COLUMBIUM IN THE GOLD- AND TIN-BEARING PLACER DEPOSITS NEAR TOFTY, ALASKA

by D. D. Southworth

Critical and Strategic Minerals in Alaska

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UNITED STATES DEPARTMENT OF THE INTERIOR

William P. Clark, Secretary

BUREAU OF MINES

Robert C. Horton, Director

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UNIT OF MEASURE ABBREVIATIONS USED IN THIS REPORT

ft	foot	pct	percent
ft^3	cubic foot	tr oz	troy ounce
lb	pound	yd^3	cubic yard
mg	milligram		

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ABSTRACT

The Tofty mining district, near Manley Hot Springs in north-central Alaska, has been the scene of placer gold mining since 1906 and has produced more than 100,000 tr oz of gold and several hundred tons of byproduct tin, in the form of placer cassiterite. Although open-cut mining methods are currently employed, drift-mining methods were formerly utilized to mine the gold- and tin-bearing gravels. As part of the current Bureau of Mines Alaska-wide assessment of critical and strategic minerals, splits of concentrate samples collected in the 1950's from 11 tailings piles representative of the presently inactive Tofty drift mines were re-analyzed in 1983 for tantalum and columbium (niobium). Most of these concentrates contained between 0.2 pct and 4.5 pct Nb. Tantalum was detected, but not measured, in only three samples. Relatively higher average niobium values from tailings piles on either side of a small hill (elev 610) suggest a possible intrusive source there at shallow depth. Niobium occurs in the Tofty area in the mineral columbite ($[Fe,Mn][Nb,Ta]_2O_6$) that could be recovered as a byproduct during placer mining of gold and/or tin. An estimated 100,000 lb of recoverable Nb_2O_5 are inferred to be present in the Tofty placer deposits.

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INTRODUCTION

Placer deposits of gold were discovered in 1906 at Tofty, near Manley Hot Springs in interior Alaska. Substantial quantities of cassiterite, the most common ore mineral of tin, were found to be present in the placer gravels, and the first shipment of tin, produced as a byproduct of the gold mining, was made in 1911. The placer deposits at Tofty are buried beneath 10 to 170 ft of frozen muck and silt. These buried placers occur in a belt roughly 8 miles long and 1 mile wide, and most production prior to 1919 (1)[2] resulted from drift mining of the gold- and tin-bearing placers. Since 1919, mining has been restricted to the shallower pay streaks, where open-cut and strip mining methods have been employed exclusively.

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

Information on recent gold production in the Tofty area is not readily available; through 1956 (2), approximately 127,500 tr oz Au were produced, along with 470,000 lb cassiterite. In the early years, much of the cassiterite was not recovered and remains in the tailings. Total tin production between 1966 and 1982 is estimated to have been approximately 100,000 lb of tin metal (3).

As part of the current Bureau of Mines Alaska-wide assessment of critical and strategic minerals, splits from placer channel samples collected in the Tofty region by Thomas (4) during the period 1954 to 1956 were re-analyzed in 1983 for tantalum and niobium, since these elements are sometimes associated with tin. The following is a summary of the results of those analyses.

PREVIOUS INVESTIGATIONS

The streams and creeks of the Tofty area (fig. 1) have been prospected for placer gold since the early 1900's. Mertie (5-6) reported on the placer gold mining activity during 1931 and described the geology of the area. Thomas (4) and Wayland (1) investigated the Tofty area for tin resources and sampled many of the placer deposits of the area (fig. 2). In 1971, Maloney (7) reported on the gossans of Hot Springs Dome, near Manley Hot Springs. Geological reconnaissance mapping of the Tanana Quadrangle at 1:250,000 scale has been compiled by Chapman and others (8). A summary of references to the area is listed in Cobb (9).

GENERAL GEOLOGY

The Hot Springs Dome intrusive body several miles to the south of the Tofty placers is a biotite-granite. Mertie (6) reports that chemical analyses of major oxides of rocks from Hot Springs Dome are similar to that of known cassiterite-bearing intrusions. Several small quartz-tourmaline dikes have been noted on Hot Springs Dome, but no cassiterite has yet been found, either in intrusive rocks or in the streams immediately draining the intrusion. Kemp reported (10) a "calcareous pegmatite dike with rare earth elements" occurring high on the west side of Idaho Gulch. Small serpentinized and chloritized mafic dikes crop out approximately 1 mile north of the belt of placer deposits, and at the head of Harter Gulch a small amount of cross-fiber serpentine occurs. The mafic dikes are probably related to the mafic and ultramafic rocks which underlie Serpentine Ridge to the north-northwest.

Coarse-grained, porphyritic biotite-monzonite forms the intrusive mass of Roughtop Mountain, immediately to the northeast of the Tofty placers. Mertie (5) describes several mafic and felsic dikes or segre-

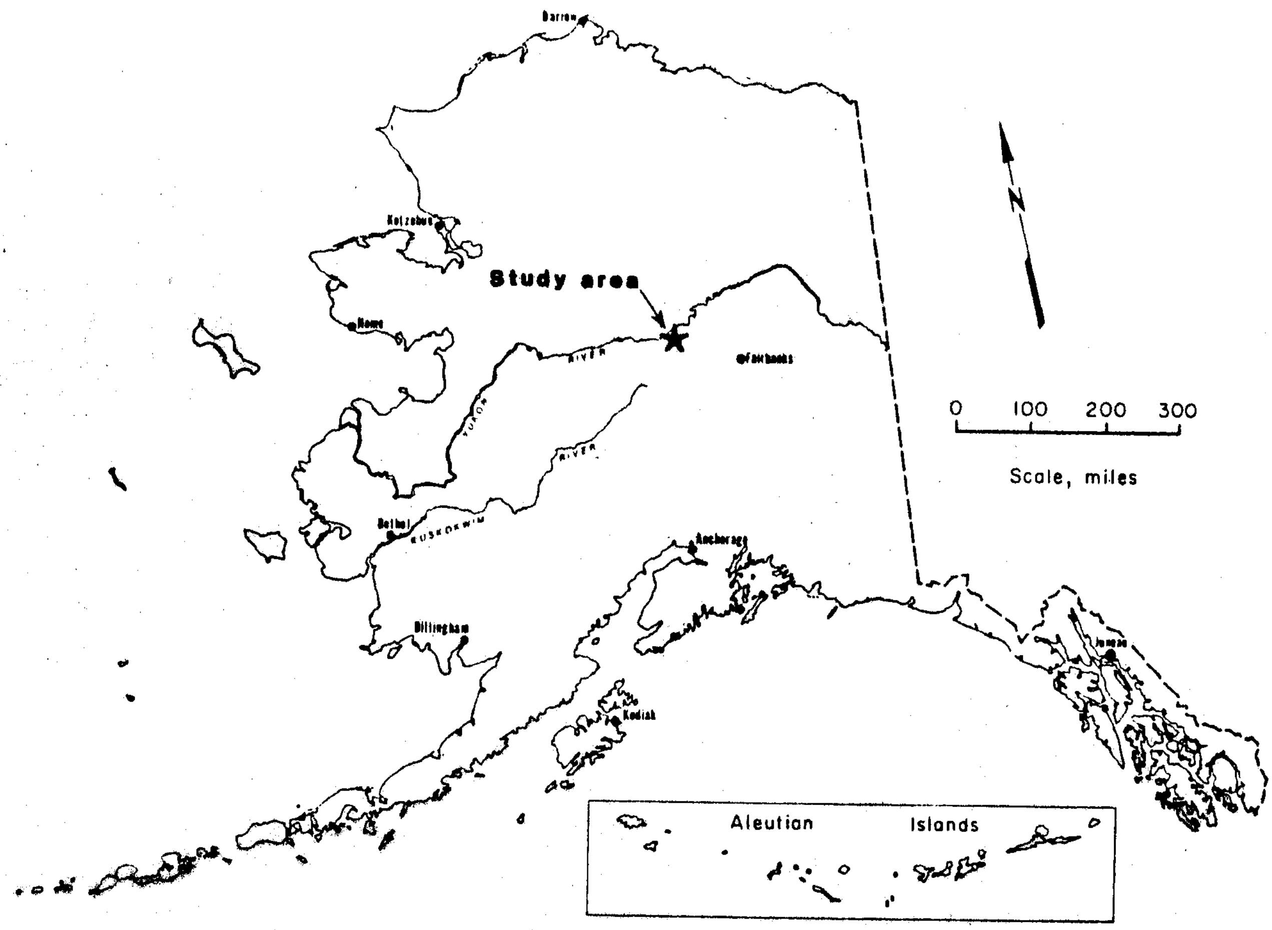

Figure 1.— Index map of Alaska.

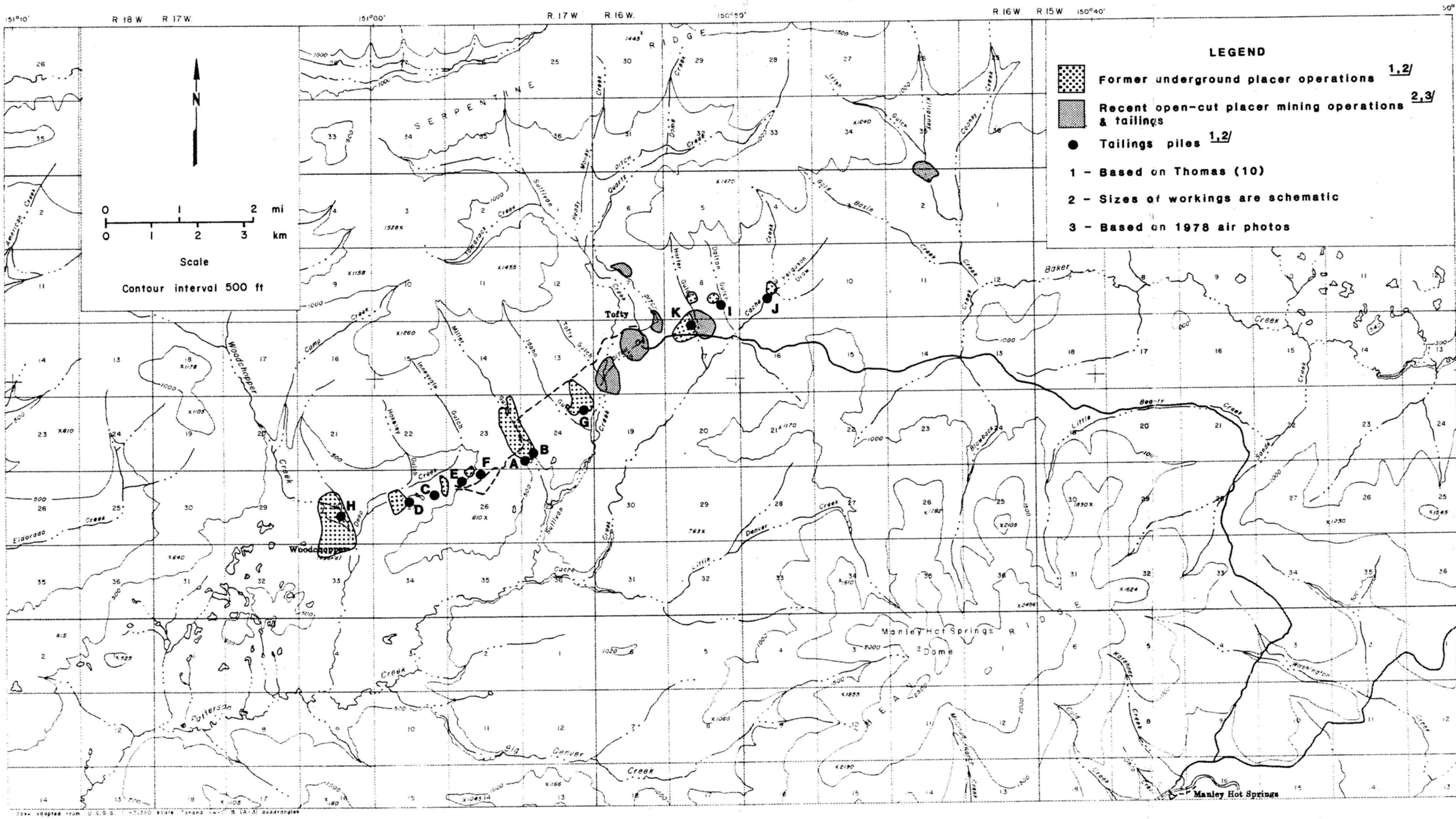

Figure 2.— Location of tailings piles in the Tofty area.

gations in and/or marginal to this stock, but cassiterite is not reported to occur in any of these.

Very little bedrock is exposed in the study area. In general, bedrock is concealed beneath tundra, heavy brush, and loess. Bedrock exposed by mining of the Tofty placers consists of undifferentiated, Cretaceous-age rocks, including soft, dark-gray phyllites and slates interbedded with minor lenses of graywacke. Phyllite, in places compressed and crenulated by intrusions, predominates. Minor dark, dense quartzite forms a few relatively resistant, more conspicuous outcrops. A 100-ft-thick lens of pale yellow limestone containing minor magnetite and apatite crystals is exposed near the head of Harter Gulch (1).

LAND STATUS

Most of the area described is covered by federal placer mining claims held by Mr. Jack Neubauer (Cassiterite Placers, Inc.) of Manley Hot Springs. The lands discussed in this report are currently (1983) administered by the U.S. Bureau of Land Management.

BUREAU INVESTIGATIONS

SAMPLING AND ANALYSES

During the period 1954 to 1956, the Bureau investigated certain gold lode and gold-tin placer prospects in the Hot Springs district near Tofty. As part of that investigation, channel samples of placer mine tailings from previous drift mining in the Tofty area were collected (fig. 2). The Bureau's sampling and analytical procedures are detailed by Thomas (4) in the 1957 report; in brief, however, the channel samples varied from approximately 1.52 ft^3 to about 6.08 ft^3 in volume, and the heavy minerals were concentrated by panning. For the 1957 report

(4), all of the tailings pile concentrate samples were sent to the Bureau's laboratory in Juneau for tin analyses and separation of free gold. At the same time, samples from tailings piles A and B, Miller Gulch, were analyzed spectroscopically for niobium pentoxide (Nb_2O_5) and are here reported in tables 1 and 2. The tantalum and niobium analyses reported in tables 3 through 11 were completed in 1983 by W. S. Roberts[3] using semi-quantitative X-ray fluorescence methods.

[3]Physical scientist, Alaska Field Operations Center, Bureau of Mines, Juneau, AK.

The lower detection limit for tantalum was approximately 100 to 150 ppm, and measurable tantalum was not detected in any of the samples. Niobium was reported in all of the samples analyzed; from these analyses the estimated recovery of Nb_2O_5 in pounds per cubic yard of tailings material was calculated and is reported in tables 1 through 11. Most of the concentrate samples contained between 0.2 pct and 4.5 pct Nb. The smallest value detected in the concentrates was 0.03 pct Nb. The Nb content in samples from Deep Creek are seen to be consistently high relative to the other creeks. Composite sample 56-521/522 (table 3) is very strongly anomalous (2.01 lb Nb_2O_5/yd^3). It is possible that this sample may have contained a substantial component of unmined material, and it may not be truly representative of the tailings.

Figures 3 and 4 are plots of percent niobium versus percent tin in the Deep Creek concentrates analyzed. Two trends were observed in Deep Creek analyses (fig. 3): (1) a pronounced inverse relationship between niobium and tin exists, and (2) significant niobium content is rare at tin values above 30 pct but is common and generally high at tin values less than

TABLE 1. - Summary of channel-sampling results, tailings pile A, Miller Gulch[1]

Channel	Vol. in place ft^3	Concentrate recovered, lb	Au recovered, mg	Conc. analyses		Recovery per yd^3			
				Sn, pct	Nb, pct	Conc., lb	Sn, lb	Nb_2O_5, lb	Au, tr oz
1....	4.50	0.340	27.63	21.7	2.2	2.04	0.44	0.06	0.005
2....	4.08	.569	79.90	.05	NA	3.77	.00	NA	.017
3....	3.65	.068	12.41	23.3	3.8	.50	.12	.03	.003
4....	4.41	.377	13.85	16.5	2.8	2.31	.38	.09	.003
5....	4.03	.332	138.00	41.0	2.1	2.22	.91	.07	.029
6....	3.85	.988	188.00	48.3	4.5	6.93	3.35	.43	.043
7....	4.25	1.080	34.80	39.6	NA	6.86	2.72	NA	.007
8....	4.66	.852	490.95	43.5	2.9	4.94	2.15	.20	.091
9....	4.41	.387	40.32	47.7	1.1	2.37	1.13	.04	.008
10...	4.25	.227	23.41	38.8	3.9	1.44	.56	.08	.005
11...	5.33	.736	36.28	39.7	1.4	3.73	1.48	.07	.006
12...	5.08	.318	5.60	33.2	2.7	1.69	.56	.06	.001
13...	4.91	.942	9.20	47.2	2.5	5.20	2.44	.18	.002
Arithmetic average of channel samples..............						3.39	1.26	.10	.017

NA Not analyzed.
[1]All analyses are from Bureau of Mines 1954 project (4).

TABLE 2. - Summary of channel-sampling results, tailings pile B, Miller Gulch[1]

Channel	Vol. in place ft^3	Concentrate recovered, lb	Conc. analyses		Recovery per yd^3			
			Sn, pct	Nb, pct	Conc., lb	Sn, lb	Nb_2O_5, lb	Au, tr oz
14...	4.00	0.053	7.6	2.9	0.36	0.03	0.01	0.004
15...	3.58	.931	15.7	2.7	7.02	1.10	.13	.009
16...	4.86	.215	28.8	2.2	1.19	.34	.04	.006
17...	4.41	.164	31.6	3.1	1.00	.32	.05	.028
18...	4.83	.176	27.0	2.0	.99	.27	.03	.024
19...	3.75	.906	1.8	.1	.52	.12	.01	.036
20...	3.08	.055	11.6	.8	.48	.06	.01	.032
21...	4.33	.087	10.0	2.4	.54	.05	.02	.004
22...	6.08	1.006	3.0	.5	4.47	.13	.03	.055
23...	4.91	.603	42.2	1.3	3.32	1.40	.07	.006
24...	4.91	.171	24.6	4.2	.94	.23	.06	.014
25...	5.33	.103	28.4	1.0	.52	.15	.01	.007
26...	4.58	.079	4.0	4.9	.47	.02	.03	.016
27...	3.50	.050	11.7	2.5	.38	.04	.01	.006
28...	3.25	.117	29.7	2.2	.97	.29	.03	.005
29...	3.00	.058	6.6	3.0	.52	.03	.02	.017
Arithmetic average of channel samples.....					1.88	.29	.03	.018

[1]All analyses are from Bureau of Mines 1954 project (4).

TABLE 3. - Summary of channel-sampling results, tailings pile C, Deep Creek[1]

Sample	Channel	Vol. in place, ft^3	Concentrate recovered, lb	Conc. analyses			Recovery per yd^3			
				Sn, pct	Nb, pct	Ta, pct	Conc., lb	Sn, lb	Nb_2O_5, lb	Au, tr oz
56-518....	30	1.95	0.273	27.2	1.6	ND	3.78	1.03	0.09	0.013
56-519....	31	2.25	.197	21.9	2.9	ND	2.36	.52	.10	.007
56-520....	32	2.45	.680	37.1	1.4	ND	7.49	2.78	.15	.031
56-521&522	33	3.65	13.571	33.3	1.4	ND	100.39	33.40	2.01	.046
56-523....	34	2.55	.067	18.1	1.9	ND	.71	.13	.02	.010
56-524....	35	2.85	.061	29.6	1.0	ND	.58	.17	.01	.003
56-525....	36	3.35	.022	.4	2.3	ND	.18	TR	.01	.006
Arithmetic average of channel samples...............							21.07	6.96	.33	.018

ND Not detected.

TR Trace.

[1]All analyses except Nb and Ta are from Bureau of Mines 1954 project (4). Nb and Ta were analyzed by semi-quantitative X-ray fluorescence in 1983. Nb_2O_5 was calculated from Nb analyses.

TABLE 4. - Summary of channel-sampling results, tailings pile D, Deep Creek[1]

Sample	Channel	Vol. in place, ft^3	Concentrate recovered, lb	Conc. analyses			Recovery per yd^3			
				Sn, pct	Nb, pct	Ta, pct	Conc., lb	Sn, lb	Nb_2O_5, lb	Au, tr oz
56-526....	37	3.00	0.167	48.6	0.4	ND	1.50	0.73	0.01	0.002
56-527....	38	2.95	.515	46.7	.2	ND	4.71	2.20	.01	.037
56-530....	40	2.45	.516	52.6	.2	ND	5.69	2.99	.02	.021
56-531....	41	3.05	1.302	52.4	.1	TR	11.52	6.04	.02	.037
56-532....	42	3.35	.682	51.6	.2	ND	5.50	2.84	.02	.009
56-533....	43	3.55	.190	43.9	.3	ND	1.44	.63	.01	.003
Arithmetic average of channel samples...............							6.32	3.22	.02	.019

ND Not detected.

TR Trace.

[1]All analyses except Nb and Ta from Bureau of Mines 1954 project (4). Nb and Ta were analyzed by semi-quantitative X-ray fluorescence in 1983. Nb_2O_5 was calculated from Nb analyses.

TABLE 5. - Summary of channel-sampling results, tailings pile E, Deep Creek[1]

Sample	Channel	Vol. in place, ft^3	Concentrate recovered, lb	Conc. analyses			Recovery per yd^3			
				Sn, pct	Nb, pct	Ta, pct	Conc., lb	Sn, lb	Nb_2O_5, lb	Au, tr oz
56-534....	44	2.60	0.062	39.9	0.2	ND	0.65	0.26	<0.01	0
56-535....	45	2.65	.015	.1	4.1	ND	.15	TR	.01	0
56-536....	46	2.55	.055	.1	4.5	ND	.59	TR	.04	0.004
56-537....	47	2.65	.016	.1	3.5	ND	.16	TR	.01	0
56-538....	48	3.05	.022	.1	4.5	ND	.20	TR	.01	0
Arithmetic average of channel samples................							.34	.05	.01	.001

ND Not detected.
TR Trace.
[1]All analyses except Nb and Ta from Bureau of Mines 1954 project (4). Nb and Ta were analyzed by semi-quantitative X-ray fluorescence in 1983. Nb_2O_5 was calculated from Nb analyses.

TABLE 6. - Summary of channel-sampling results, tailings pile F, Deep Creek[1]

Sample	Channel	Vol. in place, ft^3	Concentrate recovered, lb	Conc. analyses			Recovery per yd^3			
				Sn, pct	Nb, pct	Ta, pct	Conc., lb	Sn, lb	Nb_2O_5, lb	Au, tr oz
56-539....	49	2.65	0.027	7.3	3.0	ND	0.27	0.02	0.01	0
56-540....	50	2.55	.046	.4	2.5	ND	.48	TR	.02	0.005
56-541....	51	3.40	.110	7.8	3.5	ND	.88	.07	.04	.020
56-542....	52	3.00	.093	6.9	3.6	ND	.84	.06	.04	.005
56-543....	53	3.25	.164	4.9	3.7	ND	1.36	.07	.07	.001
56-544....	54	3.30	.053	5.5	3.5	ND	.44	.02	.02	.001
56-545....	55	2.63	.015	.4	1.0	ND	.15	TR	<.01	0
56-546....	56	1.95	.015	.2	1.1	ND	.21	TR	<.01	0
Arithmetic average of channel samples...............							.62	.03	.03	.004

ND Not detected.
TR Trace.
[1]All analyses except Nb and Ta are from Bureau of Mines 1954 project (4). Nb and Ta were analyzed by semi-quantitative X-ray fluorescence in 1983. Nb_2O_5 was calculated from Nb analyses.

TABLE 7. - Summary of channel-sampling results, tailings pile G, Idaho Gulch[1]

Sample	Channel	Vol. in place, ft^3	Concentrate recovered, lb	Conc. analyses			Recovery per yd^3			
				Sn, pct	Nb, pct	Ta, pct	Conc., lb	Sn, lb	Nb_2O_5, lb	Au, tr oz
56-547....	57	1.52	0.100	34.4	0.4	ND	1.77	0.61	0.01	0.028
56-548....	58	1.70	.027	22.0	1.0	ND	.43	.10	.01	.001
56-549....	59	1.90	.028	22.9	0.6	ND	.40	.09	<.01	.057
56-550....	60	1.90	.446	55.6	0.1	ND	.63	.35	.01	.010
56-551....	61	2.00	.693	38.1	0.5	ND	9.36	3.56	.07	.006
Arithmetic average of channel samples................							2.67	1.00	.02	.020

ND Not detected.

[1]All analyses except Nb and Ta are from Bureau of Mines 1954 project (4). Nb and Ta were analyzed by semi-quantitative X-ray fluorescence in 1983. Nb_2O_5 was calculated from Nb analyses.

TABLE 8. - Summary of channel-sampling results, tailings pile H, Woodchopper Creek[1]

Sample	Channel	Vol. in place, ft^3	Concentrate recovered, lb	Conc. analyses			Recovery per yd^3			
				Sn, pct	Nb, pct	Ta, pct	Conc., lb	Sn, lb	Nb_2O_5, lb	Au, tr oz
56-553....	62	2.40	0.026	15.8	0.2	ND	0.29	0.05	<0.01	0.034
56-554....	63	3.38	.104	42.1	.3	ND	.83	.35	<.01	.072
56-555....	64	3.30	.078	35.4	.1	TR	.64	.23	<.01	.067
56-556....	65	3.88	.090	21.1	.4	ND	.63	.13	<.01	.047
56-557....	66	3.20	.027	5.5	.5	ND	.20	.01	<.01	.055
56-558....	67	3.20	.029	18.1	1.5	TR	.24	.44	.01	.024
56-559....	68	2.85	.148	12.7	.03	ND	1.40	.18	<.01	.016
56-560....	69	2.35	.016	3.0	.4	ND	.18	.01	<.01	.022
56-561....	70	2.85	.511	50.4	.03	ND	4.84	2.44	<.01	.042
56-562....	71	3.80	.031	23.7	.2	ND	.22	.05	<.01	.040
56-563....	72	2.90	.022	8.8	.9	ND	.21	.02	<.01	.035
56-564....	73	2.90	1.035	53.9	.7	ND	9.64	5.19	.10	.079
Arithmetic average of channel samples...............							1.54	.72	.01	.045

ND Not detected.

TR Trace.

[1]All analyses except Nb and Ta are from Bureau of Mines 1954 project (4). Nb and Ta were analyzed by semi-quantitative X-ray fluorescence in 1983. Nb_2O_5 was calculated from Nb analyses.

TABLE 9. - Summary of channel-sampling results, tailings pile I, Dalton Gulch[1]

Sample	Channel	Vol. in place, ft^3	Concentrate recovered, lb	Conc. analyses: Sn, pct	Nb, pct	Ta, pct	Recovery per yd^3: Conc., lb	Sn, lb	Nb_2O_5, lb	Au, tr oz
	74	2.50	1.266	56.8	NA	NA	13.67	7.77	NA	0
56-568....	75	2.00	.024	19.6	NA	NA	.33	.06	NA	0.014
	76	2.45	2.964	29.7	NA	NA	32.66	9.70	NA	.001
56-571....	77	2.45	.178	42.3	0.09	NA	1.97	.83	<0.01	0
56-572....	78	2.40	.061	41.4	.07	NA	.69	.29	<.01	.056
Arithmetic average of channel samples................							10.28	3.90	<.01	.014

NA Not analyzed.

[1] All analyses except Nb are from Bureau of Mines 1954 project (4). Nb was analyzed by semi-quantitative X-ray fluorescence in 1983. Nb_2O_5 was calculated from Nb analyses.

TABLE 10. - Summary of channel-sampling results, tailings pile J, Cache Creek[1]

Sample	Channel	Vol. in place, ft^3	Concentrate recovered, lb	Conc. analyses: Sn, pct	Nb, pct	Ta, pct	Recovery per yd^3: Conc., lb	Sn, lb	Nb_2O_5, lb	Au, tr oz
56-573....	79	2.90	0.032	38.4	0.2	ND	0.30	0.12	<0.01	0.007
56-574....	80	2.70	.145	37.1	.3	ND	1.45	.54	.01	.002
56-575&576	81	2.45	1.401	55.7	.3	ND	15.44	8.60	.07	.097
56-577....	82	2.85	.148	43.9	.2	ND	1.40	.61	<.01	.005
Arithmetic average of channel samples................							4.27	2.26	.02	.025

ND Not detected.

[1] All analyses except Nb are from Bureau of Mines 1954 project (4). Nb was analyzed by semi-quantitative X-ray fluorescence in 1983. Nb_2O_5 was calculated from Nb analyses.

TABLE 11. - Summary of channel-sampling results, tailings pile K, Harter Gulch[1]

Sample	Channel	Vol. in place, ft^3	Concentrate recovered, lb	Conc. analyses: Sn, pct	Nb, pct	Ta, pct	Recovery per yd^3: Conc., lb	Sn, lb	Nb_2O_5, lb	Au, tr oz
56-578....	83	2.35	0.093	37.1	0.2	ND	1.07	0.40	<0.01	0.013
56-579....	84	2.75	.034	15.2	.2	ND	.33	.05	<.01	.003
56-580....	85	3.00	.104	35.8	.2	ND	.93	.33	<.01	0
56-581....	86	2.65	.105	30.1	.08	ND	1.07	.32	<.01	.055
Arithmetic average of channel samples................							.84	.27	<.01	.017

ND Not detected.

[1] All analyses except Nb are from Bureau of Mines 1954 project (4). Nb was analyzed by semi-quantitative X-ray fluorescence in 1983. Nb_2O_5 was calculated from Nb analyses.

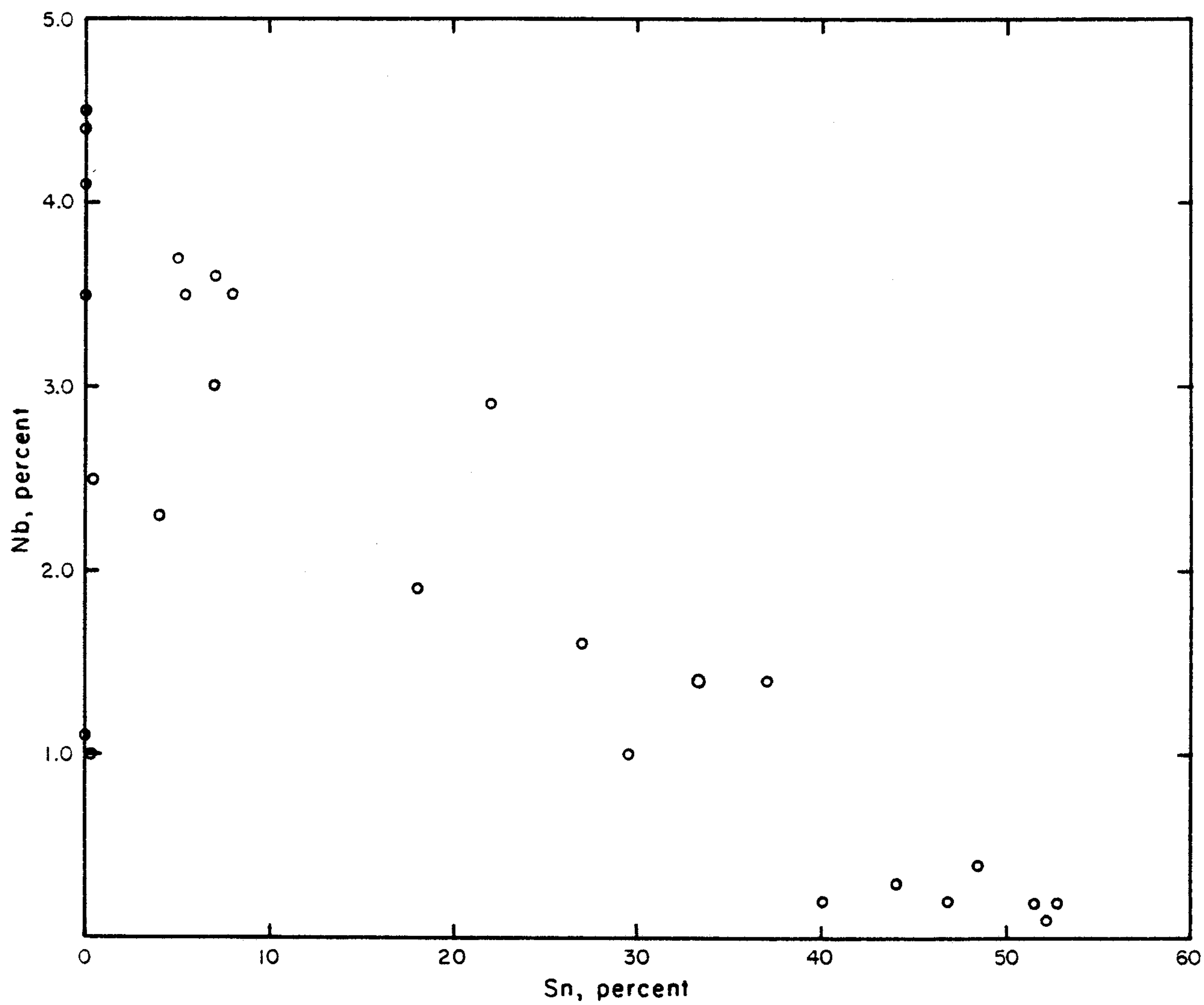

FIGURE 3.—Percent niobium (Nb) versus percent tin (Sn) in concentrates from Deep Creek. See tables 2 through 5 for analyses.

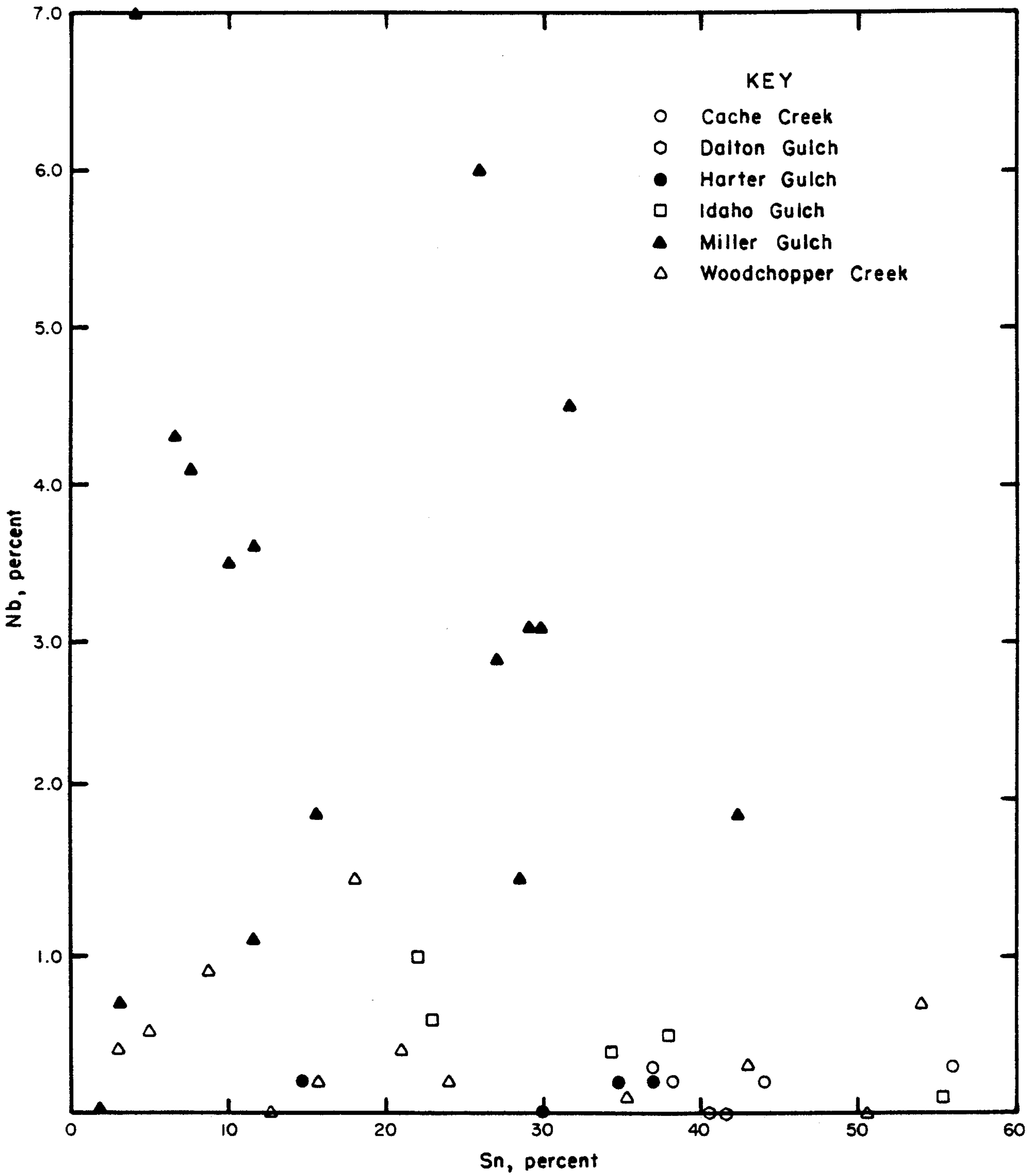

FIGURE 4 — Percent niobium (Nb) versus percent tin (Sn) in concentrates from streams in the Tofty area (excluding Deep Creek - see fig. 3). See tables 1 and 6 through 10 for analyses.

30 pct. The first trend is less pronounced but also exists in the data sets from the other six creeks (fig. 4).

Figure 5 is a plot of estimated recoverable Nb_2O_5 versus tin in Deep Creek samples. Again, as tin increases Nb_2O_5 decreases, with virtually no significant Nb_2O_5 in samples that contain more than 3.0 lb Sn/yd^3. This may be a result of the sampling procedures followed in 1956; if the heavy minerals were too highly concentrated by panning, the cassiterite (6.8 to 7.1 sp gr) would be favored over columbite (5.3 to 7.3 sp gr) in the concentrates. Most of the Nb_2O_5 values and virtually all of the highest values of Nb_2O_5 correspond to less than 1.0 lb Sn/yd^3.

The sharp but apparently systematic variations in tin and niobium ratios from Deep Creek and Miller Gulch (figs. 3-5) may suggest proximity to a niobium-rich bedrock source that may be different from the source of the tin; however, no bedrock source of either niobium or tin has yet been identified.

Suggestions that a proximal bedrock source (or sources) exists include these factors: (1) Cassiterite pebbles from the more westerly creeks are of lower specific gravity than those from the creeks further east, and (2) The gravels from Idaho Gulch to Deep Creek contain more than the usual amounts of tourmaline-rich pebbles (1). Relatively higher average niobium content (tables 2-6) of tailings piles B, E, and F (fig. 2) along lower Miller Gulch and Deep Creek suggest that these locations may be nearer to the bedrock source of the niobium. Also, the fact that these particular tailings piles are clustered on either side of a small hill (610-ft elev) may indicate a nearby intrusive source at shallow depth.

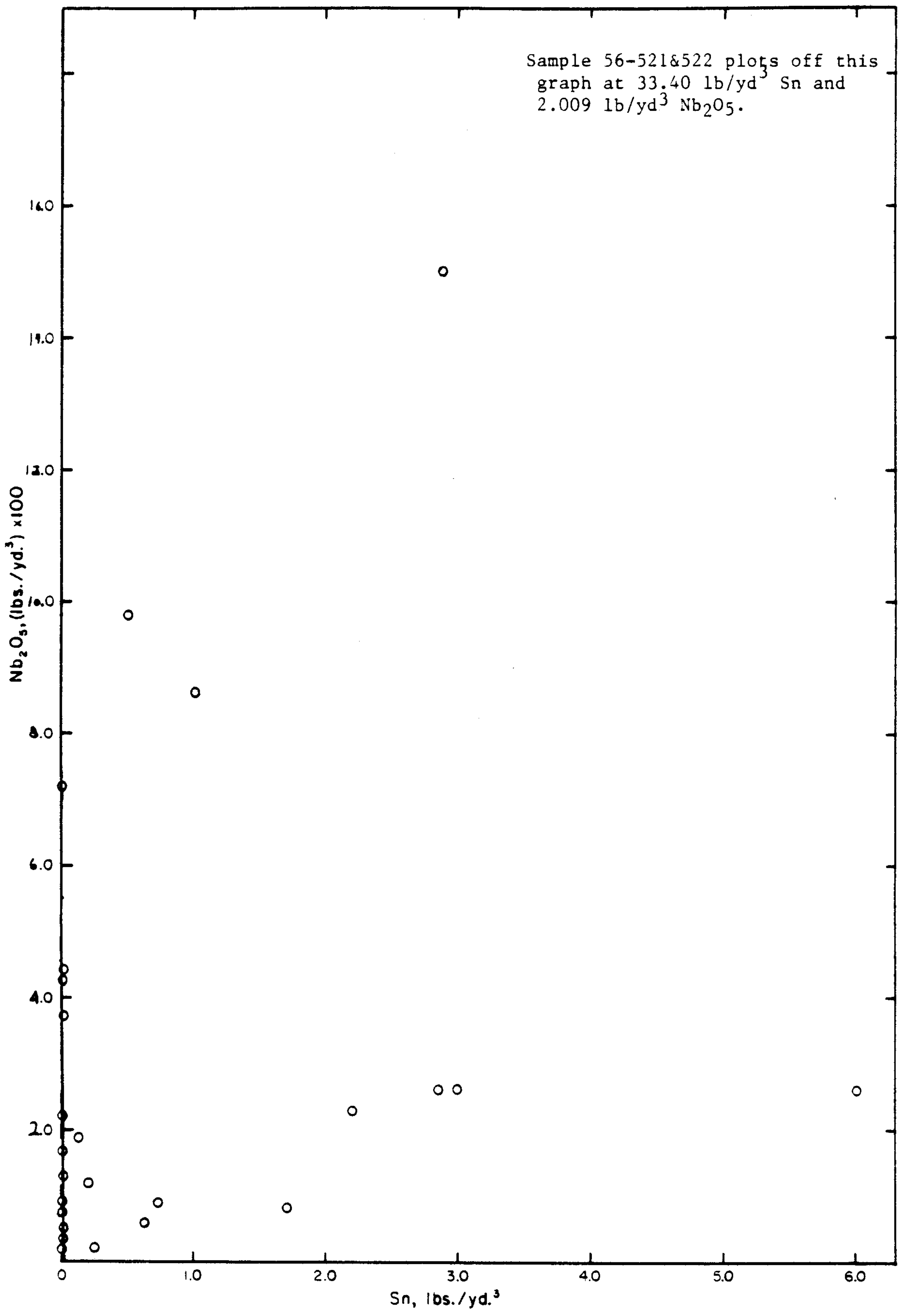

FIGURE 5.- Deep Creek samples as lb/yd^3 Nb_2O_5 versus lb/yd^3 Sn.

As mentioned previously, Kemp (10) has reported a "calcareous rare-earth-bearing pegmatite dike" occurring high on the west side of Idaho Gulch. That these or similar types of dikes or veins represent the bedrock source of tin and niobium is further suggested by the presence of angular cassiterite-quartz-tourmaline fragments in the gravels and concentrates. Wayland (1) noted the presence of sparse but uniformly distributed cobbles of equigranular quartz and tourmaline in the gravels of the placer belt. He suggests that these rocks are derived from dikes of quartz-tourmaline rock, or tourmalite.

MINERALOGY

In 1934, Waters (11), using optical methods, identified the niobium mineral aeschynite $(Ce,Ca,Fe,Th)(Ti,Nb)_2(O,OH)_6$ in grain mounts of heavy mineral concentrates from the Tofty placers. In 1983, J. Drake,[4] using X-ray diffraction techniques on mineral separates from Deep Creek, determined that the niobium-bearing phase is on the low manganese and tantalum, high iron and niobium end of the columbite series $(Fe,Mn)(Nb,Ta)_2O_6$. The principal niobium mineral in Deep Creek is therefore probably columbite, based on the more definitive X-ray diffraction analyses.

[4] Geologist, Alaska Field Operations Center, Bureau of Mines, Juneau, AK.

ESTIMATED RESERVES

Reserve estimates made in 1981 by Carnes (2) based on data from Wayland (1) for in-place indicated placer reserves and Thomas (4) for tailings reserves, indicate a probable 2,660,000 yd^3 of material.

Based on an average grade of 0.05 lb Nb_2O_5/yd^3, as indicated by the 1983 analyses reported in tables 3 through 11, total inferred niobium reserves of the known Tofty placers are on the order of 100,000 lb

Nb_2O_5. Additional undiscovered resources may also exist in hypothetical extensions of the mineralized belt, possibly as deeply buried placers to the east along Baker Creek (fig. 2) and even into the Eureka mining district a few miles further east. Similar extensions are possible to the west.

SUMMARY

Niobium is present in channel samples from tailings piles of gravels of streams in the Tofty area in small but recoverable quantities. Whereas there is very little likelihood that niobium could ever be produced as a primary commodity from these placers, it could be produced as a byproduct of the placer mining of gold or tin, or both.

The bedrock sources of the niobium and tin in the placer gravels of the Tofty area have not been identified. Probable sources include (1) the granitic stock of Hot Springs Dome, (2) the quartz-tourmaline and other dikes associated with that stock, (3) a related but unexposed intrusive, or (4) rare-earth-bearing dikes similar to that reported by Kemp (10). The cluster of relatively high niobium values at sample locations between upper Deep Creek and lower Miller Gulch suggest a bedrock source concealed in the vicinity of, or beneath, "hill 610."

Carnes (2) has estimated that the total known gold-tin placer reserves of the Tofty area are 2,660,000 yd^3 of material. Assuming an average grade of 0.05 lb Nb_2O_5/yd^3, as indicated by the samples from the tailings piles, these gravels would also contain about 100,000 lb Nb_2O_5.

It should be kept in mind that these grade estimates were based on samples of previously washed material (tailings) from which gold and some tin concentrates had been removed, and the grade of unmined material should be correspondingly higher. Additional buried deep placers may exist both to the west and to the east of the known placers of the Tofty area.

RECOMMENDATIONS

Because of the low total tonnage development potential for Nb_2O_5 in the placers of the Tofty area, no further work is recommended, beyond advising local miners and prospectors of the possibility of producing niobium as a byproduct of placer gold and tin mining.

Since the bedrock source(s) of the niobium are probably intrusive dikes associated with granitic intrusions, and because most such deposits high in niobium tend to be small and erratically distributed (12), it is doubtful that a search for the bedrock source(s) would be economically justifiable at this time. If, however, such a search is undertaken, it should be noted that the assumed intrusive source rocks are likely to have a distinct radiometric signature, compared to the surrounding sedimentary and metamorphic rocks. A grid-controlled ground radiometric survey would appear to be the logical first step. It is recommended this survey concentrate (1) in the area of "hill 610" and (2) in the higher elevations of Idaho and Miller Gulches.

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