ZINC-LEAD OCCURRENCES IN AND NEAR THE NATIONAL PETROLEUM RESERVE IN ALASKA

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UNIT OF MEASURE ABBREVIATIONS USED IN THIS REPORT

ppm	parts per million
ft.	foot/feet
mi2	square mile/miles.

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By Uldis Jansons1/

ABSTRACT

The Bureau of Mines (BOM) and the U.S. Geological Survey (USGS) in 1977 and 1978 appraised the mineral resources in the southern part of the National Petroleum Reserve in Alaska (NPR-A) as one part of the studies mandated by section 105(c) of the Naval Petroleum Reserves Production Act of 1976 (PL 94-258). The USGS did field mapping and regional geochemical sampling. The BOM investigated indications of economic minerals and discovered four zones of significant zinc-lead mineralization related to two stratigraphic horizons of different geology and geologic age. The mineral exposures are insufficient to permit the detailed sampling necessary to make reserve estimates, but the resource potential seems large enough to warrant further investigation.

The first horizon contains mineralization in the Drenchwater Creek area where an extensive geochemical anomaly coincides with Mississippian age Lisburne Group black shale, chert, and volcanic rocks. A high grade (23%) zinc deposit occurs in a 2-ft. thick siliceous mudstone. Overlying gray chert contains zinc (to 11%) and lead (to 5.1%) in fractures. Overlying the gray chert, a massive high-grade (to 26% zinc and 5.9% lead) sulfide deposit occurs at the top of a thin, acid tuffaceous sequence.

The second mineralized horizon includes high grade and zinc-lead mineralization at Kivliktort Mountain, Story Creek, and Whoopee Creeks. These zones of mineralization occur along a reasonably well-defined

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60-mile trend of lead and zinc geochemical anomalies and appear to be related to the contact zone between clastic rocks of the Mississippian Kayak Shale and the Lower Mississippian-Upper Devonian Kanayut Conglomerate. High-grade materials from along this trend assay up to 49% zinc and 44% lead. In addition to distinct high-grade zones of mineralization, some minor sulfide mineralization and geochemically anomalous samples occur in other areas widely scattered along this geochemical trend.

INTRODUCTION

In 1977 and 1978 a joint program by the Bureau of Mines (BOM) and the U.S. Geological Survey (USGS) initiated a mineral resource appraisal in the southern part of the National Petroleum Reserve in Alaska (NPR-A). This was one of the several resource studies mandated by section 105(c) of the Naval Petroleum Reserves Production Act of 1976 (PL 94-258) which transferred the management of this land from the Department of Defense (Navy) to the Department of the Interior. Field work of the two agencies was assigned along 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 the BOM. This report summarizes the results of work done by the BOM on the best zones of zinc-lead mineralization found in 1977 and 1978. The mineralized zones and other sample sites along regional geochemical anomalies possibly related to mineralization have been described in BOM Open-File reports (2, 4)[2/] and in a Bureau of Land Management Task Force 105(c) report on the resource potential of the NPR-A (3). This report presents the original results as well as more recent chemical and mineralogic analyses of the samples from the four major zones of mineralization.

2/ Underlined numbers in parentheses refer to references in back of report.

ACKNOWLEDGEMENTS

Co-workers of the USGS provided profitable discussions and agreeable working relationships throughout the study. Special acknowledgements go to I. L. Tailleur and his co-workers for their observations on the regional and local geology, based on many years of investigations in the NPR-A and adjacent areas. Their observations were used to set the geology at some mineralized sites discussed in this report. Paul Theobald and his co-workers provided not only sampling and analysis of geological materials, but also observations and interpretations of the analytical results. Mike Churkin and Warren Nokleberg provided their observations and interpretations on geologic settings in areas of mineralization.

LOCATION AND ACCESS

The study area covers the southern NPR-A and immediately adjacent lands along the crest and north slope of the Brooks Range, Alaska. It is covered by the Misheguk Mountain and Howard Pass Quadrangles (1:250,000) of the National Topographic Map Series. The boundaries of the study area are shown on figure 1. More detail on specific study areas is shown on figures accompanying corresponding sections in the text.

Access to and within the study area is limited to historic trails, water routes, or to aircraft; roads do not exist. Summer field work during this investigation was supported by fixed and rotary wing aircraft working out of the gravel strip along Driftwood River in the southwestern part of the NPR-A (figure 2).

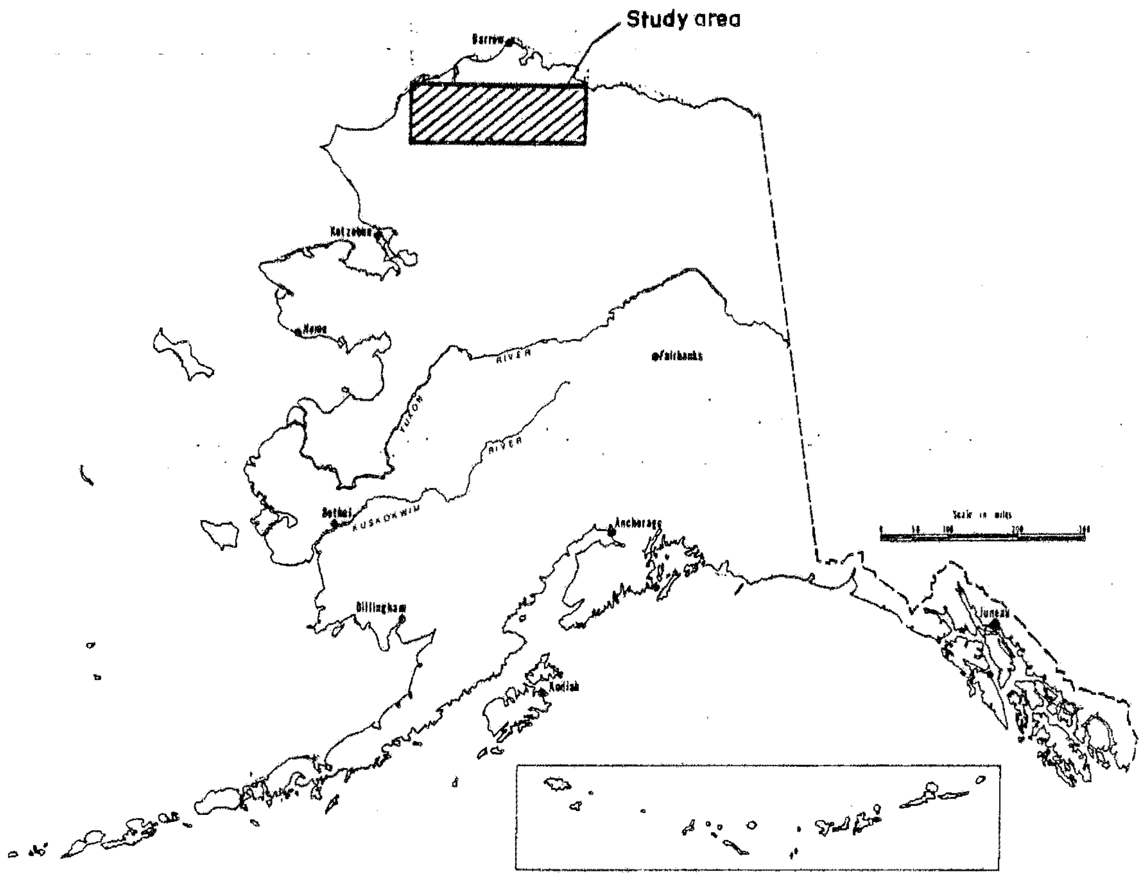


Figure 1. - Location of the study area in Alaska

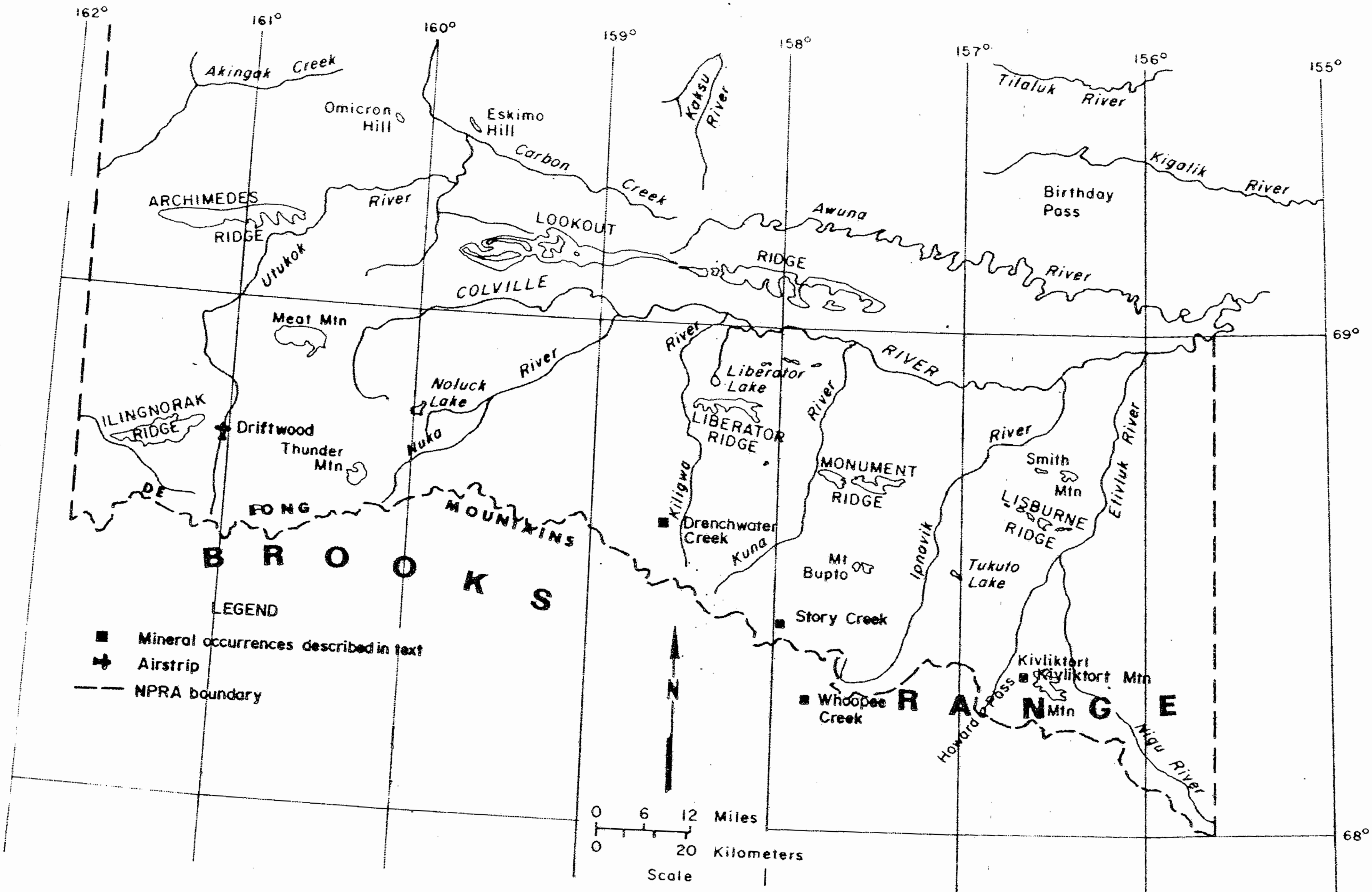


Figure 2. - Location of zinc-lead occurrences, southern NPR-A, Alaska

LAND MANAGEMENT AND STATUS

The Naval Reserve Production Act of 1976 (Public Law 94-258) transferred management responsibilities of the reserve from the Department of Defense (U.S. Navy) to the Department of the Interior. That law required that the Secretary of the Department of the Interior study the resources within the NPR-A and devise plans for the "best use" of these lands. Resource studies on which the land use selections would be made were completed in 1979. A comprehensive land-use plan has not yet (1982) been adopted. The lands within the NPR-A are withdrawn from mineral entry.

The lands south of and immediately adjacent to the NPR-A were withdrawn from mineral entry with the creation of the Noatak National Preserve by the passage, in 1980, of the Alaska National Interest Lands Conservation Act (Public Law 96-487).

PHYSICAL SETTING

The study area is within the Arctic Foothills and the Arctic Mountains physiographic provinces (11). 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 ft. 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 north 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 barren. Trees are not present, but patches of stunted willows grow along some creeks and rivers.

Elevations in the Arctic Mountains province rise to about 5,000 feet. The headwaters of the largest 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 nonmarine 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 (6). Rocks of the southern terrane include shale, siltstone, sandstone, radiolarian chert, sub-marine volcanics, and limestone. Base metal sulfide deposits occur within the southern terrane. Geologic details of the area are now being studied and some data have been published by the USGS. A one-inch-to-the-mile scale geologic map of part of the study area was open-filed by Tailleur (9); the regional structure has been synthesized by Tailleur and Brosge (8) and Martin (5); a geologic compilation has been prepared by Mayfield (6) as part of the NPR-A studies.

WORK BY THE GEOLOGICAL SURVEY

The U.S. Geological Survey conducted geological mapping, a regional geochemical study, and ground follow-up. Regional mapping was aimed at determining the geological setting of the study area; detailed mapping focused on zones of mineralization and mineral potential. The regional geochemical survey was conducted in 1977. The analytical results and preliminary interpretation (1, 10) were available for selecting anomalous areas to investigate during the 1978 field season.

Three types of materials were sampled at each site during the geochemical survey. These are: (1) minus 30-mesh stream sediment, (2) pan-concentrate of the nonmagnetic heavy minerals in the stream sediment, and (3) stream bank materials. Semi-quantitative emission spectrographic techniques were used to determine the concentration of 31 elements in both the stream sediment samples and their heavy-mineral concentrates.

An evaluation of the analytical results suggests that five distinct geochemical and geologic associations occur within the study area (1). 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; (4) arsenic, lead, and silver related to an unknown bedrock source; and (5) a broad distribution of chromium derived principally from ultramafic rocks south of the NPR-A. Regional zinc and lead geochemical anomalies identified by this work are shown on figures 3 and 4.

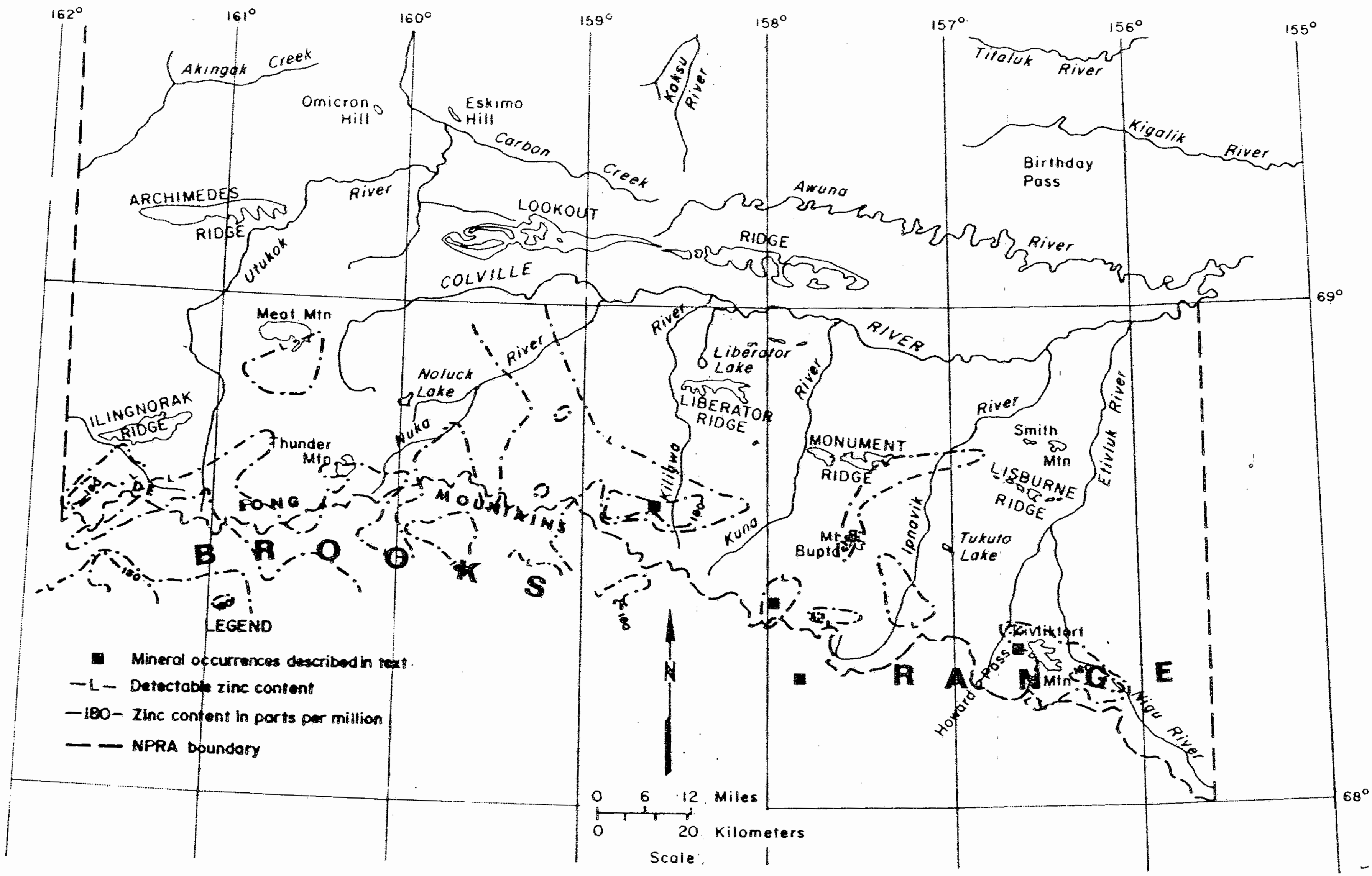


Figure 3. - Areas of anomalously high zinc concentrations in stream sediments, southern NPR-A, Alaska

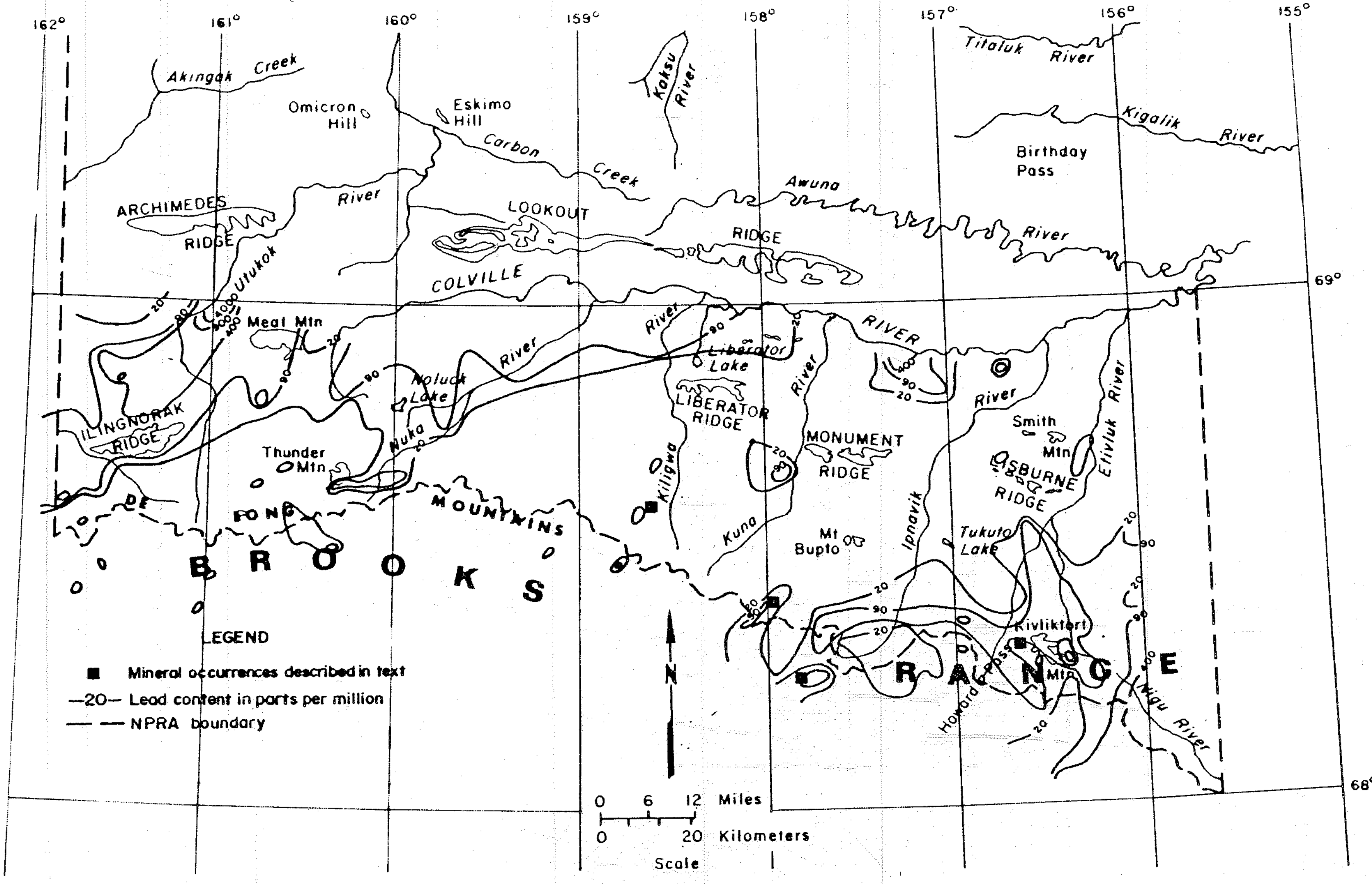


Figure 4. - Areas of anomalously high lead concentrations in non-magnetic fraction of heavy-mineral concentrates, southern NPR-A, Alaska

WORK BY THE BUREAU OF MINES

In 1977, 18 areas were cursorily investigated in 12 days by three BOM professionals. The original plan was to investigate known and reported zones of potential mineralization (that is, areas of limonite staining, previously reported mineralization, and then follow-up anomalous results of the 1977 USGS geochemical study.) This plan was partly modified because the geochemical data were not available until after the close of the 1977 field season. These data provided the basis for selecting areas for BOM field investigations during the 1978 season.

More than 80 drainages worthy of investigation were identified from the 1977 geochemical data but time constraints precluded the investigation of all anomalous areas and data screening was required. Highest priority was assigned to areas from which both the stream sediment and non-magnetic fraction of the heavy mineral concentrate contained anomalous 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. In addition to using geochemical data, drainage basins were selected for examination on basis of the geologic terrane. Areas underlain by Triassic and Paleozoic bedrock were given higher priority than areas underlain by Cretaceous and younger rocks.

Using these geological and geochemical factors, BOM personnel selected 21 areas for investigation in 1978. The follow-up consisted of traverses along drainages to search for mineralized rock that might account for the geochemical anomalies. Stream sediment samples were collected from tributaries of the geochemically anomalous drainages to determine if they would further point to zones of mineralization.

The BOM samples were analyzed at Skyline Labs Inc., Anchorage, Alaska, using standard techniques. Atomic absorption spectrophotometric methods were used to determine the content of elements in all stream sediment, soil, and selected rock samples. Semi-quantitative optical emission spectrographic techniques were used to determine the concentrations of 31 elements in rock samples.

DESCRIPTION OF THE DEPOSITS

The four zones of significant base metal mineralization discussed in this report are: (1) Drenchwater Creek (2) Kivliktort Mountain (3) Story Creek and (4) Whoopee Creek. Minor amounts of lead and zinc mineralization were found elsewhere.

DRENCHWATER CREEK AREA

The iron-oxide stained slopes and creek bed of Drenchwater Creek prompted the USGS in 1975 to obtain and analyze several surface samples. Several of these were found to contain high concentrations of barium and one contained 3,000 ppm lead. Follow-up field work in 1977 by USGS and BOM led to the discovery of a 2-ft. thick siliceous bed containing disseminated spherical grains of sphalerite. Later in 1977, the BOM identified zones of high-grade zinc-lead sulfide mineralization in the area just east of Drenchwater Creek.

Location and Physical Setting

The mineralization occurs along an east-west geologic trend located between Drenchwater and Wager Creeks. It is centered near latitude 68° 34' 75" N. and longitude 148° 42' 06" W. and in T. 10 S., R. 29 W., Umiat base and meridian.

The area is characterized by gently sloping, rolling foothills that are cut by shallowly incised drainages. Elevations in the area range from 2,000 to 2,600 ft.

Geologic Setting

The distribution of volcanic rocks and the related zones of sulfide mineralization in the Drenchwater Creek area are shown on figure 5. Sketch geologic maps, cross-sections, and sample site locations are shown on figures 6 through 9. The base metal sulfide mineralization occurs in gray to black shales, gray to black cherts, and intermediate to acid volcanic rocks of the Mississippian age Lisburne Group in the Kagvik thrust sequence (6-7). The thrust plate has been deformed and dismembered by further local thrusting in the area of the mineralization.

The Triassic Shublik and Permian Siksikpuk Formation cherts and black shales crop out in the southwest part of the mapped area. The 2-foot thick siliceous bed containing disseminated spherical grains of sphalerite is intercalated in carbonaceous shale which appears to underlie the pyritiferous tuffs and cherts that crop out along Drenchwater Creek and to the south. Along Drenchwater Creek, the overlying tuff unit contains variable amounts of pyrite. A several-foot thick pyrite zone with no base metal sulfides occurs at the top of the unit. The tuffaceous unit is overlain by an unmineralized siliceous mudstone. Gossans and zones of massive base metal sulfide mineralization crop out east of Drenchwater Creek. Galena-bearing boxworks in gossan (site 77PRUJ 65) were discovered and sampled approximately 4,000 ft. to the east of the main sulfide outcrop (site 77PRUJ 59). Several other zones of pyrite and gossan-bearing float occur more or less continuously along this horizon between Drenchwater Creek and False Wager Creek.

Mineralized dark-gray cherts which overlie black shales and mudstones and form the base of the tuffaceous section crop out along Drenchwater Creek. Mineralization in these rocks includes epigenetic pyrite, sphalerite, and galena as fracture fillings.

Sampling and Analysis

Three types of sulfide mineralization sampled and analyzed at Drenchwater Creek were mineralized sediments, massive sulfide in tuffs, and mineralized chert. Chip channel samples of the shale and siliceous mudstone units along Drenchwater Creek near the mineralized zone (see figures 7, 8, 9) contain high concentrations of lead (to 1,150 ppm) but low zinc (to 95 ppm, see tables 1 and 2). The sample of the 2-ft. thick sphalerite-bearing bed (sample 77PRUJ 30) contains 1,150 ppm Cu, 105 ppm Pb, and 230,000 ppm Zn.

Samples of rocks enclosing this mineralized "bed" show no other high zinc values but contain geochemically anomalous values of lead. Samples 77PRUJ 43 through 77PRUJ 57 (figure 9) represent a discontinuous stratigraphic section, from bottom to top, through the mineralized unit. The sampled outcrop length is about 400 ft. and the true thickness of the section is about 150 ft. The zinc content of these samples ranges from 5 to 95 ppm. Samples from the lower part of this section (samples 77PRUJ 43-50) contain from 5 to 40 ppm zinc; those stratigraphically higher (77PRUJ 51-57) contain from 20 to 95 ppm. The lead content of the samples increases vertically in the section. Lead values in the stratigraphically higher samples (77PRUJ 51-57) range from 195 ppm to 1150 ppm; the stratigraphically lower samples (77PRUJ 43-50) contain from 50 ppm to 960 ppm.

The massive base metal sulfide mineralization located at the top of the tuffaceous volcanic sequence consists of sphalerite, minor galena, lesser pyrite, and traces of fluorides (site 77PRUJ 59, figures 5 and 6). Base and precious metal, sulfur, barium, and fluorine content of seven massive sulfide samples is shown on table 3. The base metal content ranges from 7.1% to 26% zinc, 0.58% to 5.9% lead, and up to 0.018% copper. Silver values range from 24 ppm to 200 ppm; gold values are less than the 0.02 ppm detection limit of the analytical procedure used. Cadmium values range from 50 ppm to 1000 ppm. The low iron values (up to 3.3%) corroborate the virtual absence of pyrite in outcrop; the low barium values (up to 0.23%) suggest minor barite content in the massive sulfide samples. The small and variable fluorine content verifies the identification of fluorite. The amount of metal oxides was determined as an indication of the oxidation of these surface samples.

The mineralized cherts at the base of the tuffaceous rocks and at the top of the carbonaceous sequence contain variable amounts of pyrite, sphalerite, and galena as fracture filling material. A grab sample of this mineralized chert (Sample 77PRUJ 61) contained 11.0% zinc and 5.1% lead (table 1, and figures 5, 7).

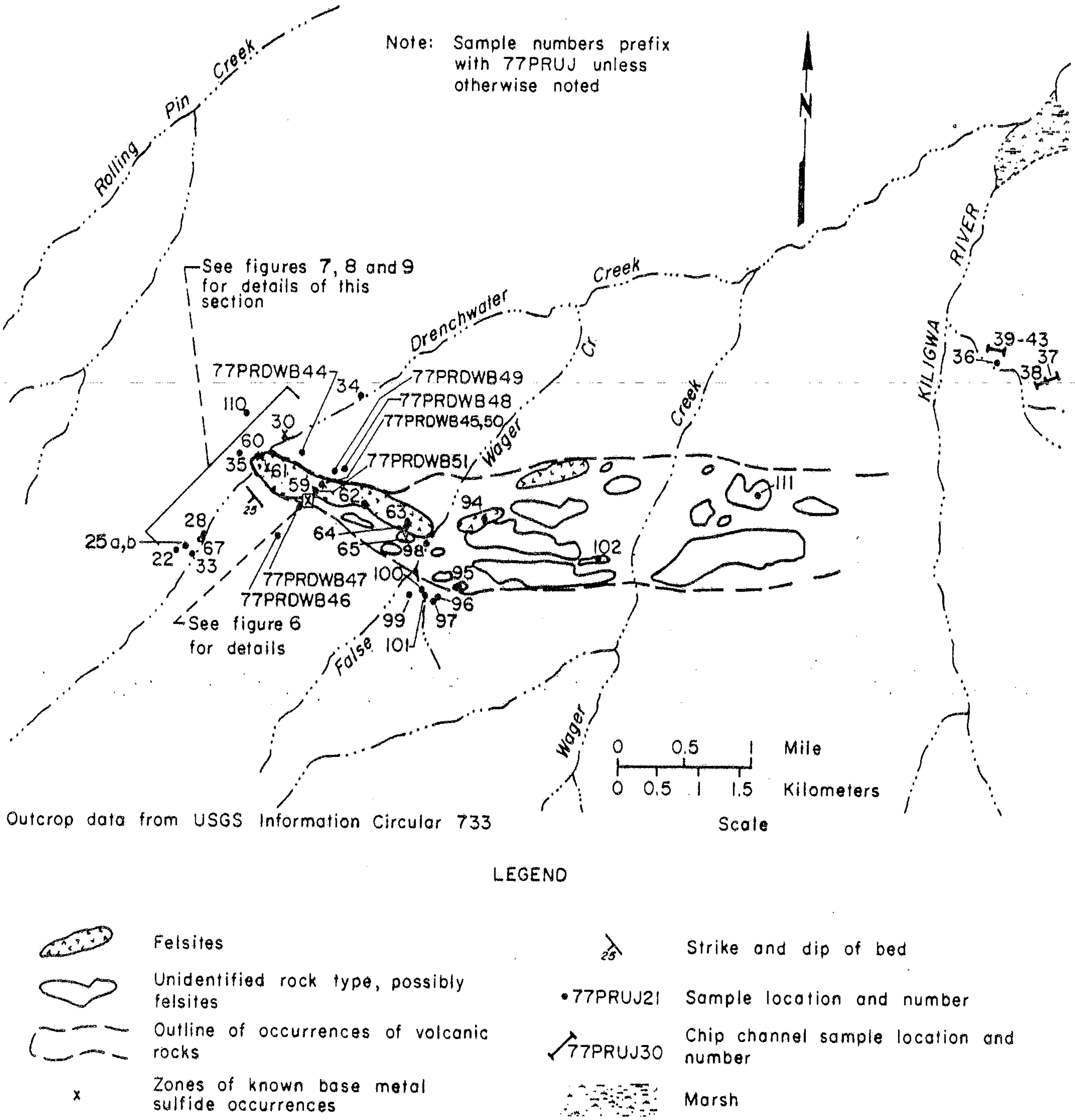
Description of the Deposits

The Drenchwater Creek area contains at least three zones of base metal sulfide mineral and rock associations of limited extent spatially related to an acid volcanic sequence. The lowest mineralized unit is a

2-ft. thick sphalerite-bearing siliceous mudstone in carbonaceous shale which contains minor to geochemically highly anomalous lead. A specimen of the mineralized bed contained 23% zinc; the black shale host rock contained up to 1,150 ppm lead but no anomalous concentrations of zinc.

The second zone consists mainly of massive silver-bearing zinc and lead sulfide mineralization which appears to be at or near the top of a several hundred-foot thick, south-dipping, tuffaceous acid volcanic sequence. This mineralization is several hundred feet higher stratigraphically than the mineralized black shales. The scattered mineral-bearing outcrops can be traced east-west along strike between Drenchwater and Wager Creeks. It is at least 6,500 ft. long and may possibly extend more than 10,000 ft. The highest grade assay of the massive sulfides samples is 5.9% Pb and 26% Zn in a grab sample.

The third mineralized zone is a dark gray chert bed at Drenchwater Creek, at the base of the tuffaceous horizon but above the black shales. It locally contains up to 5.1% Pb and 11.0% Zn (Samples 77PRUJ 60, 61). This mineralization to date has been found only along Drenchwater Creek where the chert is cut by the creek.



Assay data given in tables 1 and 2

Figure 5. - Relation of mineralized zones to felsic rocks, and selected sample locations, Drenchwater Creek area, Howard Pass Quadrangle, Alaska

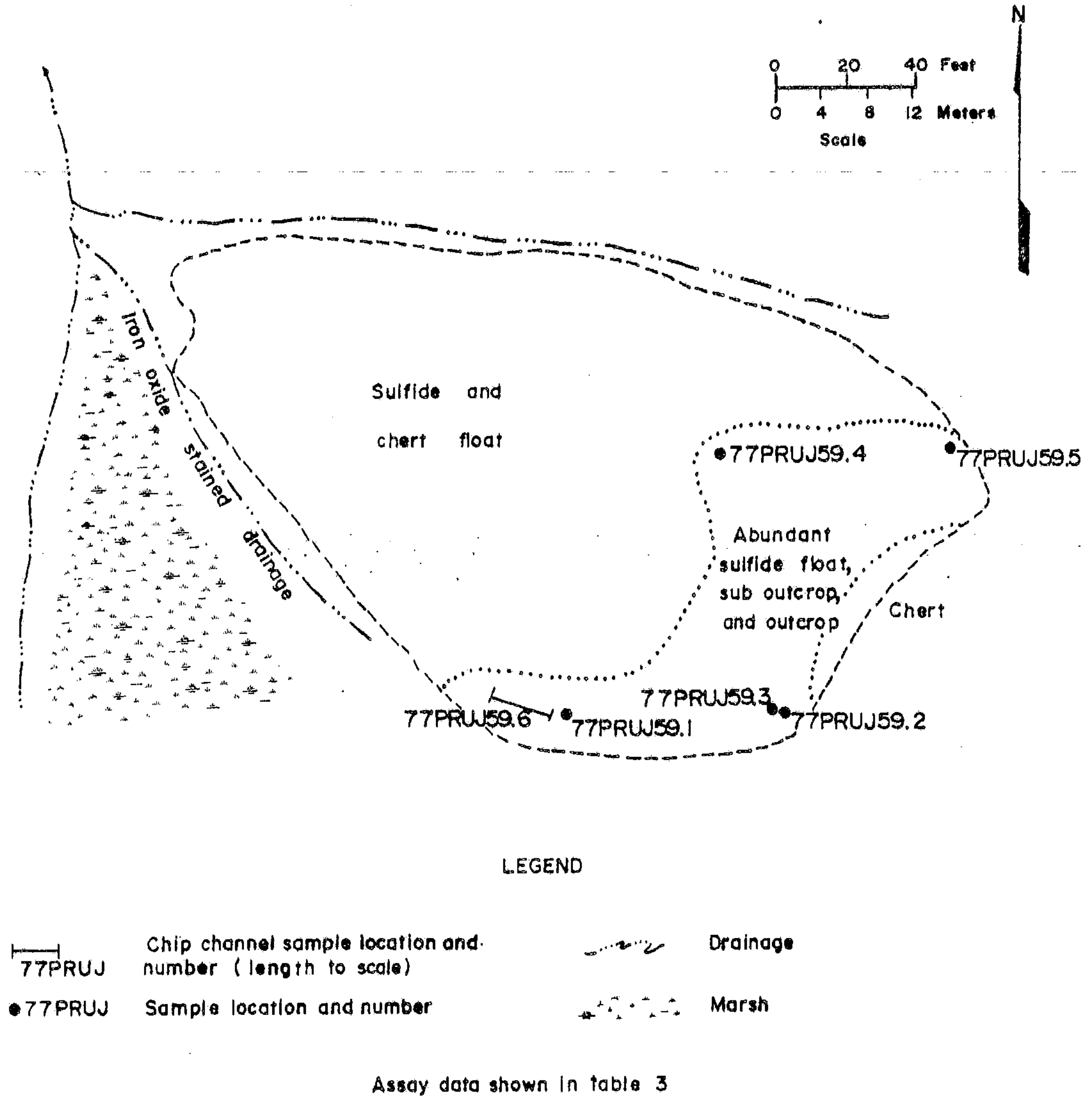


Figure 6. - Location map of massive sulfide samples, Drenchwater Creek area, Howard Pass Quadrangle, Alaska

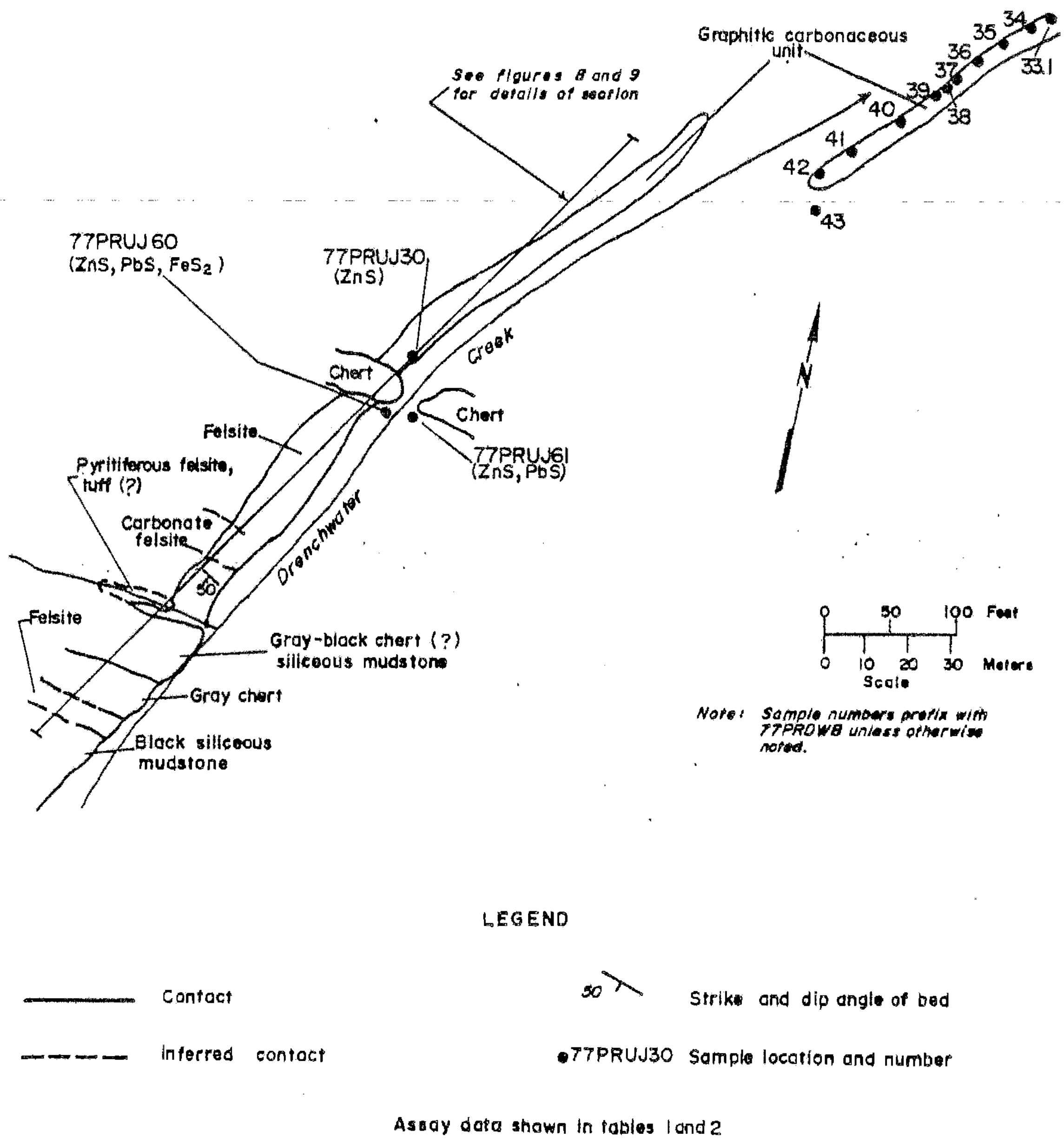


Figure 7. - Generalized geology, mineral occurrences and sample site locations, Drenchwater Creek, Howard Pass Quadrangle, Alaska

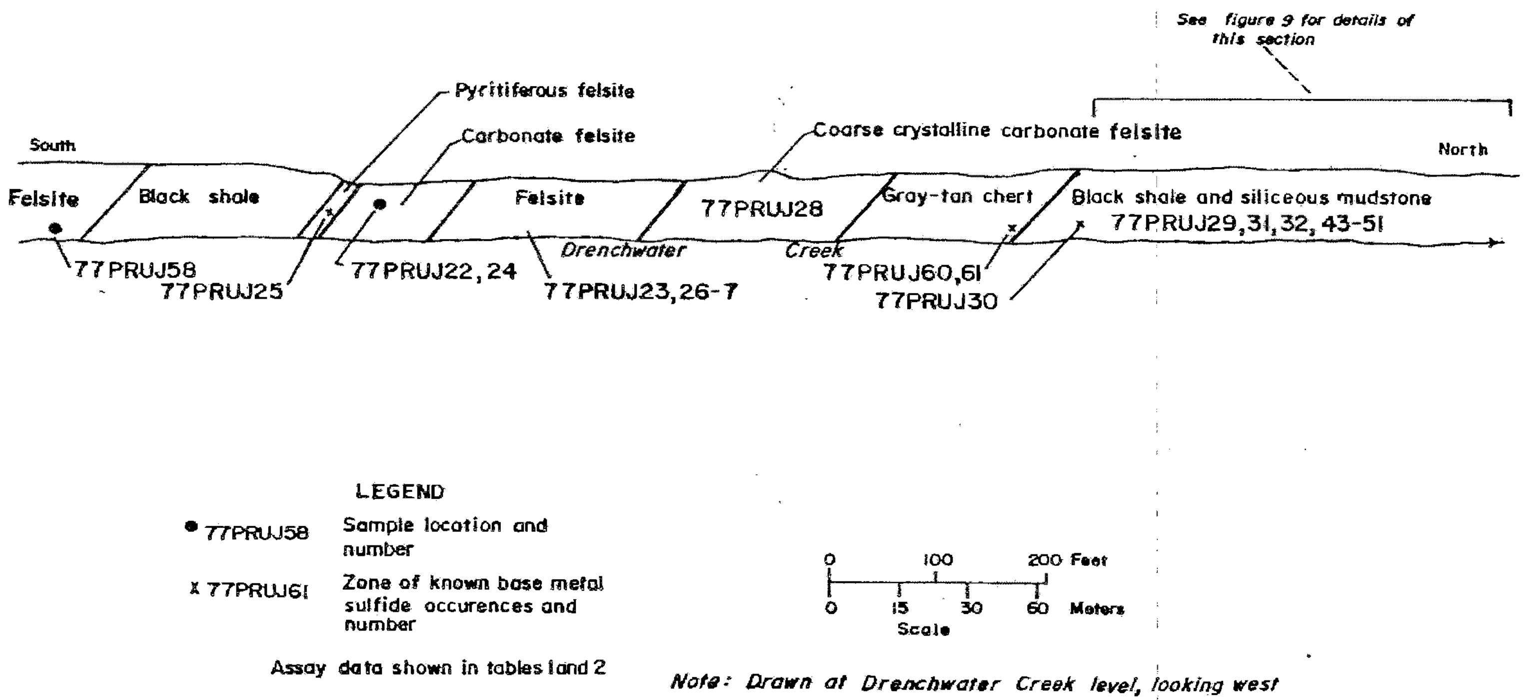


Figure 8. - Schematic geologic section and samples of rock units, Drenchwater Creek, Howard Pass Quadrangle, Alaska

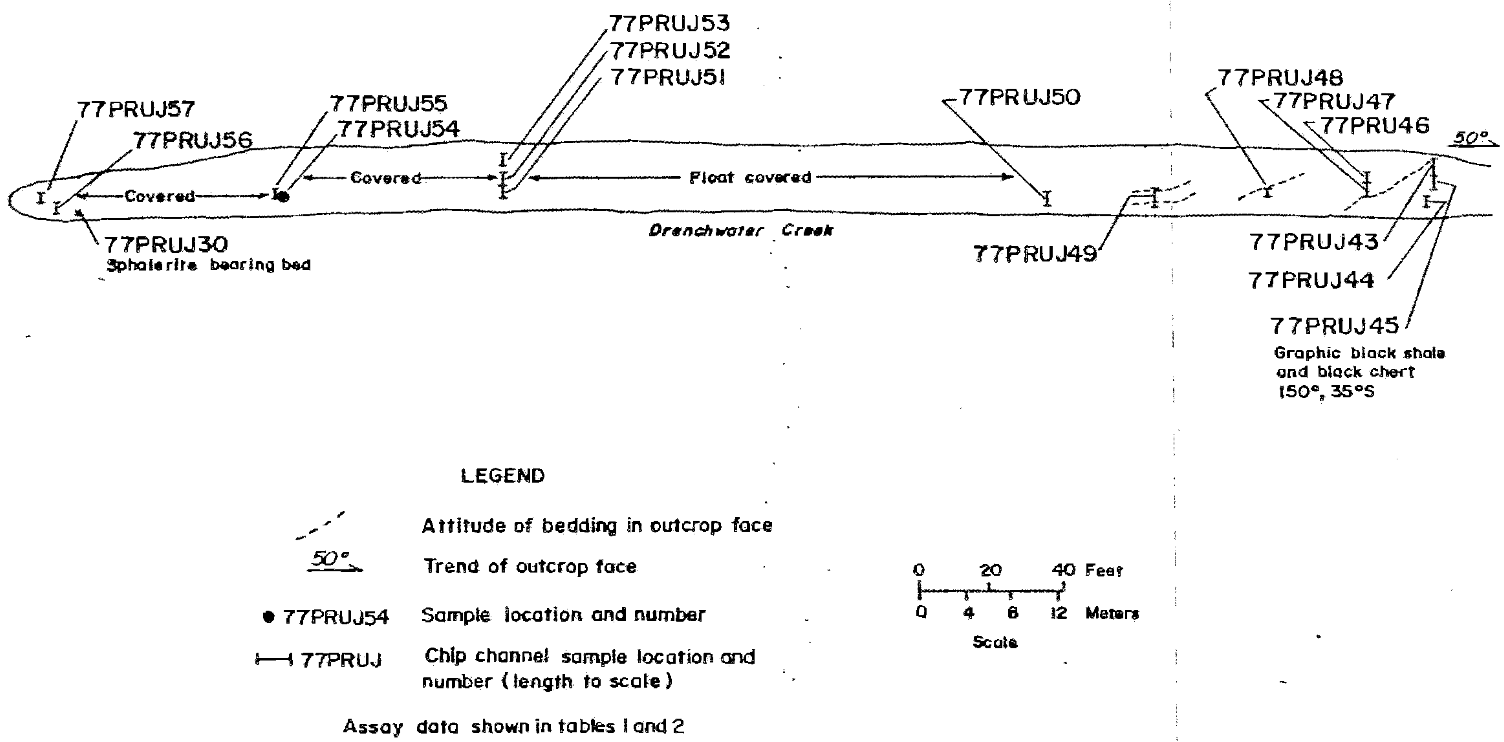


Figure 9. - Schematic geologic section of black shale outcrop and sample sites, Drenchwater Creek area, Howard Pass Quadrangle, Alaska

TABLE 1. - Analytical results of Drenchwater Creek area samples

Sample number	Elements analyzed Cu (ppm)	Pb (ppm)	Zn (ppm)	Sample description
77PRUJ 22	55	25	60	Pyritiferous gray carbonate tuff (?)
23	20	65	<5	Rhyolite tuff
24	80	95	35	Gray brecciated carbonate
25a	70	100	5	Pyrite (30%) in tuff (?)
25b	30	150	20	Gray clastic volcanic with shards
26	5	155	<5	Pyritiferous chert
27	15	15	75	Pyritiferous chert
28	5	20	75	Carbonate tuff
29	5	220	25	Gray siliceous mudstone
30	1,150	105	230,000	Sulfides in black siliceous mudstone
31	5	520	80	Gray graphitic shale -mudstone
32	5	150	25	Black carbonaceous mudstone
33	140	720	150	Stream silt
34	85	25	320	Pan concentrate; pyritiferous black shale
35	5	125	5	Banded pyritiferous chert
36	105	5	75	Gray-black siliceous mudstone
37	100	5	45	Gray chert

TABLE 1. - Analytical results of Drenchwater Creek area samples - Continued

Sample number	Elements analyzed Cu (ppm)	Pb (ppm)	Zn (ppm)	Sample description
77PRUJ 38	65	5	45	Light gray mudstone
39	45	5	60	Gray-black pyritiferous chert
40	55	5	40	Gray chert, some brecciated
41	55	5	45	Dark gray-black chert
42	65	5	65	Gray chert
43	5	125	5	Carbonaceous mudstone-shale
44	5	50	5	Carbonaceous mudstone-shale
45	5	120	10	Carbonaceous mudstone-shale
46	5	125	5	Carbonaceous mudstone-shale
47	5	75	15	Siliceous carbonaceous mudstone-shale
48	5	110	30	Siliceous carbonaceous mudstone-shale
49	5	275	35	Carbonaceous mudstone-shale
50	5	960	40	Carbonaceous mudstone-shale
51	15	1,150	55	Gray siliceous mudstone
52	5	435	40	Gray siliceous mudstone
53	10	550	20	Black carbonaceous shale
54	5	340	60	Black siliceous mudstone

TABLE 1. - Analytical results of Drenchwater Creek area samples - Continued

Sample number		Elements analyzed Cu (ppm)	Pb (ppm)	Zn (ppm)	Sample description
77PRUJ	55	10	360	95	Black siliceous mudstone
	56	10	195	50	Black siliceous mudstone
	57	15	585	45	Black siliceous mudstone
	58	50	10	135	Volcanic rock
	60	65	1,500	47,000	Main sulfide zone
	61	80	51,000	110,000	Sulfides in chert
	62	5	70	250	Volcanic rock
	63	5	60	80	Volcanic flow breccia (?)
	64	20	10	135	Volcanic rock
	65	45	1,500	4,100	Boxworks zone
	67	20	10	145	Stream silt
	94	<5	55	10	Volcanic agglomerate with chert fragments
	95	25	40	160	"Soil"
	97	20	50	120	Volcanic rock
	98	60	195	130	Stream silt
	99	90	25	285	Porphyry
	100	15	55	40	Pyritiferous volcanic
	101	135	20	950	Stream silt
	102	5	20	40	Pyritiferous volcanic grit with chert fragment
	110	40	40	50	Limonite stained
	111	30	65	90	Volcaniclastic rock
77PRDWB	33.1	50	20	105	Black mudstone
	34	25	10	625	Black shale

TABLE 1. - Analytical results of Drenchwater Creek area samples - Continued

Sample number	Elements analyzed Cu (ppm)	Pb (ppm)	Zn (ppm)	Sample description
77PRDWB 35	55	5	120	Black shale
36	5	35	75	Black mudstone
37	5	40	75	Black mudstone
38	55	50	715	Pyritiferous limestone concentrations in black shale
39	5	80	10	Black shale
40	5	420	50	Black shale
41	<5	5	<5	Black siliceous mudstone
42	5	280	5	Fissile black shale
43	<5	125	<5	Fissile black shale
44	105	135	250	Stream silt
45	55	355	185	Stream silt
46	30	5	75	Stream silt
47	55	35	70	Stream silt
48	45	180	670	Stream silt
49	10	270	1,000	Stream silt
50	15	565	75	Stream silt
51	40	1,300	180	Stream silt

TABLE 2. - Emission spectrographic analyses of Drenchwater Creek area samples
[Values in parts per million unless otherwise noted]

Element	Sample numbers									
	77PRUJ 25	77PRUJ 29	77PRUJ 31	77PRUJ 35	77PRUJ 43	77PRUJ 49	77PRUJ 50	77PRUJ 51	77PRUJ 53	77PRUJ 55
Fe	5%	0.5%	0.3%	1%	0.3%	0.2%	0.3%	0.3%		
Ca	0.1%	.02%	.5%	0.02%	.02%	.03%	.02%	.05%		
Mg	.03%	.03%	.03%	.02%	.05%	.03%	.05%	.03%	0.07%	0.05%
Ag	<1	1.5	2	1	2	1	3	2	5	2
As	<500	<500	<500	<500	<500	<500	<500	<500	<500	<500
B	10	10	10	10	10	<10	10	<10	20	10
Ba	100	200	30	20	200	20	30	30	200	500
Be	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2
Bi	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10
Cd	<50	<50	<50	<50	<50	<50	<50	<50	<50	<50
Co	5	<5	<5	<5	<5	<5	<5	<5	<5	<5
Cr	200	150	100	30	150	150	200	100	150	150
Cu	30	200	10	7	20	5	3	15	20	10
Ga	10	<10	<10	10	<10	<10	<10	<10	<10	<10
Ge	<20	<20	<20	<20	<20	<20	20	<20	<20	<20
La	100	20	20	100	50	20	30	30	50	20
Mn	150	10	<10	10	10	15	<10	<10	<10	<10
Mo	2	7	3	<2	10	2	2	2	10	2
Nb	50	<20	<20	70	<20	<20	<20	<20	<20	<20
Ni	20	15	20	<5	30	15	50	5	20	20
Pb	100	100	150	100	70	70	200	200	300	150
Sb	<100	<100	100	<100	<100	<100	<100	<100	<100	<100
Sc	20	<10	<10	<10	<10	<10	<10	<10	<10	<10
Sn	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10
Sr	50	<50	<50	<50	<50	<50	<50	<50	<50	<50
Ti	3,000	300	200	300	500	100	300	150	500	200
V	200	50	100	20	150	70	100	50	100	100
W	<50	<50	<50	<50	<50	<50	<50	<50	<50	<50
Y	15	<10	<10	10	<10	<10	<10	<10	<10	<10
Zn	<200	<200	<200	<200	<200	<200	<200	<200	<200	<200
Zr	50	20	20	100	30	20	30	20	50	20

TABLE 2. - Emission spectrographic analyses of Drenchwater Creek area samples - Continued

Element	Sample numbers							
	77PRUJ 57	77PRUJ 61	77PRUJ 62	77PRUJ 63	77PRUJ 65	77PRUJ 96	77PRUJ 101	77PRUJ 102
Fe	0.5%	1.5%	3%	0.2%	2%	3%	2%	0.7%
Ca	.02%	0.02%	0.2%	5%	0.05%	1.5%	0.15%	3%
Mg	.03%	.02%	.15%	.03%	.03%	1%	.2%	.03%
Ag	3	20	<1	<1	10	<1	1	<1
As	<500	<500	<500	<500	<500	<500	<500	<500
B	10	10	10	10	15	<10	50	10
Ba	50	100	1,000	15	200	1,000	>10,000	10
Be	<2	<2	<2	<2	<2	<2	<2	<2
Bi	<10	<10	<10	<10	<10	<10	<10	<10
Cd	<50	200	<50	<50	<50	<50	<50	<50
Co	<5	20	5	<5	<5	5	50	<5
Cr	200	20	<10	<10	10	50	100	50
Cu	30	150	7	20	50	15	100	10
Ga	<10	<10	10	10	10	10	<10	10
Ge	<20	30	<20	<20	20	<20	<20	<20
La	20	20	100	100	50	70	20	100
Mn	10	10	500	1,000	15	700	10,000	500
Mo	2	50	2	<2	<2	<2	2	<2
Nb	<20	<20	30	50	20	20	<20	50
Ni	15	20	5	<5	<5	10	200	<5
Pb	200	>10,000	150	100	700	20	15	20
Sb	<100	<100	<100	<100	<100	<100	500	<100
Sc	<10	<10	<10	<10	<10	10	10	<10
Sn	<10	<10	<10	<10	<10	<10	<10	<10
Sr	<50	<50	500	50	<50	1,000	200	100
Ti	100	<20	2,000	3,000	500	2,000	1,000	3,000
W	100	50	50	30	20	70	100	70
V	<50	<50	<50	<50	<50	<50	<50	<50
Y	<10	<10	20	20	<10	10	15	20
Zn	<200	>10,000	200	<200	1,500	<200	700	<200
Zr	<20	<20	70	100	50	50	50	70

TABLE 3. - Chemical analyses of massive sulfide samples from Drenchwater Creek area

Sample number	Cu (%)	Ox[1]Cu (ppm)	Pb (%)	Ox[1]Pb (ppm)	Zn (%)	Ox[1]Zn (ppm)	Cd ppm	Fe (%)	Ba (%)	S (%)	Au (ppm)	Ag (ppm)	F (%)	Measured specific gravity
77PRUJ 59	0.016	<20	5.9	12,000	14.0	2,200	1,000	2.4	0.02	16.8	<0.02	160	0.077	2.74
59.1	.018	<20	1.7	3,450	18.0	1,150	820	2.2	.01	12.9	<.02	70	.047	2.86
59.2	.004	<20	4.1	9,100	15.0	1,150	720	1.6	.14	9.2	<.02	200	.045	2.82
59.3	.002	20	2.1	6,650	7.1	800	50	0.8	.23	3.6	<.02	42	.13	2.94
59.4	.002	20	0.58	4,550	21.0	1,200	400	1.7	.15	13.1	<.02	24	1.4	2.94
59.5	.004	<20	1.4	7,200	21.0	1,350	240	2.5	.07	10.2	<.02	100	.057	2.86
59.6	.018	20	5.2	11,000	26.0	1,300	940	3.3	.04	15.5	<.02	190	.053	3.03

1 - Ox indicates metal-oxide compounds determined by cold acid extraction.

KIVLIKTORT MOUNTAIN AREA

The 1977 geochemical results revealed anomalously high lead and zinc concentrations in the Kivliktort Mountain area. One sample from the eastern flank of the mountain contained high lead concentrations in the non-magnetic fraction of the heavy mineral-concentrate and one sample from the western flank contained high zinc and lead in both the stream sediment and the non-magnetic fraction of the heavy-mineral concentrate. The Kivliktort Mountain area is within an extensive, generally coincident, regional lead and zinc geochemical anomaly that extends from the headwaters of Story Creek east to the Nigu River (see figure 2). In 1978 high-grade sphalerite and minor amounts of galena were found in the creek bed of the main drainage and in a small, 0.4-mi long tributary on the west flank of the mountain. Minor amounts of sphalerite also occur as pebbles in a conglomerate; traces of galena and barite were found in small fractures in shales. Mineralization was not found along the short segment prospected on the eastern flank of Kivliktort Mountain where high lead values were found by the geochemical survey.

Location and Physical Setting

The sulfide-bearing stream 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. 34 N., R. 10 E., 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 2,600 ft. (figure 10). The stream gradients range from 240 to 430 ft. per mile. The stream beds consist primarily of cobbles and boulders.

Geologic Setting

Two rock units are mapped in the area (6). The Lower Mississippian-Upper Devonian Kanayut Conglomerate, which is comprised of a quartz and chert pebble conglomerate and a clean white sandstone, underlies the stream. The Mississippian Kayak Shale, which is comprised of siltstone, shale, and sandstone, crops out southwest of the investigated creek at approximately the 2,200 ft. elevation.

Sampling and Analysis

Anomalously high zinc (300 ppm) and high lead (50 ppm) concentrations occur in stream sediment (sample H-527, figure 10); high lead (150 ppm) and zinc (1,000 ppm) concentrations occur in the heavy-mineral concentrate (10).

A short segment of the stream was investigated, local geologic relationships were noted, and sediment samples were collected. Several highly mineralized cobbles and boulders were found in the creek bed of the main drainage and a 0.4 mile long tributary stream about 2 miles upstream from the H-527 sampling site. Other nearby drainages, slopes, and ridges were investigated briefly but additional mineralization was not found.

High-grade sphalerite-bearing float (78PRUJ 539) contained 30.5% zinc, 0.13% lead, 180 ppm silver. Minor amounts of sphalerite (as pebbles in the conglomerate) and galena were also found in outcrops of the Kanayut Conglomerate (78PRUJ 538), and minor amounts of galena and barite were found in fractures in shale (78PRUJ 542).

Twenty-one stream sediment, two rock, and five mineralized rock samples were collected for analysis (tables 4 and 5). 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). Mineralized rock samples (78PRUJ 539, 544, 547) contain up to 30.5 % zinc and less than 0.5 % lead. Minor amounts of galena (150 ppm lead) and abundant barite (23 % barium) were found in shale sample 78PRUJ 542. Very high lead (to 220 ppm) and zinc (to 1700 ppm) concentrations occur in stream sediments (78PRUJ 540, 541) collected downstream from the small tributary from which mineralized sample 78PRUJ 547 was collected.

Rock grab samples have variable element contents. Sample 78PRUJ 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 sample 78PRUJ 537 contains no anomalous lead or zinc. A sphalerite-bearing chert-pebble conglomerate (78PRUJ 538) contains 500 ppm zinc.

Description of Deposits

The rock types in the area of mineralization include chert-pebble conglomerate, ferruginous chert-pebble conglomerate, chert and calcarenite, and shale. The steep slopes along the west flank of Kivliktort Mountain are underlain by coarse-grained siliceous clastics; areas of moderate to low relief are underlain by shale. Massive sulfide mineralization, found only as float rock, appears to be spatially related to the contact zone between the units. The mineralized cobbles are sparse and widely scattered along the main drainage. The greatest concentration of these was found in a small tributary to the main drainage.

Lower grade mineralization occurs as fracture filling. The high-grade cobbles consisted primarily of brecciated quartz-cemented sphalerite. The mode of the bedrock occurrence of this sphalerite was not determined.

Two modes of mineralization in bedrock are shown by the lower grade material. These are a barite-galena filling of fractures in shales, and a sphalerite pebble in the conglomeratic unit.

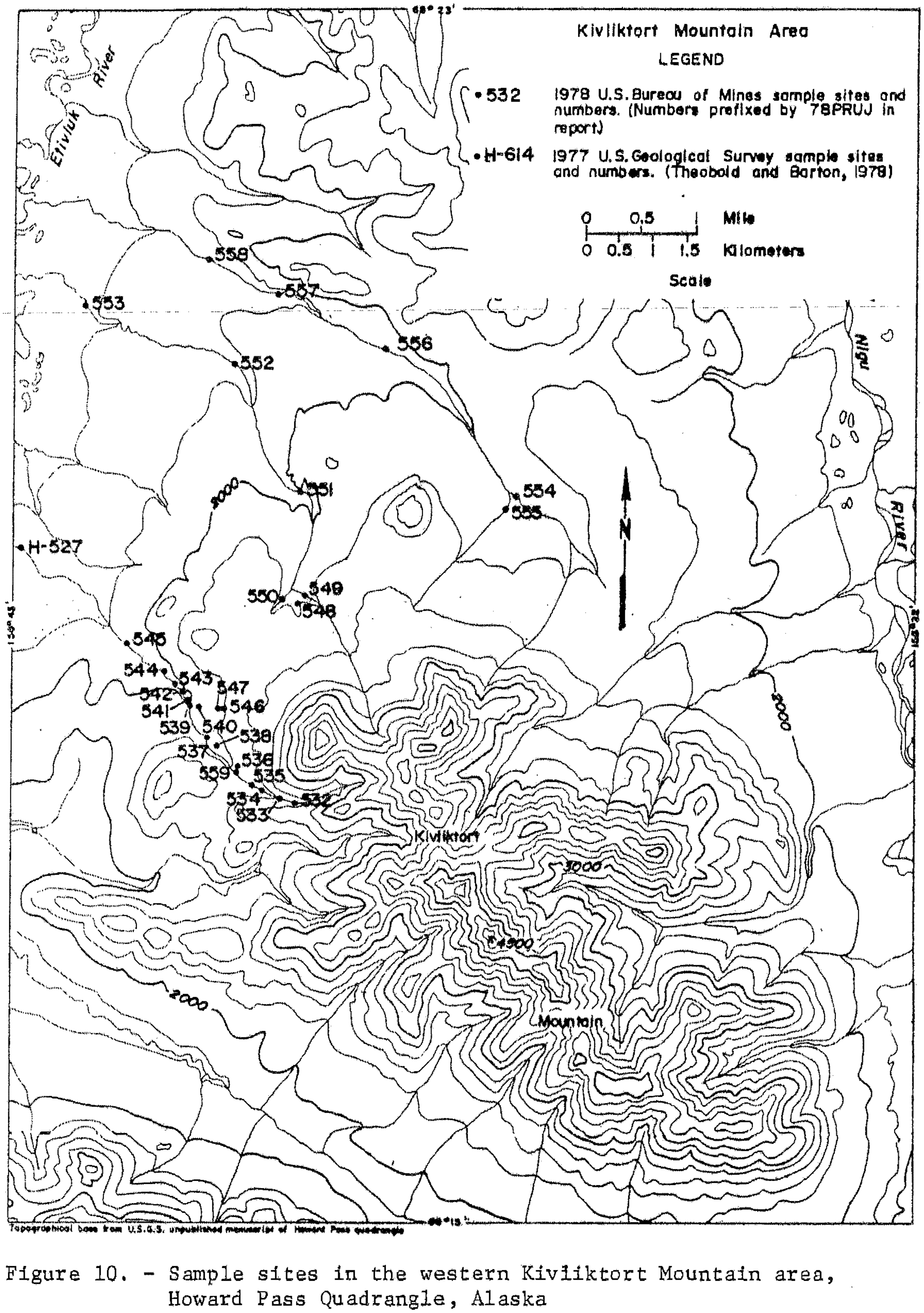


Figure 10. - Sample sites in the western Kiviiktort Mountain area, Howard Pass Quadrangle, Alaska

TABLE 4. - Analytical results of Kivliktort Mountain area samples
[Values in parts per million unless otherwise noted]

Sample number	Cu	Pb	Zn	Ag	Au	Ba	Sample type
	Elements analyzed						
H - 527	30	50	300	<0.5	ND	1000	Stream sediment ( )
H - 527	100	150	1000	<1.0	ND	7000	Heavy mineral concentrate ( )
78PRUJ 532	35	15	105	NA	NA	NA	Stream sediment
78PRUJ 533	30	10	60	NA	NA	NA	Stream sediment
78PRUJ 534	30	10	70	NA	NA	NA	Stream sediment
78PRUJ 535	25	25	140	NA	NA	NA	Stream sediment
78PRUJ 536	5	25	20	NA	NA	NA	Stream sediment
78PRUJ 537	NA	NA	NA	NA	NA	NA	Fissile shale
78PRUJ 538	NA	NA	NA	NA	NA	NA	Chert-pebble conglomerate
78PRUJ 539	NA	0.13%	30.5%	180	0.29	NA	Breccia with sphalerite
78PRUJ 540	35	220	1,700	NA	NA	NA	Stream sediment
78PRUJ 541	30	180	1,150	NA	NA	NA	Stream sediment
78PRUJ 542	NA	NA	NA	NA	NA	23%	Siltstone with barite and galena
78PRUJ 543	30	100	1,150	NA	NA	NA	Stream sediment
78PRUJ 544	NA	.03%	30.5%	NA	NA	NA	Breccia with sphalerite
78PRUJ 545	25	100	890	NA	NA	NA	Stream sediment
78PRUJ 546	20	310	1,000	NA	NA	NA	Stream sediment
78PRUJ 547	NA	.33%	8.5%	NA	NA	NA	Breccia with sphalerite
78PRUJ 548	35	25	270	NA	NA	NA	Stream sediment
78PRUJ 549	20	20	195	NA	NA	NA	Stream sediment
78PRUJ 550	10	20	85	NA	NA	NA	Stream sediment
78PRUJ 551	25	25	260	NA	NA	NA	Stream sediment
78PRUJ 552	25	30	300	NA	NA	NA	Stream sediment
78PRUJ 553	20	20	235	NA	NA	NA	Stream sediment
78PRUJ 554	5	20	165	NA	NA	NA	Stream sediment
78PRUJ 555	15	15	280	NA	NA	NA	Stream sediment
78PRUJ 556	15	35	310	NA	NA	NA	Stream sediment
78PRUJ 557	25	15	190	NA	NA	NA	Stream sediment
78PRUJ 558	20	15	135	NA	NA	NA	Stream sediment
78PRUJ 559	NA	NA	NA	NA	NA	NA	Breccia with galena and sphalerite

NA - Not analyzed
ND - Not detected

TABLE 5. - Emission spectrographic analyses of Kivliktort Mountain area samples

[Values in parts per million unless otherwise noted]

Element	Sample numbers			
	78PRUJ 537 Shale	78PRUJ 538 Conglomerate	78PRUJ 542 Siltstone	78PRUJ 559 Sulfide breccia
Fe	7%	10%	0.05%	0.2%
Ca	0.07%	0.1%	.02%	.02%
Mg	.5%	.1%	.03%	.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

STORY CREEK AREA

Geochemical sampling and follow-up investigations in the headwaters region of Story Creek led to the discovery of high-grade zinc and lead sulfide mineralization in outcrop and as float material in several small northwest-flowing tributary streams. This mineralization is within a regional lead-zinc geochemical anomaly that extends from Story Creek to Nigu River (10).

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. 12 S., R. 26 W., Umiat base and meridian. Mineralized float rock is widely scattered throughout the southern half of T. 12 S., R. 26 W.

The Story Creek area is within the central Brooks Range section of the Arctic Mountains physiographic province (11). It is characterized by a gently northward-sloping surface which has been cut by north-flowing streams (figure 11). Elevations in the area range from 2,000 to 3,000 ft.

Streams in the study area are small northerly-flowing tributaries of Story Creek, a tributary of the Kuna River. The stream channels are relatively straight and stream gradients range from 300 to 500 ft. per mile. The stream beds are comprised primarily of cobbles and boulders.

Geologic Setting

Paleozoic and Mesozoic sedimentary rock units crop out in the Story Creek area (6). Upper Mississippian Lisburne rocks and Lower Mississippian-Upper Devonian Kanayut Conglomerate comprise the north central Brooks Range thrust sequence. Mississippian Lisburne rocks and rock 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.

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 along the streams, through the zone of mineralization, includes: quartzitic sandstone, red-brown shale, mineralized brecciated shale, calcareous shale, carbonaceous siliceous shale and chert, andesite/diabase sill (?), and carbonaceous-graphitic shale. A similar general stratigraphic sequence occurs along the drainage to the west from which sample H-400 was collected.

Folding and faulting have developed to varying degrees. Two styles of folding were recognized. The rock units appear to be northwardly tilted. Intense intraformational folding is evident within the shale. Small northwardly overturned folds, with west-dipping fold axes, were noted in the shale.

Three east-northeast trending, vertically-dipping, cross-cutting mineralized siliceous breccia zones, up to 30 ft. wide, occur in the Story Creek area. Neither the origin, nature, or extent of the mineralization nor of the breccia zones was determined.

Sampling and Analysis

Two stream sediment samples, H-399 and H-400 (figure 11), were collected by the USGS 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 non-magnetic fraction of the heavy-mineral concentrate (10). Anomalously high lead (150 ppm) and detectable zinc (<200 ppm) concentrations occur in stream sediment sample H-400; the non-magnetic heavy-mineral fraction of this sample contains 700 ppm zinc and 70 ppm lead (10). Mineralized float rock was found upstream from this sample site. BOM investigators found high-grade zinc and lead sulfide mineralized float rock near the headwaters, about 2.6 miles upstream from sample site H-399. Further investigation led to outcrops of massive sulfide and sulfide breccia deposits in this drainage and other drainages to the west.

Stream sediment and rock samples were collected from various drainages in and around stream H-399 (figure 11, tables 6 and 7). The average element contents of the stream sediments, with standard deviations shown in parentheses, from the various drainage basins are:

Area	Cu ppm	Pb ppm	Zn ppm
H-399 Stream	59 (23)	220 (270)	750 (840)
Mineralized Creek West	38 (6.8)	140 (79)	290 (200)
H-400 Stream	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)

High lead (to 690 ppm) and zinc (to 2,450 ppm) concentrations are present in samples from stream H-399 and from other drainages to the west. Minor lead and zinc sulfide deposits were found in outcrops in the furthest west prospected drainage, but the presence of these sulfides is not reflected in the analyses of the stream sediment samples. Uniformly low lead (less than 55 ppm) and zinc (less than 340 ppm) concentrations are present in sediment samples from the Safari Creek drainages, located to the east of stream H-399.

Rock and mineral specimens have a highly variable lead (0.12% to 34%) and zinc (0.11% to 49%) content (tables 6 and 7). The copper content does not exceed 0.05%. In mineralized specimens the lead-oxide content (to 2%) is much higher than the zinc-oxide content (to 0.50%). The rock specimens, however, show much greater recessive weathering of sphalerite zones than of galena zones and suggest much greater leaching of sphalerite than of galena.

Composite sample 78PRUJ 278 consisting of "high-grade" surface float material assayed 6.1% lead, 9.0% zinc, and 130 ppm silver. Composite sample 78PRUJ 279, made up of mineralized as well as unmineralized material, contained 1.55% lead, 1.4% zinc, and 35 ppm silver. Randomly selected high-grade banded (bedded?) sulfide-bearing specimens contain up to 34% lead, 28% zinc, 940 ppm silver, and 1.2 ppm gold. The massive sulfide breccia contains 15.5% lead, 49% zinc, 500 ppm silver, and 0.16 ppm gold.

The emission spectrographic results show a high barium content (up to 1,000 ppm) in both mineralized and unmineralized samples (table 7). Other elements found in high concentrations in samples from this area include antimony (to 1,000 ppm), germanium (100 ppm), and manganese (to 1,500 ppm).

Description of Deposits

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-cemented shale breccia. Most of the mineralized material sampled was float rock; however, a 60-ft. long mineralized zone crops out at the headwaters of stream H-399. An approximately 9-ft. long massive zinc and lead sulfide-bearing zone occurs within the larger zone.

The quartz-cemented breccia deposits apparently are much more abundant than the massive sulfide deposits. The white quartz cementing the rock is more resistant to chemical and physical weathering than the rock itself and it is readily recognized when prospecting. Quartz-cemented 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 indicated potential subsurface continuity. Mineralized breccia has been traced along the surface in a generally east-west direction for at least 10,000 ft.

Other quartz-cemented shale breccia zones, similar in appearance to those found with the mineralized zone, are up to 30 ft. 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.

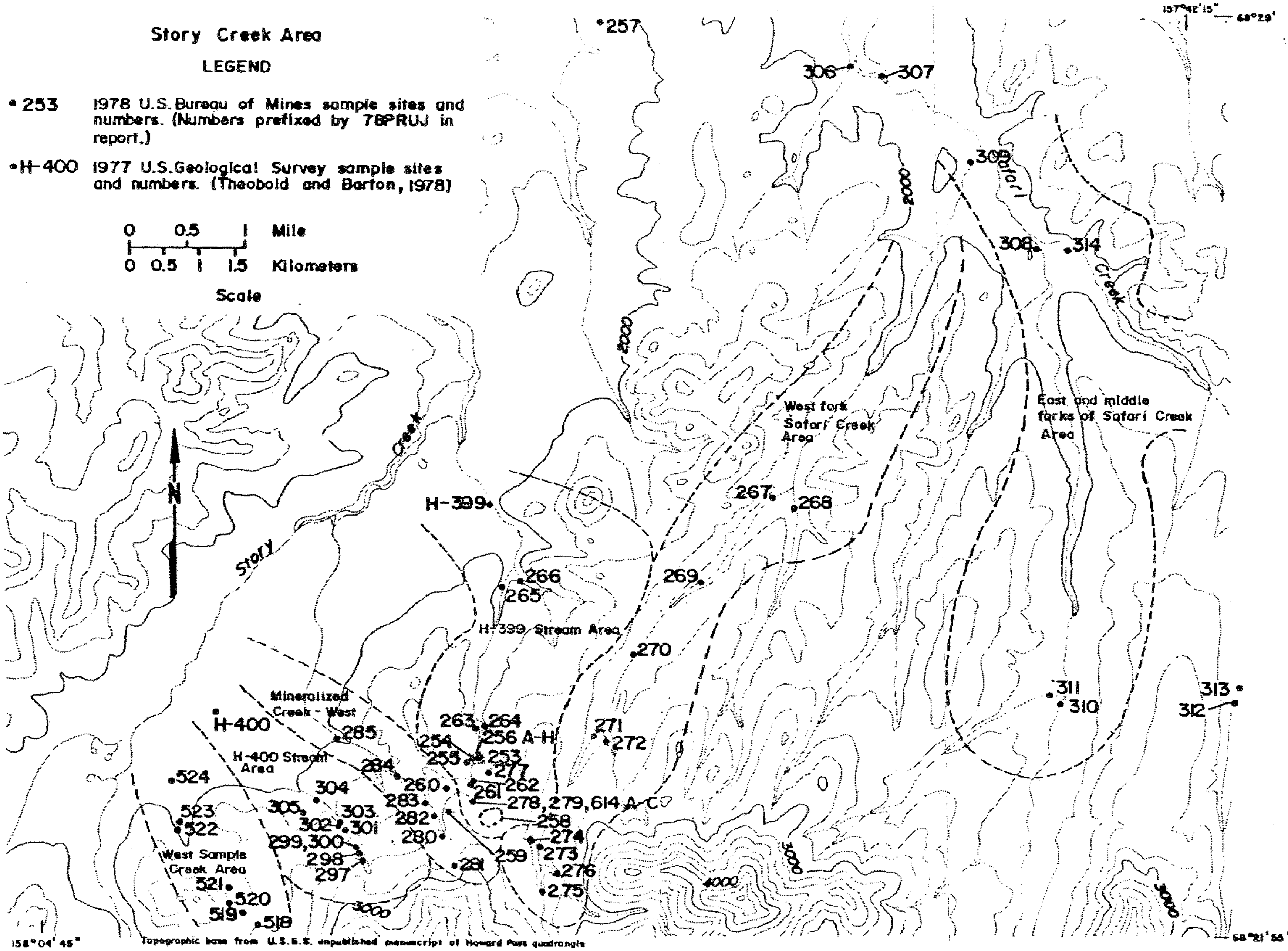


Figure 11. - Sample sites in the Story Creek Area, Howard Pass Quadrangle, Alaska

TABLE 6. - Analytical results of Story Creek area samples
[Values in parts per million unless otherwise noted]

Sample number	Elements analyzed								Sample type
	Cu	Pb	Ox[1] Pb	Zn	Ox[1] Zn	Ag	Cd	Au	
Stream H-399									
H-399	70	150	NA	300	NA	<0.5	ND	ND	Stream sediment
H-399	50	70	NA	700	NA	ND	ND	ND	Heavy mineral concentrate
Main mineralized zone									
78PRUJ 253	60	80	NA	295	NA	NA	NA	NA	Stream sediment
78PRUJ 254	70	690	NA	2,450	NA	NA	NA	NA	Stream sediment
78PRUJ 255	80	40	NA	140	NA	NA	NA	NA	Black shale
78PRUJ 256A	515	10	0.02%	190,000	0.29%	NA	NA	NA	Mineralized breccia
78PRUJ 256B	165	28,000	1.3%	18,500	.07%	NA	NA	NA	Mineralized breccia
78PRUJ 256C	85	1,200	.09%	69,000	.28%	NA	NA	NA	Mineralized breccia
78PRUJ 256D	220	125,000	1.6%	56,000	.05%	NA	NA	NA	Mineralized breccia
78PRUJ 256E	335	44,000	1.5%	76,000	.21%	NA	NA	NA	Mineralized breccia
78PRUJ 256F	505	185,000	2.0%	88,000	.12%	NA	NA	NA	Mineralized breccia
78PRUJJ256G	90	13,000	.67%	16,000	.12%	NA	NA	NA	Mineralized breccia
78PRUJ 256H	15	50,000	1.6%	75,000	.54%	NA	NA	NA	Mineralized breccia
78PRUJ 257	15	85	NA	100	NA	NA	NA	NA	Stream sediment
78PRUJ 258	60	900	NA	1,150	NA	NA	NA	NA	Shale
78PRUJ 261	50	1,850	NA	3,400	NA	5.6	17.0	NA	Stream sediment
78PRUJ 262	40	25	NA	290	NA	NA	NA	NA	Shale
78PRUJ 263	60	600	NA	1,600	NA	0.8	7.0	NA	Stream sediment
78PRUJ 264	90	25	NA	180	NA	<.2	0.4	NA	Stream sediment
78PRUJ 265	70	220	NA	750	NA	.4	2.0	NA	Stream sediment
78PRUJ 266	70	10	NA	370	NA	4.0	1.0	NA	Stream sediment
78PRUJ 277	40	80	NA	295	NA	NA	NA	NA	Stream sediment
78PRUJ 278	180	61,000	1.2%	90,000	.07%	130	475	NA	High-grade composite
78PRUJ 279	65	15,500	.38%	14,000	.025%	35	13	NA	Composite surface sample
78PRUJ 614A	0.052%	20%	NA	37%	NA	480	NA	0.77	Sulfide breccia
78PRUJ 614B	.045%	15.5%	NA	49%	NA	500	NA	.16	Sulfide breccia
78PRUJ 614C	.034%	34%	NA	28%	NA	940	NA	1.2	"Banded" sulfides

TABLE 6. - Analytical results of Story Creek area samples - Continued
[Values in parts per million unless otherwise noted]

Sample number	Elements analyzed							Sample type
	Cu	Pb	Ox[1]Pb	Zn	Ox[1]Zn	Ag	Cd	
Mineralized Creek West								
78PRUJ 259	55	2,900	0.11%	3,800	0.13%	4.0	9.0	Mineralized shale
78PRUJ 260	95	40	.025%	3,400	.18%	<0.2	36.0	High-grade composite
78PRUJ 280	40	40	NA	100	NA	NA	NA	Stream sediment
78PRUJ 281	40	70	NA	120	NA	NA	NA	Stream sediment
78PRUJ 282	35	245	NA	660	NA	NA	NA	Stream sediment
78PRUJ 283	35	205	NA	360	NA	NA	NA	Stream sediment
78PRUJ 284	30	155	NA	265	NA	NA	NA	Stream sediment
78PRUJ 285	50	110	NA	265	NA	NA	NA	Stream sediment
Stream H-400								
H-400	30	30	NA	<200	NA	ND	ND	Stream sediment
H-400	50	100	NA	700	NA	ND	ND	Heavy mineral concentrate
78PRUJ 297	35	85	NA	220	NA	NA	NA	Stream sediment
78PRUJ 298	NA	NA	NA	NA	NA	NA	NA	Coal
78PRUJ 299	50	780	NA	780	NA	NA	NA	Sandstone with galena
78PRUJ 300	35	40	NA	135	NA	NA	NA	Stream sediment
78PRUJ 301	45	75	.01%	7,500	.24%	NA	NA	Mineralized breccia
78PRUJ 302	115	38,000	1.1%	820	.015%	NA	NA	Mineralized breccia
78PRUJ 303	35	125	NA	240	NA	NA	NA	Stream sediment
78PRUJ 304	35	105	NA	290	NA	NA	NA	Stream sediment
78PRUJ 305	35	60	NA	150	NA	NA	NA	Stream sediment
West Sampled Creek								
78PRUJ 518	35	60	NA	235	NA	NA	NA	Stream sediment
78PRUJ 519	35	45	NA	240	NA	NA	NA	Stream sediment
78PRUJ 520	30	20	NA	220	NA	NA	NA	Stream sediment
78PRUJ 521	15	10	NA	135	NA	NA	NA	Stream sediment
78PRUJ 522	30	25	NA	150	NA	NA	NA	Stream sediment
78PRUJ 523	5	5	NA	50	NA	NA	NA	Stream sediment
78PRUJ 524	30	25	NA	175	NA	NA	NA	Stream sediment

TABLE 6. - Analytical results of Story Creek area samples - Continued
[Values in parts per million unless otherwise noted]

Sample number	Cu	Pb	Ox[1]Pb	Zn	Ox[1]Zn	Ag	Cd	Sample type
	Elements analyzed							
West Fork Safari Creek								
78PRUJ 267	45	20	NA	150	NA	NA	NA	Stream sedimemt
78PRUJ 268	50	25	NA	190	NA	NA	NA	Stream sediment
78PRUJ 269	45	20	NA	120	NA	NA	NA	Stream sediment
78PRUJ 270	35	15	NA	105	NA	NA	NA	Stream sediment
78PRUJ 271	40	20	NA	135	NA	NA	NA	Stream sediment
78PRUJ 272	60	40	NA	170	NA	NA	NA	Stream sediment
78PRUJ 273	30	20	NA	105	NA	NA	NA	Stream sediment
78PRUJ 274	40	40	NA	110	NA	NA	NA	Stream sediment
78PRUJ 275	30	30	NA	120	NA	NA	NA	Stream sediment
78PRUJ 276	30	20	NA	105	NA	NA	NA	Stream sediment
East & Middle Forks of Safari Creek								
78PRUJ 306	40	20	NA	130	NA	NA	NA	Stream sediment
78PRUJ 307	40	25	NA	145	NA	NA	NA	Stream sediment
78PRUJ 308	30	35	NA	120	NA	NA	NA	Stream sediment
78PRUJ 309	50	55	NA	225	NA	NA	NA	Stream sediment
78PRUJ 310	25	25	NA	120	NA	NA	NA	Stream sediment
78PRUJ 311	25	40	NA	110	NA	NA	NA	Stream sediment
78PRUJ 312	20	15	NA	80	NA	NA	NA	Stream sediment
78PRUJ 313	50	15	NA	340	NA	NA	NA	Stream sediment
78PRUJ 314	55	55	NA	190	NA	NA	NA	

NA - Not analyzed
1 - Metal oxide content, determined by cold acid extraction
ND - Not detected

TABLE 7. - Emission spectrographic analyses of Story Creek area samples
[Values in parts per million unless otherwise noted]

Element	Sample number	
	78PRUJ 278 High-grade composite	78PRUJ 279 Composite surface sample
Fe	3%	5%
Ca	0.03%	0.05%
Mg	.05%	.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 7. - Emission spectrographic analyses of Story Creek area samples - Continued

[Values in parts per million unless otherwise noted]

Element	Sample numbers		
	78PRUJ 299 Sandstone	78PRUJ 301 Mineralized breccia	78PRUJ 302 Mineralized breccia
Fe	2%	7%	1%
Ca	0.03%	0.07%	0.02%
Mg	.05%	.07%	.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

WHOOPEE CREEK AREA

Epigenetic zinc and lead sulfide mineralization hosted in clastic sedimentary rock was discovered near the headwaters of an unnamed stream, unofficially called Whoopee Creek by BOM investigators. The mineralization and geologic setting of the area are similar to those found in the area of the Story Creek mineralization. Both occur within the regional lead-zinc geochemical anomaly that extends from Story Creek to the Nigu River. The mineralized area is within the Noatak National Preserve.

Location and Physical Setting

Mineralization at Whoopee Creek (figure 12) is located at 68° 13' 45"N latitude, 157° 51' 20"W longitude, and is in section 25 of T. 33 N., R. 4 E., Kateel River base and meridian. Mineralized float rock was found throughout parts of section 25 of T. 33 N., R. 4 E. This area is 11 miles south-southeast of the base metal mineral occurrence at Story Creek and 12 miles east of Feniak Lake, south of the NPR-A.

The Whoopee Creek area is within the central Brooks Range section of the Arctic Mountains physiographic province (11). 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 ft.

Whoopee Creek is a 2.6-mile long easterly-flowing tributary to a southerly-flowing tributary of the Noatak River. The creek is relatively straight and has a gradient of 230 ft. per mile. The stream bed is comprised primarily of cobbles and boulders. The surface area of the drainage basin is approximately 5.4 mi2.

Geologic Setting

Bedrock in the Whoopee Creek area is comprised primarily of sedimentary rock and minor amounts of volcanic rock. Sandstone of the Lower Mississippian-Upper Devonian Kanayut Formation and sandstone and shale of the Mississippian Kayak Formation crop out along Whoopee Creek. Sandstone, possibly of the Cretaceous Okpikruak Formation, crops out to the west of the creek. Volcanic rock of undetermined age crops out to the east of Whoopee Creek. The volcanics are believed to be exposed through windows in an overlying thrust plate and their genetic relation to the mineralization is speculative.

Siltstone, shale, and sandstone comprise the bedrock in the area. Siltstone (78PRUJ 654) and shale (78PRUJ 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-ft. wide, S 65° E trending, non-mineralized, steeply-dipping shear zone cuts the siltstone near sample site 78 PRUJ 653.

Sampling and Analysis

Anomalously high lead (50 ppm) and copper (70 ppm) concentrations occur in stream sediment sample H-448 (figure 12); anomalously high lead (1,000 ppm) and copper (300 ppm) concentrations occur in the non-magnetic fraction of the heavy mineral concentrate (10). High-grade galena and sphalerite mineralization, with minor chalcopyrite, was found 2.1 miles upstream from sample site H-448. Other USGS samples from other drainages in the Whoopee Creek area contain anomalous lead and zinc concentrations (10), but these streams were not investigated by BOM.

Sampling of rock and stream sediments was limited to the headwaters area of the stream where base metal sulfide breccia mineralization was found along a one-half mile segment of Whoopee Creek, the headwaters of the west-flowing stream to the west of Whoopee Creek, and in the intervening divide.

Chemical analyses (table 8) show that mineralized grab samples contain: copper (0.007% to 0.24%), lead (0.07% to 44%), zinc (0.29% to 46%), gold (<0.06 ppm to 4.4 ppm), silver (5.2 ppm to 460 ppm), and cadmium (20 ppm to 3700 ppm). Optical emission spectrographic analyses (table 9) corroborate these values and also show high antimony (to 5,000 ppm), nickel (to 1,000 ppm), and cobalt (to 300 ppm).

Description of Deposits

Epigenetic mineralization in and along Whoopee Creek consists of a galena, sphalerite, quartz and carbonate-cemented siltstone breccia and fracture zone. Quartz is the most abundant epigenetic mineral; sulfides and carbonates occur in variable amounts. Mineralized float rock is abundant along, as well as east and west of, upper Whoopee Creek. The extent of the mineralization has not been delineated.

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

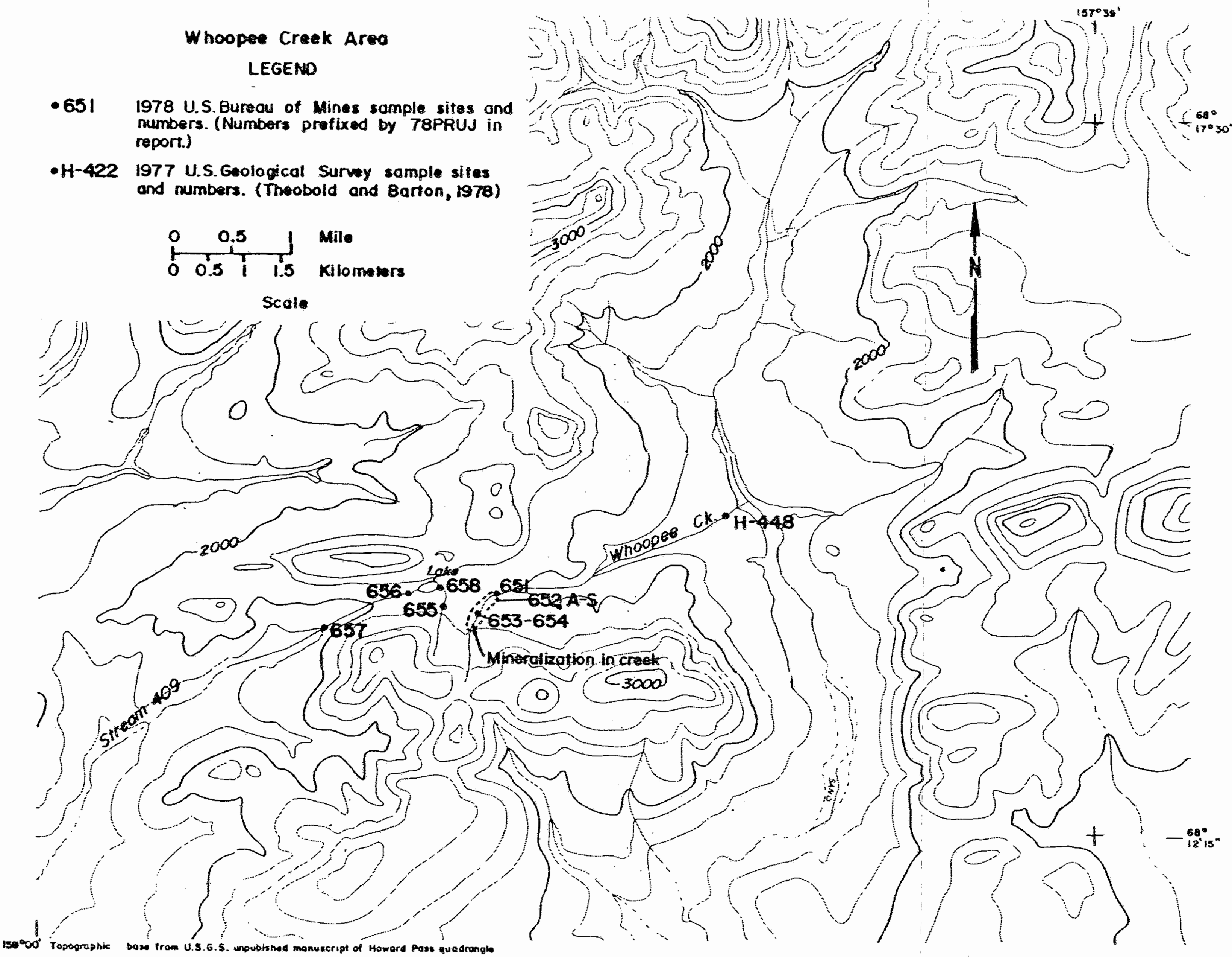


Figure 12. - Sample sites in the Whoopee Creek area, Howard Pass Quadrangle, Alaska

TABLE 8. - Analytical results of Whoopee Creek area samples
[Values in parts per million unless otherwise noted]

Sample number	Cu	Pb	Zn	Au	Ag	Cd	Sample type
	Elements analyzed						
H-448	50 (%)	30 (%)	200 (%)	ND	ND	ND	Stream sediment
H-448	300 (%)	1000 (%)	ND	ND	1.5	ND	Heavy-mineral concentrate
78PRUJ 651	35 (%)	90 (%)	470 (%)	NA	NA	NA	Stream sediment
78PRUJ 652A	0.17 (%)	19 (%)	12 (%)	3.2	180	900	Mineralized breccia
78PRUJ 652B	.070 (%)	16.5 (%)	7.2 (%)	0.67	220	440	Mineralized breccia
78PRUJ 652C	.027 (%)	5.5 (%)	2.3 (%)	.14	75	95	Mineralized breccia
78PRUJ 652D	.080 (%)	6.2 (%)	15.5 (%)	.68	80	1,200	Mineralized breccia
78PRUJ 652E	.012 (%)	0.81 (%)	3.7 (%)	.04	10	265	Mineralized breccia
78PRUJ 652F	.13 (%)	16.5 (%)	20 (%)	1.2	210	1,600	Mineralized breccia
78PRUJ 652G	.046 (%)	15 (%)	3.0 (%)	.58	150	170	Mineralized breccia
78PRUJ 652H	.075 (%)	36 (%)	1.4 (%)	3.3	450	90	Mineralized breccia
78PRUJ 652I	.028 (%)	21.5 (%)	0.29 (%)	.59	270	20	Mineralized breccia
78PRUJ 652J	.013 (%)	.75 (%)	14.5 (%)	.04	16	500	Mineralized breccia
78PRUJ 652K	.028 (%)	.71 (%)	31 (%)	.06	6.6	1,050	Mineralized breccia
78PRUJ 652L	.047 (%)	15.5 (%)	4.8 (%)	.56	220	270	Mineralized breccia
78PRUJ 652M	.015 (%)	.98 (%)	3.1 (%)	<.02	20	215	Mineralized breccia
78PRUJ 652N	.015 (%)	3.3 (%)	14 (%)	.08	26	480	Mineralized breccia
78PRUJ 652O	.045 (%)	44 (%)	5.2 (%)	4.4	460	395	Mineralized breccia
78PRUJ 652P	.24 (%)	11.5 (%)	17.5 (%)	.44	210	950	Mineralized breccia
78PRUJ 652Q	.060 (%)	.95 (%)	46.0 (%)	.30	14	3,700	Mineralized breccia
78PRUJ 652R	.007 (%)	.070 (%)	4.6 (%)	<.02	5.2	260	Mineralized breccia
78PRUJ 652S	.024 (%)	.83 (%)	15.5 (%)	.09	9.8	700	Mineralized breccia
78PRUJ 653	NA	NA	NA	NA	NA	NA	Shale
78PRUJ 654	NA	NA	NA	NA	NA	NA	Argillite
78PRUJ 655	NA	NA	NA	NA	NA	NA	Sulfide float
78PRUJ 656	25 (%)	25 (%)	105 (%)	NA	NA	NA	Stream sediment
78PRUJ 657	35 (%)	25 (%)	125 (%)	NA	NA	NA	Stream sediment
78PRUJ 658	30 (%)	35 (%)	110 (%)	NA	NA	NA	Stream sediment
78PRUJ 659	35 (%)	20 (%)	130 (%)	NA	NA	NA	Stream sediment
78PRUJ 660	45 (%)	20 (%)	120 (%)	NA	NA	NA	Stream sediment
78PRUJ 661	35 (%)	20 (%)	130 (%)	NA	NA	NA	Stream sediment

TABLE 9. - Emission spectrographic analyses of Whoopee Creek area samples
[Values in parts per million unless otherwise noted]

Element	Sample Numbers						
	78PRUJ 652C	78PRUJ 652D	78PRUJ 652F	78PRUJ 652G	78PRUJ 652H	78PRUJ 652K	78PRUJ 652L
Fe	1.5%	3%	3%	0.5%	0.5%	2%	0.7%
Ca	0.2%	0.2%	0.03%	<.02%	<.02%	<0.02%	<.02%
Mg	.1%	.05%	.02%	<.02%	.02%	.02%	<.02%
Ag	100	100	200	150	700	30	200
As	<500	<500	<500	<500	<500	<500	<500
B	15	10	20	10	10	<10	10
Ba	100	100	200	20	100	<10	20
Be	<2	<2	<2	<2	<2	<2	<2
Bi	<10	<10	<10	<10	<10	<10	<10
Cd	50	700	1,000	50	<50	700	200
Co	10	200	300	20	5	100	30
Cr	200	100	70	150	100	100	150
Cu	500	1,500	2,000	500	1,000	500	700
Ga	<10	20	30	<10	<10	20	<10
Ge	20	30	50	30	20	70	30
La	20	20	20	20	20	20	20
Mn	700	700	100	500	10	50	50
Mo	<2	<2	<2	<2	<2	<2	<2
Nb	<20	<20	<20	<20	<20	<20	<20
Ni	300	50	100	1,000	50	10	700
Pb	>10,000	>10,000	>10,000	>10,000	>10,000	5,000	>10,000
Sb	1,000	500	1,500	1,500	5,000	100	1,500
Sc	<10	<10	<10	<10	<10	<10	<10
Sn	<10	30	50	<10	10	20	10
Sr	<100	<100	<100	<100	<100	<100	<100
Ti	1,000	500	1,500	300	500	200	300
V	20	10	20	<10	10	<10	<10
W	<50	<50	<50	<50	<50	<50	<50
Y	<10	<10	<10	<10	<10	<10	<10
Zn	>10,000	>10,000	>10,000	>10,000	>10,000	>10,000	>10,000
Zr	20	<20	20	<20	<20	<20	<20

SUMMARY

Two horizons of significant silver-bearing zinc and lead sulfide mineralization were discovered in the Howard Pass Quadrangle in the Brooks Range, Alaska. One horizon, at the Drenchwater Creek area, includes mineralization which is related to Mississippian age volcanic rocks. The second horizon includes the Kivliktort, Story Creek, and Whoopee Creek mineralization, which is related to a sequence of clastic rocks of the Mississippian Kayak Shale and the Lower Mississippian-Upper Devonian Kanayut Conglomerate.

Three types of mineralization occur at Drenchwater. A 2 ft. thick mineralized siliceous mudstone bed contained up to 23% disseminated zinc, an overlying chert contained up to 11% zinc and 5.1% lead in fractures, and a thin top section of overlying tuff sequence contained up to 26% zinc and 5.9% lead.

Zones of apparently stratigraphically/structurally controlled mineralization in the southeastern part of the study area are related by regional, more or less coinciding, zinc and lead geochemical anomalies. Three zones of significant base metal mineralization were found at Kivliktort Mountain, Story Creek, and Whoopee Creek. The Kivliktort Mountain occurrence consists of mainly sphalerite-bearing cobbles found in float that contained 30.5% zinc and 0.13% lead. The Story Creek and Whoopee Creek mineralization consists of high grade zinc (to 49%) and lead (to 44%) mainly in quartz-cemented fracture zones in Lower Mississippian-Upper Devonian Kanayut Conglomerate.

REFERENCES

1. Churkin, M., Jr., and others. Geological and Geochemical Appraisal of Metallic Mineral Resources, Southern National Petroleum Reserve in Alaska. U.S. Geol. Survey Open File Rept. 78-70-A, 1978, 85 pp.

2. Jansons, Uldis, and Donald W. Baggs. Mineral Investigations of the Misheguk Mountain and Howard Pass Quadrangles, National Petroleum Reserve, in Alaska. BuMines OFR 38-80, 1978, 76 pp.

3. Jansons, Uldis and T. C. Mowatt. U.S. Bureau of Mines 1977 Field Investigations - NPR-A. Mineral Investigations 1977-1978 Southern NPR-A, National Petroleum Reserve in Alaska, Field Study 5, Part 2, pp. 47-86. Prepared for National Petroleum Reserve in Alaska 105(c) Field Studies under authority of the National Petroleum Reserve Production Act 1976, available upon request from U.S. Bureau of Land Management, NPR-A, Anchorage, Alaska.

4. Jansons, Uldis, and M. A. Parke. 1978 Mineral Investigations in the Misheguk Mountain and Howard Pass Quadrangles. BuMines OFR 26-81, 1980, 195 pp.

5. Martin, A. J. Structure and Tectonic History of the Western Brooks Range, DeLong Mountains and Lisburne Hills, Northern Alaska. Geol. Society of America Bull., v. 81, No. 12, 1970, pp. 36053622.

6. Mayfield, C. F., I. L. Tailleur, C. G. Mull, and E. G. Sable. Bedrock Geologic Map of the South Half of National Petroleum Reserve in Alaska. U.S. Geol. Survey Open File Rept. 78-70-B, 1978, 2 plates.

7. Nokleberg, W. J., and G. R. Winkler. Geologic Setting of the Lead and Zinc Deposits, Drenchwater Creek Area, Howard Pass Quadrangle, Western Brooks Range, Alaska. U.S. Geol. Survey Open File Rept. 78-70-C, 1978, 17 pp.

8. Tailleur, I. L., and W. P. Brosge. Tectonic History of Northern Alaska. Geological Seminar on the North Slope of Alaska, Palo Alto, California, 1970 Proceedings: Los Angeles, California, American Association of Petroleum Geologists Pacific Section, pp. E1-E20.

9. Tailleur, I. L., B. H. Kent Jr., and H. N. Reiser. Outcrop/Geologic Map of the Nuka-Etivluk Region, Northern Alaska. U.S. Geol. Survey Open File Rept. 266, 1966, 7 sheets.

10. Theobald, P. K., and H. N. Barton. Basic Data for the Geochemical Evaluation of National Petroleum Reserve, Alaska. U.S. Geol. Survey Open File Rept. 78-70-D, 1978, 102 pp., 2 plates.

11. Wahrhaftig, Clyde. Physiographic Divisions of Alaska. U.S. Geol. Survey Professional Paper 482, 1965, [1966] 52 pp.