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DEPARTMENT OF NATURAL RESOURCES

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GEOLOGY AND GROUND MAGNETOMETER SURVEY OF THE YELLOW PUP TUNGSTEN DEPOSIT, GILMORE DOME, FAIRBANKS MINING DISTRICT, ALASKA

By
M.S. Robinson

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INTRODUCTION

During parts of the 1979-81 field seasons, investigations were conducted on Gilmore Dome to better understand the nature and source of the tungsten mineralization in the area.

The Yellow Pup tungsten deposit is located 14 air miles northeast of Fairbanks (fig. 1). The deposit, accessible via the Steese Highway and a series of dirt roads, occurs at the 1,900-ft elevation near the head of Yellow Pup Creek, a tributary of Pearl and Fish Creeks (fig. 1). Elmer Stohl, William Birklid, and M.S. Anderson discovered the Yellow Pup deposits in 1943. During the last 4 years, Vincent Monzulla has shipped several tons of high-grade tunsten concentrates and has stockpiled a large amount of unmilled ore.

REGIONAL GEOLOGIC SETTING

The Gilmore Dome area is part of a regional polymetamorphic terrane known as the Yukon-Tanana Upland metamorphic complex, of lower Paleozoic or Precambrian age (Foster and others, 1971). The area, thought to be equivalent to the Yukon Crystalline Terrane (Templeman-Kluit, 1975), is composed of a wide variety of schists, quartzites, carbonates, amphibolites, eclogites, gneisses, and other rock types.

The Fairbanks Schist, an informal rock unit about 5,000 ft thick, occurs throughout the Fairbanks mining district and is composed predominantly of muscovite-quartz schist, biotite-muscovite-quartz schist, and quartzite. Interbedded with this unit is a sequence of rocks known informally as the Cleary Sequence, which is composed of felsic schist, felsic quartz schist, actinolitic greenschist, impure marbles, calc-silicate beds, and micaceous schist and quartzite indistinguishable from those of the Fairbanks Schist unit. The felsic and mafic rocks in the Cleary Sequence are believed to be of volcanic and volcaniclastic origin; they host most of the gold, antimony, and tungsten deposits in the district.

Locally intruding the Fairbanks Schist package are felsic to intermediate Mesozoic intrusive rocks. Rocks in the contact zones surrounding the intrusions have been thermally and chemically altered and locally mineralized.

At the Yellow Pup tungsten deposit, the rocks are dominated by a hornfelsed sequence of feldspar quartz schist, biotite-muscovite-quartz schist, muscovite quartz schist, calc-amphibolite, and marble. These rocks are believed to be part of the Cleary Sequence that has been altered by the intrusion of the Gilmore Dome stock.

GEOLOGY OF THE YELLOW PUP MINE SITE

The tungsten-bearing rocks at the Yellow Pup Mine site are marble, calc-amphibolites, and siliceous calc-silicate rocks that form distinctive stratabound

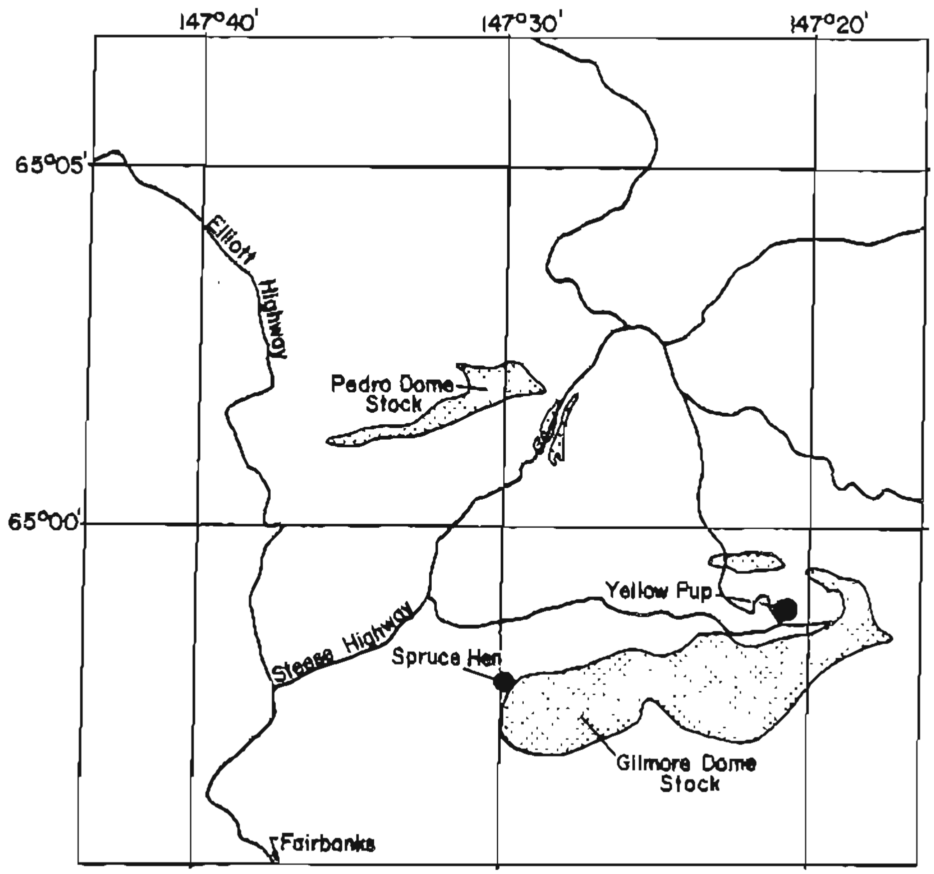

Figure 1. Location map.

layers within a package of rocks dominated by barren mica schist, quartz schist, and quartzite. The marble is generally highly crystalline and is composed of a complex mosaic of anhedral calcite intergrown with blue-green hornblende, diopside, and garnet. The marble occurs in irregular lenticular masses that contain only sporadic scheelite concentrations.

Two distinct types of calc-amphibolites are present in the Yellow Pup Mine area. The first and most common occurs as thin zones of epidote amphibolite (pl. 1) that parallel the compositional layering in the schist package. These rocks are characterized by their high silica content, light-green to dark-brown color, and sporadic scheelite and powellite concentrations. The epidote amphibolite layers are present in the southern and southeastern part of the map area and can be traced across the map area through several surface trenches (pl. 1). Petrographically, the epidote amphibolites are generally composed of 30 to 40 percent quartz, 20 to 25 percent blue-green hornblende, 20 to 40 percent epidote, up to 10 percent chlorite, and minor calcite and sericite. Scheelite concentrations as high as 5 percent by volume are present locally, although the average modal tungsten concentration is much lower. The other type of calc-amphibolite in the area (pl. 1) occurs in a 2-m-thick layer in the main open cut. Petrographically this calc-amphibolite is composed of 20 to 30 percent blue-green hornblende, 20 to 30 percent quartz, 5 to 10 percent tremolite, muscovite, epidote, clinozoisite, garnet, plagioclase, and chlorite. Scheelite concentrations as high as 10 percent are present locally.

The diopside-bearing calc-amphibolite usually contains more mineral phases than the epidote amphibolite. The difference in mineral abundance may be explained by a higher calcium content in the protolith of the diopside-bearing variety.

At the Spruce Hen tungsten prospect, about 5 miles southwest of the Yellow Pup (fig. 1), calc-silicate rocks, also believed to belong to the Cleary Sequence, contain scheelite and at least two generations of garnet; the earliest, a light-brown variety, is probably the result of a regional metamorphism. The second type is a dark-brown iron-rich variety that clearly crosscuts and surrounds the earliest formed garnet; it may have developed during hornfelsing associated with the intrusion of the Gilmore Dome stock (R. Newberry, pers. commun., 1981).

The rocks hosting the tungsten-bearing beds in the Yellow Pup Mine area are mainly pelitic schists and quartzite. The pelitic schists are typically dark-brown to brown fine- to medium-grained garnet-biotite-feldspar quartz schist and light-brown to brown fine- to medium-grained muscovite quartz schist. Petrographically, the feldspar quartz schist is composed of up to 50 percent quartz, 5 to 15 percent plagioclase (An_{40-45}), 5 to 10 percent potassium feldspar, 20 to 40 percent muscovite, and 5 to 20 percent biotite. The muscovite quartz schist is usually composed of up to 50 percent quartz, 30 to 40 percent muscovite, 5 to 10 percent potassium feldspar, minor biotite, and accessory tourmaline, spinel, garnet, and tremolite. Locally, the muscovite schist contains appreciable chlorite. Most of the pelitic schists contain large rosettes of deeply resorbtive biotite that crosscut the metamorphic fabric of the pelitic rocks, which probably reflects late hornfelsing of these rocks. Some of the more alumina-rich rocks contain large andalusite porphyroblasts 5 mm in dia, which may also reflect hornfelsing accompanying intrusion of the Gilmore stock.

MINERALIZATION

Tungsten mineralization at the Yellow Pup deposit consists of scheelite in calc-amphibolite layers within the metamorphic rock sequence. The amphibolite zone currently being mined from a small open-cut near the northeastern corner of the map area (pl. 1) is about 2 m thick and constitutes a stratabound accumulation of scheelite that is bounded on top and bottom by barren pelitic rocks. In the mine area, the mineralized horizon is arched into a small, north-plunging, assymetrical antiform that flattens to the south, where it is truncated by a high-angle fault. The eastern limb of the structure appears to have most of the mineralization, although the size and extent of the mineralized zone to the east and west are unknown.

Other scheelite occurrences are present in the surface trenching on the Yellow Pup property. The mineralization usually occurs in epidote-amphibolite layers that parallel the compositional banding in the rock package. The size of the epidote-amphibolite zones vary, but none appear to be as large or as high grade as the calc-amphibolite zone currently being mined. The tungsten concentrations in continuous chip samples (which average 15 lb) across the zone is sporadic (table 1).

Table 1. Tungsten concentrations, chip samples.

Sample	Length of sample (ft)	Weighted average tungsten conc. (%)
79MR1D	4	0.7
79MR6A	5	1.25
79MR6B	5	1.20
79MR7A	6	0.18
79MR7B	6	0.
79MR9A	8	0.
79MR9B	9	0.1
79MR9C	5	0.4

The Yellow Pup property is the extension of the Colbert tungsten property, which occurs about 1,500 ft to the south. Scheelite occurs in discontinuous calc-amphibolite zones exposed in surface trenching between the two prospects. Other scheelite lodes occur in the area, and the probability for the discovery of new tungsten mineralization is high.

GROUND MAGNETOMETER SURVEY

A ground magnetometer survey was made in conjunction with the geologic investigations at the Yellow Pup property in an effort to determine if the calc-amphibolite and epidote amphibolite horizons can be differentiated from other rocks in the schist package. The survey was conducted with a GM122 Geometrics proton precession magnetometer.

A total of 3,000 line-ft of surveying along six lines was completed. Readings were taken at 50-ft intervals with the sensing head at a constant 4 ft above the ground. Background and temporal variations were taken from magnetograms obtained from the National Oceanographic and Atmospheric Administration Observatory in Fairbanks, and no large magnetic disturbances were detected during the survey period. All magnetic readings were corrected for diurnal variation and converted to values relative to the lowest reading taken on the property. The relative magnetic data were then hand contoured and the resultant magnetic contour map was superimposed on a base map of the Yellow Pup prospect scaled 1 in. to 100 ft (pl. 1). The map shows the location of prospect trenches, open cuts, and known tungsten mineralization. A strong northeast-trending magnetic anomaly occurs parallel to the surface exposure of the mineralized calc-amphibolite zone being mined; this anomaly apparently reflects the compositional banding in the schist package.

The size and coincidence of the magnetic anomaly with the calc-amphibolite zone suggest that ground magnetic surveys will be useful in tracing amphibolite zones such as those associated with tungsten mineralization on Gilmore Dome.

SOIL SAMPLING

Two types of soil-sampling programs were attempted on the Yellow Pup property to determine the applicability of conventional soil-sampling techniques in the search for unknown mineralized areas.

The first, a base-line geochemical sampling program, was taken in an area of known tungsten mineralization, where recent trenching with a hydraulic backhoe had exposed a good soil profile, from grass roots to bedrock. Samples were collected from each soil horizon at nine localities to determine which horizon would yield the best metal concentration. Figure 2 is a diagrammatic representation of the average metal concentrations found at the nine sample sites in the various soil horizons.

The soils in the Yellow Pup area are, for the most part, permanently frozen and poorly developed; they support a dense cover of dwarf birch, black spruce, willows, and mosses of several varieties. The A_0 soil horizon is characterized by partially decomposed and matted organic matter, whereas the A soil horizon is a dark soil composed of mixed organic and mineral matter. The A horizon is separated from the underlying B horizon by a zone of oxidation characterized by a light-brown to gray zone with some organic material. The B horizon is usually red-brown and contains only minor organic material. The C horizon is generally a zone of very low organic material and mixed weathered bedrock.

Close examination of figure 2 indicates that lead, zinc, and antimony are relatively enriched in the A_0 and A soil horizons and are relatively depleted in the B and C horizons. Copper is enriched in the A and B soil horizons and relatively depleted in the A_0 and C horizons. Tungsten and manganese appear to be sympathetic and are relatively enriched in the C soil horizon and depleted in the A_0, A, and B horizons. Table 2 lists the trace element concentrations for the baseline soil samples.

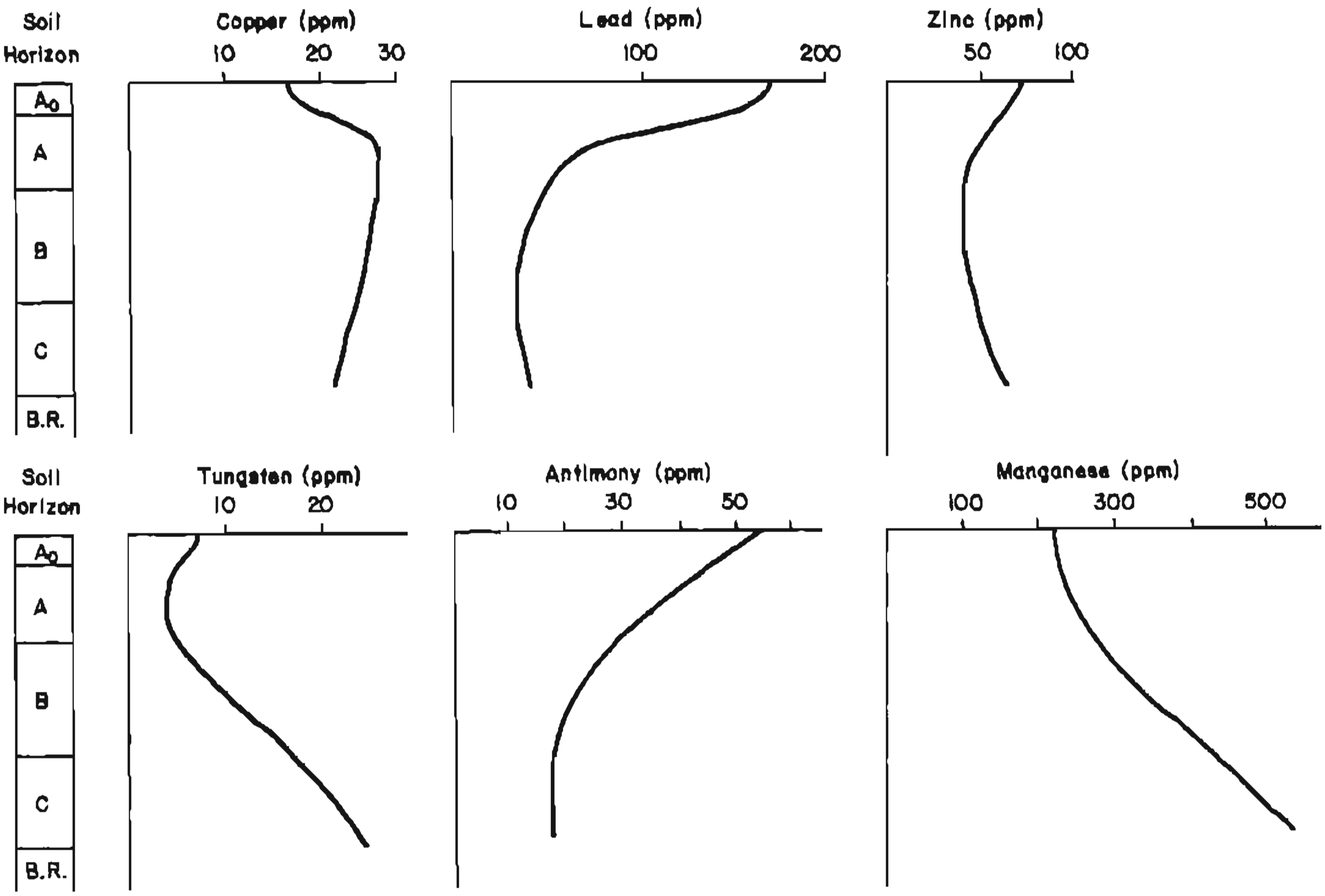

Figure 2. Trace-element concentrations in various soil horizons.

Table 2. Baseline soil geochemistry, Yellow Pup Mine area.

Sample	Pb	Mn	Mo	Cu	Zn	Ag	Sb	Fe (%)	W	Sample description
	Concentration (ppm)									
80DH1	22	700	1	26	68	1	15	3.1	-	A - horizon soil
2	19	799	1	29	67	1	14	2.9	22	B - horizon soil
3	21	860	1	33	74	1	17	2.9	173	Spoil pile - contaminated
4	22	652	1	24	62	1	17	2.6	29	C - horizon soil
5	22	740	1	25	66	1	14	2.6	23	B - horizon soil
6	26	920	1	32	76	1	16	3.1	27	B - horizon soil
7	31	840	1	34	73	1	20	2.6	21	A - horizon soil
8	22	766	2	24	59	1	17	2.4	36	B - horizon soil
9	66	2440	1	61	78	1	17	2.8	68	C - horizon - bedrock
10										
11										
12										
13										
14	340	400	1	32	198	4	84	1.08	6	A_o - horizon soil
15	26	124	1	31	32	1	18	1.69	5	A - horizon soil
16	23	160	2	24	33	1	13	1.98	5	B - horizon soil
17	23	316	1	19	42	1	14	2.94	11	C - horizon soil
18	18	640	1	22	67	1	14	2.5	83	C - horizon - bedrock
19										
20										
21										
22	48	81	1	10	26	1	22	0.47	5	A_o - horizon soil
23	66	150	1	27	49	1	32	1.40	5	A - horizon soil
24	22	151	2	20	31	1	15	2.16	12	B - horizon soil
25	24	494	2	14	61	1	17	3.40	6	C - horizon soil
26										
27										
28										
29	24	116	1	16	26	1	22	1.29	35	A_o - horizon soil
30	24	127	1	20	31	1	18	1.89	6	A - horizon soil
31	22	180	2	25	38	1	14	2.72	5	B - horizon soil
32	24	245	2	18	46	1	15	3.16	5	C - horizon soil
33										
34										
35										
36	48	125	1	16	70	1	37	0.84	5	A_o - horizon soil
37	13	74	1	20	20	1	10	1.17	5	A - horizon soil
38	115	220	2	21	61	1	53	2.62	5	B - horizon soil
39	104	145	2	31	50	1	51	1.92	5	C - horizon soil

Table 2 (cont.)

Sample	Pb	Mn	Mo	Cu	Zn	Ag	Sb	Fe (%)	W	Sample description
	Concentration (ppm)									
43	88	144	1	15	37	1	48	1.26	5	A_o - horizon soil
44	266	134	2	17	45	2	118	1.69	7	A - horizon soil
45	25	219	2	21	40	1	17	2.78	5	B - horizon soil
46	36	365	2	16	55	1	22	2.95	12	C - horizon soil
50	177	217	1	14	60	2	71	0.91	5	A_o - horizon soil
51	53	81	1	16	28	1	33	1.01	5	A - horizon soil
52	26	135	2	30	31	1	32	1.91	5	B - horizon soil
53	28	178	2	19	32	1	16	2.38	8	C - horizon soil
57	42	108	1	18	30	1	26	1.46	5	A_o - horizon soil
58	67	101	1	19	30	1	31	1.45	5	A - horizon soil
59	44	161	2	28	32	1	23	1.89	23	B - horizon soil
60	26	347	2	15	50	1	18	2.30	44	C - horizon soil
64	57	145	1	16	38	1	31	1.17	5	A_o - horizon soil
65	40	130	1	22	42	1	29	1.31	5	A - horizon soil
66	26	122	2	22	33	1	18	1.53	5	B - horizon soil
67	22	166	1	12	31	1	14	2.14	5	C - horizon soil
71	711	308	1	30	101	6	168	1.52	5	A_o - horizon soil
72	71	169	2	32	36	1	26	1.63	5	A - horizon soil
73	98	145	2	30	37	1	38	2.175	6	B - horizon soil
74	49	315	2	17	52	1	22	2.60	47	C - horizon soil
78	144	575	2	19	81	2	35	2.60	21	A_o - horizon soil
79	66	190	2	28	39	1	25	2.46	10	A - horizon soil
80	44	241	2	21	46	1	18	3.04	17	B - horizon soil
81	42	375	2	17	60	1	20	3.00	11	C - horizon soil

Table 3. Yellow Pup rock-sample trace-element concentration, 1980.

Sample	Pb	Mn	Mo	Cu	Zn	Ag	Fe (%)	Sb	Sample description
80MR1	10	512	2	31	90	1	3.7	32	Quartz-muscovite-biotite schist
2	20	900	50	53	55	1	3.0	26	Biotite-quartz schist with calcium silicate bands and $CaWO_4$
3	10	819	56	67	63	1	3.5	29	Calcium-silicate rock with $CaWO_4$
4	10	578	1	42	82	1	3.3	26	Muscovite-biotite schist
5	10	539	2	35	88	1	3.9	31	Quartz-biotite schist
6	10	875	1	67	22	1	1.34	16	Calcium-silicate rock
7	10	4130	1	78	71	1	3.9	30	Calcium-silicate rock
10	10	1610	1	64	93	1	3.3	27	Quartz-muscovite schist
11	20	1350	1	54	96	1	3.8	31	Calcium amphibolite
12	20	1120	1	80	76	1	3.1	30	Calcium amphibolite
13	20	1610	1	52	90	1	3.8	31	Calcium amphibolite
14	15	1650	1	59	99	1	3.8	31	Impure marble
15	15	735	1	86	97	1	4.9	34	Calcium amphibolite
16	20	1830	1	45	100	1	3.7	30	Calcium amphibolite
17	30	1740	1	55	87	1	3.5	28	Calcium amphibolite
18									
26	30	750	1	33	37	1	2.3	23	Calcium silicate rock
27	20	980	6	35	26	1	2.1	14	Calcium silicate rock with $CaWO_4$
28	20	506	1	64	104	1	4.5	32	Calcium silicate rock with $CaWO_4$
29	10	498	2	57	72	1	3.8	29	Biotite schist
30	20	960	1	42	99	1	3.7	28	Calcium silicate rock
31	20	965	108	62	37	1	2.3	30	Calcium silicate rock with $CaWO_4$
32	20	872	1	42	38	1	2.6	21	Calcium silicate rock with $CaWO_4$
33	20	675	1	37	116	1	5.6	39	Quartz feldspar schist
34	40	1580	1	58	101	1	6.2	41	Quartz muscovite schist
35	25	624	1	60	63	1	3.1	24	Quartz muscovite chlorite schist
36	30	1730	1	117	67	1	3.9	30	Calcium silicate rock
37	20	731	1	88	142	1	4.2	33	Quartz muscovite chlorite schist
38	60	742	1	99	28	1	1.21	9	Calcium silicate rock
65	60	745	1	54	142	1	4.1	32	
66	440	465	1	58	49	4	1.33	15	
67	30	593	1	55	82	1	4.0	29	
68	30	2270	1	115	22	1	1.8	12	

A second program, consisting of detailed soil sampling, was undertaken in the Yellow Pup area to test whether C-horizon soil samples, collected at 25-ft intervals across the prospect area, could delineate unknown tungsten mineralization.

Examination of the tungsten concentrations in the soil samples on plate 1 indicates that most of the known scheelite occurrences are reflected in relatively higher tungsten concentrations in the C horizon. Some high values are also indicated in areas were undiscovered mineralization may be present.

Table 3 lists the trace-element concentrations for rock samples collected while mapping at the Yellow Pup.

CONCLUSIONS

The tungsten deposits of the Gilmore Dome area are hosted in what appears to be a contact metamorphosed metamorphic rock sequence of volcanic or volcano-sedimentary origin, known as the Cleary Sequence. The tungsten mineralization is localized in stratabound calc-amphibolite zones in the metamorphic rocks package. Coordinated soil geochemical surveys and ground magnetic surveys may be useful in the search for unknown tungsten concentrations in the Gilmore Dome area.

ACKNOWLEDGMENTS

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