<2	<2	<2
Bi	<10	<10	<10	<10
Cd	<50	<50	<50	<50
Co	10	5	<5	<5
Cr	30	10	10	<10
Cu	15	5	3	15
Ga	<10	<10	<10	<10
Ge	<20	<20	<20	<20
La	50	<20	20	<20
Mn	700	2,000	<10	100
Mo	3	2	<2	<2
Nb	20	<20	<20	<20
Ni	30	20	<5	5
Pb	15	20	150	1,000
Sb	<100	<100	<100	<100
Sc	10	<10	<10	<10
Sn	<10	<10	<10	<10
Sr	100	100	2,000	500
Ti	3,000	1,000	2,000	20
V	100	50	20	<10
W	<50	<50	<50	<50
Y	10	<10	<10	<10
Zn	<200	500	<200	10,000
Zr	150	20	100	<20

Memorial Creek Area (H-550)

Sediment sample H-550 contains an anomalously high lead concentration. This sample comes from the extensive lead-zinc geochemical anomaly which extends from Kuna River to Koiyaktot Mountain. The headwater areas of three north-flowing tributaries of Memorial Creek were prospected and sampled. Anomalous lead and zinc concentrations found in sediment samples from one tributary.

Location and Physical Setting

The Memorial Creek area is located 1.4 miles north of the southern NPR-A boundary. It centers near 68° 21' 5"N latitude, 157° 27'W longitude, is in section 15 of T 34N, R 6E, Kateel River Base and Meridian, and the southern half of T 12S, R 42W, Umiat Base and Meridian.

Memorial Creek is in the Central Brooks Range section of the Arctic Mountains Physiographic Province(4). Stream H-550 occupies a large U-shaped valley and originates on a 3,600-foot high, steep-sloped, barren, talus covered mountain (Figure 30). At elevations below 2,500 feet, the stream valley is characterized by gently sloping, alpine tundra and boulder covered terrain. Above the 2,500-foot elevations tributary valleys are characterized by steep, barren slopes. Elevations in the area range from 1,600 to 3,600 feet.

Stream H-550 is a 5-mile long, north-flowing tributary of Memorial Creek, which is a tributary of the Ipnavik River. The prospected stream is relatively straight, about 15 feet wide, and has a gradient of 530 feet per mile. The creek bed consists mainly of boulders. The surface area of the drainage basin is approximately 3.2 square miles.

Regional Geology

Lower Mississippian-Upper Devonian Kanayut Conglomerate, which consists of quartz and chert pebble conglomerate and clean white sandstone, crops out above the 2,000 foot elevation. Mississippian Kayak Shale, which consists of siltstone, shale, and sandstone, crops out below this elevation(1). These rock units are mapped as part of the North Central Brooks Range thrust sequence.

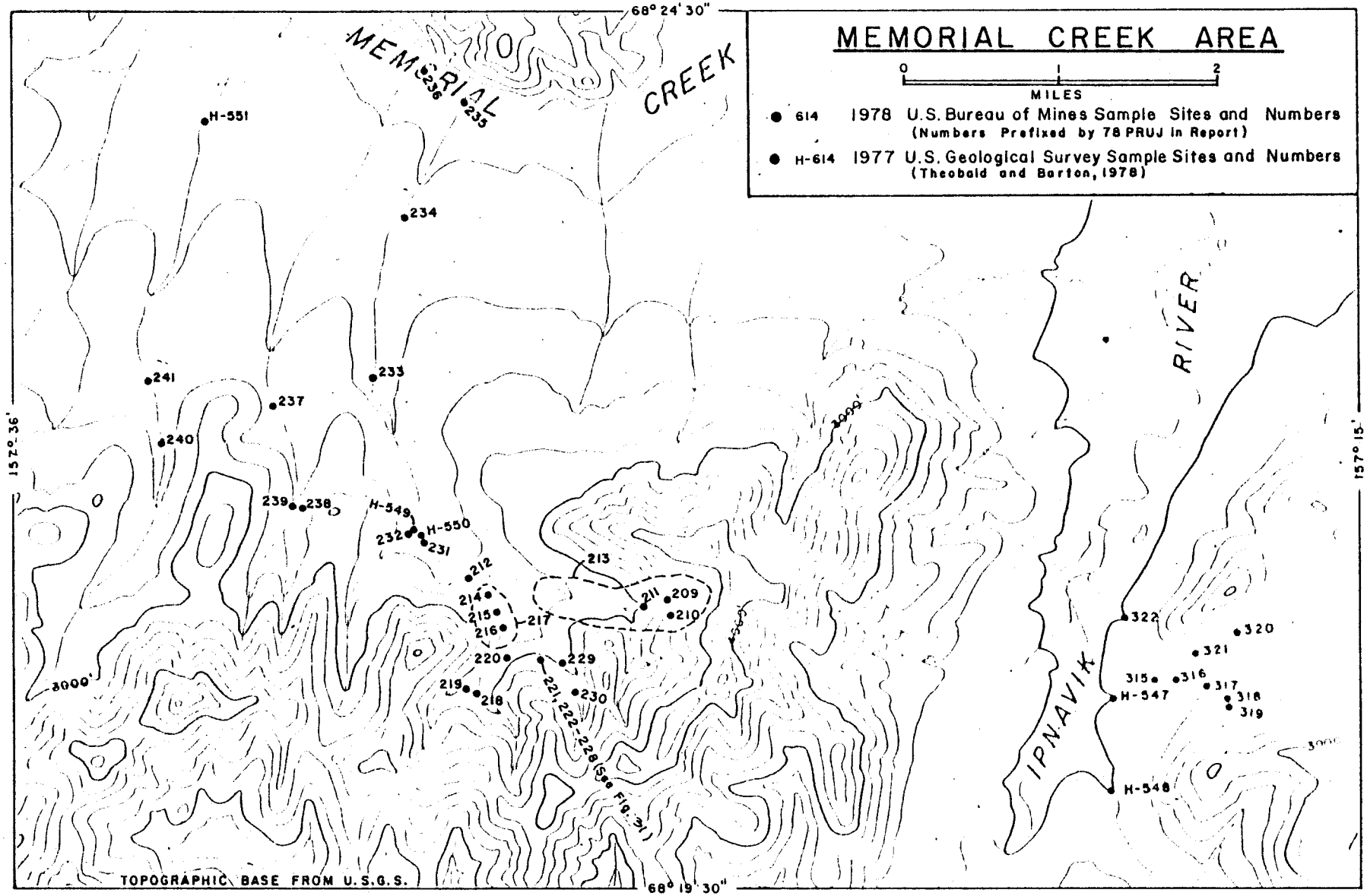


Figure 30. Memorial Creek Area

Results of the 1977 Geochemical Survey

Anomalously high lead concentrations occur in both the stream sediment (100 ppm) and the heavy-mineral concentrate (300 ppm) of sample H-550(2).

Bureau of Mines Work in 1978

Three tributaries of stream H-350 were prospected, geology was noted, and sediment and rock samples ere collected. The prospected drainages are underlain predominantly by siliceous sandstones and minor amounts of conglomerate and shale. The chert fragments in the conglomerates are highly angular and suggest a local source. An east-west striking, steeply-dipping limonite-stained zone is associated with subcropping pyritiferous conglomerate and coarse-grained sandstone (Figure 31). This conglomerate contains up to an estimated 20 volume percent of pyrite. The estimated pyrite content of other rocks from this area is less than 3 percent. Black shale crops out south of, and stratigraphically below, a pyritiferous conglomerate.

Twenty-two stream sediment and eight rock samples were collected for analysis to determine their element content (Tables 31 and 32). The average element contents of the stream sediment samples, with the standard deviations shown in parentheses, are: copper 32 ppm (5.7 ppm), lead 66 ppm (65 ppm), and zinc 150 ppm (78 ppm). The values for rock samples are: copper 44 ppm (29 ppm), lead 140 ppm (240 ppm), and zinc 77 ppm (57 ppm). The lead and zinc content is highest (to 230 ppm) in stream sediment samples 78 PRUJ 209 through 212, which were collected from a west-flowing tributary. A sandy shale (78 PRUJ 223) contains more copper (100 ppm) than any of the other rock samples. A quartzose sandstone (78 PRUJ 222) and a fine-grained sandstone (78 PRUJ 228) contain 720 ppm and 205 ppm lead, respectively. The zinc content of the rock samples is low.

The semiquantitative emission spectrographic analyses of rock samples show sandy shale (78 PRUJ 223) contains 200 ppm copper; two conglomerate samples (78 PRUJ 225 and 78 PRUJ 226) contain up to 5,000 ppm manganese; and a quartzose sandstone (78 PRUJ 222) contains 500 ppm lead. Conglomerate samples (78 PRUJ 225 and 226) contain up to 1,000 ppm strontium. Sandy shale samples (78 PRUJ 224 and 227) contain up to 7,000 ppm titanium.

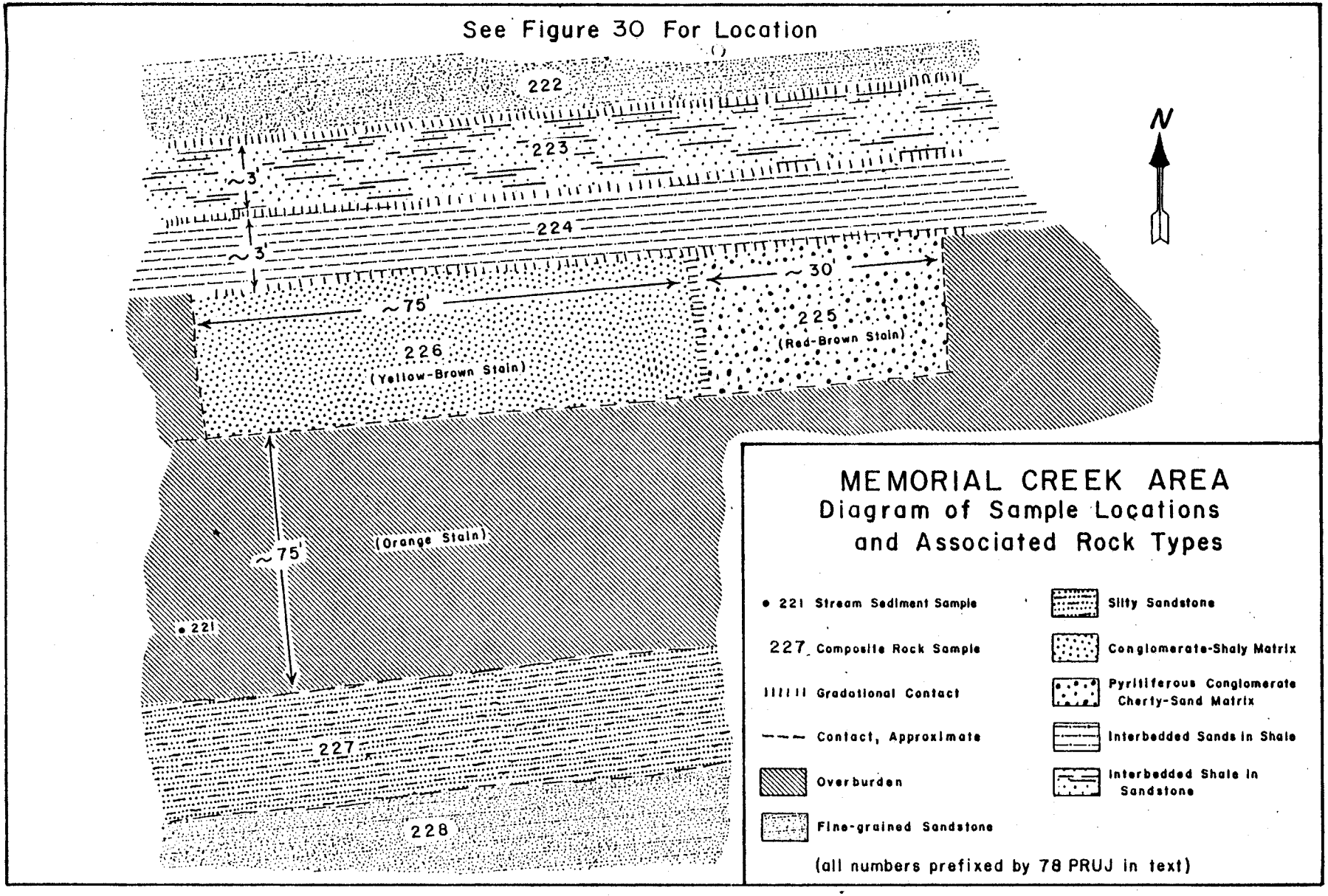


Figure 31. Memorial Creek Area diagram of sample locations and associated rock types

Stream sediment and rock samples from parts of the prospected drainage basin contain anomalously high concentrations of copper and lead. Further prospecting is merited because the source of the base metals has not been defined and high-grade base metal sulfide mineralization was found in a similar geological and geochemical setting at Story Creek, Whoopee Creek, Kivliktort and Koiyaktot Mountains.

Table 31. - Analytical results of Memorial Creek area samples
[Values in parts per million unless otherwise noted]

Sample Number	Elements Analyzed Cu	Pb	Zn	CPS	Sample Type
78 PRUJ 209	40	230	315	80-90	Stream sediment
78 PRUJ 210	30	165	110	x	Stream sediment
78 PRUJ 211	30	180	270	80	Stream sediment
78 PRUJ 212	30	185	295	70	Stream sediment
78 PRUJ 213	NA	NA	NA	x	Pyritiferous sandstone
78 PRUJ 214	30	40	140	x	Stream sediment
78 PRUJ 215	NA	NA	NA	x	Pyritiferous sandstone
78 PRUJ 216	30	30	105	x	Stream sediment
78 PRUJ 217	NA	NA	NA	x	Pyritiferous sandstone
78 PRUJ 218	25	20	70	x	Stream sediment
78 PRUJ 219	40	50	110	x	Stream sediment
78 PRUJ 220	50	10	180	x	Shale
78 PRUJ 221	30	65	170	x	Stream sediment
78 PRUJ 222	60	720	40	x	Quartzose sandstone
78 PRUJ 223	100	75	20	x	Sandy shale
78 PRUJ 224	35	35	80	x	Sandy shale
78 PRUJ 225	30	30	90	x	Pyritiferous conglomerate
78 PRUJ 226	20	20	125	x	Conglomerate
78 PRUJ 227	50	25	80	x	Bleached sandstone
78 PRUJ 228	5	205	5	x	Fine-grained sandstone
78 PRUJ 229	45	25	75	80	Stream sediment
78 PRUJ 230	40	20	65	100	Stream sediment
78 PRUJ 231	25	100	185	x	Stream sediment
78 PRUJ 232	30	80	230	x	Stream sediment
78 PRUJ 233	25	50	215	60-80	Stream sediment
78 PRUJ 234	30	60	190	x	Stream sediment
78 PRUJ 235	25	50	185	x	Stream sediment
78 PRUJ 236	30	25	110	x	Stream sediment
78 PRUJ 237	35	20	80	80	Stream sediment
78 PRUJ 238	35	20	80	70-80	Stream sediment
78 PRUJ 239	40	15	75	70-80	Stream sediment
78 PRUJ 240	30	15	85	70-80	Stream sediment
78 PRUJ 241	35	15	75	80	Stream sediment

NA - Not analyzed
x - Within range of background values

Table 32. - Emission spectrographic analyses of Memorial Creek area samples
[Values in parts per million unless otherwise noted]

Element	Sample numbers			
	78 PRUJ 220 Shale	78 PRUJ 222 Sandstone	78 PRUJ 223 Shale	78 PRUJ 224 Shale
Fe	2%	0.2%	0.5%	1.5%
Ca	0.02%	0.02%	0.02%	0.02%
Mg	0.1%	0.05%	0.1%	0.15%
Ag	<1	<1	<1	<1
As	<500	<500	<500	<500
B	30	10	20	50
Ba	100	50	200	500
Be	2	<2	<2	<2
Bi	<10	<10	<10	<10
Cd	<50	<50	<50	<50
Co	10	<5	<5	<5
Cr	30	20	70	200
Cu	15	5	200	70
Ga	<10	<10	<10	10
Ge	<20	<20	<20	<20
La	50	30	50	70
Mn	1,000	20	10	50
Mo	2	3	2	2
Nb	20	20	20	20
Ni	30	<5	5	20
Pb	<10	500	50	50
Sb	<100	<100	<100	<100
Sc	15	<10	<10	10
Sn	<10	<10	<10	<10
Sr	500	200	500	1,000
Ti	3,000	2,000	5,000	7,000
V	150	100	200	300
W	<50	<50	<50	<50
Y	10	10	10	15
Zn	<200	<200	<200	<200
Zr	100	100	200	200

Table 32. - Emission spectrographic analyses of Memorial Creek area samples - Continued
[Values in parts per million unless otherwise noted]

Element	Sample numbers			
	78 PRUJ 225 Pyritiferous Conglomerate	78 PRUJ 226 Conglomerate	78 PRUJ 227 Sandstone	78 PRUJ 228 Sandstone
Fe	15%	15%	5%	0.2%
Ca	0.1%	0.03%	<0.02%	0.03%
Mg	0.1%	0.1%	0.1%	0.1%
Ag	<1	<1	<1	<1
As	<500	<500	<500	<500
B	50	30	30	20
Ba	150	200	20	200
Be	<2	<2	<2	<2
Bi	<10	<10	<10	<10
Cd	<50	<50	<50	<50
Co	10	10	<5	<5
Cr	10	50	70	30
Cu	30	20	20	2
Ga	<10	10	10	<10
Ge	<20	<20	<20	<20
La	<20	<20	70	100
Mn	5,000	5,000	500	10
Mo	7	5	2	2
Nb	20	20	20	20
Ni	100	100	20	<5
Pb	10	<10	20	200
Sb	<100	<100	<100	<100
Sc	10	15	20	<10
Sn	<10	<10	<10	<10
Sr	1,000	1,000	300	500
Ti	1,000	2,000	7,000	5,000
V	50	70	200	100
W	<50	<50	<50	<50
Y	10	10	20	20
Zn	200	200	<200	<200
Zr	50	100	300	300

Safari Creek Area (H-417)

Anomalously high lead and zinc concentrations occur in stream sediment sample H-417; a high lead concentration occurs in its heavy-mineral concentrate(2). This area is within the regional lead-zinc geochemical anomaly which extends from the Kuna River to Koiyaktot Mountain. Several drainages were prospected and sampled to determine the source of the lead and zinc. High lead and zinc values were detected in a sediment sample from a tributary of Safari Creek. This tributary has not been prospected. Mineralization was not found in the main drainage.

Location and Physical Setting

Safari Creek area is located near 68° 20' 30"N latitude, 157° 59'W longitude, and is in T 12S, R 25W, and in the southern half of T 11S, R 25W, Umiat Base and Meridian. This area is approximately one-half mile north of the southern NPR-A boundary.

Safari Creek area is at the northern edge of the Central Brooks Range section of the Arctic Mountains Physiographic Province(4). Stream H-417 originates on steep barren mountain slopes and flows over gently sloping, rolling, alpine tundra covered foothills below the 2,500-foot elevation. Elevations in the area range from 2,200 to 4,000 feet (Figure 32).

Stream H-417 is a 2.2-mile long, northwest-flowing tributary of Safari Creek, which flows northerly into the Kuna River. The stream is relatively straight and has a gradient of approximately 400 feet per mile. The stream bed is composed mainly of cobbles. The surface area of the drainage basin is approximately 2.0 square miles.

Regional Geology

Lower Mississippian-Upper Devonian Kanayut Conglomerate, which consists of quartz and chert pebble conglomerate and clean white sandstone, underlies stream H-417(1).

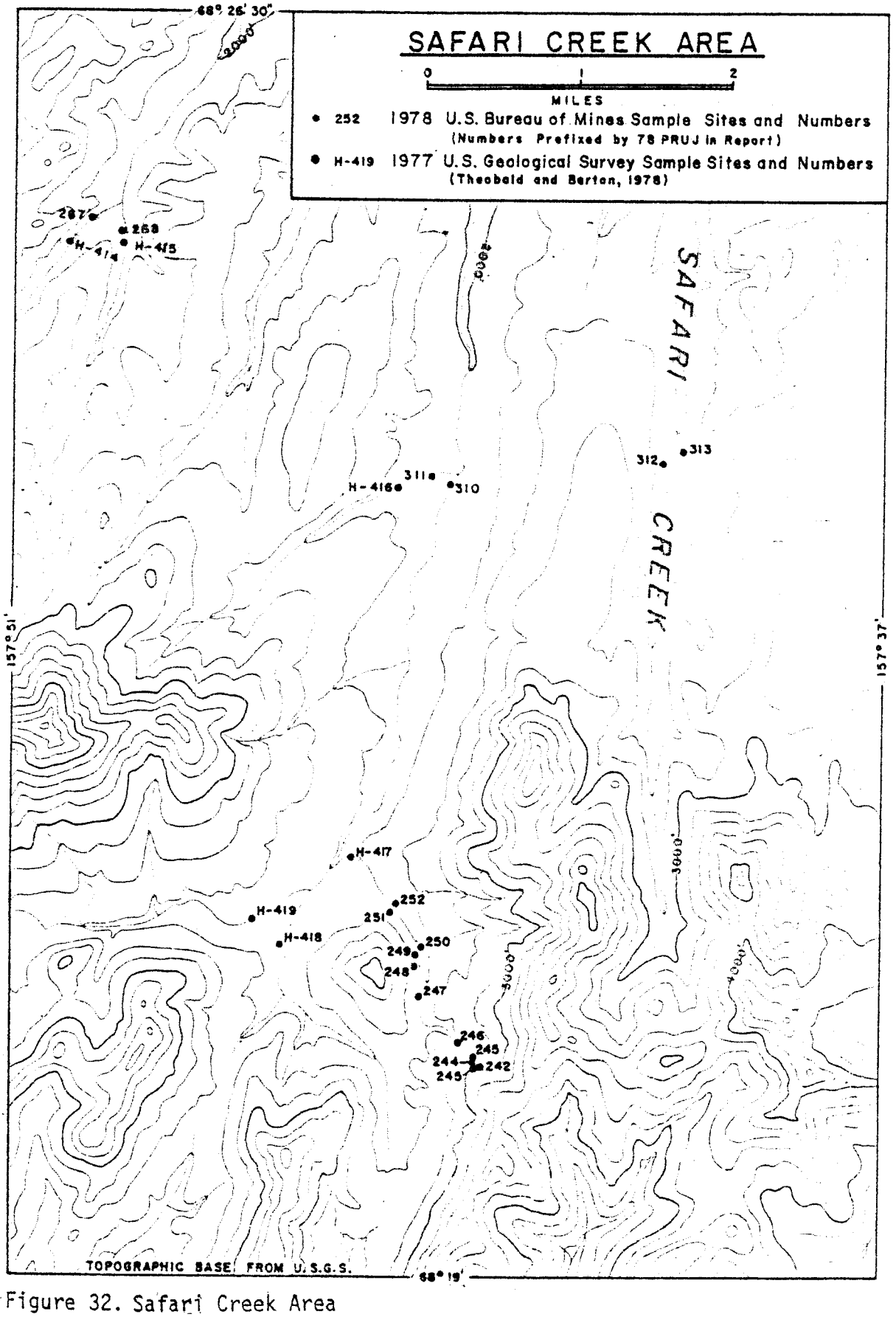


Figure 32. Safari Creek Area

Results of the 1977 Geochemical Survey

Anomalously high lead (150 ppm) and zinc (300 ppm) concentrations occur in the stream sediment sample H-417; an anomalously high lead (200 ppm) concentration occurs in the heavy-mineral concentrate(2).

Bureau of Mines Work in 1978

A 1.5-mile long segment of the west-flowing tributary of the middle fork of Safari Creek was prospected, the rock types and their distribution were noted, and stream sediments and rocks were sampled. Red and green shales and cherts, which are inferred to be part of the Permian Siksikpuk Formation, crop out in the headwaters region of the stream. Carbonaceous shales, which are mapped as part of the black clastic sequence of the Mississippian Lisburne Group(12), underlie the red and green shale and chert.

Nine stream sediment and two rock samples were collected for analysis to determine their copper, lead, and zinc content (Tables 33 and 34). The average element contents of the stream sediment samples, with the standard deviations shown in parentheses, are: copper 74 ppm (36 ppm), lead 97 ppm (130 ppm), and zinc 370 ppm (150 ppm). Two sediment samples (78 PRUJ 250 and 251) contain highly anomalous lead (415 ppm, 180 ppm) and zinc (620 ppm, 520 ppm) concentrations. Eight of the nine stream sediment samples contain more than the defined 300 ppm zinc threshold value for the 1977 results. Emission spectrographic analyses show that black shale sample 78 PRUJ 243 contains up to 215 ppm lead; carbonaceous shale sample 78 PRUJ 248 contains 5,000 ppm barium, 7,000 ppm manganese, and 5,000 ppm titanium. There has been no follow-up to determine the source of lead in sediment sample 78 PRUJ 250, collected from a west-flowing tributary of stream H-417.

Table 33. - Analytical results of Safari Creek area samples
[Values in parts per million]

Sample Number	Elements Analyzed			CPS	Sample Type
	Cu	Pb	Zn		
78 PRUJ 242	100	55	315	80	Stream sediment
78 PRUJ 243	25	215	210	80-90	Black shale
78 PRUJ 244	90	55	395	x	Stream sediment
78 PRUJ 245	90	35	345	x	Stream sediment
78 PRUJ 246	135	20	435	80	Stream sediment
78 PRUJ 247	70	45	330	x	Stream sediment
78 PRUJ 248	75	45	195	120	Carbonaceous shale
78 PRUJ 249	80	40	305	x	Stream sediment
78 PRUJ 250	30	415	620	x	Stream sediment
78 PRUJ 251	50	180	520	x	Stream sediment
78 PRUJ 252	20	25	100	x	Stream sediment

x - Within range of background values

Table 34. - Emission spectrographic analyses of Safari Creek area samples
[Values in parts per million unless otherwise noted]

Element	Sample numbers	
	78 PRUJ 243 Black Shale	78 PRUJ 248 Carbonaceous Shale
Fe	2%	7%
Ca	2%	0.2%
Mg	0.2%	1%
Ag	2	<1
As	<500	<500
B	50	100
Ba	1,000	5,000
Be	<2	2
Bi	<10	<10
Cd	<50	<50
Co	<5	20
Cr	200	50
Cu	50	70
Ga	10	10
Ge	<20	<20
La	50	50
Mn	100	7,000
Mo	5	5
Nb	20	20
Ni	100	100
Pb	200	20
Sb	100	<100
Sc	<10	20
Sn	<10	<10
Sr	200	200
Ti	2,000	5,000
V	200	300
W	<50	<50
Y	10	10
Zn	<200	<200
Zr	30	100

Story Creek Area (H-399, H-400)

Prospecting and geochemical sampling in the Story Creek area led to the discovery of zinc and lead mineralization and a small coal bed. The mineralization was found in outcrop and as float material near the headwaters of several small northwest-flowing tributaries of Story Creek. This mineralization is within the regional lead-zinc geochemical anomaly which extends from the Kuna River to Koiyaktot Mountain(2).

Location and Physical Setting

Base metal sulfide mineralization crops out near 68° 22' 55"N latitude, 156° 56'W longitude, and is in section 23, T 12S, R 26W, Umiat Base and Meridian. Mineralized float rock is widely scattered throughout the southern half of T 12S, R 26W. Coal crops out in a stream valley near 68° 22' 35"N latitude, 157° 58'W longitude, and is in section 21, T 12S, R 26W, Umiat Base and Meridian.

The Story Creek area is within the Central Brooks Range section of the Arctic Mountains Physiographic Province(4). It is characterized by a gently northward-sloping surface which has been cut by north-flowing streams (Figure 33). Elevations in the area range from 2,000 to 3,000 feet.

Streams in the study area are small northerly-flowing tributaries of Story Creek, which is a tributary of the Kuna River. The stream channels are relatively straight and stream gradients range from 300 to 500 feet per mile. The stream beds are comprised primarily of cobbles and boulders. The surface area of the main mineralized drainage basin, stream H-399, is approximately 1.2 square miles. The surface areas of the other mineralized drainage basins range from 1 to 2 square miles.

Regional Geology

Paleozoic and Mesozoic sedimentary rock units outcrop in the Story Creek area(1). Upper Mississippian Lisburne Group 1 rocks and Lower Mississippian Kanayut Conglomerate comprise the North Central Brooks Range thrust sequence. Mississippian Lisburne Group 2 rocks and rocks of the Upper Jurassic to Lower

Cretaceous Ipewik Formation comprise the Northwestern Brooks Range thrust sequence. The sequence is north of the North Central Brooks Range thrust sequence.

Results of the 1977 Geochemical Survey

Two sediment samples H-399 and H-400, were collected in 1977 from two adjacent streams in the Story Creek area. Anomalously high zinc (350 ppm) and lead (150 ppm) concentrations occur in stream sediment sample H-399; high zinc (700 ppm) and lead (70 ppm) concentrations occur in the heavy-mineral concentrate(2). High-grade zinc and lead sulfide mineralization crops out about 2.6 miles upstream from sample site H-399. Anomalously high lead (150 ppm) and detectable zinc (<200 ppm) concentrations occur in stream sediment sample H-400; the heavy-mineral fraction of this sample contains 700 ppm zinc and 70 ppm lead(2). Mineralized float rock was found upstream from this sample site.

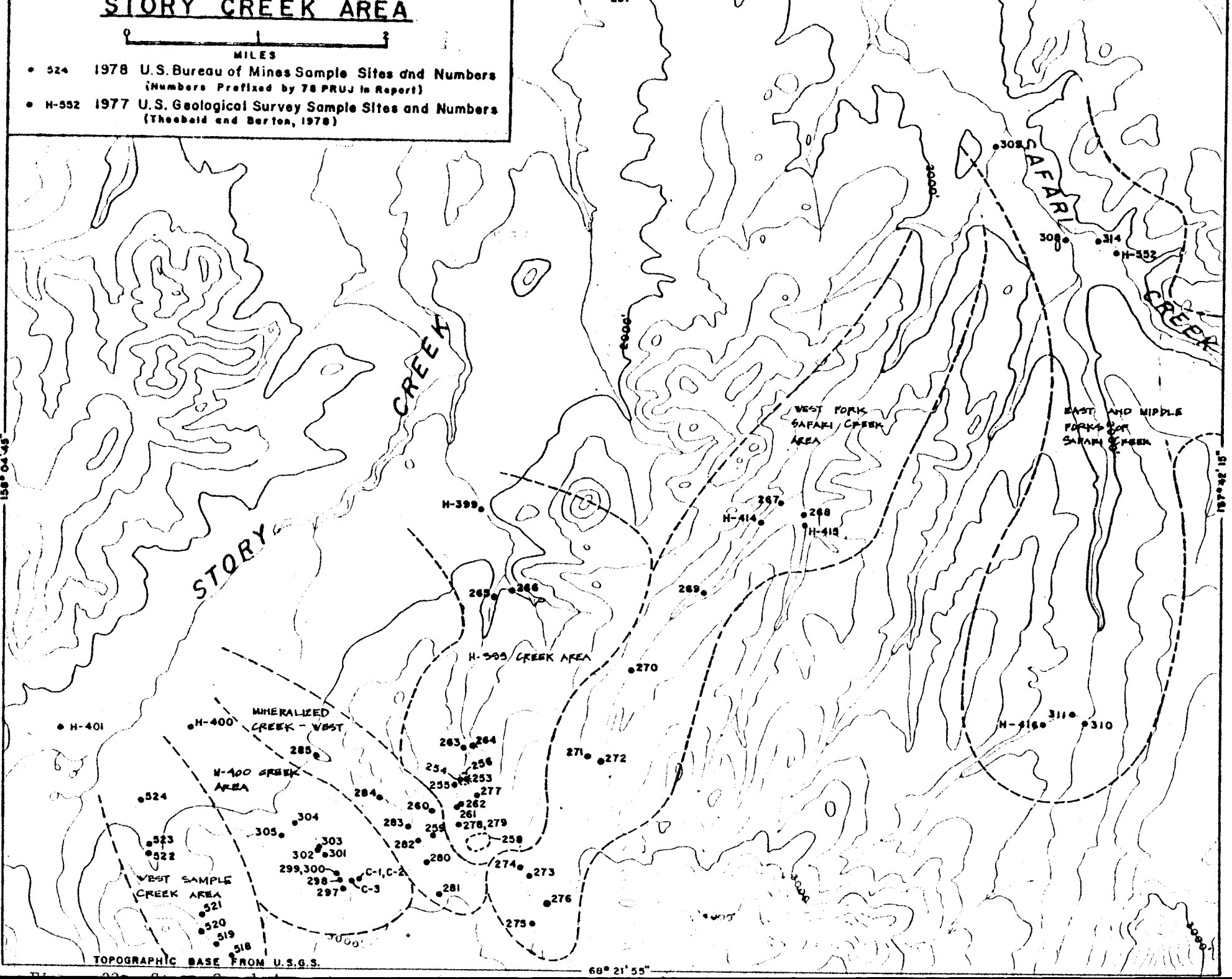
Bureau of Mines Work in 1978

The BOM prospected to determine the source of elements found in samples H-399 and H-400. Zinc and lead sulfide mineralization was found in float rock near the headwaters of stream H-399. Subsequent prospecting led to massive sulfide and sulfide breccia mineralization in this drainage and to mineralization in other drainages. Geology of the prospected areas was not mapped, but the rock types, their distribution, and structures were noted.

Local Geologic Setting

Clastic sedimentary rocks and a minor amount of mafic igneous rock crop out along stream H-399. A generalized local stratigraphic sequence, from south to north [top to bottom (?)] along stream H-399, through the zone of mineralization, includes: (1) quartzitic sandstone, (2) red-brown shale, (3) mineralized brecciated shale, (4) calcareous shale, (5) carbonaceous siliceous shale and chert, (6) andesite/diabase sill(?), and (7) carbonaceous graphitic shale. A similar stratigraphic sequence occurs along stream H-400.

Folding and faulting have developed to varying degrees. Two styles of folding were recognized. The rock units appear to be northwardly tilted.


STORY CREEK AREA
MILES
• 524 1978 U.S. Bureau of Mines Sample Sites and Numbers
(Numbers Prefixed by 78 PRUJ in Report)
• H-552 1977 U.S. Geological Survey Sample Sites and Numbers
(Theobald and Barton, 1978)
STORY CREEK
SAFARI CREEK
WEST FORK SAFARI CREEK AREA
EAST AND MIDDLE FORKS OF SAFARI CREEK
H-399 CREEK AREA
MINERALIZED CREEK - WEST
H-400 CREEK AREA
WEST SAMPLE CREEK AREA
H-401
H-400
H-414
H-415
H-416
H-552
524
285
284
304
305
303
302
301
299,300
298
297
C-1, C-2
C-3
523
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275
271
272
270
269
268
267
265
266
308
309
314
311
310
TOPOGRAPHIC BASE FROM U.S.G.S.
158° 04' 45"
68° 21' 55"
137° 48' 15"

159

Intense intraformational folding is evident within the shale. Small northwardly overturned folds, with west-dipping fold axes, were noted in the shale.

Three east-north-east trending, vertically-dipping, mineralized siliceous breccia zones, up to 30-feet wide, occur in the Story Creek Area. The origin of these breccia zones was not determined.

Sulfide Mineralization

Three types of zinc and lead sulfide mineralization have been found near Story Creek. These are: (1) massive banded (bedded?) sulfides, (2) massive sulfide breccia, and (3) sphalerite, galena, and quartz cement in a shale breccia. Most of the mineralized material sampled was float rock; however, a sixty-foot long zone of mineralization crops out at the headwaters of stream H-399. A 9-foot long zone of massive zinc and lead sulfides occurs within this larger zone.

The quartz-cemented breccia mineralization is much more common than the massive sulfide mineralization. It is also more resistant to weathering and therefore most readily recognizable. This type of mineralization was also found in the smaller drainages west of stream H-399 and on the slopes between the mineralized drainages. The presence of mineralized float rock between drainages indicates potential subsurface continuity. To date, 1978, this mineralized breccia has been traced along the surface in a generally east-west direction for at least 10,000 feet. Mineralized float has been traced downstream for at least 15,000 feet in stream H-399.

Other quartz-cemented shale breccia zones, similar in appearance to those found with the mineralized zone, are up to 30 feet wide, trend east-west to N 70° E, and dip vertically. Sulfide mineralization occurs in the breccia zones where they cut red-brown shales; sulfides were not found where the breccia cuts other rock types.

A composite sample of "high-grade" surface material (78 PRUJ 278) assayed 6.1 percent lead, 9.0 percent zinc, and 130 ppm silver. A composite sample (78 PRUJ 279) from this area, made up of mineralized as well as unmineralized material, contained 1.15 percent lead, 1.4 percent zinc, and 35 ppm silver. Randomly selected high-grade banded (bedded?) sulfide specimens contain up to 34 percent lead, 28 percent zinc, 940 ppm silver, and 1.2 ppm gold. The

massive sulfide breccia contains 1.15 percent lead, 49 percent zinc, 500 ppm silver, and 0.16 ppm gold.

Analytical Results of the 1978 Samples

Stream sediment and rock samples were collected from various drainages in and around stream H-399 (Tables 35 and 36). The average element contents of the stream sediments, with standard deviations shown in parentheses, from the various drainage basins (Figure 33), are:

Area	Cu(ppm)	Pb(ppm)	Zn(ppm)
H-399 Creek	59 (23)	220 (270)	750 (840)
Mineralized Creek West	38 (6.8)	140 (79)	290 (200)
H-400 Creek	35 (0)	83 (34)	210 (64)
West Sampled Creek	26 (11)	27 (19)	170 (68)
East & Middle Forks of Safari Creek	37 (13)	32 (16)	160 (80)
W. Fork of Safari Creek	40 (9.8)	25 (8.8)	130 (30)

Lead and zinc concentrations are high in samples from stream H-399 and from other drainages to the west. A minor amount of lead and zinc sulfide mineralization was found in the furthest west prospected drainage, but the presence of these sulfides is not reflected in the analyses of the stream sediment samples. The lead and zinc concentrations in sediment samples from the Safari Creek drainage, to the east of stream H-399, are uniformly low.

Rock and mineral specimens have highly variable base metal content (Table 35 and 36). The lead and zinc content is high; the copper content is low. Lead-oxide content in mineralized samples is much higher than the zinc-oxide content (Table 35). The specimens, however, show much greater recessive weathering of sphalerite zones than of galena zones. This suggest much greater leaching of sphalerite than of galena.

The emission spectrographic results show a high barium content (to 2,000 ppm) in both mineralized and unmineralized samples (Tables 36). Other elements in high concentrations in samples from this area include antimony (to 1,000 ppm), germanium (100 ppm), and manganese (to 1,500 ppm).

Coal Occurrence

Coal fragments were found in an unnamed drainage between streams H-399 and H-400. Subsequent cursory prospecting led to the a 2-foot thick coal bed that is underlain by a 4-foot thick coaly shale. The outcrop length of the coal is about 150 feet. Four coal samples were collected for analysis and palynological evaluation. Proximate analyses of four samples are given on Table 37. The average values are:

Moisture	3.7%
Volatile Matter	10.6%
Fixed Carbon	67.2%
Ash	22.5%
Sulfur	0.5%
Heating Value (BTU/lb)	10,479

Table 35. - Analytical results of Story Creek area samples
[Values in parts per million unless otherwise noted]

Sample Number	Elements Analyzed								CPS	Sample Type
	Cu	Pb	PbOx	Zn	ZnOx	Ag	Cd	Au		
Discovery Creek										
Main Mineralized Zone										
78 PRUJ 253	60	80	NA	295	NA	NA	NA	NA	x	Stream sediment
78 PRUJ 254	70	690	NA	2,450	NA	NA	NA	NA	x	Stream sediment
78 PRUJ 255	80	40	NA	140	NA	NA	NA	NA	130	Black shale
78 PRUJ 256A	515	10	.02%	190,000	.29%	NA	NA	NA	x	Mineralized breccia
78 PRUJ 256B	165	28,000	1.3%	18,500	.07%	NA	NA	NA	x	Mineralized breccia
78 PRUJ 256C	85	1,200	.09%	69,000	.28%	NA	NA	NA	x	Mineralized breccia
78 PRUJ 256D	220	125,000	1.6%	56,000	.05%	NA	NA	NA	x	Mineralized breccia
78 PRUJ 256E	335	44,000	1.5%	76,000	.21%	NA	NA	NA	x	Mineralized breccia
78 PRUJ 256F	505	185,000	2.0%	88,000	.12%	NA	NA	NA	x	Mineralized breccia
78 PRUJJ256G	90	13,000	.67%	16,000	.12%	NA	NA	NA	x	Mineralized breccia
78 PRUJ 256H	15	50,000	1.6%	75,000	.54%	NA	NA	NA	x	Mineralized breccia
78 PRUJ 257	15	85	NA	100	NA	NA	NA	NA	x	Stream sediment
78 PRUJ 258	60	900	NA	1,150	NA	NA	NA	NA	x	Shale
78 PRUJ 261	50	1,850	NA	3,400	NA	5.6	17.0	NA	x	Stream sediment
78 PRUJ 262	40	25	NA	290	NA	NA	NA	NA	x	Shale
78 PRUJ 263	60	600	NA	1,600	NA	.8	7.0	NA	x	Stream sediment
78 PRUJ 264	90	25	NA	180	NA	<.2	0.4	NA	x	Stream sediment
78 PRUJ 265	70	220	NA	750	NA	.4	2.0	NA	x	Stream sediment
78 PRUJ 266	70	10	NA	370	NA	4.0	1.0	NA	x	Stream sediment
78 PRUJ 277	40	80	NA	295	NA	NA	NA	NA	x	Stream sediment
78 PRUJ 278	180	61,000	1.2%	90,000	.07%	130	475	NA	x	High-grade composite
78 PRUJ 279	65	15,500	.38%	14,000	.025%	35	13	NA	x	Composite surface sample
78 PRUJ 614A	.052%	20%	NA	37%	NA	480	NA	.77		Sulfide breccia
78 PRUJ 614B	.045%	15.5%	NA	49%	NA	500	NA	.16		Sulfide breccia
78 PRUJ 614C	.034%	34%	NA	28%	NA	940	NA	1.2		"Banded" sulfides

Table 35. - Analytical results of Story Creek area samples - Continued
[Values in parts per million unless otherwise noted]

Sample Number	Elements Analyzed							CPS	Sample Type
	Cu	Pb	PbOx	Zn	ZnOx	Ag	Cd		
Mineralized Creek West									
78 PRUJ 259	55	2,900	.11%	3,800	.13%	4.0	9.0	x	Mineralized shale
78 PRUJ 260	95	40	.025%	3,400	.18%	<.2	36.0	x	High-grade composite
78 PRUJ 280	40	40	NA	100	NA	NA	NA	x	Stream sediment
78 PRUJ 281	40	70	NA	120	NA	NA	NA	x	Stream sediment
78 PRUJ 282	35	245	NA	660	NA	NA	NA	x	Stream sediment
78 PRUJ 283	35	205	NA	360	NA	NA	NA	x	Stream sediment
78 PRUJ 284	30	155	NA	265	NA	NA	NA	x	Stream sediment
78 PRUJ 285	50	110	NA	265	NA	NA	NA	x	Stream sediment
Stream H-440									
78 PRUJ 297	35	85	NA	220	NA	NA	NA	x	Stream sediment
78 PRUJ 298	NA	NA	NA	NA	NA	NA	NA	NA	Coal
78 PRUJ 299	50	780	NA	780	NA	NA	NA	x	Sandstone with galena
78 PRUJ 300	35	40	NA	135	NA	NA	NA	x	Stream sediment
78 PRUJ 301	45	75	.01%	7,500	.24%	NA	NA	x	Mineralized breccia
78 PRUJ 302	115	38,000	1.1%	820	.015%	NA	NA	x	Mineralized breccia
78 PRUJ 303	35	125	NA	240	NA	NA	NA	x	Stream sediment
78 PRUJ 304	35	105	NA	290	NA	NA	NA	x	Stream sediment
78 PRUJ 305	35	60	NA	150	NA	NA	NA	x	Stream sediment
West Sampled Creek									
78 PRUJ 518	35	60	NA	235	NA	NA	NA	x	Stream sediment
78 PRUJ 519	35	45	NA	240	NA	NA	NA	x	Stream sediment
78 PRUJ 520	30	20	NA	220	NA	NA	NA	x	Stream sediment
78 PRUJ 521	15	10	NA	135	NA	NA	NA	x	Stream sediment
78 PRUJ 522	30	25	NA	150	NA	NA	NA	x	Stream sediment
78 PRUJ 523	5	5	NA	50	NA	NA	NA	x	Stream sediment
78 PRUJ 524	30	25	NA	175	NA	NA	NA	x	Stream sediment

Table 35. - Analytical results of Story Creek area samples - Continued
[Values in parts per million unless otherwise noted]

Sample Number	Elements Analyzed								Sample Type
	Cu	Pb	PbOx	Zn	ZnOx	Ag	Cd	CPS	
West Fork Safari Creek									
78 PRUJ 267	45	20	NA	150	NA	NA	NA	70-80	Stream sedimemt
78 PRUJ 268	50	25	NA	190	NA	NA	NA	x	Stream sediment
78 PRUJ 269	45	20	NA	120	NA	NA	NA	60-70	Stream sediment
78 PRUJ 270	35	15	NA	105	NA	NA	NA	60-70	Stream sediment
78 PRUJ 271	40	20	NA	135	NA	NA	NA	70	Stream sediment
78 PRUJ 272	60	40	NA	170	NA	NA	NA	90-100	Stream sediment
78 PRUJ 273	30	20	NA	105	NA	NA	NA	90-100	Stream sediment
78 PRUJ 274	40	40	NA	110	NA	NA	NA	x	Stream sediment
78 PRUJ 275	30	30	NA	120	NA	NA	NA	80	Stream sediment
78 PRUJ 276	30	20	NA	105	NA	NA	NA	x	Stream sediment
East & Middle Forks of Safari Creek									
78 PRUJ 306	40	20	NA	130	NA	NA	NA	60	Stream sediment
78 PRUJ 307	40	25	NA	145	NA	NA	NA	x	Stream sediment
78 PRUJ 308	30	35	NA	120	NA	NA	NA	75	Stream sediment
78 PRUJ 309	50	55	NA	225	NA	NA	NA	x	Stream sediment
78 PRUJ 310	25	25	NA	120	NA	NA	NA	70	Stream sediment
78 PRUJ 311	25	40	NA	110	NA	NA	NA	x	Stream sediment
78 PRUJ 312	20	15	NA	80	NA	NA	NA	85-95	Stream sediment
78 PRUJ 313	50	15	NA	340	NA	NA	NA	x	Stream sediment
78 PRUJ 314	55	55	NA	190	NA	NA	NA	x	

NA - Not analyzed
x - Within range of background values

Table 36. - Emission spectrographic results of Story Creek area samples
[Values in parts per million unless otherwise noted]

Element	Sample number	
	78 PRUJ 278 High-grade composite	78 PRUJ 279 Composite surface sample
Fe	3%	5%
Ca	0.03%	0.05%
Mg	0.05%	0.07%
Ag	100	3
As	<500	<500
B	10	20
Ba	1,000	500
Be	<2	<2
Bi	<10	<10
Cd	300	<50
Co	10	<5
Cr	10	15
Cu	300	20
Ga	<10	<10
Ge	100	<20
La	30	20
Mn	500	500
Mo	2	2
Nb	20	20
Ni	30	20
Pb	>10,000	3,000
Sb	1,000	100
Sc	<10	<10
Sn	15	<10
Sr	200	200
Ti	1,500	2,000
V	30	50
W	<50	<50
Y	<10	<10
Zn	>10,000	2,000
Zr	100	150

Table 36. - Emission spectrographic results of Story Creek area samples - Continued
[Values in parts per million unless otherwise noted]

Element	Sample numbers		
	78 PRUJ 299 Sandstone	78 PRUJ 301 Mineralized breccia	78 PRUJ 302 Mineralized breccia
Fe	2%	7%	1%
Ca	0.03%	0.07%	0.02%
Mg	0.05%	0.07%	0.05%
Ag	<1	<1	20
As	<500	<500	<500
B	<10	10	10
Ba	10	50	50
Be	<2	<2	<2
Bi	<10	<10	<10
Cd	<50	<50	<50
Co	<5	<5	<5
Cr	<10	10	10
Cu	20	50	100
Ga	<10	<10	<10
Ge	<20	<20	20
La	20	<20	50
Mn	500	1,500	100
Mo	<2	2	2
Nb	<20	20	<20
Ni	10	10	10
Pb	500	100	10,000
Sb	<100	<100	100
Sc	<10	<10	<10
Sn	<10	<10	<10
Sr	200	200	200
Ti	1,000	1,000	1,500
V	30	50	50
W	<50	<50	<50
Y	<10	10	<10
Zn	700	5,000	1,000
Zr	<20	70	70

Table 37. - Proximate analyses of Story Creek area coal samples

Sample	BTU ("As Received")	Moisture (%)	Volatile Matter (%)	Fixed Carbon (%)	Sulfur (%)	Ash (%)
C1	10,451	3.8	10.7	63.8	0.5	21.7
C2	10,721	3.7	10.1	64.6	0.5	21.6
C3	8,980	4.1	10.5	54.8	0.5	30.6
C4	11,765	3.1	11.2	69.5	0.5	16.2

Ipnavik River Area (H-547)

Two west-flowing tributaries of Ipnavik River were prospected and sampled. An anomalously high lead concentration occurs in stream sediment sample H-547; lead and anomalously high zinc concentrations occur in the heavy-mineral concentrate(2). This area is within the regional lead-zinc geochemical anomaly which extends from Kuna River to Koiyaktot Mountain. The 1978 BOM samples contained no anomalous lead or zinc concentrations.

Location and Physical Setting

Stream H-547, a west-flowing tributary of the Ipnavik River, is located near 68° 20' 30"N latitude, 157° 17'W longitude, and is in the northwestern quadrant of T 34N, R 7E, Kateel River Base and Meridian. This site is in the western Howard Hills and approximately 4.5 miles north of the southern NPR-A boundary.

The prospected area is in the Central Brooks Range section of the Arctic Mountains Physiographic Province(4). It is characterized by a gently sloping and rolling terrain which is dissected by several small streams (Figure 34). Elevations in the area range from 2,000 to 3,600 feet.

Stream H-547 is a 1-mile long, west-flowing tributary of the Ipnavik River. The stream channel is relatively straight, 2 to 3 feet wide, and has a gradient of about 300 feet per mile. The stream bed consists primarily of pebbles and cobbles. The surface area of the drainage basin is approximately 3.2 square miles.

Regional Geology

Two clastic rock units are mapped in the area. Lower Mississippian-Upper Devonian Kanayut Conglomerate, which includes quartz and chert pebble conglomerate and clean white sandstone, underlies the main stream, H-547(1). Mississippian Kayak Shale, which is comprised of siltstone, shale, and sandstone, crops out to the south. These rock units are mapped as part of the North Central Brooks Range thrust sequence.

Results of the 1977 Geochemical Survey

High lead (70 ppm) concentrations occur in stream sediment sample H-547 (2); high lead (70 ppm) and zinc (500 ppm) concentrations occur in the heavy-mineral concentrate.

Bureau of Mines Work in 1978

Two drainages were prospected, geologic relationships were noted, and sediment samples were collected for analysis. Stream H-547 was prospected from its mid-point to its headwaters. The adjacent major tributary, located north of stream H-547, was prospected near its confluence with the Ipnavik River.

Rock types along the two drainages include chert pebble conglomerate, sandstone, and shale. Float rock in stream H-547 consists predominantly of sandstone and shale. The adjacent stream, north of stream H-547, has eroded through sandstone; shale was not noted in the prospected segment of this drainage. Pyrite disseminations occur in the sandstone.

Eight stream sediment samples were collected for analysis to determine their copper, lead, and zinc content (Table 38). Two sample populations are present. Samples 78 PRUJ 315 through 318 contain much lower concentrations of copper, lead, and zinc than samples 78 PRUJ 319 through 322. The average element contents of all samples, with the standard deviations shown in parentheses, are: copper 16 ppm (11 ppm), lead 16 ppm (12 ppm), and zinc 100 ppm (65 ppm).

All the element contents are below the defined threshold values for the 1977 geochemical data. The high lead value in the 1977 stream sediment sample was not reproduced.

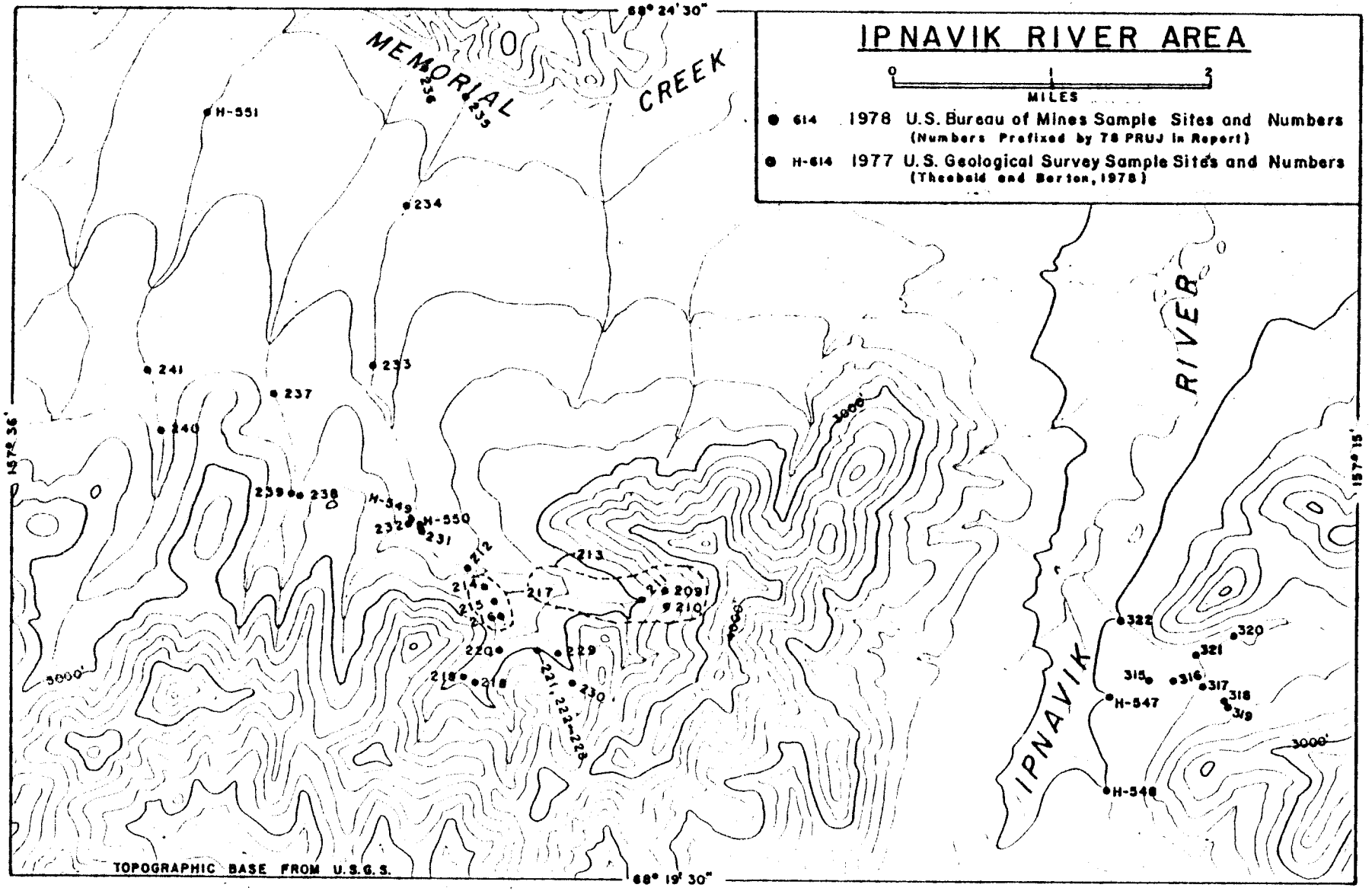

Figure 34. Ipnavik River Area

Table 38. - Analytical results of Ipnavik River area samples
[Values in parts per million]

Sample Number	Elements Analyzed			Sample Type
	Cu	Pb	Zn	
78 PRUJ 315	10	5	45	Stream sediment
78 PRUJ 316	5	5	45	Stream sediment
78 PRUJ 317	5	5	50	Stream sediment
78 PRUJ 318	5	5	20	Stream sediment
78 PRUJ 319	35	25	170	Stream sediment
78 PRUJ 320	25	25	160	Stream sediment
78 PRUJ 321	20	30	155	Stream sediment
78 PRUJ 322	20	30	160	Stream sediment

Swayback Creek Area (H-360)

Anomalously high lead and zinc concentrations occur in sediment sample H-360(2). In 1978, stream sediment samples were collected from Swayback Creek and other nearby drainages. Anomalous base metal concentrations were not detected in these samples.

Location and Physical Setting

The Swayback Creek area, located between the Kuna and Kiligwa Rivers, centers near 68° 38' 30"N latitude, 158° 10'W longitude, and is in the eastern half of T 9S and 10S, R 27W and the western half of T 9S, R 26W, Umiat Base and Meridian.

The Swayback Creek area is within the southern section of the Arctic Foothills Physiographic Province(4). This area is characterized by small, irregular knobs with intervening gently undulating, tussock-covered tundra plains which are cut by meandering streams (Figure 35). Elevations in the area range from 1,600 to 2,200 feet.

Swayback Creek is a 25-mile long, northwest-flowing tributary of the Kuna River. The three sampled tributaries of Swayback Creek are from 6 to 10 miles long. Swayback Creek and its tributaries are tightly meandering and are from 8 to 20 feet wide. Stream gradients are approximately 50 feet per mile. The surface area of the drainage basin of Swayback Creek, south of Swayback Mountain, is approximately 80 square miles. The area of the drainage basin above sample site H-360 is 2 square miles.

Regional Geology

Mississippian to Cretaceous sedimentary rocks crop out on small knobs and ridges throughout the area. The rock units include: (1) Mississippian Lisburne Group, comprised of bedded black chert, grey limestone with black chert nodules, and diabase sills; (2) Triassic to Permian Siksikpuk(?) Formation, comprised of grey, red, and green chert, commonly with diabase sills and subordinate amounts of shale; and (3) Lower Cretaceous flyschoid wacke and mudstone, with local conglomerate(1). These rocks are mapped as part of the Ipnavik River

thrust sequence. Mississippian(?) and Triassic(?) rock units crop out south of the sampled area in the headwaters of creek H-360.

Results of the 1977 Geochemical Survey

An anomalously high lead (100 ppm) concentration is present in sediment sample H-360; anomalously high zinc (1,000 ppm) and high lead (50 ppm) concentrations are present in the heavy-mineral concentrate(2).

Bureau of Mines Work in 1978

Fifteen stream sediment samples were collected from Swayback Creek and other nearby drainages to determine their copper, lead, zinc, and barium content (Table 39). The average element contents of the samples, with the standard deviations shown in parentheses, are: copper 28 ppm (15 ppm), lead 13 ppm (4.1 ppm), zinc 100 ppm (26 ppm), and barium 1,400 ppm (1,200 ppm). The copper, lead, and zinc contents are uniformly low; the barium content ranges from 400 to 4,000 ppm.

The high lead concentration (100 ppm) in the 1977 stream sediment sample was not reproduced.

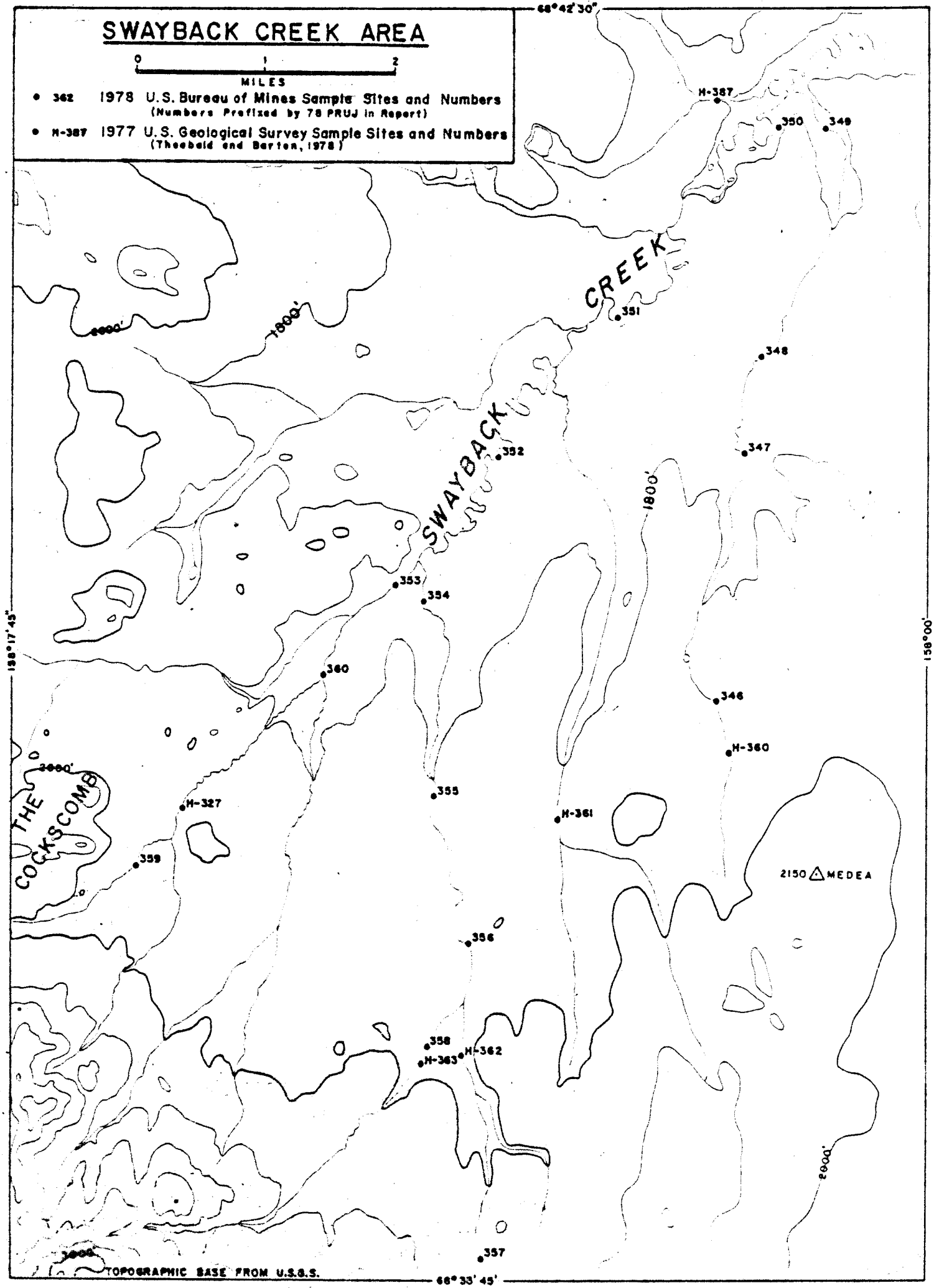

Figure 35. Swayback Creek Area

Table 39. - Analytical results of Swayback Creek area samples
[Values in parts per million]

Sample Number	Elements Analyzed					Sample Type
	Cu	Pb	Zn	Ba	CPS	
78 PRUJ 346	25	15	125	1,150	x	Stream sediment
78 PRUJ 347	25	20	120	900	x	Stream sediment
78 PRUJ 348	25	15	145	1,400	x	Stream sediment
78 PRUJ 349	80	10	135	3,900	x	Stream sediment
78 PRUJ 350	25	10	100	800	x	Stream sediment
78 PRUJ 351	20	20	95	1,500	x	Stream sediment
78 PRUJ 352	25	15	95	1,050	x	Stream sediment
78 PRUJ 353	40	10	130	4,000	x	Stream sediment
78 PRUJ 354	25	10	90	650	x	Stream sediment
78 PRUJ 355	15	10	75	500	x	Stream sediment
78 PRUJ 356	20	10	70	450	x	Stream sediment
78 PRUJ 357	25	10	75	550	x	Stream sediment
78 PRUJ 358	20	10	65	400	x	Stream sediment
78 PRUJ 359	30	15	130	2,000	x	Stream sediment
78 PRUJ 360	25	20	95	2,100	x	Stream sediment

x - Within range of background values

Mount Bupto Area (H-499)

Anomalously high zinc and barium concentrations occur in sample H-499, collected from the north side of Mount Bupto(2). In 1978, the drainage was prospected and rock and sediment samples were collected for analysis. Phosphatic and oil-bearing shales were found. These shales contain anomalous metal concentrations.

Location and Physical Setting

Stream H-499, on the north side of Mount Bupto, is located near 68° 31' 25"N latitude, 157° 30'W longitude, and is in section 14, T 12S, R 26W, Umiat Base and Meridian.

Mount Bupto is within the southern section of the Arctic Foothills Physiographic Province(4). Stream H-499 originates on the steep, barren, north-facing slope of the mountain (Figure 36). The base of the mountain and the outlying areas are characterized by a gently sloping, undulating, alpine tundra covered terrain. Elevations in the area range from 2,400 to more than 4,000 feet.

Stream H-499 is a 1.2-mile long, northeast-flowing tributary of Bupto Creek, which is an eastward-flowing tributary of the Ipnavik River. The prospected stream is relatively straight, flows through boulder-size talus at its source, and cuts 10 to 15 feet into the local terrain at lower elevations. The stream bed is comprised mainly of cobbles and boulders at the lower elevations. The stream gradient is about 800 feet per mile in the prospected area. The surface area of the drainage basin is approximately .7 square miles.

Regional Geology

Mississippian Lisburne Group carbonates, locally with black chert nodules, and Permo-Triassic Siksikpuk Formation, comprised of mudstones, cherts, limestones, and shales, crop out at Mt. Bupto(1). The Mississippian rocks crop out above the 2,600-foot elevation; Permo-Triassic rocks crop out below this elevation along stream H-499(12). The rock units are mapped as part of the North Central Brooks Range thrust sequence.

Results of the 1977 Geochemical Survey

Stream sediment sample H-499 contains an anomalously high zinc (300 ppm) concentration and more than 20,000 ppm barium(2).

Bureau of Mines Work in 1978

The stream was prospected, local geologic relationships were noted, and sediment and rock samples collected. The steep rugged part of Mount Bupto is underlain mainly by fossiliferous limestone, dolomite, and chert. Much of this rock is highly brecciated and recemented by carbonate, silica, and a minor amount of fluorite. One high-grade fluorite-bearing boulder (estimated 40 percent CaF_2) was found on the north side of Mount Bupto. The gentle terrain at the base of Mount Bupto is underlain by red and green shale and a kerogenous phosphatic shale. The calcareous and carbonaceous shales yield a strong petroleum-like odor from freshly broken surfaces.

Three rock and three stream sediment samples were collected for chemical analysis. Sediment samples contain from 45 to 50 ppm copper, 10 to 15 ppm lead, 190 to 300 ppm zinc, and 400 to 4,300 ppm barium (Table 40).

The black shales (78 PRUJ 364 and 365) contains anomalous concentrations of silver, barium, chromium, copper, manganese, molybdenum, and other elements (Table 41). These shales may be the source of elements found in anomalous concentrations in sample H-499. The black shales also contain up to 13 percent P_2O_5 (Table 40) and 7.0 gallons of oil per ton of rock (Table 42).

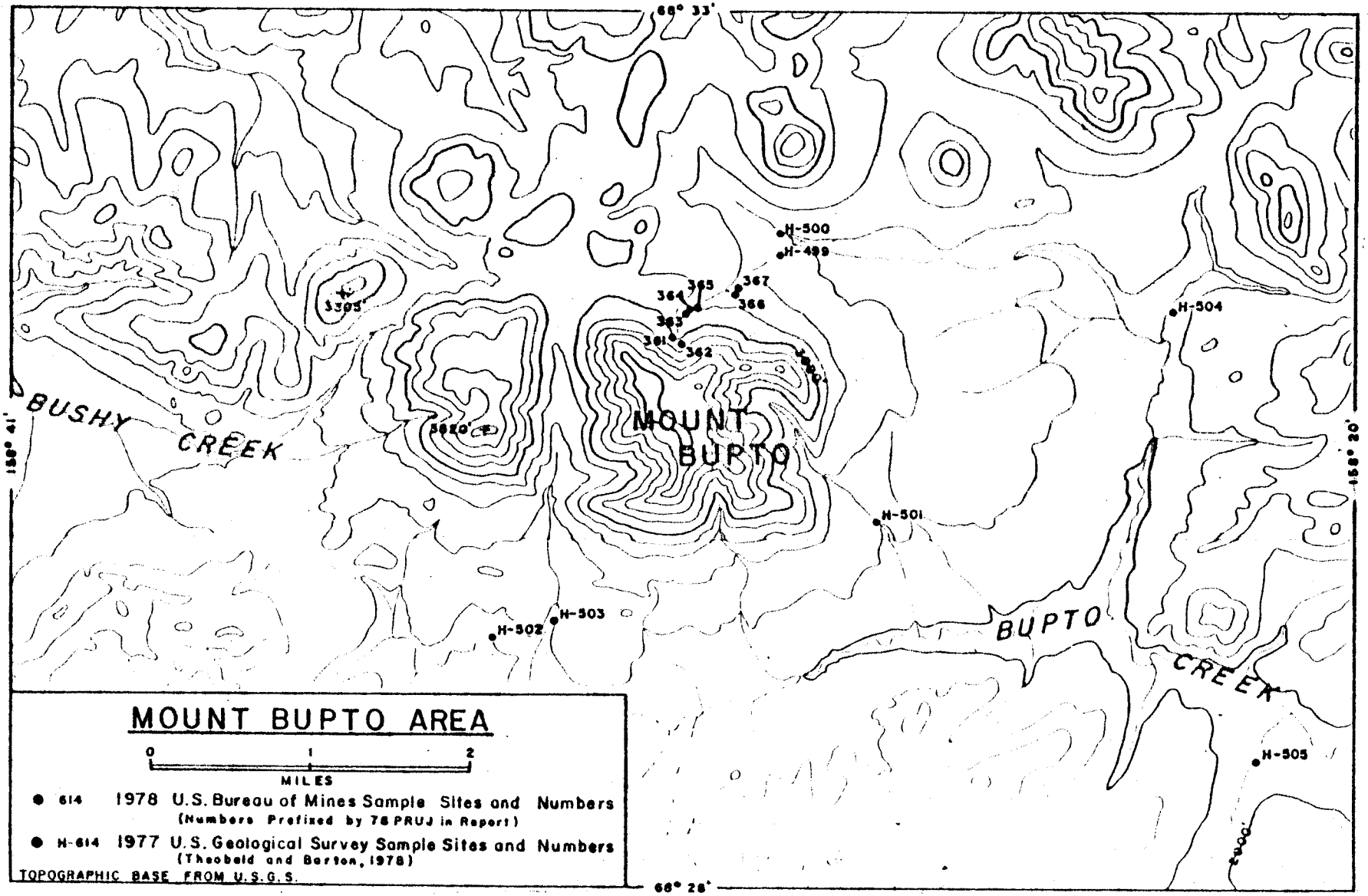

Figure 36. Mount Bupto Area

Table 40. - Analytical results of the Mount Bupto area samples
[Values in parts per million unless otherwise noted]

Sample Number	Elements Analyzed					Sample Type
	Cu	Pb	Zn	Ba	P_2O_5	
78 PRUJ 361	NA	NA	NA	NA	NA	Limestone breccia with fluorite
78 PRUJ 362	55	10	300	400	NA	Stream sediment
78 PRUJ 363	55	15	300	3,800	NA	Stream sediment
78 PRUJ 364	NA	NA	NA	NA	3.4%	Black oil shale
78 PRUJ 365	NA	NA	NA	NA	13%	Black oil shale
78 PRUJ 366	NA	NA	NA	NA	NA	Red-green shale
78 PRUJ 367	45	10	190	4,300	NA	Stream sediment

NA - Not analyzed
x - Within range of background values

Table 41. - Emission spectrographic results of Mount Bupto area samples
[Values in parts per million unless otherwise noted]

Element	Sample numbers		
	78 PRUJ 364 Oil Shale	78 PRUJ 365 Oil Shale	78 PRUJ 366 Shale
Fe	0.2%	0.5%	1.5%
Ca	10%	15%	0.1%
Mg	1.5%	2%	0.5%
Ag	3	10	<1
As	<500	<500	<500
B	10	10	20
Ba	500	1,000	>10,000
Be	<2	<2	<2
Bi	<10	<10	<10
Cd	<50	<50	<50
Co	<5	<5	5
Cr	200	500	10
Cu	30	150	30
Ga	<10	<10	<10
Ge	<20	<20	<20
La	100	200	50
Mn	1,000	2,000	150
Mo	7	70	2
Nb	<20	<20	20
Ni	100	150	50
Pb	<10	<10	<10
Sb	<100	<100	<100
Sc	<10	<10	10
Sn	<10	<10	<10
Sr	200	200	200
Ti	200	500	1,500
V	200	300	70
W	<50	<50	<50
Y	30	200	<10
Zn	<200	200	<200
Zr	20	30	50

Table 42. - Fisher Assay Report of Analysis

Sample Number	Yield of Product						Specific Gravity of oil at 60°/60°F
	Weight Percent				Gallons Per Ton		
	Oil	Water	Spent Shale	Gas+ Loss	Oil[1]	Water	
78 PRUJ 364	1.5	0.7	96.9	0.9	3.9a	1.7	
78 PRUJ 365	2.7	1.2	94.7	1.4	7.0	2.9	.929

1 "a" indicates specific gravity estimated at 0.92

Nigu Bluff Area

Previous reports mention the presence of sulfide minerals with mafic sills, or dikes, in this area. Mafic rocks on Nigu Bluff contain 2,000 ppm barium. A stream sediment sample collected downstream from a limonite "color anomaly" on the southwest side of Nigu Bluff contains an anomalous amount of chromium.

Location and Physical Setting

Nigu Bluff, on the east bank of the Nigu River, is located near 68° 29'N latitude, 156° 26'W longitude, and is in section 16 of T 11S, R 19W, Umiat Base and Meridian (Figure 37).

Nigu Bluff is within the southern Arctic Foothills Physiographic Province which consists of plateaus and low linear mountains(4). The terrain is characterized by irregular buttes, knobs, mesas, east-trending ridges, and intervening gently undulating tundra plains(4). Elevations range from 1,200 to 3,500 feet.

Regional Geology

The southern section of the the Arctic Foothills is underlain by Devonian to Cretaceous sedimentary rocks with mafic intrusions(4). All are tightly folded and overthrust to the north. The stratigraphic section at Nigu Bluff includes fine-grained clastic rocks and cherts of the Siksikpuk Formation and a mafic sill(17).

Bureau of Mines Work in 1978

The northwestern slope of Nigu Bluff was briefly traversed and a highly magnetic mafic rock (78 PRUJ 155) was sampled. A stream sediment sample (78 PRUJ 156) was collected from the Nigu River at a site immediately downstream from a "color anomaly" on Nigu Bluff, adjacent to the Nigu River. Pyritiferous sedimentary rocks underlie the "color anomaly."

Rock and stream sediment samples were analyzed (Tables 43, 44). The stream sediment sample (78 PRUJ 156) contains low concentrations of base metals; the chrome and nickel concentrations are similar to those of other samples from the NPR-A. The mafic rock (78 PRUJ 155) contains 2,000 ppm barium.

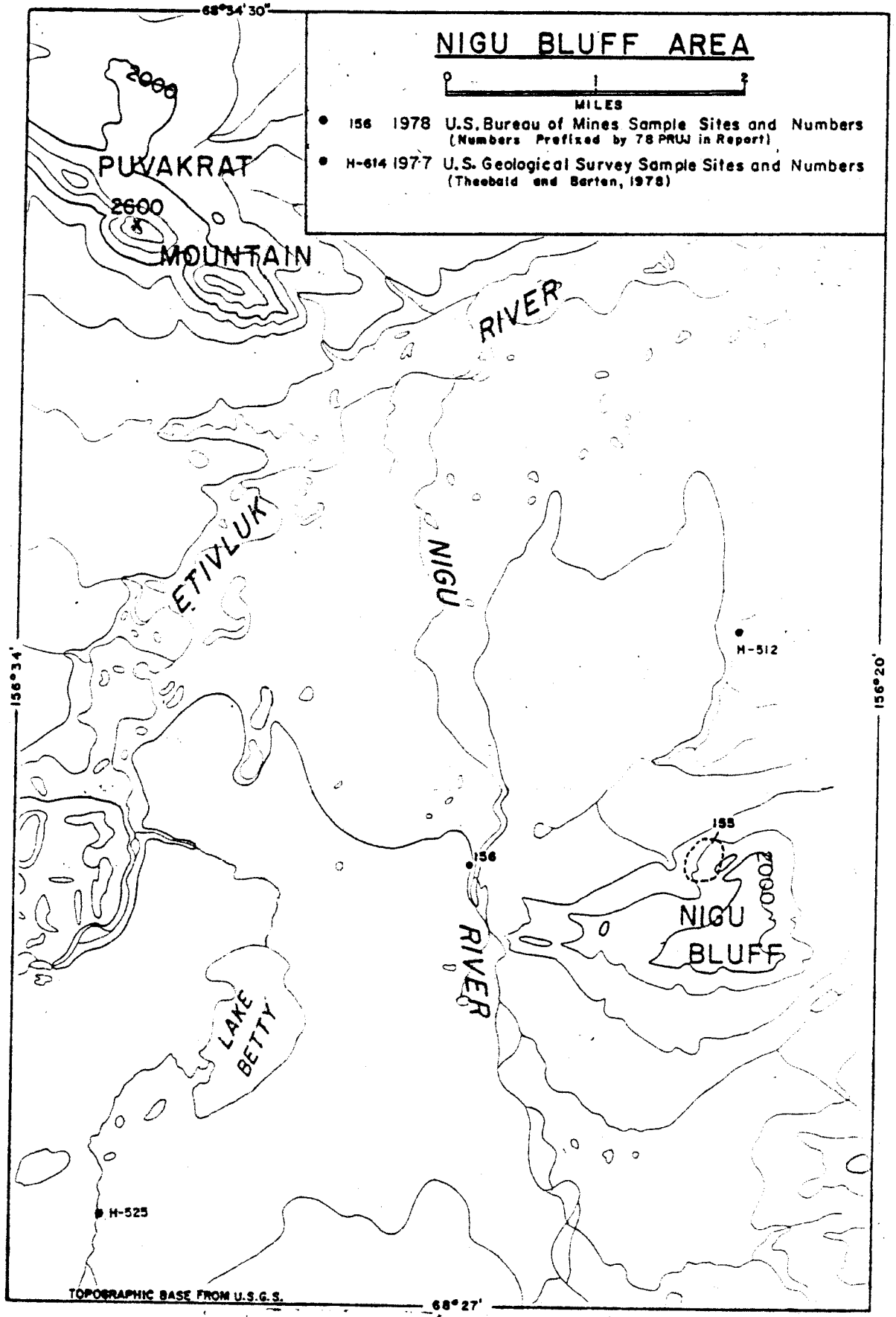

Figure 37. Nigu Bluff Area

Table 43. - Analytical results of the Nigu Bluff area samples
[Values in parts per million]

Sample Number	Elements Analyzed						Sample Type
	Cu	Co	Cr	Ni	Pb	Zn	
78 PRUJ 155	NA	NA	NA	NA	NA	NA	Diabase
78 PRUJ 156	20	25	250	50	15	95	Stream sediment

NA - Not analyzed

Table 44. - Emission spectrographic results of Nigu Bluff area sample
[Values in parts per million unless otherwise noted]

Element	Sample Number
	78 PRUJ 155 Diabase
Fe	15%
Ca	7%
Mg	2%
Ag	<1
As	<500
B	10
Ba	2,000
Be	<2
Bi	<10
Cd	<50
Co	20
Cr	200
Cu	200
Ga	10
Ge	<20
La	<20
Mn	700
Mo	<2
Nb	20
Ni	50
Pb	<10
Sb	<100
Sc	30
Sn	<10
Sr	500
Ti	7,000
V	200
W	<50
Y	10
Zn	<200
Zr	20

Whoopee Creek Area (H-448)

Sphalerite and galena were discovered near the headwaters of stream H-448, here named Whoopee Creek. The mineralization is very similar to that found at Story Creek; both occur within the regional lead-zinc geochemical anomaly that extends from the Kuna River to Koiyaktot Mountain.

Location and Physical Setting

Base metal mineralization at Whoopee Creek is located at 68° 13' 45"N latitude, 157° 51' 20"W longitude, and is in section 25 of T 33N, R 4E, Kateel River Base and Meridian. Mineralized float rock was found throughout section 25 of T 33N, R 4E. This area is eleven miles south-southeast of the base metal mineral occurrence at Story Creek and twelve miles east of Feniak Lake.

The Whoopee Creek area (Figure 38) is within the Central Brooks Range section of the Arctic Mountains Physiographic Province (4). The area is characterized by rolling hills and wide, gently-sloping, alpine tundra and tussock covered valleys. Elevations range from 1,600 to 3,000 feet.

Whoopee Creek is a 2.6-mile long easterly-flowing tributary of a southerly-flowing tributary of the Noatak River. The creek is relatively straight and has a gradient of 230 feet per mile. The stream bed is comprised primarily of cobbles and boulders. The surface area of the drainage basin is approximately 5.4 square miles.

Regional Geology

Bedrock in the Whoopee Creek area is comprised primarily of sedimentary rock and minor amounts of volcanic rock(19). Sandstone of the Mississippian-Devonian Kanayut Formation and sandstone and shale of the Mississippian Kayak Formation crop out along Whoopee Creek. Sandstone, possibly of the Cretaceous Opikruak Formation, crops out to the west of the creek. Volcanic rock of undetermined age crops out to the east of Whoopee Creek in the drainage of stream H-447. The volcanics are believed to be exposed through windows in an overlying thrust plate.

Results of the 1977 Geochemical Survey

Anomalously high lead (50 ppm) and copper (70 ppm) concentrations occur in stream sediment sample H-448; anomalously high lead (1,000 ppm) and copper (300 ppm) concentrations occur in the heavy-mineral concentrate(2). High-grade galena and sphalerite mineralization, with minor chalcopyrite, was found 2.1 miles upstream from this sample site.

Samples from other drainages (H-407, H-409, H-447) in the Whoopee Creek area contain anomalous lead and zinc concentrations(2). These streams were not prospected.

The Bureau of Mines Work in 1978

The Whoopee Creek area was prospected, geologic relationships were noted, and rock and stream sediment samples were collected. Prospecting was limited to the headwaters area of streams H-448 and H-409. Base metal sulfide breccia mineralization was found along a one-half mile segment of Whoopee Creek, the headwaters of stream H-409, and the intervening divide.

The geologic setting and mineralization in the Whoopee Creek area is very similar to that in the Story Creek area. Siltstone, shale, and sandstone of the Kayak(?) Formation comprise the bedrock. Siltstone (78 PRUJ 654) and shale (78 PRUJ 653), which crop out along the stream, presumably underlie the gentle terrain at lower elevations. Sandstone, found only as float rock in the prospected area, presumably underlies the rugged terrain which surrounds the drainage basin. An approximately 20-foot wide, S 65° E trending, steeply-dipping shear zone cuts the siltstone near sample site 78 PRUJ 653. Mineralization consists of a galena, sphalerite, quartz, and carbonate cemented siltstone breccia. Quartz is the most abundant epigenetic mineral; sulfides and carbonates occur in variable amounts. Mineralized float rock is abundant in, and east and west of, upper Whoopee Creek. The extent of the mineralization has not been delimited. Mineralized rock contains up to .24 percent copper, 44 percent lead, 46 percent zinc, 4.4 ppm gold, 460 ppm silver, and 3,700 ppm cadmium (Table 45).

In addition to the mineralized siltstone breccia, a quartz-cemented sandstone breccia is present in the area. Both are very similar in appearance but sulfide mineralization was not found in the sandstone breccia.

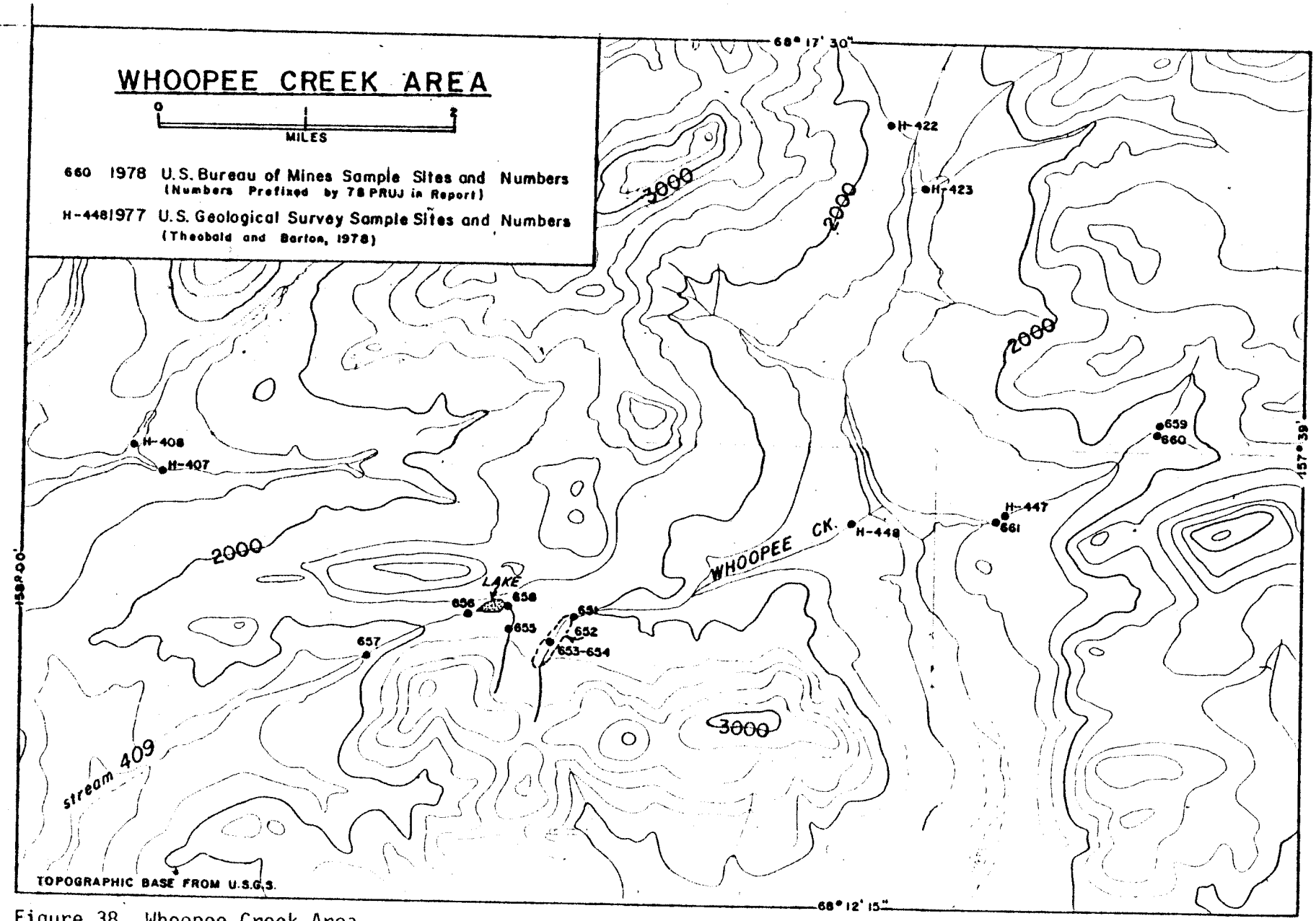

Figure 38. Whoopee Creek Area

Mineralization along Whoopee Creek (stream H-448) and Story Creek (stream H-399) occurs in similar rock types and geologic environments. Both zones of mineralization are within the regional geochemical anomaly which extends from the Kuna River to Koiyaktot Mountain.

Table 45. - Analytical results of Whoopee Creek area samples
[Values in parts per million unless otherwise noted]

Sample Number	Elements Analyzed						Sample Type
	Cu	Pb	Zn	Au	Ag	Cd	
78 PRUJ 652A	.17%	19.%	12.%	3.2	180.	900	Mineralized breccia
78 PRUJ 652B	.070%	16.5%	7.2%	.67	220.	440	Mineralized breccia
78 PRUJ 652C	.027%	5.5%	2.3%	.14	75.	95	Mineralized breccia
78 PRUJ 652D	.080%	6.2%	15.5%	.68	80.	1,200	Mineralized breccia
78 PRUJ 652E	.012%	.81%	3.7%	.04	10.	265	Mineralized breccia
78 PRUJ 652F	.13%	16.5%	20.%	1.2	210.	1,600	Mineralized breccia
78 PRUJ 652G	.046%	15.%	3.0%	.58	150.	170	Mineralized breccia
78 PRUJ 652H	.075%	36.%	1.4%	3.3	450.	90	Mineralized breccia
78 PRUJ 652I	.028%	21.5%	.29%	.59	270.	20	Mineralized breccia
78 PRUJ 652J	.013%	.75%	14.5%	.04	16.	500	Mineralized breccia
78 PRUJ 652K	.028%	.71%	31.%	.06	6.6	1,050	Mineralized breccia
78 PRUJ 652L	.047%	15.5%	4.8%	.56	220.	270	Mineralized breccia
78 PRUJ 652M	.015%	.98%	3.1%	<.02	20.	215	Mineralized breccia
78 PRUJ 652N	.015%	3.3%	14.%	.08	26.	480	Mineralized breccia
78 PRUJ 652O	.045%	44.%	5.2%	4.4	460.	395	Mineralized breccia
78 PRUJ 652P	.24%	11.5%	17.5%	.44	210.	950	Mineralized breccia
78 PRUJ 652Q	.060%	.95%	46.0%	.30	14.	3,700	Mineralized breccia
78 PRUJ 652R	.007%	.070%	4.6%	<.02	5.2	260	Mineralized breccia
78 PRUJ 652S	.024%	.83%	15.5%	.09	9.8	700	Mineralized breccia

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Appendix A. Channel samples of coal collected from surface outcrops of coal beds in the Cretaceous Corwin Formation, NPR-A, Alaska
Collected: August 1978 by Gary Martin and Carl Almquist, USGS Conservation Division

Sample Number	Location	Thickness (Meters)	Air Dry Loss	Proximate Analysis				Ultimate Analysis					BTU/lb
				Moisture%	Volatile Matter%	Fixed Carbon%	Ash%	Hydrogen%	Carbon%	Nitrogen%	Sulfur%	Oxygen(Ind)%	
A-78-14	Sec.27, T 1N, R 38W	2.5	6.2										
	As Received			11.3	28.5	57.4	2.8	5.2	66.5	1.2	.3	24.1	11137
	Moisture Free			N/A	32.1	64.7	3.2	4.4	74.9	1.4	.3	15.9	12554
	Ash Free			N/A	33.2	66.8	N/A	4.5	77.4	1.4	.3	16.4	12966
A-78-15	Sec.25, T 1N, R 38W	1.5	2.2										
	As Received			5.3	27.4	62.3	5.0	N/A	N/A	N/A	.4	N/A	12500
	Moisture Free			N/A	29.0	65.8	5.2	N/A	N/A	N/A	.4	N/A	13193
	Ash Free			N/A	30.6	69.4	N/A	N/A	N/A	N/A	.5	N/A	13924
G-78-35	Sec.22, T 1N, R 34W	0.8	.9										
	As Received			3.6	30.4	63.9	2.1	N/A	N/A	N/A	.6	N/A	13471
	Moisture Free			N/A	31.6	66.2	2.2	N/A	N/A	N/A	.6	N/A	13978
	Ash Free			N/A	32.3	67.7	N/A	N/A	N/A	N/A	.6	N/A	14286
G-78-37	Sec.7, T 4S, R 39W	1.0	5.9										
	As Received			11.3	31.6	52.5	4.6	N/A	N/A	N/A	.4	N/A	10587
	Moisture Free			N/A	35.6	59.2	5.2	N/A	N/A	N/A	.4	N/A	11941
	Ash Free			N/A	37.6	62.4	N/A	N/A	N/A	N/A	.4	N/A	12597
G-78-40	Sec.7, T 4S, R 39W	0.8	1.8										
	As Received			6.8	30.6	59.2	3.4	N/A	N/A	N/A	.2	N/A	11861
	Moisture Free			N/A	32.8	63.5	3.7	N/A	N/A	N/A	.3	N/A	12721
	Ash Free			N/A	34.1	65.9	N/A	N/A	N/A	N/A	.3	N/A	13210
G-78-41	Sec.7, T 4S, R 39W	2.2	1.0										
	As Received			4.6	33.6	58.9	2.9	N/A	N/A	N/A	.3	N/A	12934
	Moisture Free			N/A	35.2	61.8	3.0	N/A	N/A	N/A	.3	N/A	13557
	Ash Free			N/A	36.3	63.7	N/A	N/A	N/A	N/A	.3	N/A	13982
G-78-43	Sec.12, T 4S, R 40W	3.4	2.0										
	As Received			6.6	31.4	58.5	3.5	N/A	N/A	N/A	.3	N/A	12170
	Moisture Free			N/A	33.6	62.6	3.8	N/A	N/A	N/A	.3	N/A	13026
	Ash Free			N/A	34.9	65.1	N/A	N/A	N/A	N/A	.3	N/A	13534
G-78-55	Sec.6, T 4S, R 39W	0.6	.8										
	As Received			3.3	31.1	58.3	7.3	N/A	N/A	N/A	.4	N/A	12797
	Moisture Free			N/A	32.1	60.4	7.5	N/A	N/A	N/A	.5	N/A	13228
	Ash Free			N/A	34.8	65.2	N/A	N/A	N/A	N/A	.5	N/A	14303
G-78-58	Sec.31, T 3S, R 39W	0.5	2.2										
	As Received			5.4	20.1	38.5	36.0	N/A	N/A	N/A	.4	N/A	7579
	Moisture Free			N/A	21.2	40.7	38.1	N/A	N/A	N/A	.4	N/A	8016
	Ash Free			N/A	34.3	65.7	N/A	N/A	N/A	N/A	.6	N/A	12950
G-78-80	Sec.10, T 4S, R 40W	2.7	2.6										
	As Received			6.5	32.2	57.7	3.6	5.1	69.9	1.5	.3	19.6	12265
	Moisture Free			N/A	34.4	61.7	3.9	4.7	74.8	1.6	.3	14.7	13117
	Ash Free			N/A	35.8	64.2	N/A	4.9	77.8	1.7	.3	15.3	13646
G-78-84	Sec.14, T 4S, R 40W	3.5	3.3										
	As Received			7.6	30.0	56.1	6.3	N/A	N/A	N/A	.3	N/A	11582
	Moisture Free			N/A	32.4	60.8	6.8	N/A	N/A	N/A	.3	N/A	12530
	Ash Free			N/A	34.8	65.2	N/A	N/A	N/A	N/A	.3	N/A	13446
G-78-89	Sec.17, T 4S, R 39W	0.6	.8										
	As Received			2.9	29.0	59.4	8.7	N/A	N/A	N/A	.2	N/A	12738
	Moisture Free			N/A	29.8	61.2	9.0	N/A	N/A	N/A	.3	N/A	13112
	Ash Free			N/A	32.8	67.2	N/A	N/A	N/A	N/A	.3	N/A	14407
G-78-93	Sec.16, T 4S, R 39W	2.3	4.3										
	As Received			8.5	33.0	55.3	3.2	N/A	N/A	N/A	.3	N/A	11836
	Moisture Free			N/A	36.1	60.4	3.5	N/A	N/A	N/A	.3	N/A	12932
	Ash Free			N/A	37.4	62.6	N/A	N/A	N/A	N/A	.3	N/A	13403
G-78-94	Sec.11, T 4S, R 40W	2.1	2.1										
	As Received			6.3	30.3	59.2	4.2	N/A	N/A	N/A	.3	N/A	12078
	Moisture Free			N/A	32.3	63.3	4.4	N/A	N/A	N/A	.3	N/A	12886
	Ash Free			N/A	33.8	66.2	N/A	N/A	N/A	N/A	.3	N/A	13485
G-78-97	Sec.25, T 4S, R 40W	0.3	5.1										
	As Received			9.3	28.8	51.0	10.9	N/A	N/A	N/A	.5	N/A	10461
	Moisture Free			N/A	31.7	56.3	12.0	N/A	N/A	N/A	.6	N/A	11533
	Ash Free			N/A	36.1	63.9	N/A	N/A	N/A	N/A	.7	N/A	13111
G-78-99	Sec.25, T 4S R 40W	1.1	3.3										
	As Received			7.1	30.3	57.5	5.1	N/A	N/A	N/A	.3	N/A	11814
	Moisture Free			N/A	32.5	62.0	5.5	N/A	N/A	N/A	.3	N/A	12711
	Ash Free			N/A	34.4	65.6	N/A	N/A	N/A	N/A	.3	N/A	13448

NA - Not Analyzed

Appendix B. Coal samples collected from auger holes in rocks of the Cretaceous Corwin Formation, NPR-A, Alaska
Collected: August 1978 by the J. E. Callahan USGS Field Party

Sample Number	Location	Thickness (Meters)	Air Dry Loss	Proximate Analysis				Ultimate Analysis					BTU/lb
				Moisture%	Volatile Matter%	Fixed Carbon%	Ash%	Hydrogen%	Carbon%	Nitrogen%	Sulfur%	Oxygen(Ind)%	
AH-3-78	Sec.18, T 1S, R 39W	3.6	8.7										
	As Received			14.5	28.2	52.6	4.7	N/A	N/A	N/A	.2	N/A	10004
	Moist Free			N/A	33.0	61.5	5.5	N/A	N/A	N/A	.3	N/A	11694
	Ash Free			N/A	34.9	65.1	N/A	N/A	N/A	N/A	.3	N/A	12377
AH-4-78	Sec.8, T 1S, R 39W	1.3	6.8										
	As Received			12.1	31.1	52.5	4.3	N/A	N/A	N/A	.3	N/A	10216
	Moist Free			N/A	35.4	59.7	4.9	N/A	N/A	N/A	.4	N/A	11626
	Ash Free			N/A	37.2	62.8	N/A	N/A	N/A	N/A	.4	N/A	12228
AH-12-78	Sec.32, T 1N, R 38W	2.3	.0										
	As Received			5.3	31.6	53.4	9.7	N/A	N/A	N/A	.3	N/A	10449
	Moist Free			N/A	33.4	56.3	10.3	N/A	N/A	N/A	.3	N/A	11031
	Ash Free			N/A	37.2	62.8	N/A	N/A	N/A	N/A	.3	N/A	12296
AH-16-78	Sec.2, T 1S, R 39W	2.7	13.1										
	As Received			18.0	28.1	48.0	5.9	N/A	N/A	N/A	.2	N/A	9440
	Moist Free			N/A	34.3	58.5	7.2	N/A	N/A	N/A	.2	N/A	11508
	Ash Free			N/A	36.9	63.1	N/A	N/A	N/A	N/A	.2	N/A	12396
AH-18-78	Sec.11, T 1S, R 39W	3.4	7.2										
	As Received			11.2	26.2	50.6	12.0	N/A	N/A	N/A	.2	N/A	9665
	Moist Free			N/A	29.5	56.9	13.6	N/A	N/A	N/A	.2	N/A	10889
	Ash Free			N/A	34.1	65.9	N/A	N/A	N/A	N/A	.3	N/A	12597
AH-19-78	Sec.14, T 1S, R 39W	1.7	7.3										
	As Received			11.0	26.6	52.0	10.4	N/A	N/A	N/A	.3	N/A	10029
	Moisture Free			N/A	29.9	58.4	11.7	N/A	N/A	N/A	.3	N/A	11268
	Ash Free			N/A	33.8	66.2	N/A	N/A	N/A	N/A	.3	N/A	12761
AH-21-78	Sec.3, T 1S, R 38W	2.3	11.3										
	As Received			14.7	23.7	47.8	13.8	N/A	N/A	N/A	.2	N/A	9303
	Moisture Free			N/A	27.8	56.0	16.2	N/A	N/A	N/A	.3	N/A	10904
	Ash Free			N/A	33.2	66.8	N/A	N/A	N/A	N/A	.3	N/A	13012
AH-22-78	Sec.9, T 1S, R 38W	2.1	10.5										
	As Received			15.0	28.2	47.9	8.9	N/A	N/A	N/A	.1	N/A	9604
	Moisture Free			N/A	33.1	56.5	10.4	N/A	N/A	N/A	.2	N/A	11293
	Ash Free			N/A	37.0	63.0	N/A	N/A	N/A	N/A	.2	N/A	12607
AH-23-78	Sec.4, T 1S, R 38W	2.8	13.1										
	As Received			16.8	26.3	49.8	7.1	N/A	N/A	N/A	.3	N/A	9926
	Moisture Free			N/A	31.6	59.8	8.6	N/A	N/A	N/A	.4	N/A	11924
	Ash Free			N/A	34.6	65.4	N/A	N/A	N/A	N/A	.4	N/A	13041
AH-25-78	Sec.32, T 1N, R 37W	2.2	9.0										
	As Received			13.2	29.1	53.1	4.6	5.2	62.5	1.4	.3	26.0	10493
	Moisture Free			N/A	33.5	61.2	5.3	4.3	72.0	1.6	.3	16.5	12085
	Ash Free			N/A	35.4	64.6	N/A	4.6	76.0	1.6	.3	17.4	12766
AH-34-78	Sec.22, T 1S, R 36W	2.3	7.2										
	As Received			10.5	28.8	51.9	8.8	N/A	N/A	N/A	.2	N/A	10554
	Moisture Free			N/A	32.2	58.0	9.8	N/A	N/A	N/A	.2	N/A	11793
	Ash Free			N/A	35.7	64.3	N/A	N/A	N/A	N/A	.3	N/A	13075
AH-37-78(LOWER)	Sec.24, T 1S, R 36W	3.4	7.6										
	As Received			11.1	30.6	52.2	6.1	N/A	N/A	N/A	.2	N/A	10731
	Moisture Free			N/A	34.4	58.8	6.8	N/A	N/A	N/A	.2	N/A	12068
	Ash Free			N/A	36.9	63.1	N/A	N/A	N/A	N/A	.2	N/A	12953
AH-37-78(UPPER)	Sec.24, T 1S, R 36W	3.4	9.3										
	As Received			12.9	29.2	50.6	7.3	N/A	N/A	N/A	.2	N/A	10320
	Moisture Free			N/A	33.5	58.1	8.4	N/A	N/A	N/A	.3	N/A	11846
	Ash Free			N/A	36.6	63.4	N/A	N/A	N/A	N/A	.3	N/A	12934
AH-43-78	Sec.24, T 1S, R 36W	3.9	10.5										
	As Received			14.2	28.9	51.3	5.6	N/A	N/A	N/A	.1	N/A	10243
	Moisture Free			N/A	33.7	59.7	6.6	N/A	N/A	N/A	.1	N/A	11935
	Ash Free			N/A	36.1	63.9	N/A	N/A	N/A	N/A	.2	N/A	12774
AH-48-78	Sec.17, T 1S, R 35W	2.2	7.4										
	As Received			10.5	27.0	53.0	9.5	N/A	N/A	N/A	.3	N/A	10647
	Moisture Free			N/A	30.2	59.2	10.6	N/A	N/A	N/A	.4	N/A	11895
	Ash Free			N/A	33.7	66.3	N/A	N/A	N/A	N/A	.4	N/A	13304
AH-56-78	Sec.2, T 1S, R 36W	4.0	11.3										
	As Received			15.5	29.2	51.5	3.8	N/A	N/A	N/A	.2	N/A	10244
	Moisture Free			N/A	34.6	60.9	4.5	N/A	N/A	N/A	.2	N/A	12123
	Ash Free			N/A	36.2	63.8	N/A	N/A	N/A	N/A	.2	N/A	12694
AH-60-78	Sec.10, T 1N, R 36W	1.7	15.1										
	As Received			19.6	28.6	47.8	4.0	N/A	N/A	N/A	.3	N/A	9396
	Moisture Free			N/A	35.6	59.5	4.9	N/A	N/A	N/A	.4	N/A	11684
	Ash Free			N/A	37.4	62.6	N/A	N/A	N/A	N/A	.4	N/A	12289
AH-61-78(LOWER)	Sec.16, T 1N, R 36W	2.0	8.2										
	As Received			11.8	30.4	55.5	2.3	N/A	N/A	N/A	.3	N/A	11090
	Moisture Free			N/A	34.5	62.9	2.6	N/A	N/A	N/A	.4	N/A	12574
	Ash Free			N/A	35.4	64.6	N/A	N/A	N/A	N/A	.4	N/A	12910
AH-61-78(UPPER)	Sec.16, T 1N, R 36W	2.0	11.8										
	As Received			15.7	29.4	50.3	4.6	N/A	N/A	N/A	.3	N/A	10195
	Moisture Free			N/A	34.8	59.8	5.4	N/A	N/A	N/A	.4	N/A	12091
	Ash Free			N/A	36.8	63.2	N/A	N/A	N/A	N/A	.4	N/A	12782
AH-63-78(UPPER)	Sec.17, T 1N, R 36W	1.3	12.1										
	As Received			16.1	28.5	45.6	9.8	N/A	N/A	N/A	.2	N/A	9269
	Moisture Free			N/A	34.0	54.4	11.6	N/A	N/A	N/A	.3	N/A	11061
	Ash Free			N/A	38.4	61.6	N/A	N/A	N/A	N/A	.3	N/A	12507