GEOLOGICAL SURVEY OF CANADA

DEPARTMENT OF MINES AND TECHNICAL SURVEYS

PAPER 63-32

RECONNAISSANCE HEAVY-MINERAL STUDY IN NORTHERN YUKON TERRITORY

(Report and One Figure)

C. F. Gleeson

Price 35 cents

1963

GEOLOGICAL SURVEY

OF CANADA

CANADA

PAPER 63-32

RECONNAISSANCE HEAVY-MINERAL STUDY IN NORTHERN YUKON TERRITORY

By

C.F. Gleeson

DEPARTMENT OF

MINES AND TECHNICAL SURVEYS

CANADA

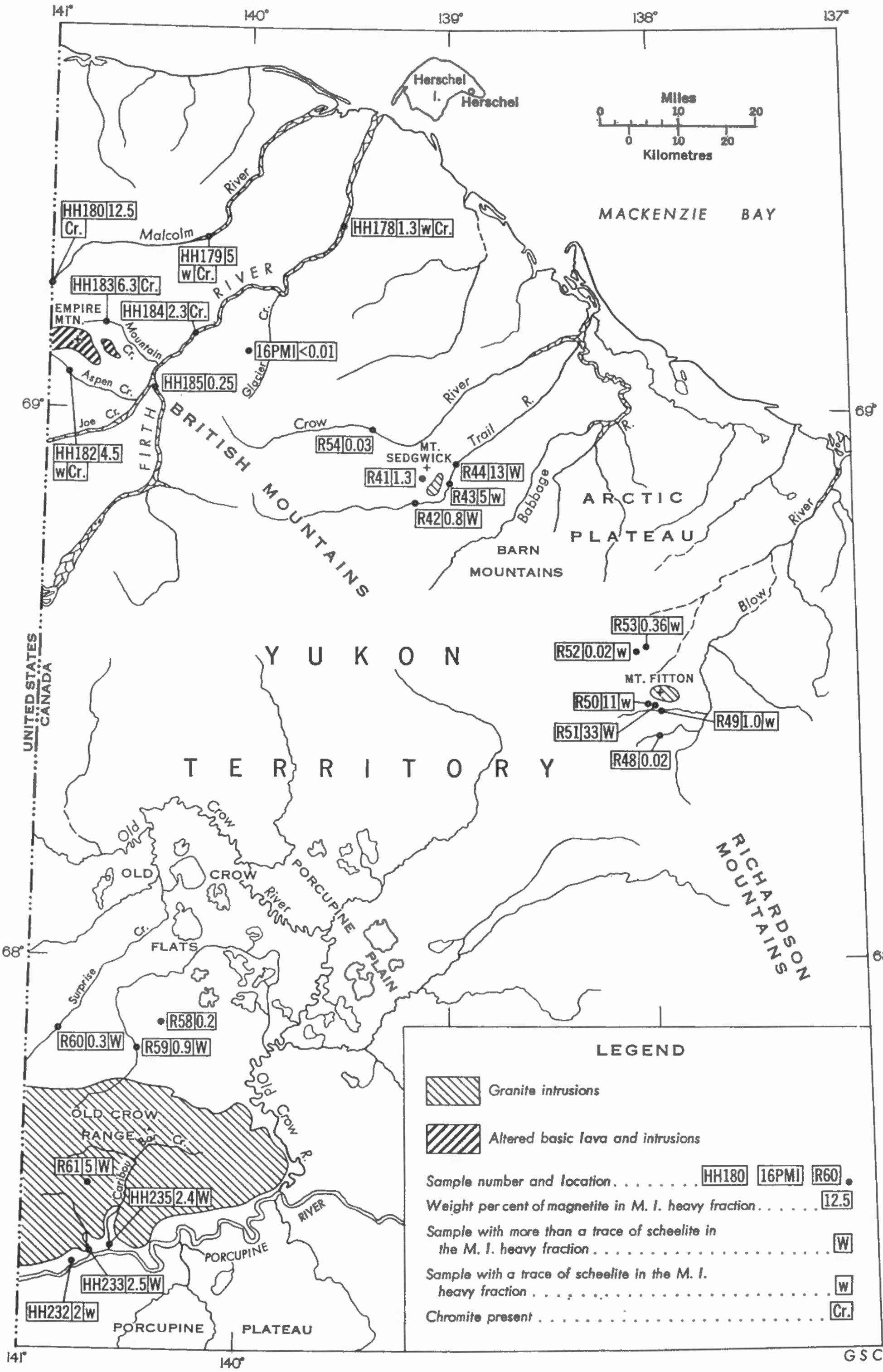

Figure 1. Locations of heavy-mineral samples and the presence of certain minerals in the -4mesh methylene iodide heavy fraction

RECONNAISSANCE HEAVY-MINERAL STUDY NORTHERN YUKON TERRITORY

INTRODUCTION

In 1962 geologists from the Geological Survey of Canada mapped an area in northern Yukon Territory and northwestern District of Mackenzie between lats. 65° and 70° and longs. 132° and 141°. This project was called Operation Porcupine.

In conjunction with the mapping, heavy-mineral samples were obtained from areas comprised of plutonic and extrusive rocks. Most of the samples were taken from stream and river gravels and several were procured from weathered bedrock. This report deals with a study of the heavy-mineral products from these samples.

ACKNOWLEDGMENTS

O.L. Hughes, V.N. Rampton and R.M. Procter collected the samples; J.C. Paris and staff made the heavy-liquid separations; and R.N. Delabio made the X-ray identification of minerals. All are on the staff of the Geological Survey of Canada.

PHYSIOGRAPHY

The dominant physiographic feature of the area is the Arctic Mountain region. This includes British Mountains, Barn Mountains, and the north part of Richardson Mountains, separated by the Arctic Plateau. Old Crow Range to the southwest is bordered on the east and north by Old Crow Plain, a part of Porcupine Plain. This range forms part of the north limit of Porcupine Plateau (Bostock, 1948).

The area sampled is unglaciated except for a small part at the head of Malcolm River[1].

GEOLOGY

The geology of the area has been described by Norris (1963). In general the rocks of the plateau and mountain areas are

---

[1] O.L. Hughes, personal communication.

Palaeozoic and Mesozoic sandstones, conglomerates, limestones, and shales. The plains are underlain by mud, silt, sand and coal deposits of Tertiary and Quaternary age. Porphyritic granites outcrop on Mount Sedgwick, Mount Fitton, and Old Crow Range. Serpentinized mafic volcanic rocks outcrop within the Neruokpuk sediments at Empire Mountain. These mafic rocks extend west into Alaska and form a belt 1 mile to 5 miles wide and about 50 miles long (Brosgé, 1962).

According to Norris (1963) most of the deformation in the area is probably of Larimide age.

METHODS OF INVESTIGATION

Twenty-two gravel samples were taken from the bars and bottoms of the streams and rivers. In addition three samples were taken of decomposed bedrock and one from an old beach in Old Crow plains. The locations of these samples are shown in Figure 1.

Two to four, 16-inch gold pans of material were worked carefully so that the loss of heavy minerals was at a minimum. The heavy-mineral concentrates were bagged and shipped to Ottawa.

In the laboratory the pan-concentrate was passed through a 4 mesh screen. The +4 mesh and -4 mesh fractions were each separated in a solution of bromoform (S.G. 2.89) into a light and heavy fraction. Each heavy fraction was further separated in methylene iodide (S.G. 3.3). The heavy residue from this last separation was dried, weighed, and the magnetite removed with a Sepor Automagnet. The magnetic fraction was weighed and its weight per cent calculated.

The non-magnetic fraction was examined under a binocular microscope and a visual estimate was made of the amount of each heavy mineral present. This figure was recorded as a volume per cent.

Many of the minerals that could not be identified easily under the petrographic or binocular microscope were submitted for X-ray diffraction analysis. An ultra-violet light was used to aid in determining scheelite.

Although the above technique is not a precise method for quantitative heavy-mineral analysis, it is rapid and practical for this type of preliminary study.

RESULTS OF THE INVESTIGATION

The results of this study are summarized in Table 1. The samples are divided into four groups as follows (see Figure 1):

1. Mount Sedgwick area, sample numbers R41 to R44 and R54,

2. Mount Fitton area, sample numbers R48 to R53,

3. Old Crow Range area, sample numbers R58 to R61, HH232, 233, and 235,

4. Empire Mountain area, sample numbers HH178 to HH185 and 16PM1.

Seven of the twenty-six heavy-mineral concentrates, three of which are from soil samples, contain no coarse fraction (+4 mesh). Six samples, all but one of which occur in the Empire Mountain area, contain coarse material that can be separated with a hand magnet. In that area the magnetic product is made up of subrounded pebbles of basic volcanic rock with various amounts of magnetite. The three samples closest to Empire Mountain (HH180, 182, 183) contain no other coarse heavy particles.

Sixteen of the samples have a non-magnetic coarse fraction. The minerals in this fraction are well rounded to subrounded, and goethite, limonite, and hematite are the commonest. Brownish red, grossularite type garnet occurs in two samples from Trail River in the Mount Sedgwick area. One sample (R53) near Mount Fitton includes a black rounded pebble of manganite.

The only other coarse heavy mineral is pyrite, found in samples HH232 and 233. On the weathered surface the pyrite is dull black and submetallic but on a fresh surface it is metallic and silver-yellow.

The magnetite in the -4 mesh fraction (see Figure 1) is black and variously rounded. The quantity in the streams and rivers draining Empire Mountain is generally high and several samples from the vicinity of the granite masses contain over 2 per cent by weight of the methylene iodide heavy fraction.

Three samples from the area between Mount Sedgwick and the Firth River contain one or more micrometeorites, 0.02 mm to 0.05 mm in diameter. These balls are black, metallic, and shiny. An X-ray determination on one from Mount Sedgwick showed it to be a mixture of magnetite and olivine. These microscopic size meteorites are either cosmic dust or material ablated from the surfaces of meteorites during their passage through the atmosphere.

SAMPLE NO.	LOCATION	SIZE FRACTION (mesh)	WEIGHT OF M. I. HEAVIES (gms.)	WEIGHT PER CENT OF HAND MAGNETICS (magnetite) IN M. I. HEAVIES	VOLUME PE						
					Goethite-Limonite	Hematite	Chromite	Ilmenite	Siderite	Pyrite	Manganit
R41	68° 53'N 139° 08'W										
		-4	1.57	1.3	95					1	
R42	68° 50'N 139° 10'W	+4	18.95		99.5	0.5					
		-4	45.01	0.8	92.5	5				Tr	
R43	68° 52'N 139° 00'W	+4	5.76		75						
		-4	6.86	5.0	95					Tr	
R44	68° 54'N 138° 58'W	+4	0.69								
		-4	99.05	13.0	54	Tr				1	
R54	68° 57'N 139° 23' W	+4	0.23		100						
		-4	7.17	0.03	82	15		Tr		Tr	
R48	68° 24.3'N 137° 59'W	+4	0.69		100						
		-4	42.80	0.02	68					1	30
R49	68° 27'N 137° 58'W	+4	2.39		30	70					
		-4	22.23	1.0	42	25				1	30
R50	68° 27.7'N 138° 02'W										
		-4	0.81	11.0	22					1	
R51	68° 27.5'N 138° 01'W	+4	0.24		100						
		-4	0.91	33.0	51					7	
R52	68° 33.7'N 138° 05'W	+4	0.13		100						
		-4	8.24	0.02	77	20					
R53	68° 34'N 138° 25'W	+4	0.44		50						50
		-4	8.51	0.36	65	20				1	10
R58	67° 53'N 140° 21'W	+4	0.53		100						
		-4	1.46	0.20	83	5		1		Tr	
R59	67° 50'N 140° 28'W										
		-4	8.86	0.90	45	10					
R60	67° 52'N 140° 51'W										
		-4	1.60	0.30	30			20		Tr	
R61	67° 35'N 140° 41'W										
		-4	2.80	5.0	40	10					
HH232	67° 26.5'N 140° 45'W	+4	23.09	1.0	80	15				5	
		-4	27.48	2.0	50	10		Tr	20	15	1
HH233	67° 27.5'N 140° 41'W	+4	3.41		80					20	
		-4	58.24	2.5	40			1		55	
HH235	67° 28.5'N 140° 36'W	+4	2.85		100						
		-4	19.03	2.4	68	5			20	2.5	
HH179	69° 18.5'N 140° 12.5'W	+4	20.30	99.9(a)		100					
		-4	8.56	5.0	55	15	15			Tr	
HH180	69° 13'N 141° 00'W	+4	4.07	100(a)							
		-4	19.31	12.5	Tr	45	20				
HH178	69° 20'N 139° 31.5'W										
		-4	14.02	1.3	63	20	10			0.5	
HH184	69° 08'N 140° 16.5'W	+4	7.99	60(a)	65	35					
		-4	13.33	2.3	20	60	10			1	
HH185	69° 02.5'N 140° 27'W	+4	25.95		73	27					
		-4	11.84	0.25	25	69		5		Tr	
HH182	69° 03.5'N 140° 54'W	+4	4.29	100(a)							
		-4	12.24	4.5		40	15				
HH183	69° 09'N 140° 43'W	+4	2.33	100(a)							
		-4	27.75	6.3		55	10				
16PM1	69° 06.3'N 140° 00'W										
		-4	1.11	Tr	90	0.5				0.5	

(a) Magnetic pebbles, magnetite in basic volcanic pebbles

Tr .... Trace

Table

MINERALS IN NON-MAGNETIC FRACTION										REMARKS	AREA
Clino-Pyroxene	Hyperstene	Hornblende	Tremolite	Barite	Zircon	Anatase	Sphene	Rutile	Scheelite		
				Tr	4					Mount Sedgwick - Soil. 2 pans one micrometeorite, 0.05 mm diameter	Mount Sedgwick
				Tr					0.5	Trail R. (tributary of Babbage R.) Gravel, 3 pans	Mount Sedgwick
				1			1		Tr	Trail R. (tributary of Babbage R.) Gravel, 3 pans	Mount Sedgwick
		Tr		3			Tr		2	Trail R. (tributary of Babbage R.) Gravel, 3 pans Trace of Smithsonite	Mount Sedgwick
Tr				1	2	Tr				Crow R. (tributary of Babbage R.) 2 micrometeorites 0.02 mm, 0.04 mm diameter Gravel, 3 pans	Mount Sedgwick
				1						Tributary of Blow R. Gravel, 3 pans	Mount Fitton
				2					Tr	Tributary of Blow R. Gravel, 3 pans	Mount Fitton
		1		1	.20		20	Tr	Tr	Mount Fitton area Gravel, 2 pans	Mount Fitton
				1	5		5	1	10	Tributary of Blow R. Gravel, 3 pans	Mount Fitton
				2					Tr	Tributary of Blow R. Gravel, 3 pans	Mount Fitton
				1	Tr		Tr		Tr	Tributary of Blow R. Gravel, 3 pans	Mount Fitton
					1					Beach on Old Crow Plain Sand, 2 pans	Old Crow Range
	Tr	1			5			Tr	2	Tributary of Old Crow R. Gravel, 3 pans	Old Crow Range
	Tr	Tr	Tr	Tr	3	Tr	1		1	Surprise Cr. (tributary of Old Crow R.) Gravel, 3 pans	Old Crow Range
Tr					3				2	Old Crow Granite Soil, 2 pans 10% Muscovite aggregate	Old Crow Range
	Tr			3	Tr				Tr	Tributary of Porcupine R Gravel, 2 pans	Old Crow Range
	Tr			1	Tr	Tr			1	Tributary of Porcupine R. Gravel, 2 pans	Old Crow Range
				1	1	Tr			0.5	Caribou Bar Cr. (tributary of Porcupine R.) Gravel, 2 pans	Old Crow Range
10				1	0.5	Tr			Tr	Malcolm R. Gravel, 2 pans	Empire Mountain
25				Tr	Tr					Malcolm R. Gravel, 2 pans	Empire Mountain
2				1	Tr	Tr	Tr		Tr	Firth R, Gravel, 2 pans	Empire Mountain
5				Tr	Tr					Firth R. Gravel, 2 pans	Empire Mountain
Tr				Tr	Tr					Firth R. Gravel, 2 pans	Empire Mountain
40				Tr	Tr				Tr	Aspen Cr. (tributary of Joe Cr.) Gravel, 2 pans	Empire Mountain
30				Tr	Tr					Mountain Cr. (tributary of Firth R.) Gravel, 2 pans	Empire Mountain
Tr				1	2	1	Tr	Tr		Tributary of Glacier Cr. - tributary of Firth R. One micrometeorite 0.05 mm diameter Gravel, 4 pans	Empire Mountain

frequencies

The non-magnetic heavy minerals in the -4 mesh part of the samples are more angular than those from the +4 mesh part. Goethite, limonite, hematite, manganite, and some pyrite are the only minerals that show appreciable rounding.

1. MOUNT SEDGWICK AREA

Opaque Minerals (-4 mesh, non-magnetic fraction)

All the samples taken in the Mount Sedgwick area contain appreciable amounts of goethite and limonite. These minerals occur as well rounded medium to coarse grains of various shades of brown. Some of the goethite is pseudomorphic after pyrite.

Hematite resembles goethite and limonite but has a red streak and is always dark brown to reddish brown. Three of the gravel samples from the vicinity of Mount Sedgwick contain a trace, 5 per cent, and 15 per cent hematite.

Only one sample contains a trace of ilmenite. Pyrite, although present in all samples of this group occurs in amounts never exceeding 1 per cent. It is yellow, metallic, and angular except in samples R54 where it occurs as black rod-like forms.

Non-opaque Minerals (-4 mesh, non-magnetic fraction)

Grossularite garnet and epidote are abundant in R44 and are present in lesser amounts in the two samples upstream from R44. The garnet grains are dark, glassy, brownish red, and angular and most are medium sized. The epidote is angular to subangular, yellowish green, and in grains of medium size.

Fine-grained zircon makes up an estimated 4 per cent of the heavy component of soil sample R41 and 2 per cent of the heavy component in gravel sample R54. In the former the zircon occurs as short, dirty-grey, euhedral crystals and in the latter as subrounded, colourless and transparent grains. Zircons from R41 do not fluoresce but those in R51 fluoresce yellow.

Barite is found in amounts varying from a trace to 3 per cent. Its white colour, perfect cleavage, and angular appearance distinguishes it from other heavy minerals. It is present in fine- to medium-sized grains.

Scheelite occurs in this fraction of the three samples from Trail River. It is white, anhedral, and is distinguished by its white fluorescence under ultraviolet light.

Fine- to medium-grained, angular, subhedral to euhedral, flattened, brown crystals of sphene occur in R43 and R44.

A trace of clinopyroxene and a trace of hornblende is present in samples R54 and R44 respectively.

2. MOUNT FITTON AREA

One soil and five gravel samples were taken from this area.

Opaque Minerals (-4 mesh, non-magnetic fraction)

Again goethite and limonite are the most abundant heavy minerals, but hematite is also present in noticeable amounts. These minerals have the same properties as those from the Mount Sedgwick area.

A rounded, dull-black, medium- to coarse-grained mineral, with a sooty-black streak proved to be manganite. It is common in gravel samples R48, R49 and R53. Very faint X-ray patterns were obtained on this mineral and it is probable that much of the manganese is amorphous.

Pyrite is present in all but one sample. It is in dull-black, medium-grained, rod-shaped and rounded masses that have a silvery yellow colour and metallic luster on a fresh surface. Yellow pyrite is present also in trace amounts.

Non-opaque Minerals (-4 mesh non-magnetic fraction)

Angular, reddish brown grains of grossularite garnet occur in samples R50 to R53. It is most common in R50 and R51, which contain 15 and 10 per cent of it respectively. These two samples also contain appreciable amounts of epidote.

Barite, similar in appearance to that noted previously, makes up 1 to 2 per cent by volume of the heavy minerals in this fraction.

Yellowish zircon and brown sphene are common in soil sample R50 and gravel sample R51. The zircon is present in fine euhedral crystals and the sphene occurs as medium to fine flattened euhedral grains. Black, fine-grained, striated, prismatic, crystals of rutile are present in small quantities in these two samples. In addition green hornblende makes up 1 per cent of sample R50.

Five of the samples from Mount Fitton area contain scheelite. It is plentiful in sample R51 but occurs only in trace amounts in the other samples. It is white, anhedral, fine-grained, and fluoresces white.

A limited amount of prospecting was done in the vicinity of Mount Fitton by the late Anker Hoidahl. The author studied a sample of placer concentrate from Hoidahl's property and found that it contained abundant wolframite and scheelite, a little gold, and a trace of molybdenite. A sample of nearby granite contained medium-sized flakes of molybdenum.

3. OLD CROW RANGE

One soil, one beach-sand, and five gravel samples were taken from the north and south parts of Old Crow Range.

Opaque Minerals (-4 mesh, non-magnetic fraction)

Well rounded brown goethite and limonite are common in all samples of this fraction, which comprises most of the coarse fraction of the -4 mesh material.

Hematite is recorded in all but two samples. Some of it resembles goethite but some is black and shiny; all of it has a red streak.

Ilmenite in black, shiny, metallic grains is common in the medium-grained part of R60, and is present in small quantities in three other samples.

Yellow, metallic grains of pyrite occur in trace amounts in R58 and R60 but pyrite is plentiful in black, rod-like, and rounded medium- to coarse-grained particles in samples HH232, 233 and 235. Over half of the heavy minerals in HH233 is pyrite of this sort.

Siderite is common in samples HH232 and HH235. It forms reddish brown, medium-sized balls that have a radiating internal structure.

Manganite similar to that found in R48 and R49 is present in HH232.

Non-opaque Minerals (-4 mesh non-magnetic fraction)

Five samples contain garnet but only two samples (R59, R60) have more than 1 per cent of this mineral. Both the grossularite and a light pink variety are present. Epidote is recorded in every sample of this fraction and is abundant in samples R58 to R61. It is in medium- to fine-grained, anhedral to subhedral, yellowish grains. Barite in white, angular, medium to fine grains occurs in minor amounts in samples HH232, 233, 235 and as a trace in R60. Zircon, in colourless, euhedral, fine grains, is present in all samples from the Old Crow Range. All the gravel samples and the one soil sample contain small amounts of scheelite. Minor to trace quantities of anatase, hypersthene, clinopyroxene, tremolite, hornblende, and sphene occur in various samples from this area.

4. EMPIRE MOUNTAIN AREA

Opaque Minerals (-4 mesh, non-magnetic fraction)

All but three samples from this area carry abundant mixtures of yellowish brown to dark brown goethite, limonite, and reddish brown hematite. The three samples HH180, 182 and 183, although they contain very little goethite and limonite, carry appreciable amounts of hematite and chromite (see Figure 1). The latter occurs as black, metallic, shiny, slightly magnetic, fine- to medium-grained angular fragments, and euhedral crystals.

Small amounts of yellow pyrite occur in most samples from this series but none is present in samples from the immediate vicinity of Empire Mountain. Ilmenite is present in one sample from the Firth River (HH185).

Non-opaque Minerals (-4 mesh, non-magnetic fraction)

Clinopyroxene is found in all samples of this series but it is particularly abundant near Empire Mountain. The pyroxene occurs as medium- to fine-grained angular fragments which are glassy and medium green in colour. Epidote forms white to yellowish green anhedral fragments in the medium- to fine-grained part of the fraction. All samples contain epidote but it is more common in the samples near Empire Mountain (HH180, 182, 183). Sample 16PM1 is the only one that has an appreciable amount of garnet. It is usually fine-grained and angular. Most of it is pink but several brownish red grains are also present. The zircon in 16PM1 occurs as fine, colourless transparent, subrounded grains that have subhedral to euhedral crystal shapes. It fluoresces yellow. The rest of the samples in this group contain trace amounts of zircon. Barite, anatase, sphene, and scheelite occur in small quantities in various samples.

CONCLUSIONS

Sufficient studies have not yet been made to permit the presentation of a complete report on provenance. However, some general conclusions can be attempted.

The chromite, magnetite, clinopyroxene, and some of the epidote was derived from the serpentinized mafic rocks of Empire Mountain. Probably much of the goethite, limonite, and hematite came from ferruginous beds in the Neruokpuk and other formations. The black pyrite probably was derived from black slates and phyllites. The granitic plutons and their contact rocks are the sources of goethite, limonite, zircon, epidote, garnet, sphene, barite, and scheelite.

The amount of scheelite in the unconcentrated soil and gravel samples from Mount Fitton, Mount Sedgwick, and Old Crow Range areas is very small but does indicate that the nearby granitic bodies are favourable locations for tungsten and probably associated mineralization. They and their border rocks deserve prospecting.

REFERENCES

Bostock, H.S.
1948: Physiography of the Canadian Cordillera, with special reference to the Area North of the Fifty-fifth Parallel; Geol. Surv., Canada, Memoir 247.

Brosgé, W.P., and others
1962: Palaeozoic Sequence in Eastern Brooks Range, Alaska; Bull. Am. Assoc. Petrol. Geol., vol. 46, No. 12, pp. 2174-2198.

Norris, D.K., and others
1963: Geology of Northern Yukon Territory and Northwestern District of Mackenzie; Geol. Surv., Canada, Map 10-1963.

ROGER DUHAMEL, F. R. S. C.
QUEEN'S PRINTER AND CONTROLLER OF STATIONERY
OTTAWA, 1963
Price 35 cents Cat. No. M44-63/32