GEOLOGICAL SURVEY OF CANADA

DEPARTMENT OF MINES AND TECHNICAL SURVEYS

PAPER 64-54

GEOLOGY OF CANADIAN TIN OCCURRENCES

(Report and Map 32-1964)

R. Mulligan

Price, 75 cents

1966

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OF CANADA

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Price, 75 cents   Cat. No. M44-64-54

Price subject to change without notice

ROGER DUHAMEL, F.R.S.C.
Queen's Printer and Controller of Stationery
Ottawa, Canada
1966

CONTENTS

Illustrations

TIN OCCURRENCES IN CANADA

Introduction

No deposits are being mined primarily for tin in Canada at present. Several hundred tons of tin per year have been produced regularly since about 1941 by The Consolidated Mining and Smelting Company of Canada Limited as a by-product from the lead-zinc-silver-iron ores of the Sullivan mine, Kimberley, British Columbia. The tin-tungsten-molybdenum-zinc-lead deposit of Mount Pleasant Mines Limited, in Charlotte county, New Brunswick, has been in an active exploration and development stage for several years. Small amounts of cassiterite have been recovered from placer-gold operations in the Atlin, British Columbia area and perhaps also in the Yukon. Small mining operations have been carried on in the Bernic-Shatford Lakes area, Manitoba and the New Ross area, Nova Scotia, but no substantial production has been recorded.

The accompanying Map 1045-M6 and Table I include most of the occurrences that have been reported up to 1963, although a few of these are considered dubious. The others, with some exceptions, are probably of no commercial importance, but have considerable significance from a metallogenic point of view. Besides indicating belts and areas favourable for tin deposits, they illustrate the remarkable variety in type of tin mineralization and association in Canada. This points up the need for careful investigation of all types of mineralization, and the advisability of spectrographic analysis for tin both on new discoveries and on previously known mineral deposits.

Classification of Deposits

Canadian tin occurrences are herein loosely grouped into the following types, as indicated by symbols on the map accompanying this report:

1) Placer Deposits

   (a) crystalline cassiterite
   (b) 'wood-tin' cassiterite

2) Pegmatites, albitites
3) Quartz veins, greisen, with minor or no sulphides
4) Quartz and/or calcite-sulphide veins
5) Disseminated and massive sulphide replacement bodies
6) Miscellaneous (in skarns, pitchblende ore, sperrylite ore, chromite ore, etc.)

Placer cassiterite deposits, especially those of southeast Asia and Indonesia, supply most of the world's tin. The Canadian placer occurrences are, in general, much poorer in tin. They have been worked almost exclusively for their gold content and tin has been, at best, an incidental by-product. However, some local concentrations have been noted, and these may be worth investigation as possible indications of valuable tin occurrences nearby.

Pegmatites have been mined for tin in a few places, as in the Karibib area of southwest Africa, and parts of Nigeria (Jones, 1925)[1]. They have supplied much of the tin found in some placer tinfields.

Cassiterite-bearing quartz veins and related stockworks, pipes, and disseminations, some with abundant metallic sulphides, are the main sources of tin, both in lode and placer deposits.

Mineralogy

Cassiterite and stannite are the only common tin minerals, although other tin minerals occur exclusively in some deposits.

Cassiterite (SnO_2) has been the only important ore mineral of tin. When pure it contains 78.6 per cent tin. It is tetragonal with no cleavage, has high refractive indices and birefringence. Although generally crystalline it is commonly in fine-grained aggregates. 'Wood-tin' is an extremely fine-grained or cryptocrystalline variety of cassiterite, with colloform structure marked by concentric banding. In colour, cassiterite varies from colourless or white through pink shades to dark brown or black. Dark colours are most common. Cassiterite is infusible and inert to acids. Its hardness is 7 and its specific gravity also about 7. As the specific gravity of common rock minerals is about 2.5 to 3, cassiterite is concentrated in placers and residual soils. Thus enriched areas can be detected and traced by panning and similar techniques.

A simple and reliable field test to distinguish cassiterite from other heavy minerals is to place the mineral in contact with zinc, in hydrochloric acid (a 1:1 solution of the concentrated acid is satisfactory). Within a few minutes the surface becomes coated with a dull grey film of metallic tin (due to reduction by atomic hydrogen). The film brightens when rubbed with cloth or soft paper. Zinc filings are convenient for large grains and fine material may be treated fairly well in a zinc tray.

Souxite or varlamoffite is a hydrated tin oxide found in Bolivia and the Congo. It is a yellow earthy powder that is soluble in hydrochloric acid.

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[1] Names and/or dates in parentheses refer to publications listed in the References.

Stannite ($Cu_2S.FeS.SnS_2$) contains 27.5 per cent tin when pure. It commonly contains some zinc and other metals. It is tetragonal in crystal form, but is generally in massive aggregates, and is brittle, with indistinct cleavage. Its hardness is 3.5 and specific gravity is 4.3-4.5. In colour it is steel-grey to black. A bluish tarnish, as shown by stannite from the Snowflake-Regal Silver property, British Columbia (loc. 22[1]) is fairly common. Stannite is similar to tetrahedrite. It is readily fusible and yields a white sublimate on charcoal, but is not positively identifiable by such methods.

Other sulphostannates, much rarer, are:

Franckeite ($5PbS.2SnS_2.Sb_2S_3$), H. = 2.5, G. = 3.5-5.5

Cylindrite ($6PbS.6SnS_2.Sb_2S_3$), H. = 2.5-3, G. = 5.42

Teallite ($PbS.SnS_2$), H. = 1-2, G. = 6.4

Canfieldite ($4Ag_2S.SnS_2$ ($\pm$Ge)) H. = 2.5, G. = 6.28

Argyrodite ($4Ag_2S.GeS_2$), H. = 2.5, G. = 6.1-6.3

All are dark grey to black. Most are known to occur only in Bolivia but franckeite occurs at Coal River, Yukon (loc. 17) and teallite and argyrodite occur at Frieberg, Saxony.

Wodginite, a tin-manganese tantalate containing 9-13 per cent SnO_2 (Nickel et al., 1963a) occurs at Wodgina, Australia and at the Chemalloy mine, Bernic Lake, Manitoba (loc. 37). Physically similar to columbite-tantalite, it is a hard, dark brown to black, refractory mineral with specific gravity about 7.2.

Hielmite, a Y, Fe, Mn, Ca stanno-niobate is reported only from Norway, and Ixiolite, a stanniferous niobate-tantalate from Finland (Nickel et al., 1963b).

Other very rare tin minerals include: (1) the borates Hulsite and Pageite found on Seward Peninsula, Alaska, and Nordenskioldine (2) two complex silicates, Stokesite and Arandisite, and (3) native tin, found in place at Beaverlodge, Saskatchewan (loc. 33).

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[1] Indicates number in accompanying table and map.

Associated Minerals and Metals

In pegmatites, tin occurs generally as cassiterite, rarely as wodginite or other minerals, and is commonly associated with lithium and/or beryllium minerals (Mulligan, 1965). Muscovite or lithia mica is characteristic and albite may be the dominant or only feldspar. Tourmaline is common; topaz and/or fluorite are locally present.

In typical quartz-greisen deposits muscovite (or lithia mica in a few places) is characteristic. Fluorite is common, and topaz is generally present, whereas tourmaline may be abundant or absent. Beryllium minerals occur in some such deposits (Mulligan, 1960; in press). Tungsten minerals, especially of the wolframite-ferberite group, are generally present in some abundance, also molybdenite, especially where sulphides of other base metals are abundant. Tin occurs partly as stannite in some of these. Bismuthinite and native bismuth are also common associates and arsenopyrite is generally conspicuous among the iron sulphides.

The quartz-greisen deposits grade into typical sulphide deposits, containing cassiterite and/or stannite or other sulphosalts. Some of these deposits, like the Sullivan mine, have one or more of the above-mentioned commonly associated gangue or metallic minerals. Some others have none. More zinc-lead deposits than primarily copper orebodies are tin-bearing. Sphalerite from many localities in 'tin-belts' contains small but significant amounts of tin (Warren and Thompson, 1944), and stannite occurs most commonly as small blebs in sphalerite.

Origin of Tin Deposits

Primary tin deposits are generally related to, and generally supposed to be derived from, granitic intrusions or rhyolitic intrusions and lavas. The most closely related granite bodies are commonly light coloured, with abundant potassic feldspar, and muscovite with or without biotite. Such bodies presumably represent the last phases of intrusive activity, and tin-bearing rhyolite bodies in most places are younger than the main granitic intrusions. However, muscovite granite bodies may result from late or postmagmatic hydrothermal alteration of biotite granite by which potassic feldspar is converted to albite and biotite to muscovite ('albitization' and 'greisenization'). Dome-shaped protuberances and cupolas on the roofs of granitic batholiths and small stocks on their flanks are considered favourable areas for tin concentration.

The common association of tin with fluorine-bearing minerals (fluorite, topaz, muscovite) has led to the theory that tin is transported from its granitic sources in the form of fluoride complexes and deposited as cassiterite in the course of reactions with the country rocks by which the complexes are broken down to produce the fluorine-bearing minerals.

Similarly, the association with tourmaline suggests that boron complexes may be effective in transporting tin. Various known sulpho-stannate complex ions have been suggested as the form in which tin was carried in hydrothermal solution into tin-sulphide deposits.

Geology of Canadian Tin Occurrences

In Canada the distribution of known tin occurrences suggests the existence of several more or less definite metallogenic provinces.

Cordilleran Region

In the Cordilleran region tin occurs mainly within a belt along the east flank of the Western Cordilleran subregion, which is bounded on the east by the Rocky Mountain Trench between latitudes 49°00 and 60°00. This trench marks the eastern limit of large igneous intrusions. Northwest of latitude 60 degrees the belt is less definite but it appears to be linked with an intermittent trans-Alaska tin belt by the Klondike-McQuesten-Mayo placer occurrences and one lode deposit. The bedded rocks are mainly Proterozoic and Early Palaeozoic metasediments. The belt includes some old metamorphic terrains, but the large granitic bodies are mainly late Mesozoic biotite granites and granodiorites. Within the belt most of the tin occurrences are in areas fringing the northern part of the Cassiar batholith in the north, and the Nelson batholith and its eastern satellites in the south.

In the northernmost part of the belt, the placer tin occurrences of the Klondike area are on the opposite side of the Tintina Trench (a major geological boundary) from those of the McQuesten area, and are markedly different in character. In the Klondike area the cassiterite occurs as smooth, polished, partly-rounded pebbles. These are banded in light-and-dark shades of brown ('wood-tin') and the bands are commonly concentric within individual pebbles. Microscopic examination shows that they consist mainly of cassiterite, in part at least crystalline. Some contain fluorite. Radial cracks cut across the concentric banding. Such material has been found in place in lode deposits in Nevada, New Mexico and Mexico, all related to Tertiary rhyolitic rocks. The wood-tin of the Klondike may be genetically related to rhyolitic quartz-porphyry intrusions such as now outcrop in the district. One such intrusion contains fluorite veinlets and a little topaz in one locality but no cassiterite was found there, and samples taken were not significantly rich in tin. The placer cassiterite of the McQuesten area (and of other Canadian placer occurrences) consists of discrete grains and crystal aggregates without colloform structure. The cassiterite of Dublin Gulch resembles lumps of coagulated brown sugar.

These are agglomerations of fine angular cassiterite grains and other material including fine tourmaline, and resemble the material found in place on the ridge northwest of the creek (loc. 3)[1].

Many of the tin-bearing creeks of the McQuesten area have granitic stocks in their source areas and generally contain also scheelite or wolframite. Samples collected by the writer from the large stock south of Dublin Gulch contained only about 1 part per million tin (Geol. Surv. Can., spectrographic lab.). This is quite low, as granites near some other tin occurrences in Yukon and northern British Columbia contain up to 8 ppm. tin. This is not much above the 3 to 5 ppm. generally considered to be the average tin content of granites in the earth's crust (Barsukov, 1957). Within the northernmost part of the Cordilleran 'tin belt', sphalerite samples from the lead-zinc-silver ores of Galena-Keno Hill have been found to contain up to 0.1 per cent tin (Warren and Thompson, 1944). A hypothetical southeastward extension of the belt may be manifested by the Sheldon Mountain and Coal River occurrences (locs. 16 and 17) and by the Canada Tungsten deposit.

Fringing the northern part of the Cassiar batholith, indications of tin enrichment include, beside the occurrences listed, several lead-zinc-silver sulphide ores found to contain up to .085 per cent tin (Geol. Surv. Can., spectrographic lab.). Tin accompanies beryllium at several localities, and bismuth is commonly associated with it.

Similarly in the Kootenay district, at its southern end, the belt coincides approximately with that of beryllium occurrences, and tin occurs in more than trace amounts in some pegmatites. However, most of the tin appears to be concentrated in zinc-lead sulphide ores. Most noteworthy of these, beside the producing Sullivan mine (loc. 29), is the Snowflake-Regal Silver deposit (loc. 22).

Canadian Shield

In the Precambrian Canadian Shield most of the tin occurrences are in the Archaean Slave and Superior structural provinces, very few being known in the younger Churchill and Grenville provinces. In the Slave Province metasedimentary and minor metavolcanic rocks of the Yellowknife Group are cut by a complex of granitic intrusions, the youngest of which are muscovite-bearing granites and pegmatites. Many of the latter contain lithium and beryllium minerals and, more rarely, cassiterite In the Superior Province, outside the Rush-Bernic-Shatford Lakes area, occurrences are too scattered to suggest any particularly favourable belts, although that extending east from Linklater Lake (loc. 39) to O'Sullivan Lake,

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[1] Indicates number in accompanying table and map.

which contains several lithium and beryllium occurrences, might be so regarded. Fractional percentages of tin in pyrite, pyrrhotite, and chalcopyrite in the deposits at Manitouwadge, Ontario (loc. 40) and Normetal, Quebec (loc. 44) emphasize the possibility of important tin concentration in sulphide deposits.

Appalachian Region

In the Appalachian region, where the major granitic intrusions of New Brunswick and mainland Nova Scotia are of Devonian age, tin occurs in or on the fringes of each of the main belts of granitic intrusions.

The belt extending through central New Brunswick contains the Burnt Hill and adjacent wolframite-molybdenite-beryl-cassiterite-topaz-fluorite deposits (loc. 49), molybdenite-beryl occurrences near Bathurst, and molybdenite-beryl occurrences near Burtt's Corners, as well as the tin-bearing sulphide ores of the Bathurst district (loc. 50). In the general area of the Burnt Hill mine where bodies of muscovitic and miarolytic granite and alaskite are found (Poole, 1960b; 1963), samples of different granites collected by the writer ranged generally from 6 to 12 ppm. tin (Geol. Surv. Can., spectrographic lab.), but were substantially higher where evidence of greisenization was found.

In the southern New Brunswick belt, it is not certain that the rhyolitic volcanic rocks in which the Mount Pleasant deposit is emplaced are post-granite in age, and the relationship of the deposit to the main granitic belt is therefore uncertain. However, the Square Lake occurrences (loc. 48) are emplaced in granite of the main batholith. A composite sample of granite collected along the road from Wirral to Nerepis contained 30 ppm. tin (Geol. Surv. Can., spectrographic lab.). A sample of the red granite along the road north of St. George contained 25 ppm. tin, but two samples of porphyritic grey granite farther north contained only 5.5 and 2.8 ppm. respectively.

In Nova Scotia the tin occurrences of the New Ross area (loc. 51) are in or on the borders of the area mapped as muscovite granite (Faribault, 1908; 1924; 1931). This area appears to be significantly richer in tin (average of sample taken by the writer: 26 ppm.) than the adjoining biotite granite (average: 5 ppm.), although it includes a large proportion of granite indistinguishable from the 'biotite granite'.

Although workable deposits of tin have not been found in the area, despite extensive investigation, it is possible that better concentrations existed in or above the upper contact of the muscovite granite area, above the present level of erosion. Other similar bodies that have not yet been unroofed may be present off the flanks of the main granite batholiths of the province. These might be indicated by anomalous tin concentrations in pan concentrates of soils and stream sediments, and in mineralized zones. Pan concentrates from the mouth of McQuarrie Brook (loc. 53) contain abnormal amounts of tin (McCartney and McLeod, 1965). Vague reports of cassiterite in surficial material in several other parts of Nova Scotia may also provide clues to favourable general areas for prospecting.

Large parts of Newfoundland, where the geological environment is similar to that of Nova Scotia and New Brunswick, also offer possibilities for tin discoveries.

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Table I
Tin Occurrences in Canada

No.	N.T.S. Map Sheet	Name, Locality	Lat.	Long.	Type	Tin Mineral	Associated Minerals/metals	References	Remarks
1	1150, 116B	Klondike Gold Fields, Yukon. (Hunker, Dominion, Bonanza Creeks, etc.)	64°02 63°40	139°30 138°30	Placer	Cassiterite	Au	Bostock, 1942(geol) Green & Roddick, 1962 (geol) Green, paper 63-38	fine-banded(wood tin) pebbles(also Germaine Creek).
2	115P, 106D 105M	McQuesten District, Yukon. (Clear Creek to Dublin Gulch)	64°03 63°40	137°20 135°40	Placer	Cassiterite	Au, tungsten	Bostock, 1943	crystalline only, including Arizona, Clear, Vancouver, Boulder, Johnson, Minto, Haggart Creeks.
3	106D4	Dublin Gulch, Yukon	64°02	135°50	Quartz-veins	Cassiterite	tourmaline	Thompson, 1945	small veins in argillaceous schist.
4	105M14	Thunder Gulch, Keno Hill, Yukon	63°55	135°15	Placer	Cassiterite		Bostock, 1947 (geol)	
5	105M10	Ledge Creek(S.E. arm Mayo Lake)	63°41	134°50	Placer	Cassiterite	tungsten	Bostock, 1947 (geol)	
6	115J	Canadian Creek, Yukon	62°45	138°50	Placer	Cassiterite	wolframite	Little, 1959	very little if any tin.
7	115G6	Burwash Creek, Yukon	61°36	139°27	Placer	Cassiterite			traces to 1% in placer concentrate.
8	115A3	Tatshenshini R., Yukon/B.C. (tributary of)	60°±	137°10±	Placer	Cassiterite			source of sample dubious.
9	114P10	State of Montana claim, Rainy Hollow, B.C.	59°33	136°32		?	Cu-Zn-Bi-Ag sulphides	Watson, 1948 (geol) Kindle, E.D. (pers. comm.)	0.1% spectro in high-grade Cu-Ag-Bi ore.
10	104N11-	Atlin, B.C.-Pine, Boulder, Birch, Ruby Creeks	59°43 35	133°30 20	Placer	Cassiterite	wolframite (Boulder Cr.)		small amount recovered with wolframite.
11	105B3	Partridge Creek, Yukon	60°07	131°15	Quartz vein	Cassiterite	fluorite, tourmaline	Poole, 1960a	spectrographic traces other localities.

12	105B2	Fidler Claims (Yukon tungsten), Yukon	60°08	130°26	Quartz vein	Cassiterite	wolframite, fluorite	Poole, 1960a	tin also in wolframite.
13	104O8	Ash Mountain, B.C.	59°18	130°31	pyroxene-garnet-vesuvianite skarn	?	scheelite, minor Be	Watson, & Mathews, 1944	to 1.1% tin spectro. in samples by writer mainly associated with pyroxene-garnet
14	104P4	Needlepoint Mt. (McDame), B.C. low-grade claim	59°08	129°46	magnetite skarn	?	helvite-danalite fluorite	Holland, 1955 p. 11	tin .01-.1 range spectro.
15	104P5-	Wing property, Quartz Creek (McDame), B.C.	59°16	129°41	Placer	Cassiterite			1-3% in heavy mineral fraction.
16	105J11	Sheldon Mt., Yukon	62°44	131°05	Quartz vein	?		Kindle, 1946	assay 0.06% plus Au, arsenopyrite.
17	95E6	Coal River, Yukon	61°24	127°20	Calcite vein	Franckeite, stannite	sphalerite, galena, geocronite	Evans, 1957	thin vein in argillite, exposed for about 50 ft. drilled by Nicolet Asbestos, 1963.
18	94C,F	Findlay River, B.C.	56-58°	124-26°	Placer	Cassiterite		Dolmage, 1928	small amount reported, none found in ores or pegmatites.
19	93M4	Black Prince, Rocher Déboulé etc., Hazelton, B.C.	55°10±	127°43 32	Quartz veins	?	W, Cu, etc.	Kindle, 1954	to 1.3% in assays
20	93K13	Tsitsutl Mt., Fort St. James District, B.C.	54°57	125°37	Rhodonite vein	?	Mn, Zn, V, etc. sulphides	Armstrong, 1949	0.2-.3% max. found.
21	92H16	Renfrew Group, Similkameen District, B.C.	49°47	120°20	Quartz veins	?	Pb-Zn-Cu-Ag sulphides	Rice, 1947	spectro. traces tin.
22	82N4	Snowflake, Regal Silver, Revelstoke, B.C.	51°12	117°54	Quartz veins	Stannite, cassiterite	Pb-Zn-Cu-Ag sulphides, tungsten, fluorite	Gunning, 1929 McClelland, 1952 Stevenson, 1943 pp. 120-130	former Pb-Zn-Ag and scheelite producer (see additional notes)

Table I (cont'd.)
Tin Occurrences in Canada

No.	N.T.S. Map Sheet	Name, Locality	Lat.	Long.	Type	Tin Mineral	Associated Minerals/metals	References	Remarks
23	82~~N4~~ K13	McDougall Creek, B.C.	51°	117° 1/2	Pegmatite	Cassiterite		B.C. Dept. of Mines Ann. Rpt. 1914 p. 271 Stevenson, 1943 p. 131	
24	82K11/10	Cockle Creek, Duncan River, B.C. (Erdahl-Pinchback claims)	50°34	117°00	Quartz veins	?	scheelite, tourmaline, sulphides, Be	B.C. Dept. of Mines Ann. Rpt. 1945 p. A 107	to 0.04% max. spectro. anal.
25	82K3 F14	Slocan (Payne, Lucky Jim, etc.)	50°	117°15±	Calcite-quartz veins	Cassiterite	Pb, Zn, Ag, Cu sulphides	Warren & Thompson, 1944 Hedley, 1952 p. 58	to 0.3% in sphalerite.
26	82F10	Ainsworth camp, B.C.	49°44	116°58	Calcite-quartz veins	?	Pb, Zn, Ag, Cu sulphides		to 0.03% spectro.
27	82F15	Humbolt & Rose Pass, E. Kootenay, B.C.	49°45	116°38	Quartz veins	Stannite	Pb-Zn-Ag sulphides	Rice, 1941 (p. 73-74)	to 2% spectro.
28	82F8	Storm King claim, E. Kootenay, B.C.	49°29	116°27	?	?	Cu-Pb-Sb sulphides	Leech, 1952	to 0.31% (selected sample)
29	82G12	Sullivan Mine, Kimberley, B.C.	49°40	115°59	Sulphide	Cassiterite	Pb-Zn-Fe sulphides, tourmaline	Pentland, 1943 Swanson & Gunning, 1944 Cominco Staff, 1954	regular production of tin as by-product (see additional notes)
30	85J9	Homer Lake-Walsh Lake (Yellowknife District, N.W.T.)	62°39 35	114°18 15	Sulphide, Au-quartz veins	?	Pb-Zn-Fe-As sulphide	Lord, 1951 p. 177, Jolliffe, 1946	traces to 0.06%.
31	85H	Outpost Island, Great Slave Lake	61°45	113°30	Au-quartz-sulphide shear zones	?	W., Mo, Cu	Lord, 1951 p. 239, Hawley, 1937	to 0.2% some samples.

32	85I	Yellowknife-Beaulieu Distr. (Bore, Buddy Tan, Bighill, Best Bet, Freda, etc.)	62°47 08	112°36 13	Pegmatite	Cassiterite	Li, Be, Nb, Ta	Jolliffe, 1944 Lord, 1951 p. 88, 118-121, 153	see additional notes
33	74N9	Nesbitt-Labine, Beaverlodge, Sask.	59°34	108°30	Calcite veins	native tin	Pitchblende, Cu-Zn-Pb sulphides	Silman, 1954	very rare
34	63N2	Walton Lake (Peace River Group), Man.	55°12	100°49	dissem. sulphide	?	Fe & Cu sulphide tourmaline	Wright, J.F., 1930	0.2% tin reported one assay.
35	53K	Red Sucker Lake, Man.	54°10±	93°45±	albitite pegmatite	Cassiterite	minor topaz, tourmaline	Bateman, 1943 Downie, 1937	up to 0.4% tin in restricted areas
36	52L14	Moore Lake, near Beresford Lake, Man.	50°56±	95°17±	sulphide	?		Bateman, 1943	trace to 0.8% reported.
37	52L6	Bernic, Shatford, Rush Lakes, Man.	50°27 23	95°30 20	pegmatite albitite	Cassiterite, also wodginite	Li, Be, Cs, Nb, Ta	Wright, J.F., 1932 Bateman, 1943, Davies, 1955, 1957 Nickel et al., 1963a	tin-manganese tantalate (see additional notes)
38	52L7	Werner Lake, Ont.	50°28	94°55	chromite-sulphide	Cassiterite	Cr, Fe-Ni-Cu sulphides	Rose, 1958	rare microscopic grains
39	52I10	Linklater Lake, Ont.	50°38	88°47	granitic dykes	Cassiterite	Be, tourmaline	Chisholm, 1948	thin stringers to 1.8%.
40	42F4	Manitouwadge, Ont. (Willroy)	49°08	85°47	sulphide	?	Cu-Zn-Fe sulphides	Nichol, 1958	samples 0.3% average in pyrite 0.1% average in pyrrhotite and chalcopyrite
41	41P13	Redore Mining Co. near Gogama, Ont.	47°50	81°32	pegmatite	?		McClelland, 1952	analyses to 2.5% in tin reported.
42	41I6	Vermilion Mine, Denison Tp., Ont.	46°25±	81°20±	vein	Cassiterite	sperrylite	Wells, 1889	minute amounts.
43	41I-P	Vermilion River, Sudbury District, Ont.			placer	Cassiterite		Haultain, 1942	minute quantities by superpanner; locality indefinite.
44	32E3	Normetal Mine, Abitibi Co., Que.	49°00±	79°22±	sulphide	?	Fe-Cu sulphides	Nichol, 1958	to 0.46% in pyrrhotite samples.

Table I (cont'd.)
Tin Occurrences in Canada

No.	N.T.S. Map Sheet	Name, Locality	Lat.	Long.	Type	Tin Mineral	Associated Minerals/metals	References	Remarks
45	31G12	Buckingham Tp., Que.	45°38±	75°32±	dissem. in mica gneiss	Cassiterite	graphite	Johnston, 1915	microscopic grains identified by bead test.
46	21L16	Talon Tp., Lot 39, RV, Que.	46°45	70°04	sulphide	?	Zn-Ni-Cu sulphide	Beland, 1954 p. 6	traces in shear zone.
47	21G7	Mt. Pleasant Mines Ltd., Charlotte Co., N.B. (and Kedron Brook)	45°26	66°49	sulphide	Cassiterite stannite	W, Mo, Fe-Zn-Pb Cu sulphide, fluorite	Riddell, 1962, Hosking, 1963, Petruk, 1963	underground exploration -development (see additional notes)
48	21G8	Square Lake, Queens Co., N.B.	45°26	66°23	quartz-greisen	Cassiterite	W, Mo, fluorite, topaz	Wright, W.J., 1940b.	.04% tin on composite by writer.
49	21J10	Burnt Hill Mine, York Co., N.B.	46°33	66°49	quartz-greisen	Cassiterite	W, Mo, Be, topaz fluorite	Wright, W.J. 1940a; Victor, 1957; Poole, W.H., 1960b.	tin-bearing greisen several localities. (see additional notes)
50	21P5	Brunswick Mines, Bathurst, N.B.	47°27±	65°50±	sulphide	Cassiterite stannite	Fe-Zn-Cu-Pb sulphide	Aletan, 1960	.05-.1% tin.
51	21A16	New Ross District, N.S. (Turner Prospect, Wallaback Lake, etc.)	44°48 43	64°32 25	quartz-greisen veins pegmatite	Cassiterite	fluorite, chalcopyrite, locally Mo, W, Li, Be.	Messervey, 1933; Faribault, 1908; Douglas, G.V., & Campbell, 1941	assays to 1% in very restricted areas.
52	21A7	Malaga Gold District, N.S.	44°20	64°53	Au-quartz veins	Cassiterite		Hoffman, 1890	minute quantity in tailings from Battery Lead.
53	11E8	McQuarrie Brook, N.S.	45°17	62°23	Placer			McCartney and McLeod, 1964.	0.2% tin in heavy mineral concentrate.

Appendix: Notes to Supplement Table I

Locality 22, Snowflake-Regal Silver

A series of quartz-sulphide veins dip 30 to 60 degrees, nearly parallel with enclosing carbonaceous slates and carry pyrite, galena, and sphalerite, in places stannite, scheelite, wolframite, fluorite, a little chalcopyrite and silver minerals, and perhaps cassiterite. The main known stannite-bearing area is in the upper workings that cross the boundary between the Snowflake and Regal Silver properties, and has been estimated (McClelland, 1952) to contain about 10,000 tons of ore averaging 1 per cent tin. Scheelite-wolframite concentrations have been found mainly in the lower workings.

The property was first opened up in 1922 and operated until 1930, about 12,000 feet of development being done on five levels. Some underground diamond drilling was done in 1942 by the Federal Government in an attempt to investigate the down-dip extension of the upper stannite shoot. The property was operated again from 1940 to 1953 (B.C. Dept. of Mines, Annual Reports), when small shipments of lead and scheelite concentrates were made.

Locality 29, Sullivan Mine

At the Sullivan mine the ore consists of mainly well-banded lead, zinc, and iron sulphides, apparently a replacement of argillaceous phases of the Proterozoic Aldridge strata. The ore as mined contains only about 0.06 per cent tin, mostly as very small (about 75 microns) cassiterite grains with about 10 per cent in unknown form in the sulphides.

The tin content is considerably higher in some parts of the footwall zone and in areas near the central 'barren zone' of the orebody, which consists mainly of pyrrhotite and pyrite. The footwall zone includes a conglomeratic horizon that has a cherty appearance due to replacement by extremely fine-grained tourmaline. It locally contains abundant pyrrhotite and grades upward into massive pyrrhotite. Some shear zones that cut this horizon, especially near the central iron-sulphide core or 'barren zone', are especially rich in tin. Only about half the total tin content is recovered in the treatment process, which consists of gravity separation after removal of most of the sulphides by flotation. A small amount is also recovered from drosses at the smelter. Production has averaged about 308 tons of tin per year for the past 10 years.

Locality 32, Yellowknife-Beaulieu District

Tin occurs in significant amount in fewer than 10 of the hundreds of pegmatite dykes known to contain rare-element minerals, but nowhere in economic amounts. It is much scarcer than columbite-tantalite, with which it is commonly associated. The cassiterite-bearing dykes are not noticeably different from the others. No fluorite or topaz has been found in them, and tourmaline is not a conspicuous associate. Where found, cassiterite is mainly in very small dark grains, but occurs in a few places, such as Dyke section 28, Bore Group, Sproule Lake (Jolliffe, 1944) as aggregates an inch or more across. Concentrate recovered from the Best Bet property in 1947 contained 13.4 per cent tin as well as 58 per cent Ta_2O_5 and 8 per cent Cb_2O_5 (Lord, 1951, p. 119).

Locality 37, Bernic-Shatford-Rush Lakes Area, Manitoba.

Cassiterite occurs in significant amount only in a few albite-rich dykes among the many lithium and beryllium-bearing pegmatites of the district. None are of commercial importance as tin deposits. A considerable amount of exploration work was done on them about 1929, and shafts were sunk at Bernic Lake (at the site of the present Chemalloy property) and at the Shatford Lake occurrence. The dykes on the Rush, Stannite, and Odd claims were re-examined in 1940-1942. At the Odd claim, 2,200 feet of drilling was done by the Federal Department of Mines and Resources in addition to 600 feet already done.

The dykes near Rush Lake contain albite, quartz, yellowish muscovite, and tourmaline, and minor amounts of spodumene and beryl. Cassiterite occurs only in restricted areas, generally near contacts, but at the Odd dyke a length of 320 feet of the albitite phase was found to contain 0.35 per cent tin over a width of 4.7 feet.

At Shatford Lake the exposed pegmatite consists of quartz, albite, tourmaline, biotite, and pale yellow mica. Cassiterite occurs mostly in quartz-muscovite at the contact with a garnetiferous band. Some fluorite was reported.

At the Bernic Lake occurrence the surface dykes, generally flat-lying, consist of albite, quartz, pale yellow mica, and abundant black tourmaline. Cassiterite occurs in narrow fine-grained dykes and in the fine-grained margins of wider ones. The large flat-lying lithium- and caesium-rich pegmatite, which lies immediately beneath and has been developed by Chemalloy Mines Limited, contains little cassiterite, but an albitite phase of the pegmatite contains a significant amount of wodginite, a rare tin-tantalate with about 13 per cent SnO_2 (Nickel et al., 1963a).

Locality 47, Mount Pleasant Mines Limited

The property is on Mount Pleasant ridge, about 22 miles north of St. George, New Brunswick, and 14 miles northeast of Rolling Dam.

The deposit is in altered rhyolites, breccias, and other pyroclastic rocks, near their contact with phyllitic slates and quartzites of the

Ordovician Charlotte Group. These volcanic rocks have been mapped as Mississippian, but there is some doubt as to their age, consequently as to whether the deposit may be genetically related to the Devonian granite of the region or must be younger. The process of mineralization may be genetically related to the rhyolitic volcanic rocks themselves or intrusive hypabyssal phases, and thus resemble some Bolivian and Mexican deposits. The deposit lies on the general line of several small granite stocks that outcrop in a belt north of the main batholith.

The volcanic rocks at the site of the deposit are in large part silicified and chloritized, in places replaced by fluorite, topaz, sericite, and kaolin, and impregnated with varying amounts of cassiterite and of sphalerite, arsenopyrite, pyrite, chalcopyrite, galena, stannite, molybdenite, wolframite, and other minerals. Most of the tin is in the form of cassiterite, which is very fine grained (10 to 300 microns). It is most commonly associated with fluorite and arsenopyrite, but occurs among and within other sulphides. Some kaolinized zones are especially rich in tin. An estimated 15 per cent of the tin is in the form of stannite, which occurs as lamellae and inclusions in sphalerite, where it is closely associated with chalcopyrite.

The distribution of tin and other metals suggests control by fracture systems, but the structure, while evidently complex, is most difficult to interpret, owing to heterogeneity of rock type and variation in alteration. Consequently the trend of lodes and shoots is determined mainly by assay.

Most of the known potential ore, as indicated by drilling, is in a "north" zone and a "Fire-Tower" zone, which are some 4,000 feet apart. The north zone has been partly explored underground by a development adit and several crosscuts.

Ore reserves, as announced by the company in its Annual Report for 1963, were calculated as follows:

RESERVES AS OF MAY 1st, 1964 (Inclusive)

			GRADE %			
	ZONE	TONS	Sn	Zn	Cu	Pb
PROVED ORE	North	272,000	0.6	2.3	(0.30)	(0.36)
PROBABLE ORE	North	310,000	0.6	2.4	(0.30)	(0.36)
	Fire Tower (No. 7 Lode)	165,500	0.43	3.73	0.40	1.18
POSSIBLE ORE	North	430,000	0.6	2.35	(0.30)	(0.36)
	Fire Tower (No. 7 Lode)	862,000	0.4	3.7	0.4	1.18
TOTAL		2,039,800				

Tin occurs in significant amount also in small quartz-sulphide veins on Kedron Brook, about 4 miles west of Mount Pleasant.

Locality 49, Burnt Hill Mine, New Brunswick

This property is of interest as an example of a wolframite-cassiterite deposit in a greisenized-granite environment. Although the tin content is evidently low, it might be economically recoverable if the deposit were to be re-worked for wolframite.

At the mine, a number of subparallel fissure veins up to 4 feet wide cut more or less schistose slates and quartzites near a body of Devonian granite. A considerable amount of development work, and some mining and milling were done prior to 1956.

Muscovite is not conspicuous in the ore material but topaz is second in abundance only to quartz. Fluorite is common. Beryl, in radiating bursts of fine green needles, is found in much of the vein material. Molybdenite is fairly abundant, though much less so than wolframite. Arsenopyrite, pyrrhotite, pyrite, chalcopyrite, sphalerite, galena, and native bismuth are present in relatively minor amounts. Greisenized granite from a drill core on the property was found to contain 160 ppm. (0.016 per cent) tin and greisen veins in the granite in the general area also contain significant amounts of tin.