COPPER-COBALT-ZINC INVESTIGATIONS ALONG THE MARSH FORK OF THE CANNING RIVER, NORTHEAST ALASKA

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Critical and Strategic Minerals in Alaska --

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By J. C. Barker[1] and D. Southworth[2]

ABSTRACT AND CONCLUSION

A mineral investigation of two areas adjacent to the Marsh Fork of the Canning River was conducted as part of the U. S. Bureau of Mine's Strategic Metals Program in Alaska.

While anomalously high values of Co (670 ppm) and Zn (1850 ppm) were detected in stream sediment samples from 'Iron' Creek, no in-place or float mineralization was found. The anomalous values may be due to elemental scavenging by hydrous iron, aluminum, and manganese oxides. However, further investigation of the southwestern headwaters of the Iron Creek location is still warranted before a final recommendation can be made regarding mineral potential in the area.

Examination of the 'Chert' Creek location indicated anomalous Cu values in stream sediments are apparently due to numerous but minor occurrences of chalcopyrite mineralization beneath a pre-Mississippian unconformity. No anomalous cobalt values were detected in samples from the "Chert' Creek area.

INTRODUCTION

An investigation of possible copper-cobalt-zinc mineralization in the region of the Marsh Fork of the Canning River (fig. 1) was made by the

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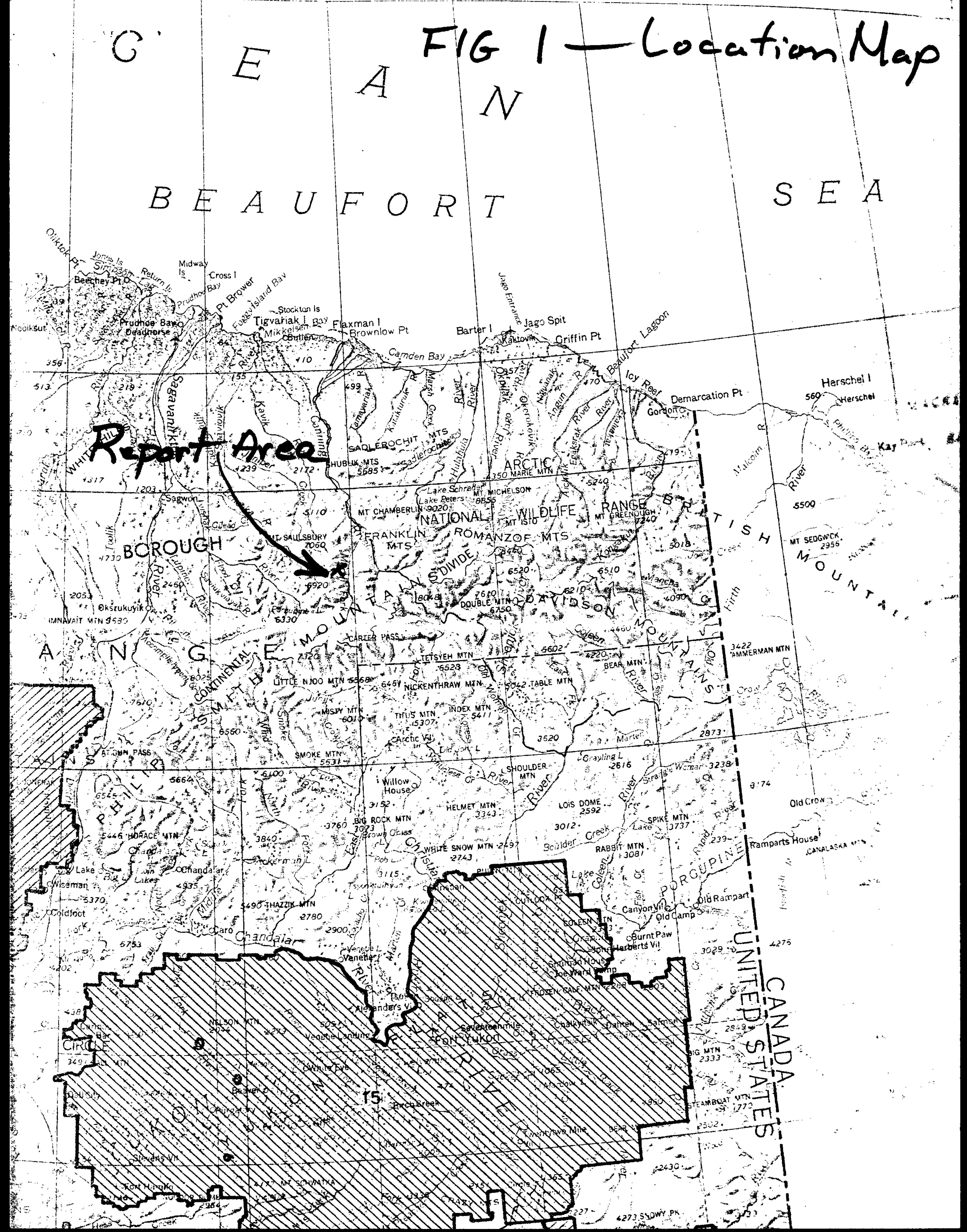

FIG 1 — Location Map

Alaska Field Operations Center, U. S. Bureau of Mines. The work was part of an Alaska-wide assessment of 'critical and strategic' minerals, and it follows-up on previous reports of mineralization and geochemical anomalies by the Bureau (Barker, 1981)(1).[3] The following manuscript is a summary of field work to date, and it will be updated if additional work is undertaken.

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

Specific objectives of this investigation were to re-examine the previous reports of mineralization and to evaluate the potential for economic zinc-copper $\pm$ cobalt deposition in an area where above background geochemical values were previously found. Since the area is virtually unexplored at the present time, the likelihood of actually discovering ore deposits with this scale of effort, even if they occur in the region, is nil. It is not the present intention of the Bureau to commit the necessary time and expenditures to discover and to determine grade and tonnage of mineral deposits in the region.

While only minor occurrences of copper have been visually noted in the Marsh Fork area, it was felt that the geological setting may be favorable for an association of cobalt mineralization. Presumably an investigation of the geology and possibly the mineralization of the Marsh Fork area would further serve as an exploration guide within similar rocks of a widespread geologic terrane in the Eastern Brooks Range.

The area examined covers approximately 80 sq mi of rugged mountainous terrain in the eastern Brooks Range.

HISTORY AND PREVIOUS INVESTIGATION

There has been no known mineral exploration of the Canning River region. Undoubtedly some gold prospectors visited the region after the early Alaskan gold strikes of this century, however there were no reports of gold discoveries. At that time, minerals other than precious metals were of no economic interest in such a remote area as northeastern Alaska.

Early work by the U. S. Geological Survey included regional reconnaissance by Leffingwell in 1919 (9), who described and named the Neruokpuk rocks in the Hulahula and Canning River valleys. In 1948, Whittington and Sable (16) reported on the nearby Sadlerochit River area. In 1968, Reed (10) described the Lake Peters area to the northeast, and Sable reported detailed work in the pre-Mississippian rocks to the northeast in the Romanzof Mountains in 1959, 1977 (12, 13). Regional reports of interest include Brosge & others, 1962 (2), Dutro, 1970, 1972, 1977 (5, 7, 6), Churkin, 1973, (4), Wood, 1975 (17). Geological reconnaissance mapping at 1:250,000 scale was compiled by Reiser and others, 1971 (11) for the Mt. Michelson quadrangle, and by Brosge and Reiser, 1962 (3) for the Arctic quadrangle. Other Geological Survey investigators, too numerous to list here, have compiled regional studies pertaining to various aspects of geology, geomorphology and geophysics of the eastern Brooks Range.

A recent Bureau of Mines report entitled the "Mineral Investigations of the Eastern Brooks Range" (1), summarized a mineral land assessment in the general region. It was suggested that the area of the Marsh Fork was favorable for deposition of copper in the pre-Mississippian rocks and an unassessed potential existed for zinc $\pm$ copper in the Permian-Triassic sequence. This was based on the presence of mafic volcanic rocks containing a high intrinsic copper content, the occurrence of copper mineralization below the pre-Mississippian unconformity and the results of geochemical sampling in the vicinity. Multi-element analyses of the Bureau's sampling were published in 1980 (15) and this data further indicated an additional favorability for cobalt.

OWNERSHIP

The entire area of this investigation is included within the additions to the Arctic National Wildlife Range. The wildlife range was originally established by Public Land Order 2214 on December 6, 1960. As part of the Alaska Lands legislation of December 2, 1980, (PL 96-487) the Marsh Fork area was added to the original classification. The area is administered by the National Fish and Wildlife Service from their field office in Fairbanks. There have been no past recording of mining claims within the general region.

PHYSIOGRAPHY AND CLIMATE

The Marsh Fork flows northward through the rugged northeasterly trending mountains of the eastern Brooks Range (fig. 2). Local relief is frequently in excess of 5000 ft.

Figure 2. - Valley of the Marsh Fork of the Canning River.

The valleys in the region have been well-glaciated. Moraines are common and are particularly well-exposed along the east side of the Marsh Fork valley. Flood plain sediments consist of former till and material reduced by mechanical fracturing and abrasion. Primary river channels such as the Marsh Fork are generally quite braided and occupy valley floors with flood plains up to a mile wide. Secondary creek drainages tend to be steep to cascading in V-shaped valleys and contain little fine sediment. Massive alluvial fans have formed at the base of the steep smaller tributaries as a result of the outpouring of frost-fractured rock.

Climate is arctic alpine, with low precipatation levels. However extended periods of mist, wind and light drizzle are typical in the summer. The snow free period generally extends from mid-June to early September, although snow can occur in any month of the year.

Vegetation is sparse, consisting of tundra on the valley floors and on moderately inclined slopes. Stunted growths of willow and alder brush are found in protected ravines at lower elevations. Rock exposure as bedrock or rubble is extensive. Due to the arctic climate and active erosion there is very little soil development by normal chemical processes.

ACCESS

Access to the report area is limited to air during the summer. Small wheeled aircraft can land on two unimproved gravel bar strips. The village of Kaktovik at Barter Island, approximately 100 mi to the northeast, is the most practical logistical center. The oil field service center at Deadhorse is located an equal distance to the northwest. Communications, lodging, supplies and charter aircraft are available at both localities. Bush plane operation on VFR is most reliable from the two fields to the north since the continental divide to the south is frequently obscure, thus blocking access from more southern bush villages.

REGIONAL GEOLOGY

The geological setting of the Marsh Fork of the Canning River is dominated by its proximity to the regional uplift of the Romanzof Mountains and the complexity of thrust-faulting which is typical of the eastern Brooks Range. The uplift exposes a broad anticlinorium with a core of slightly to moderately metamorphosed Precambrian sedimentary rocks. Within the Romanzof uplift are a diverse group of lithologies known collectively as the Neurokpuk Formation and overlain by poorly defined, lower to mid-Paleozoic rocks. Some previous investigators combined all of these units into an undivided Neruokpuk (10, 2, 7, 9). Middle to late Paleozoic rocks, comprised of the Shublik Formation, the Sadlerochit Group, the Lisburne Group, the Kayak Shale, and the Kekiktuk Conglomerate, unconformably overlie the older rocks as south-southeast dipping, imbricate thrust sheets. Mafic intrusive dikes, basaltic flows and agglomerates in the study area appear to relate to the same period of intrusion and volcanism as described by Sable (12) in the Romanzof region to the east.

Preliminary lithologic descriptions of the local geology are available in the previously cited references and will not be repeated here. The 1981 investigation of potential cobalt mineralization was confined to the shales and sandstones of the Permian to Triassic Sadlerochit Group and to the phyllite-chert member of the Neurokpuk Formation as described by Dutro and others, 1972 (7).

BUREAU OF MINES INVESTIGATION

FIELD WORK

A brief investigation of a portion of the Marsh Fork valley was made in July, 1981. Work was conducted by a three-man team working on foot from a tent camp near an unimproved landing strip. A total of four days were spent working the area which included mapping and geochemical sampling in the vicinity of two small creeks herein referred to as 'Iron' and 'Chert' creeks (fig. 3, in back pocket).

No mineralized exposures or float were found. Tables 1 and 2 and figures 3 and 6 also include data and observations from the 1977-1978 Bureau investigation. Work throughout the area was hampered by extremely poor weather including snow.

SAMPLING AND ANALYTICAL PROCEDURES

Rock samples were usually taken as random chip samples across a geologic unit of interest. The outcrop characteristics of the area covered by the chip sample was recorded, and these are summarized on table 1.

Stream sediment samples were collected with a steel shovel from the finer, sandy portion of the active channel or deepest most active part of a dry creek bed. Both sediment and soil samples were air-dried before screening at -80 mesh and pulverizing to -100 mesh. Float-rock and stream characteristics were noted and recorded at each sample station and are included on table 2.

Analyses were by standard atomic absorption methods for Cu, Pb, Zn, Ag, Mo, and Co unless otherwise noted. Results are tabulated in tables 1 and 2. Based on a review of the geochemical literature and personal analytical experience elsewhere in the Brooks Range, anaomalous values for Co, Cu and Zn were arbitarily choosen to be those levels equal to or greater than 50, 150, 350 ppm respectively.

TABLE 1. - Analyses[1] and description of rock samples - Marsh Fork of the Canning River.

Map No.	Field No.	Ag	Co	Cu	Mo	Pb	Zn	Sample Description
	AW19002	1.1	5	9	2	8	62	South dipping black shale coated with a white precipatate, contains minor disseminated pyrite.
	AW19005	1.8	15	10	<2	24	88	Massive limestone with pyritic chert nodules.
	AW19006	1.4	7	7	<2	14	54	Heavily iron-stained fissile black shale at sediment sample site AW19004.
	AW19009	3.1	12	6	<2	18	170	Chips from fault breccia forming contact between black shale and limestone, abundant calcite veins.
	AW19011	2.3	16	6	<2	26	200	From stained shale and sandstone occurring as rubble parallel to the shale-limestone contact.
	AW19035	0.9	3	4	<2	7	19	Ash-fall tuff occurring as stratified units in shale and black quartzite and containing some boxwork and unidentified black mineral.
	AW19036	4.6	31	5	<2	20	370	Leached ferrugenious sandstone to quartzite with secondary goethite banding.
	AW19037	2.7	5	11	<2	11	57	Iron-stained moderately foliated black shale.
	AW19039	2.5	16	5	<2	25	280	Light colored limestone with up to 5 percent pyrite as disseminations and massive nodules.
	AW19040	2.4	14	220	23	32	205	Black shale with disseminated sulfides at contact with black chert.
	AW19042	1.3	18	83	2	19	34	Gray to black, iron-stained, sheared chert with disseminated pyrite.
	AW19050	1.5	11	15	<2	16	130	Pyritic black shale.
	AW19051	0.6	15	7	<2	22	47	Pyritic black shale from contact with gray massive shale.
	AW19052	0.2	21	4	<2	39	200	Red leached conglomerate rubble near shale contact with the Lisburne limestone.
	AW19053	0.3	7	17	<2	11	66	Pyritic black shale.
	AR11558	<3	---	64	<15	<15	57	Hematite rich basalt with quartz and calcite filled amygdules.
	AR11569	5	25	310	35	200	420	Gouge from fault zone near AR11570.
	AR11570	10	---	3,800	25	<15	42	Resilified breccia zone 18 in thick in chert with disseminated chalcopyrite.

[1] Analyses performed by standard atomic absorption quantitative procedures.

NOTE. - All units reported in parts per million.

TABLE 2. - Analyses of stream sediment samples - Marsh Fork of the Canning River[1]

Map No.	Field No.	Ag	Co	Cu	Mo	Pb	Zn	Sample Descriptions
	AW19001	Ins	12	10	<2	19	120	Sediment from large spring with slight sulfur odor.
	AW19003	1.6	14	14	<2	26	120	Stream gravel is entirely limestone.
	AW19004	Ins	265	62	2	20	1,850	Stream bed cutting across fissile black shale, is heavily iron-stained, no mineralization seen in shale.
	AW19007	Ins	18	26	2	25	185	Stream gravel is entirely barren limestone.
	AW19008	Ins	175	55	<2	19	1,400	Heavily iron-stained stream bed following contact of fissile black shale and massive limestone, no visible source of iron-staining found.
	AW19010	1.2	20	31	<2	18	165	From gulch cutting across iron-stained gray shale.
	AW19012	Ins	100	36	<2	16	1,300	Stream gravel is black shale.
	AW19013	Ins	17	23	<2	15	155	Do
	AW19014	1.1	12	14	2	23	180	Stream gravel is limestone and chert.
	AW19015	1.1	13	19	2	25	180	Do
	AW19016	0.8	12	12	2	24	150	Stream bed follows limestone-shale contact.
	AW19017	Ins	7	17	4	20	61	From saddle downslope of limestone-fissile black shale contact.
	AW19018	Ins	13	8	<2	25	130	Sediment from dry gulch below limestone contact with underlying black shale.
	AW19019	0.9	16	12	<2	25	155	Sediment from dry stream bed cutting brown-black shale.
	AW19020	Ins	15	11	2	23	145	Stream gravel is limestone and shale.
	AW19021	0.4	13	12	2	18	165	Stream gravel is mostly shale with minor limestone.
	AW19022	1.6	15	8	<2	23	150	Stream gravel is mostly limestone with minor shale.
	AW19023	Ins	63	78	<2	19	560	Stream gravel is limestone, black shale and chert with heavy coating of a blue-white slime.

See footnotes at the end of this table.

Map No.	Field No.	Ag	Co	Cu	Mo	Pb	Zn	Sample Descriptions
	AW19024	Ins	63	78	5	24	395	Taken upstream of AW19023 where the blue-white precipatate begins sharply at the confluence of two tributaries.
	AW19025	1.2	11	26	2	20	91	Taken above the white precipatate zone of AW19023-24, stream bed is black shale.
	AW19026	Ins	32	225	3	15	375	Stream bed is shale with limestone and chert, there are traces of a white precipatate and iron-staining at the water edge.
	AW19027	Ins	34	57	3	16	515	Stream bed is limestone with shale and chert.
	AW19028	Ins	670	70	3	18	930	Stream bed is black shale with some thin white coating of the gravel.
	AW19029	0.8	290	93	3	20	1,760	Stream bed is shale with lesser limestone, all with light to moderate iron-staining.
	AW19030	Ins	170	95	3	20	1,630	Stream bed is black shale, occasional limestone, heavy iron-staining, and red gum accumulation.
	AW19031	Ins	27	350	9	28	550	Stream gravel is black, gray to green chert, with light to moderate iron-staining. Some dark gray to black limestone with calcite veins.
	AW19032	Ins	25	265	7	20	330	Do
	AW19038	1.1	73	48	3	19	970	Stream gravel is black shale with no iron-staining above this level.
	AW19041	1.2	16	225	9	37	195	Stream bed draining red and green argillite bedrock, limestone outcrops further upstream.
	AW19054	Ins	17	150	9	29	100	Stream bed drains chert and argillite bedrock.
	AW19055	Ins	17	71	3	25	105	Mostly chert gravel.
	AW19056	Ins	17	300	9	31	180	Mostly chert gravel with some black shale.
	AR 489	<3	2.9	7	<15	20	100	*
	AR 490	<3	5.2	6	<15	15	100	*

See footnotes at the end of this table.

Analyses of stream sediment samples - Marsh Fork of the Canning River[1] - continued.

Map No.	Field No.	Ag	Co	Cu	Mo	Pb	Zn	Sample Descriptions
	AR 491	<3	3.9	6	<15	20	90	*
	AR 492	<3	25.1	32	<15	20	320	*
	AR 493	<3	27.7	5	<15	25	50	*
	AR 494	<3	4.7	5	<15	<15	71	*
	AR 495	<3	7.2	12	<15	15	89	Rusty weathering, finely laminated siltstone in float.
	AR 496	<3	13.2	74	<15	25	130	*
	AR 497	<3	22.3	150	<15	35	255	*
	AR 498	<3	24.5	110	<15	25	170	*
	AR 499	<3	9.6	15	<15	20	140	Sooty limestone in float.
	AR 500	<3	12.9	44	<15	15	120	*
	AR 582	<3	10.2	14	<15	15	140	*
	AR 583	<3	18.9	75	<15	25	130	*
	AR 584	<3	24.0	83	<15	25	135	*
	AR 585	<3	28.0	90	<15	30	145	*
	AR 586	<3	11.2	16	<15	<15	130	Fissile, iron-stained, gray shale and siltstone in streamside talus.
	AR 587	<3	33.1	43	<15	20	500	*
	AR 588	<3	45.9	40	<15	15	470	Stream flows over bedrock of black shale. Shale weathers orange.
	AR 589	<3	6.4	14	<15	20	130	*
	AR 597	<50	NA	<50	<300	<300	<100	*
	AR 598	<3	4.3	8	<15	<15	65	*
	AR 600	<3	5.4	8	<15	<15	95	*
	AR 609	9	9.5	32	<15	40	200	Float is vein quartz, black shale, chert, limestone and conglomerate.
	AR 610	<3	7.9	11	<15	15	105	Iron-stained shales in outcrop.
	AR 611	<3	13.6	335	<15	30	320	Abundant disseminated pyrite in black shale bedrock.
	AR 631	<3	6.6	11	<15	<15	120	*

See footnotes at the end of this table.

Map No.	Field No.	Ag	Co	Cu	Mo	Pb	Zn	Sample Decriptions
	AR 632	<3	2.8	5	<15	<15	55	Malachite, pyrite, and chalcopyrite found in outcrop near stream.
	AR 633	<3	11.2	8	<15	20	130	*
	AR 634	<3	12.5	10	<15	15	135	*
	AR 635	<3	5.0	7	<15	<15	100	*
	AR 636	<3	11.3	13	<15	15	175	*
	AR 637	<3	2.6	3	<15	<15	45	*
	AR 639	<3	64.5	9	<15	<15	70	*
	AR 640	<3	5.2	5	<15	<15	75	*
	AR 641	<3	14.7	14	<15	30	190	'Greasy' shale in stream sediments.
	AR 642	<3	2.1	3	<15	<15	40	*
	AR 643	<3	5.2	4	<15	15	60	*
	AR 645	<3	7.5	10	<15	20	120	*
	AR 646	<3	15.4	13	<15	35	140	Slight iron-staining in creek. Some black shale in creek float.
	AR 2824	<3	9.9	9	<15	20	105	*
	AR 2926	<3	3.7	4	<15	<15	50	*
	AR11556	<3	19.3	225	<15	40	190	Stream float is red and green phyllite, gray chert, black chert. Pyrite in green phyllite.
	AR11560	<3	17.8	110	<15	25	145	Chert breccia, limestone, fine-grained black phyllite, and hematite-rich basalt in float.
	AR11564	<3	16.1	145	<15	45	200	Sample taken below the red zone.
	AR11565	<3	26.0	195	<15	30	375	Stream bedrock is conglomerate of quartz pebbles in a quartz matrix.
	AR11566	<3	18.8	280	<15	40	440	*
	AR11567	<3	26.9	34	<15	45	200	*
	AR11572	<3	8.5	10	<15	15	110	Float is predominately sooty black shale.
	AR11573	<3	14.0	41	<15	25	240	Quartz, quartzite and iron-stained green to black chert.
	AR11574	<3	19.6	125	<15	35	290	Iron-stained chert bedrock.

See footnotes at the end of this table.

Analyses of stream sediment samples - Marsh Fork of the Canning River[1] - continued.

Map No.	Field No.	Ag	Co	Cu	Mo	Pb	Zn	Sample Descriptions
	AR11576	<3	16.1	72	<15	30	170	Chert bedrock. Interlayered black and green. Black chert contains disseminated pyrite.
	AR11577	<3	15.5	130	<15	45	150	Very heavily vegetated area.
	AR11578	<3	17.6	190	<15	50	160	*
	AR11579	<3	30.8	270	<15	40	490	Creek slightly iron-strained.
	AR11580	4	75.4	930	<15	50	910	*
	AR11582	<3	14.2	89	<15	25	82	*
	AR11583	<3	16.6	120	<15	30	97	Argillite.
	AR11584	<3	23.5	85	<15	25	130	Stream float is iron-stained.
	AR11585	<3	14.1	93	<15	25	180	*
	AR11589	<3	17.9	17	<15	30	160	Shale, black brecciated chert.
	AR11590	<3	16.1	21	<15	30	180	Outcrop of massive gray shale.
	AR11591	<3	11.6	27	<15	25	120	Large quartz boulders. Shale and limestone predominate.
	AR11592	<3	8.9	21	<15	20	150	Float is black shale and gray quartzite. Limestone outcrops at head of stream.
	AR11595	<3	7.9	15	<15	30	100	Some iron-staining on black shales in stream.
	AR11596	<3	82.4	45	<15	25	1100	Do
	AR11598	<3	101.4	40	<15	20	1500	Boggy area.
	AR11599	<3	10.6	18	<15	20	110	Outcrop of gray shales nearby.
	AR11601	<3	26.5	28	<15	45	190	*
	AR11605	<3	17.1	25	<15	40	210	Large quartzite boulders among shales float.
	AR11606	<3	5.6	9	<15	30	130	Minor limestone with pyrite. Most of float is shale.
	AR11607	<3	NA	7	<15	25	64	*
	AR11610	<3	14.2	16	<15	25	170	Quartzite in stream is highly fractured with quartz veining.
	AR11611	<3	9.5	8	<15	20	110	Brecciated chert and pyritic limestone as float.
	AR11612	<3	3.1	8	<15	30	64	Float is shale with occasional pyrite nodules.
	AR11613	<3	17.9	24	<15	35	215	Float is shale.
	AR11614	<3	26.2	210	<15	25	480	*

See footnotes at the end of this table.

Map No.	Field No.	Ag	Co	Cu	Mo	Pb	Zn	Sample Descriptions
	AR11615	<3	17.2	240	20	50	140	*
	AR11616	<3	14.5	85	<15	20	97	Red-stained area at the head of the creek.
	AR11617	<3	17.5	145	15	45	125	*
	AR11618	<3	24.7	140	<15	30	160	From just below a color anomaly in the dolomite and sandstones.
	AR11625	<3	9.0	15	<15	25	140	Pyritic nodules in chert float.
	AR11626	<3	7.6	12	<15	25	88	Float is shale with prominant quartz veining.
	AR11628	<3	23.0	110	<15	35	150	Bedrock is chert, and red and green phyllite.
	AR11629	<3	15.2	100	<15	35	140	Chert, quartzite, green argillite float.
	AR11630	<3	NA	210	<15	30	320	Do
	AR11631	<3	24.2	290	<15	35	370	Chert.
	AR11632	<3	28.8	74	<15	20	97	Outcrop of green phyllite. Heavily iron-stained chert.
	AR11633	<3	31.3	95	<15	25	100	Red and green phyllite.
	AR11634	<3	20.5	170	<15	35	130	Chert breccia. Some specimens contain dolomite.

[1] Analyses performed by standard atomic absorption quantitative analytical procedures except for Co in samples AR489 to AR11634 which was analyzed by neutron activation.

NOTE. - All units reported in parts per million.
* Sample locations where stream aggregate is a typical, non-descript mix of local lithologies.

MINERAL INVESTIGAITON OF THE 'IRON' CREEK AREA

The valley of 'Iron' Creek is underlain by a complexly folded synclinal structure of Sadlerochit shale, quartzite, siltstone and sandstone (fig. 4). There is no known mineralization in the area. Previous USBM samples collected in 1978 (1), from 'Iron' Creek and several adjacent ravines, however, indicated anomalous (2 - 10 x background) stream sediment concentrations of Zn, Cu and Co.

The 1981 data reconfirmed anomalous values for Co, Zn and Cu. The local terrain is typified by a more recessive topography due to the higher susceptibility of the shales to weathering than the adjacent Lisburne Limestone. Overturned bedding is observable along the southern side of the valley. The fold structure is interpreted to overlie the southern limb of the syncline with a thrust fault contact (fig. 4).

Figure 4. - Folding in Sadlerochit Shale - looking west along axis of syncline. A thrust fault dipping to the left is interpreted to underly the overturned shales.

The shale is dark gray to black in color, micaceous, and typically has a high degree of fissility. While shales predominate, there are also bedded horizons of fine-grained black quartzite and siltstone. The basal zone as exposed along the north limb of the syncline is composed of a higher percentage of massive, fine grained (<0.1 mm) sandstone and siltstone strata. The basal zone is locally ferruginous (fig. 5) with an iron-oxide matrix. In thin-section the sandstone is composed of quartz, chert, calcite and feldspar grains, which are sub-rounded to angular in shape.

At rock sample location AW19035 (fig. 3), an outcrop of black quartzite was interbedded with light-colored bedded material tentatively identified as ash-fall tuff. Extensive devitrification has altered the glass to epidote. The light-colored beds also contained a dissemination of diatom replacements.

Figure 5. - Ferruginous sandstone and shale of the Sadlerochit overlaying the Lisburne Limestone on north limb of syncline. Structure dips to the left of photo.

Locally, shale outcrops exposed along 'Iron' Creek contain disseminated nodular pyrite, which result in weathering surfaces coated with light-colored mineral salts and iron encrustations. No sulfides other than pyrite were observed. The pyrite appears to be the cause of the intense iron-staining in the stream beds of the lower valley of 'Iron' Creek (fig. 3). While certain shale and sandstone strata were ferruginous as in figure 5, there were however, no exposures of true gossan. Bedrock samples were collected of a variety of pyritic, iron-stained, altered or ferruginous lithologies to determine if other sulfide minerals may have been present or if anomalously high backgrounds of Ag, Cu, Co, and Zn were persistent in these rock types. Results shown on table 1, indicated only the sample of a ferruginous sandstone (AW19036R), contained element concentrations of Ag, Co, and Zn slightly above background.

The 1981 stream sediment sampling (fig. 6, in back pocket) indicated concentrations of Co, Cu and Zn range up to 670, 225 and 1850 ppm respectively. There was a close association of the higher values with the chemical preciptitions and coatings in the stream beds. The lower segment of 'Iron' Creek was heavily stained with blood-red iron coatings. Proceeding upstream this dissipated gradually until reaching the vicinity of sediment samples locations AW19023 and AW19028 (fig. 7) where a thick blue-white slime coating was encountered.

This flocculent white precipitate was discovered to originate abruptly several hundred feet further upstream at the confluence of two smaller tributary streams. Litmus paper tests revealed that these two streams differ substantially in pH.

Stream sediment samples were collected so as to avoid inclusion of the blue-white precipitate.

Figure 7. - Blue-white precipitate coating in creek bed.

MINERAL INVESTIGATIONS OF THE 'CHERT' CREEK AREA

Copper mineralization occurring as minor pods and disseminations was identified in the upper 'Chert' Creek area (fig. 3). The host rocks are pre-Mississippian in age and unrelated to the Permian-Triassic bedrock described previously. Structurally, pre-Mississippian units consist of a wedge of metasediments and volcanics identified as the chert-phyllite member of the Neruokpuk Formation [see type-section description by Dutro (7)]. This member is bounded by Triassic to Mississippian units to the north and west. Intersecting lineations visible on Landsat imagery appear to separate the younger overturned (Lisburne and Shublik) units from the older rocks. Remnant Mississippian, Kayak Shale and Kekiktuk Conglomerate strata lie unconformably over the older chert-phyllite metasedimentary units. East-west trending folds which appear to plunge to the southwest are the major structural control of all of the geologic units.

Fractured, brecciated and resilicified cherts outcroping in a small canyon (AR 11570, fig. 3) contain minor amounts of chalcopyrite, pyrite, malachite, graphite, siderite (?) and zinc oxides in scattered pods and fracture fillings. The mineralization appears to be restricted to the upper 50 ft of the chert unit and was found intermittently wherever this stratigraphic level was exposed. A fracture zone that is nearly vertical to the bedding, about 18 in. in width and exposed for approximately 150 ft was channel sampled and found to contain 0.38% copper and 0.24 oz/ton of silver (AR11558). This was the most consistently mineralized zone observed. Other steeply dipping fractures show evidence of shearing and clay alteration. Gouge from one such fracture (AR 11569) contained 0.031% Cu, 0.02% lead, 0.042% zinc, and

0.12 oz of silver. No cobalt above normal background levels of concentration was detected in any of the 'Chert' Creek samples.

DISCUSSION

The ability of hydrous iron and manganese oxides to scavenge minor elements, in an aqueous environment is described by Hawkes and Webb, 1962 (8, pp. 120-122) and by other geochemical investigators. In some cited example situations anomalous stream sediment values can be attributed to only normal elemental background concentrations in upstream bedrock. Zinc, particularly, is quite mobile and cobalt, to a lesser extent, is also. It is likely that the zinc anomalies in lower 'Iron' Creek are due to the iron oxide sediment in the stream bed.

The white precipitate observed on the bed of Iron Creek are probably hydrous aluminum oxides and/or aluminum sulfates. This material may well be formed by a sequence of events postulated by Ansheles [sited in Theobald, et.al., 1962 (14)] involving (1) oxidation of pyrite, releaseing sulfuric acid into the stream, (2) decomposition of clays by the acid, releasing aluminum, and finally (3) precipitation of the aluminum when the acidic waters are neutralized. It is likely that the anomalous concentrations of cobalt, copper and zinc in upper 'Iron' Creek are a result of the ability of the aluminum-rich precipitate to absorb these elements (14).

While some sort of metal scavenging may well be taking place the possibility of stratiform or tectoniccontrolled mineralization can not yet be ruled out. The copper anomaly in the upper southern headwaters of 'Iron' Creek is indicative of a closer and anomalous source of the metal ions.

Further investigation is recommended in the upper headwaters of 'Iron' Creek, particularly along the trace of the interpreted thrust fault (fig. 3, in back pocket).

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fig 3

Overturned bedding

EXPLANATION*

Thrust Fault (teeth indicate the upper plate), dashed where inferred

Contact between prevailing rock types, dashed where inferred.

Linear visable on ERTS imagery, dashed where uncertain.

x Coal — Mineral occurence

28 — Strike and dip of sedimentary beds

Anticline

R — Local iron staining

B — Breccia

o 19010 — Rock sample location - see table 1

*For statigraphic and geologic correlation, refer to Reiser et al., 1971 (45) and Brosge and Reiser 1965 (17).

Very fissile black shales, partially calcareous; local areas of clay - ironstone nodules; pyrite and/or blue/white phosphate stain and gypsum crystals appear frequently.

Fissile to massive black shales which locally grade to fine sandstone, slate and quartzite. Pyrite nodules occur in some shale stratas.

Massive gray limestone, fine to medium grain size. Contains minor cherts and black chert nodules. Appears to correlate to the Wahoo and Alapah Limestones of the Lisburne Group.

Black fine grained shale grading to phyllite, locally highly sheared. Unit contains several anthracite coal occurrences as discontinuous lenses.

Limestones not of the Lisburne Group. The locality exposed on the east bluff of the Marsh Fork is reported to contain Lower Cambrian Trilobites (45).

Light colored quartzite, often poorly sorted; zones of subrounded quartz pebbles.

slants wrong way

Gray to black and green cherts. Interbedded dolomite, limestone and argillites. Shown only where chert predominates. Frequently ironstained and occassionally pyritic and brecciated.

Dolomite, generally orange weathering; frequently brecciated; locally appears to grade to chert.

Sandstone.

Maroon and green argillites and phyllites; some interbedded cherts and calcareous sandstones. Includes stratas of red argillite and jasperoid (?) chert up to approximately 150 feet thick.

Mafic volcanics; basalts containing carbonate and hematite; basaltic/andesitic flow rock.