CANADA
DEPARTMENT OF MINES AND TECHNICAL SURVEYS

GEOLOGICAL SURVEY OF CANADA
Economic Geology Series No. 17

TUNGSTEN DEPOSITS OF CANADA

By

H. W. Little

THE QUEEN'S PRINTER AND CONTROLLER OF STATIONERY
OTTAWA, 1959

Price, $1.50 No. 2536

CANADA
DEPARTMENT OF MINES AND TECHNICAL SURVEYS

GEOLOGICAL SURVEY OF CANADA
Economic Geology Series No. 17

TUNGSTEN DEPOSITS OF CANADA

By

H. W. Little

THE QUEEN'S PRINTER AND CONTROLLER OF STATIONERY
OTTAWA, 1959

4,000-1956-992

No. 2536

Price $1.50 Cat. No. M43-17
Available from Queen's Printer,
Ottawa, Canada.

CONTENTS

PAGE

Preface vii

CHAPTER I

Introduction 1
History 1
Mineralogy 1
Fluorescence of tungsten minerals 4
Properties 6
Uses 6

CHAPTER II

General character and origin of tungsten deposits 7
Deposits formed by mechanical processes of concentration 7
Alluvial (placer) deposits 7
Eluvial (residual) deposits 8
Primary deposits 8
Disseminations in igneous rocks 8
Pegmatites 9
Contact metamorphic deposits 10
Quartz veins 11
Hypothermal 12
Mesothermal 12
Epithermal 12
Hot spring deposits 13

CHAPTER III

Description of deposits 14
Yukon Territory 14
Placer deposits 16
Lode deposits 30
British Columbia 37
Placer deposits 38
Lode deposits 39
Northwest Territories 121
Lode deposits 121
Saskatchewan and Manitoba 147
Lode deposits 147
Ontario 157
Lode deposits 157
Quebec 178
Lode deposits 179
New Brunswick, Nova Scotia, and Newfoundland 190
Lode deposits 191
New Brunswick 191
Nova Scotia 194
Newfoundland 201

CHAPTER IV

Tungsten deposits in other countries 203
Europe 203
British Isles 203
Portugal 203
Spain 204

CONTENTS—(*Con.*)

	PAGE
Asia	204
Burma	204
Thailand	205
Malaya	206
China	206
Japan	209
Republic of South Korea	210
Northern Korea	210
U.S.S.R.	211
Australasia	211
Australia	211
New Zealand	213
Africa	213
Belgian Congo	214
Southern Rhodesia	214
Union of South Africa	214
Nigeria	215
Egypt	215
South America	215
Argentina	215
Brazil	216
Bolivia	217
Peru	218
North America	218
Cuba	218
United States	219

CHAPTER V

Statistics of production	223
Bibliography	230
Index	243

Illustrations

		PAGE
Figure	1. Map showing belt of granodiorite stocks extending eastward from Clear Creek, and locations of tungsten occurrences within the belt	15
	2. Index map showing location of tungsten deposits in Yukon Territory	17
	3. Sketch map of the area containing ferberite at head of Canadian Creek	18
	4. Plan of Dublin Gulch scheelite placer ground	23
	5. Castnor (Cement) Creek scheelite area	31
	6. Castnor (Cement) Creek contact area	32
	7. Dublin Gulch area	35
	8. Index map showing location of tungsten deposits in British Columbia	In pocket
	9. Composite plan of underground workings, Rocher Déboulé mine, Western Tungsten Copper Mines, Limited	47
	10. Plan of underground workings with geology and tungsten occurrences, Hardscrabble Creek, Cariboo area, B.C.	In pocket
	11. Last Chance group, Swakum Mountain, showing surface workings, drill-holes, and main geological contacts	82
	12. Assay plan, Last Chance group, Swakum Mountain	83

CONTENTS—(*Conc.*)

PAGE

13. Plan of pits and trenches and their geology, Bunker Hill scheelite deposit, Nelson area, B.C. 101
14. Plan of part of the property of Canadian Exploration, Limited, showing the Emerald, Feeney and Dodger tungsten deposits 107
15. Composite plan and three cross-sections of the Emerald tungsten deposit .. In pocket
16. Cross-sections of Feeney tungsten deposit 111
17. Cross-section of Dodger tungsten deposit 113
18. Plan of trenches on the property of Arrow Tungsten, Limited .... In pocket
19. Index map showing location of tungsten deposits in Northwest Territories 122
20. Plan showing location of scheelite-bearing veins near Tibbitt Lake, Northwest Territories 128
21. Plan showing grade of scheelite veins in gabbro dyke at south end of Peninsula Lake, a mile southwest of Tibbitt Lake, Northwest Territories 129
22. Scheelite-bearing veins, Gilmour Lake area, Northwest Territories 137
23. Discovery scheelite-bearing vein, Gilmour Lake area, Northwest Territories. In pocket
24. Index map showing location of tungsten deposits in Saskatchewan and Manitoba 148
25. Index map showing location of tungsten deposits in Ontario .... In pocket
26. Index map showing location of tungsten deposits in Quebec 180
27. Index map showing location of tungsten deposits in New Brunswick, Nova Scotia, and Newfoundland 192
28. Wolframite-bearing veins, Burnthill Brook, New Brunswick .... In pocket
29. Graph showing yearly average prices of tungsten concentrates for period 1898 to 1953, inclusive 227

PREFACE

Tungsten ores in Canada have been mined, with minor exceptions, only under the stimulus of wartime production, or of stockpiling in the event of hostilities that may cut off normal sources of supplies. The first report upon tungsten ores of Canada was prepared by the late T. L. Walker and published by the Mines Branch in 1909. During World War I and more particularly during World War II the increased demand for tungsten stimulated prospecting for this metal, and numerous new discoveries were made. During the latter war many officers of the Geological Survey of Canada, the Mines Branch, and of some of the Provincial Departments of Mines were employed in the examination of promising deposits. Except in British Columbia, few reports on these properties have been published.

This report includes considerable unpublished information and, it is hoped, all of the significant published data concerning tungsten-bearing deposits in Canada up to the end of 1953. This information is supplemented by the examination by the author in 1951 of the Emerald tungsten mine, at that time owned by the Crown, and several nearby deposits. Other such properties in British Columbia were examined by E. D. Kindle and S. Duffell whose reports are included in this volume. The section on Yukon Territory was written by H. S. Bostock.

GEORGE HANSON,
Director, Geological Survey of Canada

OTTAWA, July 15, 1956

TUNGSTEN DEPOSITS OF CANADA

CHAPTER I

INTRODUCTION

History

The word *tungsten* is derived from the Swedish, and means heavy stone. It was first used by A. F. Cronstedt in 1755, and referred to the heavy minerals of tungsten. In 1781, C. W. Scheele showed that the mineral now known as scheelite is a compound of calcium and a peculiar acid. Two years later, J. J. and F. de Elhuyar isolated the element from wolframite. The metal became known as tungsten in the English-speaking world, but in some other parts, particularly in Germany, it has been called wolfram. In 1949, the International Union of Pure and Applied Chemistry suggested that the name wolfram be used exclusively, but because of the opposition to this suggestion, it was decided that both names would be acceptable[1], and both are recognized. In view of the fact that the word *tungsten* has been used universally on this continent for more than a century, and that the word wolfram has been widely used, particularly by British writers, as a general term embracing wolframite, ferberite, and hübnerite, the term *tungsten* will be used in this work in referring to the element. The symbol is W and the element belongs to the chromium group.

It was not until about 1850 that industrial uses for tungsten were discovered, and since that time the production of tungsten has increased enormously as its uses both in times of peace and of war have multiplied.

Mineralogy

The following four tungsten minerals are of major importance:

Ferberite: Iron tungstate $FeWO_4$, in which atomic substitution of Fe by Mn up to 20 per cent may occur. Monoclinic. Lustre, submetallic to metallic. Colour, black. Streak, dark brown to nearly black. Hardness, 4½ to 5. Cleavage, perfect in one direction. Parting, sometimes observed. Fracture, uneven. Brittle. Specific gravity 7.5. Weakly magnetic. Forms isomorphous series with hübnerite.

Hübnerite: Manganese tungstate, $MnWO_4$, in which atomic substitution of Mn by Fe up to 20 per cent may occur. Monoclinic. Lustre, submetallic to metallic-adamantine, tending towards resinous. Colour, yellowish brown to reddish brown, rarely brownish black. Streak, yellow to reddish brown, or greenish grey. Hardness, 4 to 4½. Cleavage, perfect in one direction. Parting, sometimes observed. Fracture, uneven. Brittle. Specific gravity 7.1 to 7.3.

Wolframite: Iron-manganese tungstate, $(Fe, Mn)WO_4$. Contains 20 to 80 per cent ferberite molecule, the remainder comprising the hübnerite molecule,

[1] *Chemical Abstracts*, 1952, p. 8429 E.

forming an isomorphous series. Monoclinic. Lustre, submetallic to metallic-adamantine. Colour, dark greyish or brownish black to black. Streak, reddish brown to brownish black, and black. Hardness, 4 to 4½. Cleavage, perfect in one direction. Parting, sometimes observed. Fracture, uneven. Brittle. Specific gravity 7.2 to 7.5.

Scheelite: Calcium tungstate, $CaWO_4$. With the powellite molecule, $CaMoO_4$, this molecule forms a partial isomorphous series, in which MoO_3 up to 24 per cent by weight, but rarely more than 2 or 3 per cent, may replace WO_3. The molybdenum-bearing variety is known as molybdoscheelite[1]. This distinction is economically important because of the penalties imposed on scheelite concentrates containing more than 0.10 to 0.40 per cent molybdenum. Tetragonal. Lustre, vitreous, inclining to adamantine. Colour, colourless to white, usually yellowish white, pale yellow, buff, or brownish; also greenish, grey, reddish, or orange-yellow. Streak, white. Hardness, 4½ to 5. Cleavage, good in four directions. Fracture, uneven to subconchoidal. Brittle. Specific gravity 6.1, decreasing to 5.5 as the molybdenum content increases.

The following tungsten minerals are of minor importance:

Powellite: Calcium molybdate, $CaMoO_4$, in which atomic substitution of W for Mo, up to 10 per cent occurs. Tetragonal. Lustre, greasy on fracture surfaces, subadamantine on crystal faces. Colour, straw yellow, brown, greenish yellow, pale greenish blue; also dirty white to grey, blue, and nearly black. Hardness, 3½ to 4. Cleavage, indistinct in one direction. Fracture, uneven. Specific gravity 4.2.

Stolzite: Lead tungstate, $PbWO_4$. Tetragonal. Lustre, resinous. Colour, reddish brown, brown, fawn, yellowish grey, straw yellow; also green, yellow-red, red. Streak, uncoloured. Hardness, 2½ to 3. Specific gravity 7.9 to 8.3.

Raspite: Lead tungstate, $PbWO_4$. Monoclinic. Lustre, adamantine. Colour, yellowish brown, light yellow, grey. Hardness, 2½ to 3. Cleavage, perfect in one direction. Specific gravity 8.5.

Cuprotungstite: Basic copper tungstate, $Cu_2(WO_4)(OH)_2$. Microcrystalline. Lustre, vitreous, waxy, or earthy. Colour, pistachio-green to olive-green and emerald green. Streak, greenish grey to greenish yellow.

Tungstite: Hydrous tungstite oxide, WO_3H_2O (?). Possibly orthorhombic. Lustre, resinous; on the cleavage faces, pearly. Colour, bright yellow, golden yellow, or yellowish green. It is an alteration product of wolframite, hübnerite, ferberite, and scheelite.

Meymacite: Variety of tungstite pseudomorphic after scheelite.

Ferritungstite: Hydrous, basic iron tungstate, probably $Fe_2(WO_4)(OH)_4 \cdot 4H_2O$. Forms earthy coatings composed of hexagonal plates. Colour, pale yellow to brownish yellow.

[1] In many reports, molybdian scheelite has been erroneously referred to as powellite.

The following group includes rare tungsten minerals and doubtful minerals:

Chillagite: Lead tungsto-molybdate, $Pb(Mo,W)O_4$, in which the ratio of Mo : W is 5:3 to 1:1. Tetragonal. Colour, straw yellow to ochre yellow. Known only at Chillagoe, Queensland, Australia.

Reinite: Formerly classed as a tetragonal modification of ferberite. Now known to be ferberite pseudomorphic after scheelite.

Sanmartite: Zinc, iron, calcium tungstate, $(Zn,Fe,Ca)WO_4$. Monoclinic. Lustre, resinous. Colour, dark brown to brownish black. Cleavage, perfect in one direction. Specific gravity 6.7. Known only at San Martin, Argentina, where it is an alteration product of scheelite.

Cuproscheelite: Formerly classed as calcium, copper tungstate, $(Ca,Cu)WO_4$, but since shown to be a mixture of a basic copper tungstate (cuprotungstite) and scheelite.

Russellite: Bismuth, tungsten oxide, $(Bi_2,W)O_3$. Tetragonal. Colour, pale yellow to greenish. Hardness, 3½. Specific gravity 7.35. Known only at Castle-an-Dinas mine, Cornwall.

Thorotungstite: Basic tungstate or oxide with (Al,Fe):(Th,Ca,Ce,Zr):W-1:1:3. Formula uncertain. Colour, yellow. Specific gravity 5.55. Alteration product of wolframite or scheelite. Known only in the Kintla district, Malay States.

Anthoinite: Hydrous, basic aluminum tungstate, $Al(WO_4)(OH)H_2O$. Isotropic (?). White, chalky masses resembling kaolin. Hardness, 1. Specific gravity about 4.6. Known only in the Belgian Congo, at two localities.

Tungstenite: Tungsten sulphide, WS_2 (?) Hexagonal. Colour, dark lead-grey; soils the fingers. Known only at Emma mine, Salt Lake county, Utah.

Tungstenian Limonite: $(Fe_2O_3)n\ WO_3(H_2O)n$. According to Kerr (1946, pp. 76, 77), at Golconda, Nevada, limonite containing tungsten that is either adsorbed or is present as finely divided tungstic acid has been found in considerable quantity.

Hydrotungstite: $(H_2WO_4)H_2O$. Monoclinic (?). Name suggested by Kerr (1946, p. 75) for this mineral, which occurs as a greenish alteration of ferberite. Hardness, 2. Specific gravity 4.6. Known only at Calacalani, Bolivia.

Tungomèlane: Name proposed by Kerr (1946, p. 78) for a tungstenian psilomelane (MnO_2) that occurs at Golconda, Nevada, and in other parts of the world. It is reported to contain up to 7 per cent WO_3.

Hollandite: According to Kerr (1946, p. 79) a small amount of tungsten was detected by Vaux in hollandite (probably $MnBaMn_6O_{14}$), but it is not known if the presence of tungsten in this mineral is widespread.

Fluorescence of Tungsten Minerals

Fluorescence is the ability of a substance to absorb invisible wave lengths of light (ultraviolet or X-ray), and to emit visible wave lengths. It is believed that when ultraviolet radiation strikes an atom, it causes a displacement of an inner electron to an outer orbit. The energy absorbed from the ultraviolet radiation during this process is released as radiations of greater wave length when the electrons return to their former more stable orbits. Some of these radiations may be emitted as visible light, and under these circumstances, the mineral is said to be fluorescent.

Warren (1944) lists 108 fluorescent minerals, but not all varieties of these minerals fluoresce. The reason for this is not known, but it is probable that the presence of minute quantities of chemical impurities is largely responsible. Such impurities have been shown by Greenwood (1943) to affect the colour of fluorescence of scheelite.

Of all the tungsten-bearing minerals, only scheelite fluoresces. This fact is of inestimable value in the discovery and grading of scheelite deposits. Other minerals that might be mistaken for scheelite because they may have a similar colour of fluorescence are hydrozincite, cerussite, willemite, diopside, wollastonite, powellite, and scapolite.

Hydrozincite occurring underground is commonly a gelatinous slime formed by the oxidation of sphalerite, but on continued exposure to air it becomes a white crustiform mineral. In both forms, the mineral fluoresces a brilliant white. Cerussite occurs as an oxidation product of galena and also has a brilliant white fluorescence. Willemite, which is not a common mineral rarely shows white fluorescence. According to Eardley-Wilmot (1942, p. 445) both diopside and wollastonite which occur mainly in contact metamorphic deposits may exhibit a white fluorescence similar to that of scheelite. Powellite fluoresces yellow, which may cause it to be mistaken for molybdian or manganiferous varieties of scheelite. Scapolite usually has an orange fluorescence, though the variety wernerite fluoresces yellow. In addition, it should be noted that oil spattered from drilling machinery shows a blue fluorescence, but smears when rubbed with the finger. Finally, it may be worthwhile to mention that lichen which is so abundant on many outcrops will usually react to the ultraviolet lamp with a bright bluish white fluorescence.

A list of the principal fluorescent minerals has been compiled by Stevenson (1943, p. 17), and this list is presented below, with a few modifications.

Mineral	Colour of Fluorescence
Agate—usually non-fluorescent	variable, greenish
Amber	variable, yellow-green, light blue
Amethyst—usually non-fluorescent	deep blue
Apatite—usually non-fluorescent	green, grey, blue, orange
Aragonite	variable, green, cream, white
Beryl—faintly fluorescent	green
Calcite—usually fluorescent	variable, scarlet or white; also yellow, orange, green, pink, blue, and gradational
Cerussite	green

Mineral	Colour of Fluorescence
Chalcedony—usually non-fluorescent	green
Fluorite—occasionally fluorescent	variable, green, blue-green, grey
Hydrozincite	bright blue to cream
Jasper	green
Opal—usually fluorescent	bright green
Petroleum (oil, kerosene, paraffin, etc.)	strong blue, yellow or green
Powellite	yellowish white to yellow
Quartz—usually non-fluorescent	
var. rose	pale purple
var. smoky	brownish yellow
Rhodochrosite	brownish, grey
Scapolite	
var. wernerite	yellow-orange, orange-yellow
Scheelite	variable and gradational between blue, blue-white, white, cream, yellow, orange-yellow. (Yellow colours usually due to molybdenum or manganese content.)
Smithsonite	green
Sphalerite—usually non-fluorescent	orange, green, brown
Willemite	bright green, reddish brown, pink; rarely bluish white
Wulfenite	green
Zincite	bright green

Pure scheelite fluoresces bluish white, but with the addition of molybdenum, replacing tungsten, the fluorescent colour changes, with increasing molybdenum content, through white and yellowish white to yellow. According to work done at the United States Geological Survey by R. S. Cannon, Jr., and K. J. Murata, scheelite that contains from 0.35 to 1.0 per cent molybdenum fluoresces white, and above 1.0 per cent molybdenum fluoresces yellow. Cards were made up, using artificial mixtures, by means of which an approximation of the molybdenum content of scheelite ore could be obtained by comparing the fluorescent colour with that on the card. This approximation would of necessity be very general because variation in colour is noticeable with different ultraviolet lamps, and the presence of other impurities, particularly manganese, has a similar effect (Greenwood, 1943).

Stevenson (1943, p. 18) states that scheelite invariably fluoresces. Kerr (1946, p. 73) concurs with this statement, but adds that a film opaque to ultraviolet light may coat the mineral. The only non-fluorescent scheelite known in Canada is that reported by Faessler (1939).

Ultraviolet lamps should be used in total darkness. No problem is presented in lamping underground if the surfaces are washed, but on surface outcrops and trenches, lamping can best be done at night, or else under a light-proof cover. In the latter case, if the sun is shining, working under a hood or tarpaulin becomes a hot and unpleasant task.

A fairly accurate method of determining the WO_3 content of a scheelite deposit visually has been developed by Jolliffe and Folinsbee (1942). Briefly, the procedure is to measure the total area of fluorescent scheelite, crystal by crystal, by comparison with punched holes of various sizes in a card. The grade as per cent WO_3 is then obtained by the following formula:

$$\frac{\text{Area of scheelite in square inches}}{\text{Total area lamped in square feet}} \times 1.2$$

It is recommended that an area of at least 10 square feet be lamped. It is possible for two men to grade a vein 2 feet wide and 400 feet long in a day.

Properties

Tungsten is a brilliant, white metal with many remarkable properties. Its melting point of 3,370°C. and boiling point of 5,900°C. are higher than those of any other metal. It has a low volatility. Its tensile strength of 590,000 pounds per square inch is likewise the greatest for all metals. Its specific gravity of 19.3 is the same as that for gold, and is exceeded only by iridium, osmium, platinum, and rhenium. When worked, it becomes so elastic and ductile that it can be drawn into very fine wire which retains its rigidity at very high temperatures. It is rather inert chemically, and may be dissolved only in a mixture of hydrofluoric and nitric acid, or a fused mixture of sodium hydroxide and nitrate. It forms alloys with many metals and with carbon, and to these it imparts such desirable properties as increased hardness, durability, and resistance to corrosion.

Uses

From the foregoing brief résumé of the more important properties of tungsten, it is evident that the metal and its alloys are indispensable for certain purposes. Ferrous alloys account for 60 to 90 per cent of total tungsten production, and most of these are high-speed steels in cutting tools. A small part of these alloys are used in dies, valves and valve seats in internal combustion engines, and permanent magnets. In all cases these alloys are characterized by hardness and toughness, even at red heat.

Five to ten per cent of tungsten is consumed in the manufacture of tungsten carbide, an extremely hard substance which when embedded with small amounts of molybdenum, chromium and/or diamond powder, and up to 10 per cent cobalt, in a suitable cementing material is unexcelled as a cutting tool for hard steels, bakelite, porcelain, and glass.

Variable amounts of tungsten are consumed in the manufacture of non-ferrous alloys, of which stellite is the most widely used. Stellite is composed of 45 to 70 per cent cobalt, 28 to 35 per cent chromium, 3 to 17 per cent tungsten, and 1 to 2 per cent carbon. This alloy retains a greater hardness above 1,100°F. than the best high speed tool steel, and because of its resistance to corrosion and tarnish, it is used in the manufacture of surgical and other instruments.

Metallic tungsten, though used only in relatively minor quantity in electrical apparatus in contact points, radio tubes, and filaments of electric lamps, is virtually irreplaceable.

CHAPTER II

GENERAL CHARACTER AND ORIGIN OF TUNGSTEN DEPOSITS

A classification of tungsten deposits is as follows:

I. Formed by Mechanical Processes of Concentration
- A. Alluvial (placer)
- B. Eluvial (residual)

II. Primary
- A. Disseminations in igneous rocks
- B. Pegmatites
- C. Contact metamorphic
- D. Quartz veins
  1. Hypothermal
  2. Mesothermal
  3. Epithermal
- E. Hot spring

I. DEPOSITS FORMED BY MECHANICAL PROCESSES OF CONCENTRATION

Tungsten-bearing deposits formed by mechanical processes of concentration are known in some parts of the world, but have yielded only a small percentage of the world's tungsten production. They may be subdivided into two types: alluvial (placer) and eluvial.

A. ALLUVIAL (PLACER) DEPOSITS

The origin of tungsten-bearing placers is similar to that of gold placers, and, indeed, the two minerals are not uncommonly associated in them. The source of the material is of course a primary deposit containing tungsten minerals, where such a deposit is exposed to the chemical and mechanical processes of erosion, which free the resistant constituents from their enclosing matrix. Should this material now be transported by a stream or river, the dense, resistant parts are concentrated in zones of slow-moving water, while the lighter or less resistant parts are for the most part carried away either by suspension, or in solution. The common tungsten minerals, wolframite, ferberite, hübnerite, and scheelite, are suitable for concentration in placers because of their relatively great density in comparison to the common rock- and vein-forming minerals, and their resistance to chemical corrosion. However, the tungsten minerals, particularly the first three, are sufficiently friable that if they are transported very far, especially in a swiftly abrading stream, they become so finely comminuted that their recovery is difficult or impossible.

In addition to sands derived from the common rock-forming minerals, quartz, feldspar, and mica, the tungsten-bearing gravels usually contain other heavy minerals with which they have been associated in the primary deposit, such as gold, cassiterite, magnetite, monazite, garnet, and zircon.

In Canada, tungsten-bearing placers are known only in the Cordilleran region at Cariboo and Atlin districts of British Columbia, and in Mayo and Dawson districts of Yukon Territory. Some production of tungsten concentrate has been attained from some of these deposits, together with gold, and in some places, cassiterite. The source of the tungsten minerals has been traced, and found to be quartz veins or pegmatites that are, in a few cases, of mineable grade.

B. ELUVIAL (RESIDUAL) DEPOSITS

Eluvial deposits are formed by the decay of primary deposits, so that the less resistant materials are broken up and transported, thus effecting a concentration of the more inert substances. This process is most common in the tropics, but examples are known even in areas now underlain by permafrost.

Tungsten-bearing eluvial deposits occur in parts of China and Burma, and have yielded some tungsten concentrates, but are becoming less important. The only eluvial deposit known in Canada was described by Cockfield (1918, pp. 12, 13) near the head of Dublin Gulch, Yukon Territory. There, scheelite that is disseminated in granodiorite has been concentrated to a depth of 5 feet by the partial decomposition of the latter.

II. PRIMARY DEPOSITS

Primary, or hypogene, deposits are those that have been formed from ascending waters or by segregation from a magma. Primary tungsten-bearing deposits appear to be genetically related to igneous bodies of acidic composition.

A. DISSEMINATIONS IN IGNEOUS ROCKS

Disseminations of tungsten minerals in igneous rocks occur in many parts of the world, but the tungsten minerals are rarely sufficiently concentrated to be of economic interest. Some writers, among them Hess (1909) and Li and Wang (1947, p. 17), believe some of these are of orthotectic origin, i.e., formed by differentiation in magmas during cooling. Such magmatic segregations are commonly formed by chromite, ilmenite, magnetite, and the sulphides of copper, iron, and nickel. P. F. Kerr (1946, p. 37), however, states that "tungsten does not crystallize out early in the consolidation of an igneous mass. Only when subsequent alteration or invasion of fluids, forced up from below, produces areas of alteration or fills cracks and fissures is tungsten precipitated."

In the tungsten deposits of Mawchi, Burma, described by Dunn (1938*a*), cassiterite is disseminated throughout granitic rocks, but wolframite and scheelite occur only in segregations in these rocks with cassiterite and kaolinized feldspars. Another example is in Whetstone Mountains, Arizona, where wolframite occurs in quartz masses in granite, associated with aggregates of muscovite. These are regarded by Kerr (1946, p. 100) as of pneumatolitic origin.

In Canada, there are no known deposits that could be of orthotectic origin. At Ross Lake, Northwest Territories, scheelite is disseminated in granitic rocks (Fortier, 1947, p. 4) but in view of the fact that it also occurs in basic rocks that cut the granite, the scheelite probably was introduced long after the consolidation of the granitic rocks.

In many other localities, tungsten minerals are disseminated in zones in altered granitic rocks. Some of these zones are greisen, as at Square Lake and Burnt Hill, N.B., and consist of quartz, mica, and topaz, with a little wolframite, fluorite and sulphides, and are commonly traversed by quartz veins. Elsewhere, as at Blue Moon property, near Rossland, B.C., and at Canadian Creek and Dublin Gulch, Yukon Territory, tungsten minerals occur in granitic rocks up to several feet or yards from quartz veins or pegmatite dykes that are themselves tungsten-bearing. These crystals have apparently been introduced by the vein-forming solutions, which have had little effect upon the wall-rocks other than chloritization of biotite and hornblende. In contact metamorphic deposits, as in the Emerald, more intense alteration of granite occurs near the contact with skarn and silicified limestone. Here the biotite has been altered to pale green hydromica, the feldspars have been sericitized and kaolinized, and much quartz has been introduced. Scheelite has been introduced in abundance, especially in the more siliceous parts, and has been mined as far as 40 feet from the contact.

B. PEGMATITES

Pegmatites are coarse-grained, irregular or dyke-like bodies that are regarded by some as representing the later stages of the consolidation of a magma. Others believe them to be a result of the recrystallization of the igneous rock by a reaction with hydrothermal solutions originating in the parent magma. Pegmatites are commonly of granitic composition, comprising quartz, alkaline feldspars, and mica, with concentrations of rarer minerals such as fluorite, tourmaline, topaz, allanite, cassiterite, beryl, and many others.

Tungsten-bearing pegmatites occur in many parts of the world, but are most abundant in Burma, China, and the United States, and they are rarely of commercial importance. In the United States, the best known deposits of this type are those in the Black Hills region of South Dakota, and at Oreana, Nevada.

In Canada, pegmatite tungsten deposits occur in granite at New Ross, N.S., at Little Herb Lake, Man., and at Scheelite Creek and Dublin Gulch, Yukon Territory. At Dublin Gulch, a pegmatite dyke, one foot wide, is the only one known to contain enough wolframite and scheelite to be of economic interest. This dyke cuts granodiorite, and, in addition to white mica, quartz, feldspar, and hornblende, contains some scheelite, and possibly wolframite, and a little tourmaline, siderite, and graphite.

C. CONTACT METAMORPHIC DEPOSITS

Tungsten deposits of contact metamorphic origin have yielded a large percentage of the tungsten production of the United States and Canada. Other important deposits of this type occur on King Island, between Tasmania and Australia, and in Mexico, Brazil, and Korea.

Contact metamorphic deposits are usually formed at or near the contacts of granitic rocks, though in some cases deposits may be thousands of feet from any known granitic bodies. The deposits are the product of intense thermal metamorphism, and the invaded rocks have been recrystallized and new minerals have been formed both by the reaction between original constituents and by reaction of these with materials introduced by hot solutions emanating from the igneous body. Contact metamorphic deposits may be formed in any type of rock, but usually in limestone, and not uncommonly in impure shales and sandstones.

Kerr (1946, pp. 55-61) has described in some detail the progressive stages in the process of the formation of contact metamorphic tungsten deposits. He shows that the mineral assemblage in such deposits is due much less to the original composition of the altered rock than to the degree of metamorphism. The first step is marmorization, during which the original constituents are recrystallized, and there is often an increase in silica and a corresponding decrease in lime and carbon dioxide. The next step is initial metamorphism, or pale garnet-wollastonite stage, wherein pink or cream garnet, wollastonite or tremolite, and pale vesuvianite are formed. The third stage, that of advanced replacement, is characterized by more widespread replacement of limestone than in initial metamorphism and is accompanied by the formation of epidote in addition to garnet, wollastonite, and scheelite. In the final stage, regressive effects are superimposed on those of advanced metamorphism. Widespread impregnation by silica occurs, and short, irregular quartz veins are formed, mainly occupying shrinkage cracks resulting from the decrease in volume of the original rock during metamorphism. It is during the early part of this stage that magnetite and sulphides are introduced.

The final product of contact metamorphism of limestone is skarn, a rock name first applied by Swedish miners to the silicate gangue (amphibole, pyroxene, garnet, etc.) of certain iron ore and sulphide deposits of Archæan age, particularly to those formed by replacement of limestone or dolomite. It has since been extended to include similar deposits of younger ages, and is often loosely applied to these contact metamorphic silicates where the presence of magnetite and sulphides has not been observed. In the United States, the term 'tactite', first suggested by Hess (1919), is widely used for the zones rich in garnet, epidote and similar products of contact metamorphism. This term is perhaps more desirable than 'skarn' because the original connotation has not been changed, but in Canada 'skarn' is much more widely used, and will be used in this volume. The term 'garnetite' is applied to skarn in which the dominant mineral is garnet.

Tungsten-bearing contact metamorphic deposits are characterized by the development of garnet (usually grossularite or andradite), pyroxene (usually diopside), wollastonite, amphibole (usually hornblende or tremolite), vesuvianite, epidote, scapolite, quartz, and a host of less common silicates. Other minerals that are often present in minor amounts are fluorite, titanite, zircon and apatite. Magnetite, pyrrhotite, pyrite, and molybdenite are common constituents of skarn, and locally a little galena or sphalerite may be present. Scheelite is virtually the only tungsten mineral in these deposits, and is often molybdian. Wolframite has been detected in some deposits, but in insignificant amounts.

Although contact metamorphic deposits are sometimes formed along the contacts of basic rocks, such as gabbro, those that contain scheelite ores are invariably related to more acidic intrusive rocks, granite, granodiorite, quartz monzonite, or quartz diorite.

At the Emerald mine near Salmo, B.C., the largest tungsten deposit in Canada is in part of this type. However, in addition to the normal skarn ore and replacement ore in altered granite, there are numerous orebodies that consist of pyrrhotite-biotite-scheelite replacements of partly dolomitized limestone. This latter type is apparently related to the normal skarn ore and such replacements of limestone should therefore be regarded as a modification of the contact metamorphic type of deposit.

Other typical scheelite-bearing skarn deposits occur in the Salmo district, and at a few scattered localities in southern British Columbia, and in the Mayo district, Yukon Territory.

D. QUARTZ VEINS

Tungsten minerals are common constituents of quartz veins; indeed, the greater part of the tungsten of the world has been derived from this source. In the world as a whole, wolframite is the most abundant ore mineral.

In Canada, in the Precambrian Shield, only scheelite has been reported in veins, and this is rarely molybdian. Scheelite is widespread in gold-bearing veins, though it is usually most abundant where the gold content is low. Elsewhere in Canada wolframite, ferberite, scheelite, and, rarely, hübnerite occur in quartz veins. Scheelite is rarely present in quartz veins that contain lead and silver. The tungsten minerals are usually erratically distributed in the quartz veins.

Quartz veins are classified, according to the temperature and pressure at the time of deposition, as hypothermal, mesothermal, and epithermal, the first representing conditions of highest temperature and pressure, and the last representing the lowest. The three types may be represented in a single vein system, which under these circumstances is said to be telescoped, as in the classic example of Cornwall. Here tin occurs at depth, succeeded by copper and then lead and zinc in the upper parts. Tungsten minerals are found in all three types of veins but occur most commonly in those of higher temperature and pressure.

1. Hypothermal Veins

Hypothermal veins are believed to have been formed at a temperature of 300° to 500°C. and at high pressure (Lindgren, 1933, p. 212). The non-metallic gangue minerals characteristic of these deposits may be, in addition to quartz, ankerite, alkaline feldspars, pyroxenes, amphiboles, tourmaline, topaz, garnet, brown or green micas, and spinel. Characteristic metallic minerals are magnetite, pyrrhotite, pyrite, specularite, ilmenite, cassiterite, and arsenopyrite. According to Li and Wang (1947, p. 18), most wolframite-bearing hypothermal veins contain also chalcopyrite, molybdenite, and bismuthinite, and a little galena, sphalerite, stibnite and cinnabar, although the last two minerals usually occur in epithermal veins. They regard some of the deposits at Kiangsi, China, and those of Burma, Malaya, Australia, Portugal, and Bolivia as typical of hypothermal vein deposits.

In Canada, hypothermal tungsten-bearing veins occur at Burnt Hill, N.B., where wolframite, cassiterite and topaz are present; at Mill Road, N.S., where feldspar, fluorite, stannite, arsenopyrite, chalcopyrite, wolframite, and scheelite are reported; at Red Rose and Black Prince properties, British Columbia, where the veins contain scheelite, pyrrhotite, chalcopyrite, pyrite, and a little ferberite and molybdenite; and at Dublin Gulch, Yukon Territory, where the quartz veins grade into pegmatite dykes.

2. Mesothermal Veins

Mesothermal veins are believed to have formed at temperatures of 200° to 300°C. and at intermediate pressures. They may be distinguished from hypothermal veins by the usual lack of such high temperature minerals as biotite, pyroxenes, amphiboles, garnet, tourmaline, and topaz; and by the relative abundance of the carbonates, calcite, dolomite, ankerite, and siderite, fluorite, and barite. The association of pyrite, chalcopyrite, arsenopyrite, galena, sphalerite, tetrahedrite, tennantite, tellurides, and gold is also diagnostic of mesothermal veins.

Mesothermal tungsten-bearing veins appear to be much less common than those of higher temperature. Li and Wang regard certain of the Kiangsi deposits as of this type, and those of Boulder county, Colorado, also probably are mesothermal. In Canada, the tungsten-bearing gold-quartz veins of Nova Scotia and some of those in the Precambrian Shield are mesothermal, as are the gold-quartz veins of the Bridge River and Cariboo districts of British Columbia.

3. Epithermal Veins

Epithermal veins were probably formed at temperatures of 50° to 200°C. and at relatively low pressure. Quartz is the most abundant gangue mineral, but almost all of it is chalcedonic, and colliform bands are well developed. Calcite, dolomite, barite and fluorite are often abundant, and rhodochrosite, rhodonite, adularia, kaolin and zeolites may be present.

Tungsten minerals rarely occur in epithermal deposits. Li and Wang quote as examples the hübnerite-bearing veins at Tonapah, Nevada, and the ferberite-bearing veins in Boulder county, Colorado. In Canada, the only known deposits that may be of this type are the Tungsten Queen and Bristol properties of the Bridge River district, British Columbia.

E. HOT SPRING DEPOSITS

The only known occurrence of tungsten minerals in hot spring deposits in sufficient quantity to be of economic interest is in the manganese ores of Golconda, Nevada (Kerr, 1946, p. 67). Here the deposits occur both as veinlets filling fractures in the rocks below the spring deposits, and as lenses within the spring deposits. In both cases the tungsten minerals probably are of colloidal origin.

CHAPTER III

DESCRIPTION OF DEPOSITS

YUKON TERRITORY

by H. S. Bostock

In the Yukon Territory production of tungsten concentrates as a by-product of placer gold mining has exceeded 23,300 pounds, and is valued at some $15,700. Tungsten minerals occur widely spread in the southern and central parts of the territory in both placer and lode deposits. Reports of their occurrences include many small or little known discoveries of scheelite and ferberite or wolframite[1]. The main occurrences to date, with the exceptions of Canadian Creek and the Fiddler group, are in the Mayo Mining Division. Here the deposits are commonly associated with small granitic intrusions that are distributed along a belt from the northwest parts of the McQuesten map-area (Bostock, 1948) eastward across the Mayo map-area and thence southeastward into little explored country (*see* Figure 1). In those parts of the belt in the Mayo and McQuesten map-areas where glaciation was light or absent the gold placer creeks, with a few exceptions, have their headwaters around the granitic stocks of this belt, and scheelite and cassiterite occur with the gold. It is thought that the same association would have been found in gold placer creeks around the intrusions in the southeastward extension of the belt were it not that glaciation was much more intense in that region and the placers have been generally destroyed. The lode sources, however, may be there and the writer has regarded the southeastward extension of this belt of intrusions as most promising for the occurrence of mineral deposits including those of tungsten. Indeed, a tungsten deposit was found there in 1952 by J. O. Wheeler of the Geological Survey (Wheeler, 1954, p. 40) and prospectors have reported a number of other scheelite discoveries from around granitic stocks in the same region.

In the concentrates from the placer deposits the scheelite, as it crushes readily, appears as a fine, heavy, light grey or creamy coloured sand. The ferberite and wolframite (?) form a dark brown to black, non-magnetic sand of generally somewhat coarser grains that show a good cleavage when the material is well crystallized. Some of the ferberite grains and pebbles, however, are formed of aggregates of extremely finely crystalline material that shows no sign of cleavage under the hand lens.

The lode deposits consist of pegmatite dykes, quartz veins, and disseminations in schist and altered limestone, often referred to as skarn. The pegmatite dykes are confined to the stocks that commonly consist of granodiorite, but

[1] In 1940 H. V. Ellsworth of the Geological Survey of Canada identified the "wolframite" from Canadian Creek as "ferberite" and since then specimens from Dublin Gulch have also been determined as ferberite by R. M. Thompson of the University of British Columbia.

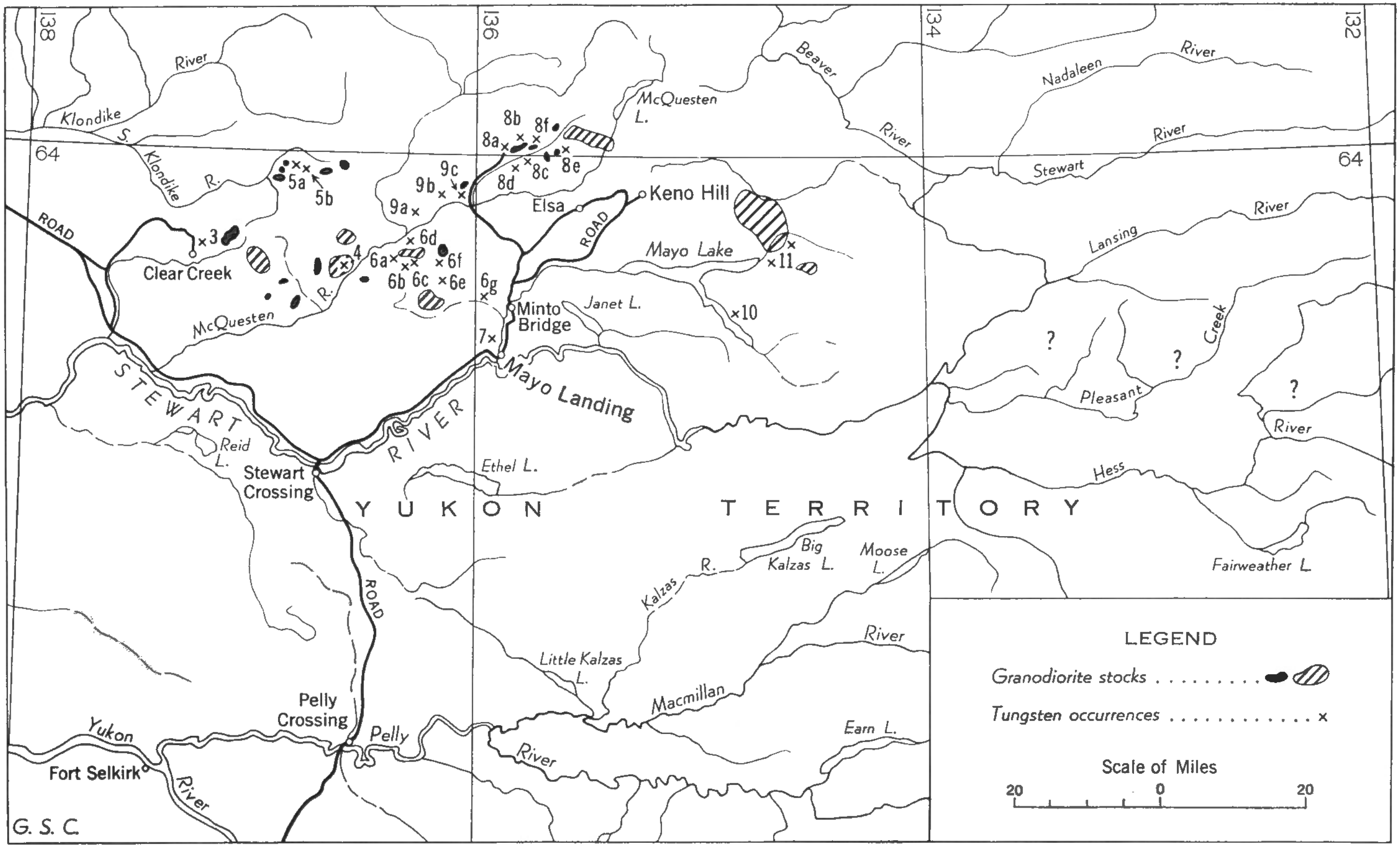


Figure 1. Map showing distribution eastward from Clear Creek, Yukon Territory, of the granitic intrusions with which tungsten deposits have been found. 3. Clear Creek, 4. Boulder Creek, 5a. Arizona Creek, 5b. Gem Creek, 6a. Johnson Creek, 6b. Sabbath (Swede) Creek, 6c. Scheelite Creek, 6d. Castnor (Cement) Creek, 6e. Highet Creek, 6f. Rudolph Creek, 6g. Minto Creek, 7. Canyon Creek, 8a. Haggart Creek, 8b. Dublin Gulch, 8c. Lynx Creek, 8d. Snowshoe Creek, 8e. Skate Creek, 8f. Ray Gulch, 9a. Rodin Creek, 9b. Goodman Creek, 9c. Secret Creek, 10. Ledge Creek, 11. Roop Creek.

quartz monzonite and syenite including porphyritic variations are represented in some of the intrusions. The quartz veins are found in the intrusions and also in the surrounding rocks. Deposits of disseminated scheelite occur in altered calcareous rocks near the stocks. Scheelite is the most commonly recognized tungsten mineral in all three types of lode deposit in the Mayo Mining Division. Ferberite or wolframite is present as the main tungsten mineral at Canadian Creek where it occurs widely disseminated in a pegmatitic and porphyritic granitic complex, also in the Fiddler group where it is found in veins and in a prospect reported near Gladstone Creek.

Because the northwestern part of central Yukon Territory escaped extensive glaciation, it contains placer deposits. Up to the present, the gold placers have received all the attention of prospectors and miners and have been of spectacular importance. The presence of large quantities of other heavy minerals caught with the gold in the sluice boxes suggests that placer deposits of other heavy minerals, including those of tungsten, occur. However, the tungsten production has come from concentrates recovered incidentally in gold mining and it is mainly due to the search for and mining of gold that the presence of the tungsten and other valuable minerals is known. No endeavour to search for placers carrying such metals as tungsten as the main ore metal has been made except in a very minor exploratory way by the Geological Survey.

The gold placer deposits carrying tungsten occur in a number of creeks (*see* Figure 1). During the two wars when tungsten shortages threatened, the presence of the tungsten in the placers stimulated the search for lode sources in the hills around them and many lode tungsten discoveries have resulted though none has reached the mining stage except the Fiddler group.

PLACER DEPOSITS

Dawson Mining Division

Canadian and Casino Creeks (2)[1]

References: Cairnes, 1917, pp. 29-31. Bostock, 1941*b*, pp. 28-30. Mines Branch Invest. No. 1182, 1942.

Canadian Creek is a tributary of Britannia Creek that enters Yukon River about 50 miles below the Pelly River. Tungsten, mainly as ferberite, has been found from near the head of Canadian Creek downstream including Britannia Creek nearly to the river. It has also been reported on Casino Creek that flows to Klotassin River from the southeast side of a pass that crosses the Dawson Range to Canadian Creek. The main tungsten placer deposit (*see* Figure 3) is at an elevation of about 4,100 feet in Canadian Creek and in its small tributary, Patton Gulch near their junction. Patton Gulch heads in a hill on the south side of Canadian Creek that stands on the southwest side of the pass where

[1] The numbers in parentheses refer to localities plotted on the index map (Figure 2).

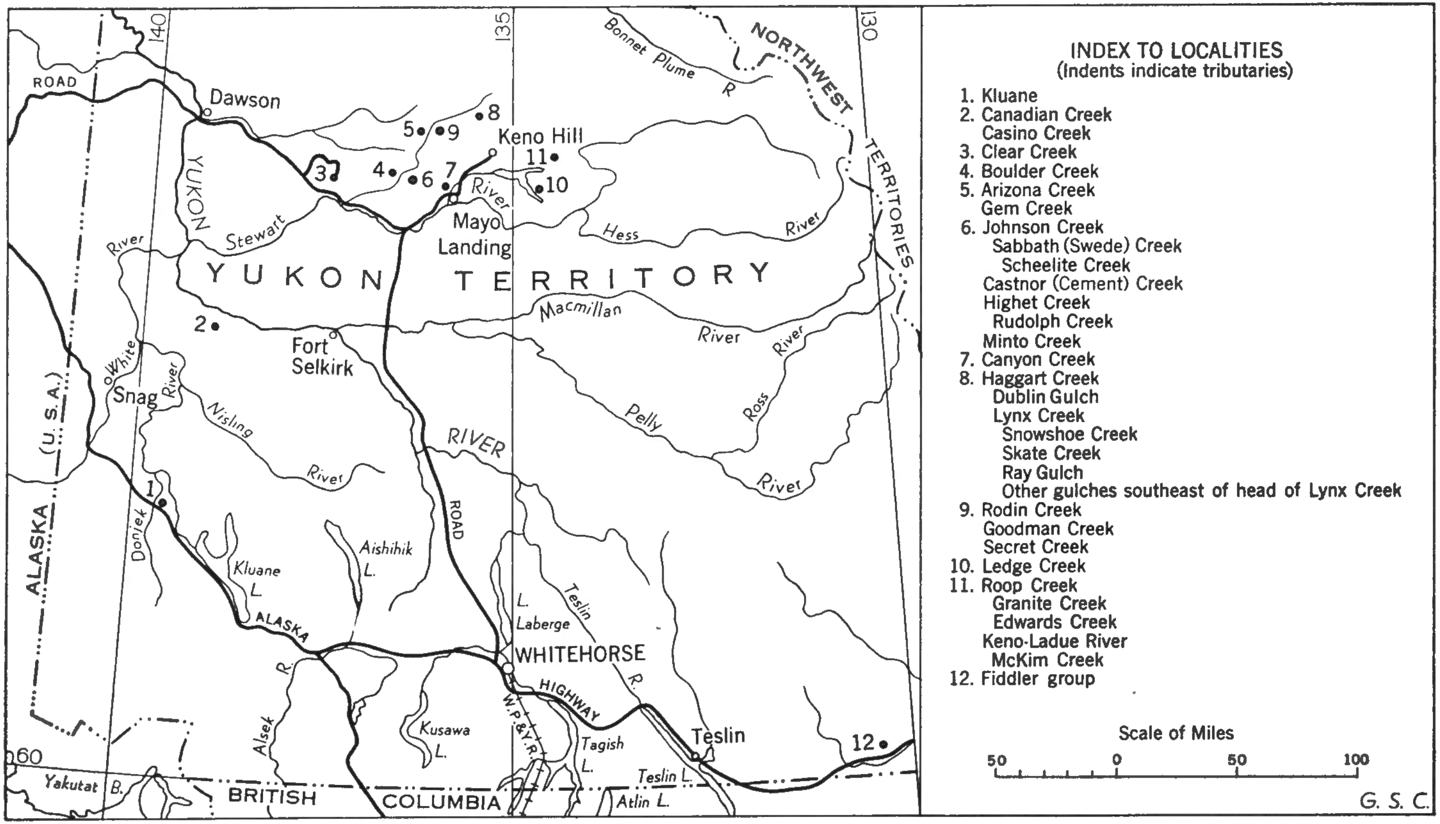


Figure 2. Index map showing location of tungsten deposits, Yukon Territory. For example *see* page 14.

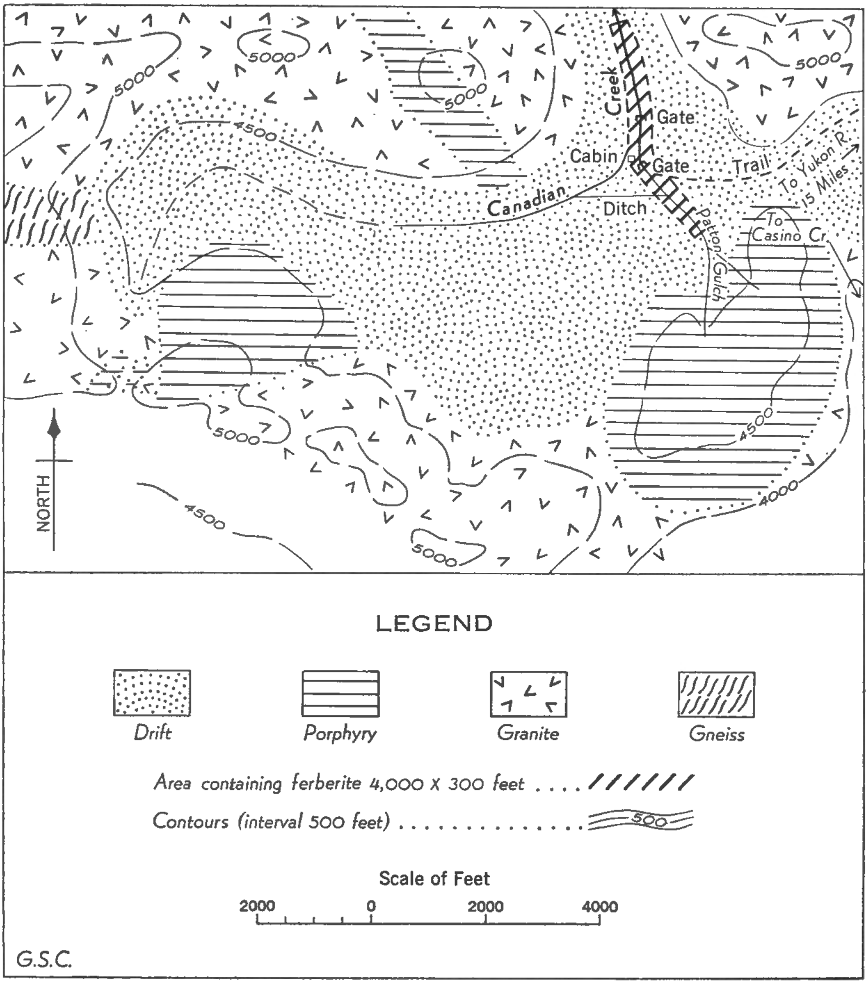


Figure 3. Sketch map of the area containing ferberite at head of Canadian Creek, Yukon Territory. (*After* A. R. Allen, 1940.)

Casino Creek heads. A rough truck road, 15 miles long, was built in 1943 from the landing on the river at Britannia Creek to the placer workings at Patton Gulch. The chief claims on Canadian Creek and Patton Gulch are owned by J. Meloy and associates[1].

Placer gold was discovered in the lower part of Canadian Creek in 1911. Two years later the upper part was staked. "Wolframite" (identified in 1940 as ferberite by H. V. Ellsworth of the Geological Survey of Canada) was recognized and, in 1916, a shipment was made of several hundred pounds of tungsten concentrate containing 64.32 per cent WO_3.

In his report on the occurrence, Cairnes (1917, pp. 30-31) states that bedrock is at a depth of at least 42 feet, and that the pay gravels, which are beneath 3 feet of muck, are 3 to 5 feet thick. They are locally cemented by a reddish, iron-stained matrix to form a "hard pan".

[1] Ownerships mentioned in this report are the latest records.

The property was examined briefly by A. R. Allen for the Geological Survey of Canada in 1940 (Bostock, 1941*b*, pp. 28-30), and a company, Canadian Tungstens Limited, optioned the property from J. Meloy. During the summer of 1941, this company washed 2,800 cubic yards of gravel, yielding about 6 tons of heavy black sand containing ferberite, gold, magnetite and hematite, with a little scheelite, molybdenite, zircon, cassiterite, tourmaline, titanite, hornblende, feldspar, quartz and mica. A sample of this, weighing 1,587 pounds, was sent to the Mines Branch in Ottawa, and this assayed 14.79 per cent WO_3 and 5.78 ounces gold a ton.

In 1941, Bostock made a more detailed examination and sampling of the property on behalf of the Geological Survey. This indicated that, except for a small area in the vicinity of the junction of Patton Gulch with Canadian Creek, the ferberite content is less than 0.1 pound per cubic yard, with very low gold values. The small area just above the mouth of Patton Gulch was estimated to contain 75,000 cubic yards to a depth of 9 feet, averaging about 0.75 pound ferberite and about $1.00 gold per cubic yard.

In 1942, the property returned to the owners and later that year a new option was taken on it by Yuba Consolidated Gold Fields, a subsidiary of Bralorne Mines Limited. It was hoped that values would increase with depth, but the drilling and sampling by this company showed substantially the same results as before.

Mayo Mining Division

Clear Creek (3)

Reference: Bostock, 1948, p. 11.

The Clear Creek placer dredge camp is reached by summer road built to connect it with the steamboat landing and airfield on the bank of the Stewart River, and now this road also links it to the Whitehorse-Dawson road. The heavy minerals occurring with the gold on the north fork of Clear Creek include scheelite, but in variable quantities from place to place. For a mile or more above Barney Gulch both scheelite and cassiterite were found in some abundance in dredging, but farther up the valley they are scarce and arsenopyrite and pyrite are the main heavy constituents of the sands. In 1944, Ernest Patty, then general manager of the Clear Creek Placers Company Limited, in a letter to the writer, stated that when the dredge was near Barney Gulch as much as 200 pounds of crude concentrates, largely tin, were being recovered per day but no mention of tungsten in the concentrate was made. The tin-rich zone was soon passed and no concentrate of either tungsten or tin minerals was shipped.

Boulder Creek (4)

Boulder Creek is a tributary of McQuesten River, 41 miles above its mouth. The creek traverses a granitic stock around which a variety of lode mineral discoveries have been made. These contain values in gold, lead, copper, silver and zinc. A. Aho while employed with the Geological Survey obtained a heavy mineral concentrate by panning from the surface gravel in the stream where it enters the McQuesten Valley. He examined the concentrate while at the University of British Columbia and found that it contained some scheelite as well as other heavy minerals including 5 per cent of monazite.

Arizona and Gem Creeks (5)

Reference: Bostock, 1948, p. 11.

In the northeast part of the McQuesten map-area, northeast of Clear Creek, placer gold has been found in several small remote creeks. Among them, Arizona and Gem Creeks are the only ones in which gold placer mining has been done. Examination of concentrates of heavy minerals from Arizona Creek showed much barite, some cassiterite and a very little scheelite besides other heavy minerals. In Gem Creek the concentrate also contained a very little scheelite.

Johnson, Sabbath (Swede), and Scheelite Creeks (6)

References: Cockfield, 1919, pp. 14B-15B. Bostock, 1939, p. 14; 1941*b*, pp. 32-33; 1948, p. 11.

Johnson Creek and its tributaries, Sabbath (Swede) and Scheelite Creeks, flow northwesterly into McQuesten River about 45 miles from the Stewart River. The creeks are reached by following the Highet Creek road to its end and thence the trail, once a wagon road, over the divide into Sabbath Creek valley.

These creeks were originally discovered in 1897 by the Gustaveson family, the pioneers of the district, and Sabbath Creek is sometimes referred to as Swede Creek after them.

During the last part of the Pleistocene epoch the valley of the McQuesten River was occupied by ice that reached, at least, to the 2,500-foot contour and moved westward. The valleys of the tributary creeks were sheltered by the high ridges between them and escaped glacial scouring but much drift was deposited in the lower parts of some of them and their heads were generally above the level of the ice and drift.

Scheelite occurs in the soil on the slopes of granitic rock around the basin of Scheelite Creek. It occurs in the stream gravel on Scheelite and Sabbath Creeks, and some miles down Johnson Creek in diminishing quantities. It forms a large part of the heavy sand recovered in placer mining in these creeks and a little cassiterite was found with it in the abandoned sluice boxes on Johnson Creek.

In 1943, E. Corp, a prospector employed by the Geological Survey, found several areas around the north side of the head of Scheelite Creek where the soil contains considerable quantities of scheelite (*see* Figure 5). The richest area lies at elevations between 4,100 and 4,200 feet at the head of a small gulch joining Scheelite Creek and draining the south side of the saddle between the two domes on the ridge. The scheelite is unusually coarse and lies in the soil and gravel and appears to have become concentrated with very little transportation so that it may be partly residual from the erosion of the local bedrock just up the slope from it. The area was tested by panning the surface material and the writer estimated that it could contain as much as 100,000 cubic yards with an average of 0.20 pound of scheelite per cubic yard. The area, however, could be worked only during the spring run-off by standard placer methods as the gulch is dry during the main part of the summer.

Minto, Highet and Rudolph Creeks (6)

References: Keele, 1905, p. 38. Walker, 1909, p. 43. Cockfield, 1918, pp. 14B-15B. Bostock, 1939, p. 14; 1941*b*, pp. 28 and 32; 1948, p. 11.

Highet Creek is a tributary of Minto Creek, which flows into Mayo River below Minto Bridge. Scheelite was reported (Keele, 1905, p. 38) in the upper part of the stream, about 12 miles from Minto Bridge. The 'white sand' obtained in the sluice boxes is finer grained than that in Dublin Gulch. Cockfield states that no very rich spots were found. During the 1920's and 1930's several miles of the creek, starting above Rudolph Creek, a north tributary of Highet Creek, and extending down stream, were mined by E. Middlecoff and others. No records of the abundance of scheelite encountered and no recovery from the sluice boxes were made. Bostock (1941*b*, p. 32) reported that scheelite is also present in the gravels of Rudolph Creek. He concluded that there is not sufficient scheelite in the placers of Highet and Rudolph Creeks to recover at a profit and notes that small amounts of scheelite can be found in places in Minto Creek and in the gravels of the terrace in the fork between Highet and Minto Creeks.

Canyon Creek (7)

Canyon Creek is a small stream entering Mayo River from the west about a mile above the hydro-electric dam. From time to time some small-scale gold placer mining has been done on this creek particularly by George Besner in the 1940's. Besides gold, a very little scheelite and cinnabar were found in the creek.

Haggart Creek and Dublin Gulch (8)

References: Keele, 1905, p. 33. Hoffman, 1905, p. 340. Walker, 1909, p. 43. Cairnes, 1917, pp. 12-18. Cockfield, 1919, pp. 10B-12B. Mines Branch, 1920*b*, pp. 68, 76 and 88-89; Pub. No. 509, pp. 36 and 150-151. Bostock, 1939, p. 8; 1941*b*, pp. 30-32.

The gold placer deposits of Dublin Gulch have been the chief source of tungsten in the Yukon Territory to the present. The Gulch is about 3 miles long and enters Haggart Creek 12 miles above the creek mouth at McQuesten River. It is reached by a motor road, built in 1942, that leaves the road between Mayo and Elsa at Halfway Lakes.

Gold placers were discovered in Dublin Gulch in 1898. Keele (1905, p. 33) first reported the presence of scheelite in the deposits, and Hoffman (1905, p. 340) pointed out the economic possibilities of the mineral.

In 1916, Cairnes made a special investigation of the deposits and encouraged the production of scheelite concentrates. Two samples, of 300 and 800 pounds, were shipped to Ottawa and these assayed 68 and 66.3 per cent WO_3, respectively.

Two years later, Cockfield, who was making further investigations, reported the shipment of more than a ton of scheelite concentrates from placer operations. He estimated that an additional 20 to 30 tons could be obtained. The heavy sands yielded, in addition to scheelite, wolframite, ironstone, garnet, and other heavy minerals.

In 1942 and 1943 the writer examined the area to determine its possibilities as a source of tungsten.

The bedrock of the Dublin Gulch area consists of schists and quartzites intruded by a small granodiorite stock and other smaller bodies of the same general composition. The schists and quartzites form an open southwesterly plunging anticline. The stock penetrates the structure along the northerly side of the crest of the fold and outcrops around the heads of Dublin Gulch and its tributaries.

The area immediately around Dublin Gulch is beyond the limit of the last well-marked Pleistocene glaciation but evidence of earlier glaciation is present. The streams of Dublin Gulch and Haggart Creek have entrenched parts of their courses in deep overburden forming terraces with old modified profiles. Prospect cuts in the terrace on the south side of Dublin Gulch below Bawn Boy Gulch (*see* Figure 4), at an elevation of 3,700 feet, revealed 12 feet or more of glacial till, mantled by 1 foot to 3 feet of well-developed brown soil. The till contains many foreign rocks, most of them weathered to a crumbly condition, but also some fresh andesitic volcanic rocks that show striated facets. Coarse boulders in fine material, the whole having a till-like texture and largely weathered to a crumbly state, were exposed in placer workings in Dublin Gulch, a little below Ann Pup. Prospecting pits and trenches in the upper slopes on the north side of Dublin Gulch west of Ann Pup and around the head of Bawn Boy Gulch at elevations between 3,500 and 4,500 feet show deep residual soil and weathering of the bedrock to depths of 8 feet or more. These phenomena are believed to show that the glacial advance over this area took place earlier in the Pleistocene epoch than that whose fresh debris occurs in the McQuesten River valley.

Tungsten has been found in the area in a variety of types of deposits including veins, pegmatites, skarn zones, stream placers and residual concentrations or eluvial deposits. In addition, to these deposits, veins carrying gold, silver, copper or tin as their chief metal have been found in the area but their relationships to the tungsten deposits are not known.

The stream placers have been the productive deposits to date and they contain the only known reserves. From near the head of Dublin Gulch they extend downstream into Haggart Creek and on down its course. Tungsten as scheelite can be panned in Haggart Creek valley for several miles below Lynx Creek as well as in many of the small tributaries of Lynx Creek above Haggart Creek, and from the soil in places on the ridge between the head of Lynx Creek and McQuesten Lake. This wide distribution suggests the possibility of other

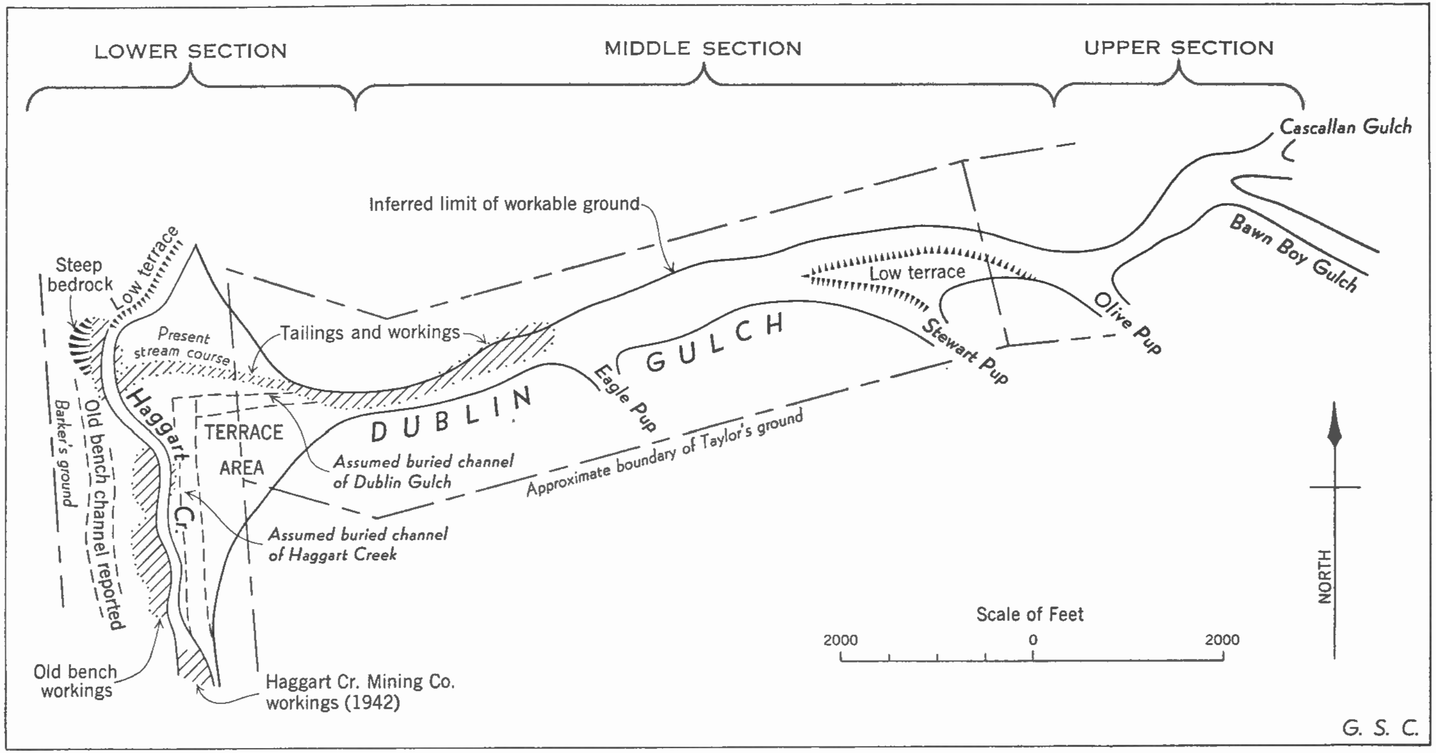


Figure 4. Plan of Dublin Gulch scheelite placer ground, Yukon Territory. (Geology *by* H. S. Bostock, 1943.)

placers or residual deposits, notably in the drainage of Lynx Creek which has suffered less glaciation than the region to the southeast. From present information, however, the tungsten placers lie in Dublin Gulch and down Haggart Creek for about 3 miles below Gill Gulch and the main reserves are in Dublin Gulch and for a short distance below it.

The early gold placer mining was mainly in the lower mile of Dublin Gulch and along the first 2 miles of Haggart Creek below Dublin Gulch, though placer prospecting spread to the head of the gulch and down Haggart Creek to below Secret Creek and the ruins of old shafts and cabins are still to be seen in places.

In the 1920's, Frank Cantin and associates mined the terrace on the west side of Haggart Creek below the mouth of Dublin Gulch but a few years later the area was practically abandoned. About 1936 interest in the area revived and E. H. Barker and George Potter and associates staked Haggart Creek from the mouth of the gulch downstream, Fred Taylor staked the gulch for a mile above their Haggart Creek claim line, and E. Bleiler and H. Seaholm staked above Taylor. By 1938 the Haggart Mining Company, manager E. H. Barker, was mining on the creek, and Taylor was mining the gulch. These operations have been the most important ones in the neighbourhood. In 1942, Taylor worked his cut on Dublin Gulch and V. Lunde and R. Swanson worked tail races of old workings mainly for scheelite and some virgin ground for gold on the two claims below Taylor's workings. The following year, Taylor leased his workings to Swanson, and Lunde continued working on the ground below Taylor against the north side until the end of 1946. Seaholm worked a cut in Dublin Gulch a few hundred feet upstream from Taylor's line in 1942 and 1943. During these years the Haggart Creek Mining Company had been operating regularly but closed down in 1944. In 1945 Taylor returned to his workings and has operated every year except from 1945 until 1949 and again from 1952 to 1954. In 1952 T. Gregg mined near the head of Bawn Boy Gulch. Starting in 1954 the Wadd Placer Company for three years mined the ground staked by Potter below that worked by the Haggart Mining Company.

The gold placer operations have revealed the presence of a large variety of minerals in the stream gravels. These include scheelite, ferberite, ilmenite, gold, arsenopyrite, limonite, pyrite, hematite, garnet, allanite, tourmaline, cassiterite, bismuth, zircon, galena, albite, tetradymite, magnetite and monazite (?) as well as common rock-forming minerals[1].

The reserves of gravel in the Dublin Gulch area are described in three sections: an upper section from Olive Pup upstream including Bawn Boy Gulch, a middle section below this extending downstream to opposite the bluff on the north side of the main gulch, about 2,200 feet from Haggart Creek, and a lower section below the bluff, extending down to Haggart Creek and including the large fan-like terrace-area on each side of the gulch stream in the Haggart Creek valley. Most of this lower section is covered by the Haggart Creek claims that reach 1,000 feet on each side of the base line along the creek.

[1] Aho, A.: Unpublished Bachelor thesis, University of British Columbia, 1949.

The workings farthest upstream are those of Gregg on Bawn Boy Gulch. This gulch is a small tributary on the south side of Dublin Gulch. At the lower end it cuts through a terrace that lies on the side of Dublin Gulch between Cascallen Gulch and Olive Pup. The lower part of the Bawn Boy valley at the terrace and for a short distance above is narrow and fairly steep but it widens into a shallow, undefined depression in the broad slope of the main gulch higher up.

Gregg's working on Bawn Boy Gulch was in the broad upper part at about 4,300 feet elevation. Here, he used the spring run-off to wash about 350 cubic yards of material, from which he is reported to have recovered 500 pounds of scheelite concentrate indicating an average grade of 1.4 pounds of scheelite per cubic yard. The cut shows as much as 6 feet of soil, and boulders of local granodiorite resting on a layer of sticky, light grey, sandy material several inches thick, that in turn lies on a deeply weathered, crumbly granodiorite bedrock. The main concentration of the scheelite is in, or on top of, the sticky layer. A strip of similar ground, perhaps as large as 40 acres, extends down the gulch, but as Gregg chose what he believed to be the best part, the average grade would probably be much below that of his cut.

On the same slope as that occupied by Bawn Boy Gulch and Gregg's workings, Cockfield (1919, pp. 12-13) described quartz veins in granodiorite weathered to a depth of 5 feet, in which the original texture of the rock is still visible in the walls of the prospect pits. In the vicinity of the veins scheelite occurs in the decomposed granodiorite. Cockfield took three samples, two of them cut across 2½ feet, one from each side of a vein 1,500 feet east of the line between Bawn Boy and Cairnes claims and one from a vein on the claim line. The assays of these samples yielded 0.85 and 1.20 per cent and a trace of WO_3, respectively. The writer (Bostock, 1941*b*, p. 32) pointed out that the scheelite in the weathered granodiorite adjacent to the veins may be the result of residual concentration. If so, then the scheelite content in the wall-rock below this weathered zone would be lower.

Fine scheelite and bright, yellow, rough gold have been found in the surface material on the lower slopes of Bawn Boy Gulch and on the terrace at its lower end in Dublin Gulch. In 1943, the Geological Survey washed three prospect cuts across the terrace or bench between Bawn Boy Gulch and Olive Pup to test the possibility of a deep channel with a "paystreak" lying in the bench. The cuts showed that the soil is from a few inches to 4 feet thick and underlain by old glacial till. In the cut nearest to Bawn Boy Gulch washed gravel was exposed for a length of 20 feet from 2 to 7½ feet below the surface, beneath the glacial till and carried some values in gold and scheelite. The cut was more than 12 feet deep for a considerable part of its length but bedrock was not reached. The second cut, about half-way between Bawn Boy Gulch and Olive Pup reached bedrock at 5 feet but only in the upper part. The main part of the cut was 10 to 12 feet deep and exposed only glacial till. From these two cuts, the second of which measures 55 cubic yards, the quantity of scheelite recovered in the sluice boxes was negligible.

The third cut, about 5 feet deep and 5 feet long, was in the bench just above the valley of Olive Pup. The cut exposed blocky granodiorite bedrock; 0.063 pound of scheelite per cubic yard was recovered in the sluice boxes from the overburden of soil gravel and rubble.

Dublin Gulch in this upper section does not appear to have many possibilities. Above Cascallan Gulch, Dublin Gulch is narrow, steep-walled, choked with blocks of granodiorite and no placer mining has been done in it. Between Cascallan Gulch and Olive Pup the floor of Dublin Gulch is narrow and the stream flows among boulders.

The middle section of Dublin Gulch starts as a narrow valley below Olive Pup and widens downstream with diminishing grade and numbers of boulders. Above Stewart Pup the course of the main stream becomes cut in a low, uneven, sloping terrace of overburden that lies mainly on the south side. From here the main stream of the gulch flows in a shallow inner valley that widens downstream until it approaches the lower end of the section where it narrows again.

The uppermost working in the middle section is that of Bleiler and Seaholm, where Seaholm mined in 1942 and 1943. The surface material between the boulders on this ground gave 0.75 pound of scheelite per cubic yard by panning; 3,700 cubic yards were washed and about 900 pounds of scheelite concentrates and 11 ounces 2 pennyweights of gold recovered in the sluice boxes. The gold was bright, yellow, wiry and rough. There was very little cassiterite in the concentrates. The cut exposed many great boulders and it is due partly to this and partly to the fact that much of the scheelite recovered in panning is too fine to recover in the sluice boxes, that the final recovery is only approximately 0.25 pound of scheelite per cubic yard.

Remains of three old pits or shafts show in the low terrace in the fork between Dublin Gulch and Stewart Pup. The old dumps beside the pits and the surface material were panned and found to average about 0.35 pound of scheelite per cubic yard, while samples from the bottom of Stewart Pup averaged 0.10 pound per cubic yard.

There has been no mining below Seaholm's cut to Taylor's working beyond Eagle Pup but some scheelite and gold were found at every point tested and the boulders, on the surface at least, decrease in size and abundance downstream.

Taylor began mining about 1,500 feet upstream from the boundary of the Haggart Creek claims. He first made a bedrock drain up the old course of the creek. When the drain reached bedrock it was extended to the north side to form and "T"-shaped cut and subsequently the upstream bank was mined by sluicing. In this way the cut was worked up to a short distance below Eagle Pup and then a parallel working was made on the north side starting near where the bedrock was reached. In somewhat the same way Lunde worked a large area of ground on the north side of the old workings in the stream course below Taylor's workings.

A number of old adits could still be seen in 1938, entering the banks on either side of the old workings along the lower part of the middle section. Two are of interest. One entered the bank on the south side about 1,000 feet below Eagle Pup and is said to have been driven north about 100 feet without reaching the limit of gold values. The other entered the south bank in a westerly direction where the valley floor narrows and the stream bed bends northwesterly. The old workings and hearsay indicate that the best pay was found above there. The values in the stream bed diminished downstream and the adit was driven to follow the pay that was thought to continue westerly under the terrace-area that lies in the lower section.

Below Eagle Pup the scheelite content was found by panning on the surface and in a few places in the workings to average about 0.29 pound of scheelite per cubic yard. Some increase in the scheelite content was noted with depth but no "paystreak" was defined. During 1942 and 1943 the yield from parts of Taylor's workings was 2,400 pounds of scheelite concentrate from 10,000 cubic yards of gravel, and 2,000 pounds of scheelite concentrate from 8,000 cubic yards, respectively. These concentrates were cleaned in a large hand jig before weighing. As the scheelite recovered by panning is much finer than that in the concentrates, yet the value per cubic yard is nearly the same, it is thought that the increase in scheelite content of the ground towards bedrock must be considerable. Also there seems little doubt that if the sluice boxes were designed and operated primarily to recover scheelite instead of gold, the recovery of scheelite per cubic yard might be considerably higher as the riffles frequently clogged with scheelite and when they were loosened, much scheelite was allowed to go down the tail race.

No mining has been done in the lower section for many years. Old workings can be seen along the stream course of Dublin Gulch and on low rock benches on both sides of Haggart Creek downstream from Dublin Gulch for about half a mile, and a number of old pits and shafts exist in the terrace-area. The terrace-area forms the main part of this section and was the only part examined and mapped in 1942, but Frank Cantin reported that a second, higher bench channel carrying gold values lies on the west side of Haggart Creek above the old workings and this constitutes another possible area workable for scheelite.

The mapping of the terrace-area on a scale of 200 feet to 1 inch with a 20-foot contour interval suggests that as much as 140 feet of unconsolidated material occurs in it and that it has a volume of more than 6,000,000 cubic yards. Examination of its surface by panning showed that in most places in the northern and central parts rusty gravel on the surface contains more than one-tenth of a pound of fine scheelite per cubic yard and some fine, bright gold. The dump of an old shaft, said to have been about 80 feet deep, that is located about 70 feet west of the limit of the Haggart Creek claims and 100 feet or more from the present course of Dublin Gulch also yields considerable gold and scheelite. These factors suggest that the terrace contains a large quantity of scheelite and its elevated position above Haggart Creek makes it appear workable.

The chief possibilities of the terrace-area are in the gravels on its surface and in buried channels of Dublin Gulch and Haggart Creek. The scheelite in the old shaft dump suggests that there may be some all through the body of the terrace but that the ground could only be mined to depth if the terrace was worked as a whole. The surface gravel at its high elevation can readily be sluiced into Haggart Creek. The old buried channels may contain the highest values but they would have to be mined by underground methods unless again the whole terrace was worked.

The following table summarizes the figures obtained by mapping and panning Dublin Gulch including the terrace-area. The degree of accuracy is only sufficient to make them a guide as to where the best areas lie to start more systematic detailed examination.

ESTIMATE OF PLACER RESERVES ALONG DUBLIN GULCH AND PART OF HAGGART CREEK

Areas on Map Name	Length in ft.	Width in ft.	Depth in ft.	Volume in cu. yd.	Scheelite from tests, etc. in lb./cu. yd.	Scheelite Recoverable in lb./cu. yd.	Total Scheelite Possibly Recoverable in lb.
Upper Section							
Bawn Boy G........	3,000	60	3	20,000	1.4[1]	0.50	10,000
In Dublin Gulch, Bawn Boy G. to Olive Pup	3,000	30	3	10,000	0.5	0.10	1,000
Middle Section							
Olive Pup to Stewart Pup.............	1,000	100	9	33,000	0.75	0.25[1]	8,000[2]
" "	1,000	150	9	50,000	0.50	0.20	10,000
" "	1,000	150	12	66,000	0.25	0.10	6,600
Gravel Terrace opposite Stewart Pup...	2,000	250	9	166,000	0.35	0.15	25,000
Stewart Pup........	1,500	100	9	50,000	0.20	0.05	1,000
Stewart Pup to Eagle Pup.............	2,000	300	9	200,000	0.29	0.15	30,000
Opposite Eagle Pup..	1,000	180	9	60,000	0.25	0.15	9,000
Eagle Pup to Terrace area.............	2,000	150	12	150,000	0.29	0.25[1]	3,300[3]
Lower Section, Terrace Area							
Dublin Gulch Buried Channel..........	1,500	100	9	50,000	——	0.25[4]	12,500
Haggart Creek Buried Channel..........	3,000	100	9	100,000	——	0.15[4]	15,000
Surface area.........	——	——	——	450,000	0.05 to 0.15	0.10	45,000
Remaining body of the Terrace area...	——	——	——	5,000,000+	None	——	——
Total......	....	....	....	....	....	....	176,400

[1]Figures reported from actual recovery in workings.
[2]Part of this has been mined by Seaholm and Bleiler.
[3]Largely worked. Perhaps one-tenth remains and this is used in total.
[4]Assumed.

In 1942 the Haggart Mining Company tested the heavy concentrates caught in its sluice boxes as it worked past Gill Gulch. The tests showed that the quantity of scheelite increased upstream and that about 75 pounds per day could be saved that was normally cleaned out of the riffles and sent down the tail race to keep the boxes in condition to hold gold. The concentrate was found to contain much heavy mineral that was difficult to separate from the scheelite in the normal way and 847 pounds were sent to the Bureau of Mines, Department of Mines and Resources, Ottawa for research on the separation and cleaning problem. This shipment was found to assay:

Tungstic Oxide	WO_3	14.24%
Sulphur	S	1.73
Tin	Sn	30.80
Iron	Fe	12.96
Manganese	Mn	0.16
Lime	CaO	2.32
Gold	Au	13.755 oz/ton
Moisture	—	0.70

No other shipment of heavy concentrates, however, was made and the company stopped mining and only development work was done in 1943.

Lynx, Snowshoe, Skate Creeks, and Ray Gulch (8)

Snowshoe and Skate Creeks and Ray Gulch are tributaries of Lynx Creek, which flows into Haggart Creek, in the northwest part of Mayo map-area. In 1943, a Geological Survey party under the writer found scheelite in the gravel and soil of Lynx Creek and the three tributaries mentioned above as well as in other small tributary gulches southeast of the head of the creek and in the soil on the granodiorite body north of Skate Creek.

Secret Creek (9)

Secret Creek enters Haggart Creek from the northwest about 5 miles from South McQuesten River. Some gold placer prospecting was done on it near the first fork and scheelite was found among the heavy minerals with the gold.

Rodin and Goodman Creeks (9)

Rodin and Goodman Creeks enter the valley of the South McQuesten River between Haggart Creek and North McQuesten River. A little gold placer mining has been done on both creeks and scheelite was found in panning them.

Ledge Creek (10)

Ledge Creek has been the most important of the gold placer creeks that flow into the southeast arm of Mayo Lake. The gold in it is unusually coarse for the Mayo Mining Division. Only a small amount of heavy concentrate is caught in the sluice boxes but the chief heavy minerals in the samples in 1942 and 1943 were cassiterite and scheelite.

Roop and Edwards Creeks (11)

Roop and Edwards Creeks flow into the east end of Mayo Lake. In 1943, a Geological Survey party discovered scheelite in the overburden on the slope between Edwards and Roop Creeks southeast of Roop Lakes. The slope is to 'glacial leeward' of the skarn zone (*see* p. 15) 1½ miles northeast of Wilson's Cabin and the origin of the scheelite may have been in the skarn zone.

LODE DEPOSITS

Whitehorse Mining Division

Kluane (1)

In 1945, a Geological Survey party found crystals of scheelite with garnet and other contact silicate minerals in places along the contacts between granitic intrusions and limestone north of the Alaska Highway between Kluane and Donjek Rivers (Bostock, 1952, p. 42).

Dawson Mining Division

Canadian Creek (1)

Reference: Cairnes, 1917, pp. 29-31.

The placer deposits of Canadian Creek have been described on pages 16-19. Because the region is unglaciated, Cairnes concluded that the source rocks of the placer deposits are in the surrounding hills. These consist of Mesozoic granitic rocks (*see* Figure 3) of which pegmatitic and porphyritic phases that are highly mineralized outcrop directly up the slope to the south from the main placer workings. From this area of mineralized rocks Cairnes took three chip samples across 900 feet, each covering about one-third of the distance. Assays of these for WO_3 yielded a trace in one sample and 0.10 per cent in the other two.

Mayo Mining Division

Scheelite Creek and Castnor (Cement) Creek (4)

References: Cockfield, 1918, p. 14B. Bostock, 1939, p. 14; 1941*b*, pp. 32-33; 1948, p. 11; Map 48-25A; unpub. report, 1943.

The source of scheelite in the placers of Johnson, Sabbath, Scheelite, Rudolph, and Highet Creeks appears to lie in the area around the small granodiorite stock and its satellites that occupy the ridge at the heads of these creeks. On the south side of the ridge which extends in a general westerly to southwesterly direction, the scheelite had been followed up Johnson and Sabbath Creeks into Scheelite Creek, and Cockfield advised that it might be profitable to search for the source around Scheelite Creek. In September 1942, a party of the Geological Survey of Canada headed by the writer made a rapid examination of the ridge containing the stock and discovered scheelite in place in small veinlets and pegmatitic dykelets in the intrusion at the head of Scheelite Creek and in a skarn zone on the northeast slope opposite the head of Scheelite Creek in the drainage of Castnor (Cement) Creek. The skarn zone was staked by J. J. Winter and others late in the year and the claim containing the original discovery was purchased by T. McKay.

The following summer, the Geological Survey mapped the area around the stock and its satellites on a scale of 2 inches to 1 mile (*see* Figure 5) and made a detailed map (*see* Figure 6) of the most promising locality on a scale of 1 inch to 400 feet.

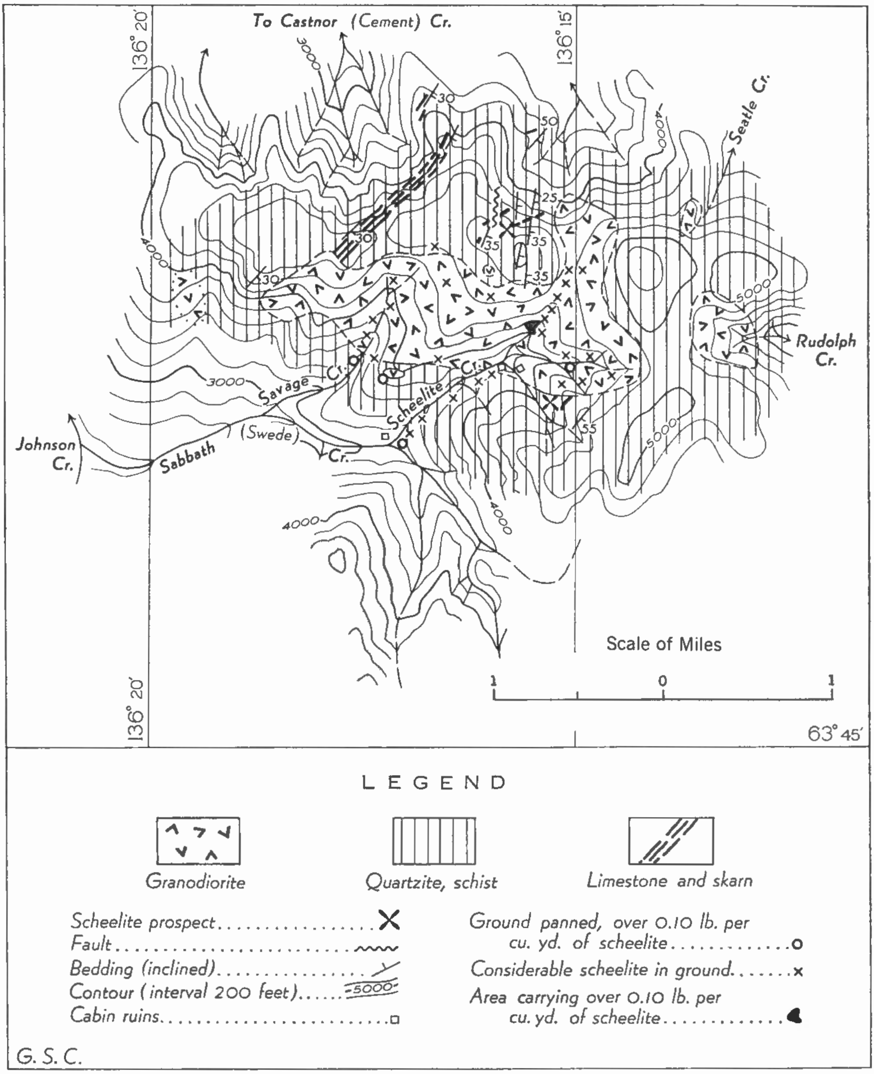


Figure 5. Castnor (Cement) Creek scheelite area, Yukon Territory. (Geology *by* H. S. Bostock, 1943.)

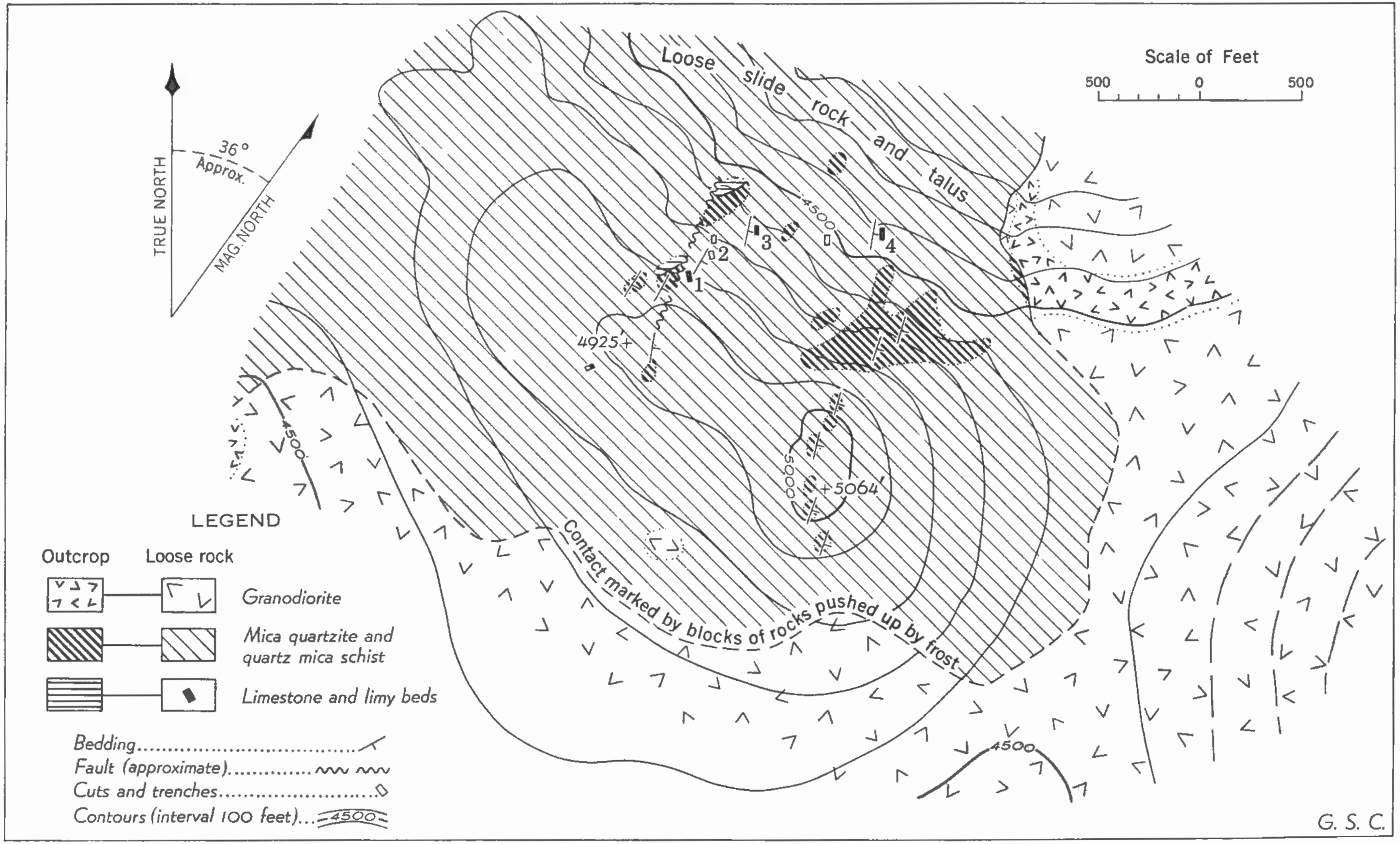


Figure 6. Castnor (Cement) Creek contact area, Mayo District, Yukon Territory. (Geology *by* H. S. Bostock, 1943.)

The stock and its satellites intrude schists, quartzite and limestone of the Yukon group of Precambrian or Palæozoic age and form a centre of mineralization. A variety of mineral deposits occurs around them and include some lode deposits with values in gold, antimony and copper as well as tungsten.

In the slope of the ridge on the north of Scheelite Creek the granodiorite stock is cut by numerous veinlets, some pegmatitic dykelets and rusty fractures with scheelite scattered thinly through them, but the best picked samples crushed, panned and weighed carried less than 0.2 per cent scheelite. These small deposits are scattered through the stock except in its west part but no prospecting has been done on them. Though they do not appear to be numerous enough to be of economic value as lode source of scheelite, they are thought to be the main source of the placer scheelite on the south side of the ridge.

The scheelite-bearing skarn zone, referred to above, lies within an embayment on the north side of the granodiorite stock. Here the quartzite and schist of the Yukon group contain pods of limestone and beds of impure limestone that have been altered to skarn. The micaceous quartzite adjacent to the skarn in places exhibits faint, contorted bedding showing a general strike of north 10 to 20 degrees east, and dips about 25 degrees east in the general direction of the granodiorite contact on the east side of the embayment.

The skarn is a fine-grained, speckly textured, dark greenish grey rock, strikingly like some of the greenstones or dioritic bodies in the Galena and Keno Hills neighbourhood. It consists, mainly, of dark green pyroxene, calcite and quartz. Pyrrhotite and scheelite are the chief ore minerals and a little pyrite, chalcopyrite and molybdenite are present in places. The scheelite is irregularly disseminated in the skarn and forms small patches of high grade.

At trench 1, widths of 3½ and 5 feet of skarn irregularly mineralized with scheelite, are separated by 3 feet of barren limestone. Southwest of this trench, the skarn band terminates at a fault that strikes north 20 degrees east and dips very steeply. The skarn was not found west of this fault.

At trench 2, about 200 feet northeast and diagonally down the slope from trench 1, bedrock was not reached but large blocks of skarn were exposed. In trench 3, about 250 feet farther and more easterly, 6 inches of skarn containing a considerable quantity of scheelite was exposed across 20 feet of altered limestone, but the main skarn band may lie above this horizon. At trench 4, about 1,000 feet east from trench 1, only loose blocks of skarn with scheelite were found. The limy beds here resemble those of trench 3. The scheelite-bearing skarn band may extend eastward down the dip to the intrusive contact. The scarcity of skarn float in the talus to the northeast down the slope where its outcrops might be expected, suggests that the zone may not be extensive. Assays of high-grade specimens of skarn taken from these trenches range from 3 to 8.15 per cent WO_3. A specimen carrying chalcopyrite assayed 0.18 ounce in gold. No similar skarn was found elsewhere around these intrusions but outcrops are generally scarce, and it is likely that the source of the scheelite in Rudolph and Highet Creeks on the southeasterly side of the ridge is not exposed.

Dublin Gulch and Ray Gulch (8)

References: Cockfield, 1919, pp. 12B-14B. Bostock, 1941*b*, pp. 31-32, unpub. report, 1943.

Although the presence of scheelite in the placer deposits of Dublin Gulch had been reported in 1904, it was not until 1918 that a lode source of the scheelite in the area was found. In that year, Cockfield examined several localities at the head of the gulch and found scheelite in quartz veins and in pegmatite dykes that intersect schists of the Yukon group and granodiorite (*see* Figure 7). The quartz veins occur in three sets of fractures approximately at right angles to one another, and range in thickness from 1 inch to 8 inches, but none have been traced for any great distance. Scheelite crystals occur both in the veins and in the adjacent wall-rock. Quartz is usually the only gangue mineral, but in some places, calcite and white mica are present, forming a transition into pegmatite dykes. In all, ten quartz veins were reported by Cockfield. These stand somewhat in relief relative to the surrounding granodiorite that is weathered to a depth of about 5 feet.

At the head of Bawn Boy Gulch, three quartz stringers were exposed in weathered granodiorite, two being nearly vertical and at right angles, and the third horizontal. The maximum width is 2 inches. A sample, taken across a vein, assayed 1.80 per cent WO_3.

About 1,500 feet to the east, three quartz veins, 4 to 5 inches wide, occur in weathered granodiorite and contain scheelite crystals up to 1 inch long. A sample across a vein assayed 1.70 per cent WO_3.

At a third locality, between Bawn Boy and Cairnes claims, two veins cut granodiorite. The larger is 6 to 8 inches wide and a sample taken across it assayed 2.60 per cent WO_3. A sample across the smaller one assayed 10.10 per cent WO_3.

Two quartz veins cut hornblende and mica gneiss, and limestone on the slope facing Lynx Creek and its tributary, Ray Gulch, near a contact with the granodiorite stock. Scheelite occurs sparingly in one vein, but is more abundant in the adjacent gneiss. The vein is 4 inches wide, and assays 1.25 per cent WO_3. A sample of the wall-rock adjacent to the vein assays 3.40 per cent WO_3.

Cockfield reports that in one instance only, at the head of Dublin Gulch, does pegmatite carry an appreciable amount of scheelite. Here, a dyke, 1 foot wide, cuts granodiorite and contains white mica, quartz, feldspar, and hornblende, with minor amounts of tourmaline, siderite, graphite, scheelite, and possibly wolframite, and a sample from it assayed 6.35 per cent WO_3.

In 1940, when Dublin Gulch was visited by the writer, the walls of the pits exposing these veins had caved and no work is known to have been done on them since Cockfield's visit.

In 1942, however, Harvey Ray prospected for lode scheelite deposits east of Dublin Gulch and found some large blocks of float containing scheelite on the west side of Ray Gulch at an elevation of 3,400 feet where the slope curves into Lynx Creek Valley. The float consisted of crystals of scheelite up to half an inch long in pale green, coarsely crystalline tremolite with some

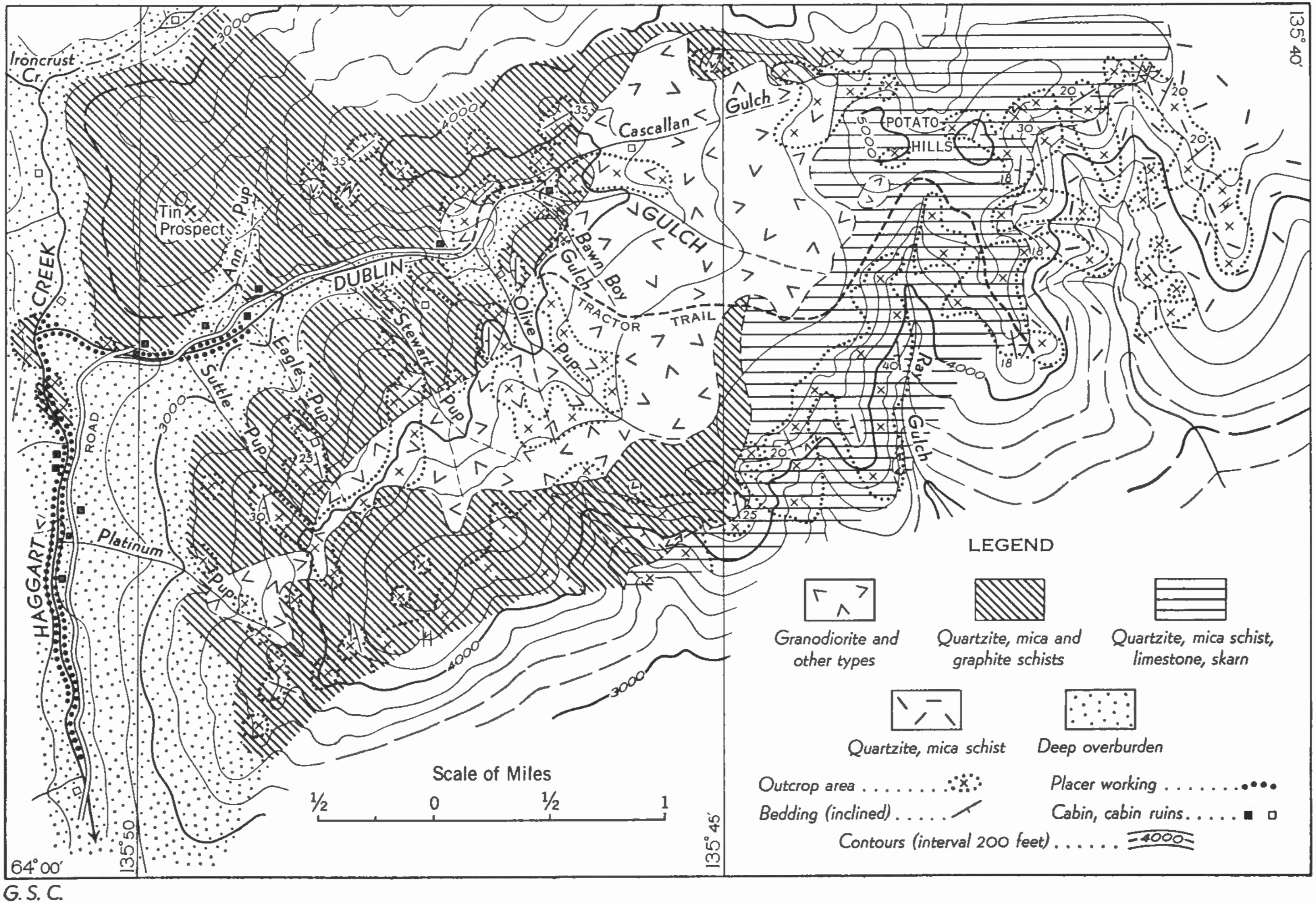


Figure 7. Geological map, Dublin Gulch, Yukon Territory. (Geology *by* H. S. Bostock, 1943.)

calcite and quartz. Fragments from it, after being crushed, weighed, and panned, yielded 2.7 to 3.3 per cent scheelite. The source of this rock was not discovered but above it for more than 2 miles along the west side of the gulch and around the head Ray found skarn material containing disseminated scheelite. In general appearance the skarn material resembles a medium-grained diorite as it is mainly composed of crystals of dark green silicates with calcite filling the interstices. In 1943, mapping by the Geological Survey showed that the skarn is in a zone of limy beds about 75 feet thick in schist and quartzite of the Yukon group. Around Ray Gulch the limy beds are exposed in cliffs reaching elevations close to 4,000 feet. They are cut by granitic dykes and lie on the crest and northerly side of the anticline referred to earlier (*see* page 22). As the anticline plunges southwesterly, the beds strike in northerly directions and dip westerly towards the granodiorite stock whose contact lies from 300 feet to half a mile northwest, back from the top of the cliffs. This is a most favourable structure and general situation for the skarn type of scheelite deposit. Despite the widespread presence of disseminated scheelite, no spot as rich as the float referred to above was found. The samples taken by the Geological Survey from the accessible parts of the cliffs assayed 0.27 to 0.50 per cent WO_3.

A visit to the granitic stock north of Skate Creek (Map 43-9) showed that scheelite can be recovered by panning from the soil lying on the granite on top of the ridge in a number of places.

Edwards and Roop Creeks and Keno-Ladue River (11)

The occurrence of tin and tungsten minerals in gold placer deposits around granodiorite stocks north and northwest of Mayo in the unglaciated and lightly glaciated terrain suggests their presence around similar stocks to the east where glaciation was more intense and placer deposits have not been found. In view of this, in 1943 a Geological Survey party briefly explored the contact areas around the granodiorite stock that lies between Edwards Creek and Keno-Ladue River. Over large areas the contact is covered by overburden but in exposed parts, where quartzite is intruded, disseminated pyrite and small veins carrying pyrite and tourmaline commonly occur in the quartzite. About 1½ miles northeast of Wilson's Cabin, limestones and limy beds are mingled with the schists and quartzites of the Yukon group and are intruded by the granodiorite stock. A zone of intense alteration occurs here. The rocks near the contact include coarsely crystalline skarn now largely banded in highly quartzose material alternating with some silicates and light brown garnet. Coarsely crystalline titanite and radiating brown tourmaline (?) are present in patches with the bands rich in garnet. The Yukon group and the granodiorite are cut by numerous pegmatites of quartz and feldspar with abundant black tourmaline, commonly in long crystals as large as pencils, in the interior of the pegmatites and as radiating masses of smaller crystals along the sides of the pegmatites. Scheelite commonly occurs thinly disseminated or in small patches in the skarn, and in one instance was noted in pegmatite as a few small scattered crystals. The scheelite crystals are coarser than in other localities but none more than ½ inch long was seen.

Some pegmatites and some alteration were noted in places along the granodiorite contact as it rises over the face of the hill to the southeast and a few specks of scheelite were detected in places.

Fiddler Group (12)

Reference: **Lord, 1944, pp. 16 and 17.**

The Fiddler group, owned by Consolidated Mining and Smelting Company of Canada, is 4 miles north of the Alaska Highway, 105 miles east of Teslin. It is described by Lord in the following words:

"The group was staked early in July, 1943 by Messrs. D. M. Baird, H. B. Denis, K. C. Fahrni, J. W. Forrest, and D. R. E. Whitmore, and included Bach, Greig, Elgar, Handel and Franck claims. The country rock is mostly grey, crystalline, micaceous limestone and soft, grey sericite schist or phyllite, (of Carboniferous (?) age). The attitude of the beds probably varies from place to place, but the dip is generally less than 15 degrees. These rocks are cut by many barren stringers or groups of stringers of glassy to white, rhythmically banded, crystalline quartz with numerous open crystal-lined spaces. Elsewhere brecciated rock is cemented by similar quartz. Mineralized vein quartz outcrops at an elevation of about 5,100 feet on a rounded peak and on an adjacent cirque wall. The vein or veins trend northeasterly, dip gently southeasterly, range in width from a fraction of an inch to about 3½ feet, and in part lie at an angle to the bedding. The quartz is glassy to white, banded, and in crystals up to about 1½ by 3 inches. These project into long open spaces that parallel the banding and vein walls. On the top of the peak the quartz probably ranges up to about 1 foot in width and has been traced for some 200 feet by several shallow pits. On the cirque wall, which forms one side of the peak, a quartz vein up to 3½ feet wide is reported to have been traced for about 400 feet. Some of the quartz on the peak contains abundant, glistening, dark brown wolframite in blades an inch or more long. Associated, less abundant minerals include galena, sphalerite, malachite, azurite, chalcopyrite, grey copper (?), fluorite, scheelite (?), white carbonate, a soft greenish micaceous mineral, powdery greenish yellow material, and iron oxide. A specimen of wolframite contained[1] 12.6 per cent MnO. A picked sample of quartz and wolframite assayed[2] 0.59 per cent tin and 15.00 per cent WO_3."

BRITISH COLUMBIA

About 90 per cent of the recorded production of tungsten concentrates in Canada up to the end of 1952 had been derived from British Columbia. The major producers of tungsten concentrates in this province are Canadian Exploration, Limited, who operate the Emerald, Feeney and Dodger orebodies; and Western Tungsten Copper Mines, Limited, who operate the Red Rose mine. Minor production has been derived from a few vein deposits, and from placers.

---

[1] Fabry, R. J. C.: Mineralogy Section (now Division), Geological Survey of Canada.
[2] Bureau of Mines, Dept. of Mines and Resources (now Mines and Technical Surveys), Ottawa.

PLACER DEPOSITS

Atlin Area

Boulder Creek (1)

References: Minister of Mines, B.C., Ann. Repts., 1949, pp. 238-239; 1950, pp. 72, 73, and 196, 197.

Placer gold deposits were operated on Boulder Creek (*see* Figure 8) about 3 miles above Surprise Lake and at an elevation of about 4,000 feet, for several years prior to 1942 by the Consolidated Mining and Smelting Company of Canada, Limited; a crew of about 20 men was employed. In 1942, Norman Fisher and associates leased the deposit, and continued its operation for some years. In 1949, Mr. Fisher and five partners again leased the property and installed two hydraulic monitors. About 40,000 cubic yards of gravel were washed into a 100-foot length of sluice boxes using 40-pound rails as riffles. In addition to gold, 6,002 pounds of black sand were recovered and this was shipped to Derby and Company, England, in two lots, the assays averaged by weight, 48.5 per cent WO_3, 10.0 per cent Sn, trace As, 2.83 ounces gold a ton, 1.22 ounces silver a ton, 0.38 ounce platinum a ton, and 0.11 ounce iridium a ton.

In 1950, in addition to gold, 2 tons of black sand containing tungsten and tin were recovered. All workable gravels were treated and the operation discontinued.

Cariboo Area

Scheelite has been known in the placer gold deposits of Cariboo district since 1904 (Minister of Mines, British Columbia, Annual Report, 1904, p. G 49). At this time scheelite and barite were identified by A. J. R. Atkin in placer workings on Hardscrabble Creek. The economic possibilities were pointed out by Mr. Atkin and the source of the scheelite was discovered. Subsequent work was limited to the development of the lode deposits.

In 1942, Stevenson (1943, p. 79) examined black sand concentrates and gravels from many creeks in Cariboo district to determine their tungsten content, and also to aid in the discovery of lode deposits. It was found, however, that black sand concentrates were not abundant, and the quantity of scheelite in them was low. In the gravels, scheelite occurs as pieces ranging in size from fine sand to pebbles 2 inches in diameter.

Scheelite is present in the gravels of Hardscrabble Creek, Red Gulch, Lowhee Creek, Stevens, California and Nugget Gulches, Penny Creek and Peter Gulch Creek. These occurrences are within a broad northwest-southeast zone. Only a small quantity of scheelite has been produced.

Slocan Area

Mineral Claim (70)

Reference: Minister of Mines, B.C., Ann. Rept., 1943, p. 80.

"This property lies on the outskirts of Kaslo. The owner, A. G. Pearson, of Kaslo, discovered scheelite in the material from an old well and cleaned this out for further examination and sampling. The sand and gravel did not contain sufficient scheelite to be of value."

LODE DEPOSITS

Atlin Area

Black Diamond Tungsten Limited[1] *(1)*

References: Stevenson, 1943, p. 51. Thomas, 1944, pp. 218-219. Minister of Mines, B.C., Ann. Rept., 1950, pp. 72-73.

The thirty-seven claims and fractions owned by Black Diamond Tungsten Limited, a subsidiary of Transcontinental Resources Limited, were acquired by purchase and subsequent staking in 1951. Included were the Tungsten and Wolframite groups, staked by the Consolidated Mining and Smelting Company of Canada, Limited in 1939, and transferred to Norman Fisher and Ole Olsen for development (Stevenson, 1943). The important known showings are on ground staked in 1951.

The property is at the head of Boulder Creek, about 12 miles northeast of the town of Atlin. A motor road connects the camp with Atlin, thence to Carcross and Whitehorse. Early in 1952 the road was extended from the camp to the power-house site and the workings.

The claims cover a part of the southern end of a large granitic batholith, and are underlain, according to Stevenson, by feldspar porphyry and granodiorite. These rocks are traversed by shear zones containing quartz veins, and the six explored are designated Nos. 1 to 6 Zones. The quartz veins are irregular in shape and contain specks and patches of wolframite.

From the earlier workings a bulk test-sample of 98 pounds of sorted and cobbed ore assayed 19.5 per cent WO_3, 1.2 per cent Mn, 6.8 per cent Fe, 0.01 per cent P, and 66.4 per cent SiO_2 (Stevenson, 1943, p. 51). A second lot of 1,797 pounds of dry ore was assayed at the Prince Rupert sampling plant of the British Columbia Department of Mines, and ran 15.20 per cent WO_3, 0.18 per cent Sn, 0.10 per cent Bi, 0.01 per cent P, *nil* MoS_2, 0.31 ounce gold a ton, and small amounts of lead, copper and sulphur (Minister of Mines, British Columbia, Annual Report 1943, pp. 52, 54). The lot was then shipped to the Bureau of Mines, Ottawa, for assaying and milling tests. The heads averaged 14.15 per cent WO_3, the recovery 95 per cent, and the concentrate 65 to 70 per cent WO_3 (Thomas, 1944, p. 219).

No. 1 Zone strikes north 40 degrees east. The deposit has been traced by longitudinal and transverse trenches for 320 feet, and averages 0.50 per cent WO_3 (uncut) across 11 feet. The southern part of the body is wider than the north but the grade is low and may be submarginal. The tungsten content is erratic. Silver assays, up to 2 ounces a ton, were obtained, and a little gold and tin.

Little development work has been done on Nos. 2 and 4 Zones, and No. 3 Zone is indicated by float only.

[1] Described from published reports and from data supplied by G. M. Radisics of Transcontinental Resources Limited.

The most promising vein is No. 5 Zone exposed along its strike of north 45 degrees east by five pits within a distance of 440 feet. It averages across 3 feet, 1.85 per cent WO_3 and 0.07 ounce silver a ton (uncut), with traces of gold and tin; in thin sections of selected specimens supplied by Mr. Radisics from this zone, veinlets of quartz about 1 inch wide cut granodiorite in part altered to fine-grained kaolin. Wolframite was deposited first, followed by quartz and sericite. In the veinlets quartz is the most abundant mineral and is in large and small crystals forming comb structure that has grown from the vein walls, against wolframite crystals, and, rarely, against larger quartz crystals. The sericite is fine grained, and interstitial to quartz. Both wolframite and ferberite have been reported (Minister of Mines, British Columbia, Annual Report, 1950, pp. 72, 73), but in the specimens sent to the Geological Survey, only wolframite was recognized. An X-ray powder photograph of the wolframite indicated that its ratio of manganese to iron is approximately 3 to 2[1].

No. 6 Zone was discovered in 1953. The vein has been exposed for 150 feet, is 4 feet wide, and averages about 1 per cent WO_3.

Stikine Area

Devil's Elbow (2)

References: Kerr, 1927, pp. 21-33; 1948, pp. 72-73. Stevenson, 1943, p. 52.

Mineral deposits on Devil's Elbow Mountain have been described by Kerr. All are replacement bodies in Palæozoic limestone close to bodies of granodiorite. Stevenson reported scheelite and galena in specimens from this area. In 1952, a company known as Tungsten of British Columbia, Limited, was organized to explore prospects in this area[2].

Portland Canal Area

Little Pat, Badland, and Hogback (3)

Reference: Stevenson, 1943, pp. 52-53.

These claims are on the northeast side of Bitter Creek Valley, east and southeast of Bitter Creek bridge on the Bear River road, 9 miles north of Stewart. The showings are in quartz diorite and consist of narrow fissure veins containing quartz, pyrite, chalcopyrite and scheelite, and, locally, molybdenite. The known veins carry from *nil* to 0.12 per cent WO_3.

Lucille No. 1 (United Empire) (4)

Reference: Stevenson, 1943, p. 53.

"Scheelite was discovered in the workings on this claim in the Stewart area by the owner, Ernest Low of Stewart."

[1] Determined by E. J. Brooker, Mineralogy Division, Geological Survey of Canada.

[2] *Northern Miner*, February 14, 1952.

Louise and Dot (5)

Reference: Stevenson, 1943, pp. 53-54.

"Two claims, the Louise and Dot, were staked in August 1942 on a small scheelite showing by Arthur Cameron of Stewart. They are on the steep, lower slopes of the west wall of the Bear River valley, about 4½ miles north of Stewart.

"The only workings consist of one old open-cut and a recent small excavation 20 or 30 feet below it, at an elevation of 400 feet above sea-level, or slightly more than 300 feet above the floor of the Bear River valley. They are reached by a foot-trail, brushed out along the river-flats, leading for 1¾ miles from the road-bridge across the Bear River.... The cuts are in a small draw sloping steeply (35 to 50 degrees) southeastward, amid a number of cliffs and thickly wooded hillside.

"Small amounts of scheelite are found in a bed of lime-silicate rock 2 to 6 feet thick and in lenses of the same type of rock from 1½ to 2 feet thick and 3 feet long. Two grab samples, one from a well-mineralized part of a lens, assayed: Tungstic oxide (WO_3), 0.04 to 0.27 per cent.

"A large body of granite outcrops 150 feet from the lime-silicate rock and associated metamorphosed sediments."

Molly B (6)

Reference: Stevenson, 1943, pp. 54-56.

The Molly B group of ten claims is on the east bank of Bear River, opposite Stewart. The showings are on the Skamakoonst Indian Reserve.

The workings consist of four open-cuts and one short adit. These expose a bed of lime-bearing silicate rock, striking south 60 degrees east and dipping 65 to 75 degrees southwest, and varying in width from 2 to 8 feet. This bed is a member of the Hazelton group, probably of Jurassic age. Granite occurs about 1,000 feet north of the showings.

During the war period 1914-18, a small shipment of molybdenite ore was made. No subsequent shipments are recorded. Scheelite is present throughout the lime-silicate bed, as disseminated specks, and local streaks and patches. The highest grade material occurs where the bed is widest.

The following assays of the ore from this deposit are from Stevenson (1943, p. 55):

Samples	1	2	3	4
WO_3 (per cent)	1.5	0.15	0.37	0.22
Mo (per cent)	4.2	0.2	0.17	0.02

Sample 1, 360-pound test-shipment to the sampling plant of the British Columbia Department of Mines, Prince Rupert.

Sample 2, 148 pounds, blasted from the lowest cut, and the face of the adit.

Sample 3, channel sample 5½ feet long, from across the face of the adit.

Sample 4, 4-foot channel sample, from the open-cut 90 feet above the river-level.

Rainier (Silverado) (7)

References: Hanson, 1935*a*, pp. 146, 147. Stevenson, 1943, p. 56.

The Silverado claims are on the mountain side about 2 miles southeast of Stewart. Scheelite occurs in the lower workings on the Rainier claim, at an elevation of 1,700 to 1,800 feet above Portland Canal.

The claims are underlain by breccia and lava of the Hazelton group, mainly of Jurassic age. The lower showings consist of a zone 4 to 6 feet wide containing reticulating quartz veins 3 to 6 inches wide. An adit, 35 feet long, has been driven in on the zone. Stevenson (1943, p. 56) reports that a sample across 5½ inches of the best mineralization assayed 0.22 per cent WO_3.

Red Bluff Mountain (8)

Reference: Stevenson, 1943, p. 56.

"Scheelite has been found by J. Flynn of Alice Arm, on the Washout Creek slope of Red Bluff Mountain."

Esperanza (9)

References: Hanson, 1935*a*, pp. 62-65. Stevenson, 1941, p. 37; 1943, p. 57.

The Esperanza claims are on the west side of Kitsault River Valley, about a mile north of Alice Arm. The property is underlain by argillite and quartzite of the Hazelton group. Stevenson reports ten adits, of which five follow the scheelite-bearing quartz vein. This vein varies in width from 3 inches to 3 feet, but the average width is near 3 inches. It contains some arsenopyrite, pyrite, pyrrhotite, chalcopyrite, sphalerite, galena, tetrahedrite, ruby silver, native silver, probably polybasite, and other silver minerals, in a gangue of quartz and ankerite. Scheelite occurs as small grains in patches in the main vein and the adjoining wall-rock, and as disseminations in small branch veinlets.

The average tungsten content across mining widths is low and the average assay of ten samples of best grade in the veins is 0.3 per cent WO_3 across 14 inches (Stevenson, 1943, p. 57).

North Coast Area

Princess Royal Island (10)

Reference: Stevenson, 1943, p. 57.

"Gottfrid Knutson, of Butedale, reports finding scheelite in specimens obtained from the Butedale area."

Terrace-Usk Area

Bear and Cub Claims (11)

References: Kindle, 1937*a*, pp. 17-19. Stevenson, 1943, p. 58.

These claims, which are on the west slope of Maroon Mountain east of Kitsumgallum Lake, are owned by W. J. Asselstine and associates, of Victoria.

The claims are underlain by slate, sandstone, and conglomerate of the Hazelton group, the bedding of which strikes northeast and dips 50 to 75 degrees southeast.

The Bear vein, which contains pyrrhotite, sphalerite, chalcopyrite, pyrite, and galena, in a quartz gangue parallels the bedding. It had been developed as a gold property, but Stevenson reported scheelite, although the grade is not reported.

Ptarmigan Group (Annie Laurie Claim) (12)

References: Hanson, 1926, p. 118A. Marshall, 1927, pp. 39, 41. Kindle, 1937*a*, pp. 27-29. Stevenson, 1941, pp. 37, 38; 1943, p. 58.

The Ptarmigan group, owned by J. A. and A. Michaud of Terrace, is on the north slope of Thornhill Mountain, about 6½ miles southeast of Terrace. The property is underlain by schistose greenstone of the Hazelton group representing a roof pendant in granodiorite. On the Annie Laurie claim, a pegmatitic quartz vein cutting granodiorite, is 6 inches to 2 feet wide and has been traced for 200 feet. The vein carries pyrite, chalcopyrite, galena, free gold, and scheelite, in a gangue of quartz, barite, and feldspar. The scheelite forms irregular streaks and nodules, up to 3 inches in diameter, in some of which free gold has been observed. No information concerning grade is available.

Black Bull (13)

References: Kindle, 1937*a*, p. 37. Stevenson, 1943, p. 58.

This claim, on the southwest side of Kleanza Mountain, about 7 miles east-northeast of Terrace, was owned by W. Hagan of Copper River. It lies in sheared andesite of the Hazelton group, near the contact of a granodiorite batholith. Three parallel quartz veins, 6, 10 and 12 inches, respectively, separated by andesite bands 6 and 12 inches wide have been traced for 200 feet but are narrow at both ends. An assay of a sample returned a trace of gold and silver and the owner reported scheelite.

White Bluffs Group (14)

References: Kindle, 1937*a*, pp. 36, 37. Stevenson, 1943, p. 58.

This property, owned by T. Turner of Terrace, is on the west end of Kleanza Mountain, about half a mile northeast of the highway bridge over Zymoetz River.

A pegmatite dyke that strikes north 65 to 80 degrees east and dips vertically is about 60 feet wide and at least 1,000 feet long. The pegmatite cuts coarse granodiorite and contains about 75 per cent quartz and 25 per cent pink orthoclase. In two or three places small cross-fractures contain auriferous pyrite. Specimens from the dyke contain a few small crystals of scheelite[1].

[1] Kindle, E. D.: Geol. Surv., Canada, personal communication.

Lucky Luke Mine (15)

References: Hanson, 1926, p. 116A. Kindle, 1937*a*, pp. 49-51. Stevenson, 1943, p. 58.

The Lucky Luke mine is on the east slope of Kitsalas Mountain at an elevation of 1,000 feet, about 1½ miles southwest of Usk, and a few hundred yards from the railway. It is owned by L. E. Moodie and R. Lowrie of Usk, and they operated the property from 1917 to 1923. S. A. Davis held a lease and shipped in 1923 and 1924, 25 tons of handsorted ore, yielding 18 ounces of gold, 316 ounces of silver and 11,152 pounds of copper. Some development work was done in 1934 by R. W. Seely, and in 1939 by L. E. Moodie.

The bedrock is andesitic flows and biotite and chlorite schists of the Hazelton group. The ore zone comprises narrow, lenticular quartz veins striking north 70 degrees west and dipping 65 degrees north. The veins contain bornite, chalcopyrite, chalcocite, pyrite and free gold.

The deposit has been developed by two adits and a winze exposing a vein about 9 inches wide for a length of 130 feet. Assays of samples taken by Kindle yielded from 0.06 ounce to 1.46 ounces gold a ton, from 1.06 to 2.34 ounces silver a ton, and from 1.50 to 2.78 per cent copper. These samples also contain specks of scheelite[1].

Cordillera Mine (16)

References: Hanson, 1926, p. 115A. Kindle, 1937*a*, pp. 46-49. Stevenson, 1943, p. 58.

The Cordillera property, owned by Usk Mining Company is near the base of Kitsalas Mountain about a mile southwest of Usk. The property has been inactive since 1930, and the charter of the company was cancelled in 1948.

The claims are underlain by chlorite schist and tuffs of the Hazelton group. Four veins are known and some gold, silver and copper has been produced. Assays of samples taken by Kindle are, however, low in gold and silver. Some of these samples contain scheelite[1].

Emma and IXL Claims (17)

References: Hanson, 1926, pp. 116A, 117A. Kindle, 1937*a*, pp. 44, 45. Stevenson, 1943, pp. 58, 59.

The Emma and IXL are reverted Crown-granted claims that are situated at the base of Bornite Mountain about a mile northeast of Usk.

The bedrock is andesitic lava of the Hazelton group. The Emma vein, which was explored by an adit, strikes north 75 degrees west and dips 25 to 40 degrees north. The vein varies from 1 foot to 6 feet in width, and has been traced for 250 feet, but in this distance is offset slightly by two faults. The vein quartz

[1] Kindle, E. D.: Geol. Surv., Canada, personal communication.

contains a little bornite, chalcopyrite, gold and silver. The IXL vein, which is about 1,000 feet east of the Emma vein, strikes north 60 degrees west and dips 65 degrees south, and is exposed for 100 feet across a maximum width of 7 feet. Locally the vein contains bornite and chalcopyrite. Two adits have been driven, but one has caved. Stevenson reports that J. Bell, of Usk, found scheelite in the veins on the Emma and IXL claims.

Ridge (18)

Reference: Stevenson, 1943, p. 59.

"J. Bell of Usk, the owner, reports scheelite in quartz veins on this property. The property is 4 miles north of Usk, at an elevation of about 3,000 feet on the ridge between Hardscrabble and Nicholson Creeks on the west side of the Skeena River."

Grotto Group (19)

References: Kindle, 1937*b*, pp. 38-40. Stevenson, 1943, p. 59.

The Grotto group, owned by G. Alger and associates of Usk, is on Hardscrabble Creek about a mile west of the railway. The property is underlain by andesite of the Hazelton group, intruded by dykes of diorite porphyry and a small body of quartz diorite. Three small veins have been developed by short adits. The veins contain pyrite, specularite, and chalcopyrite in a gangue of quartz. Specimens collected by Kindle contain a little scheelite[1].

Zona May Group (20)

References: Hanson, 1926, p. 112A. Kindle, 1937*b*, pp. 23-24. Stevenson, 1943, p. 59.

The Zona May group is on the east side of the south fork of Legate Creek, about 14 miles from Pacific. The country rock is volcanic breccia of the Hazelton group. A granodiorite stock lies a short distance southeast of the property. A quartz vein, from 2 to 10 feet wide, strikes south 60 degrees east and dips steeply south. It follows the north wall of a quartz porphyry dyke, 15 feet wide, and consists of quartz with secondary sericite and calcite. The vein was traced continuously for 125 feet across a bench, and can be seen beyond in the steep wall of a cirque. This vein outcrops again about 1,000 feet west, at the edge of a glacier, and Hanson reports that a vein appears on the other side of the glacier along the projected strike. A shoot 1 foot wide and 25 feet long within the vein carries 80 per cent sulphides, mainly galena, sphalerite and tetrahedrite, the whole cut by narrow veinlets of chalcopyrite. Elsewhere sulphides are scattered. Hanson reports scheelite locally, but none was found in specimens collected by Kindle.

[1] Kindle, E. D.: Geol. Surv., Canada, personal communication.

Hazelton-Telkwa Area

Rocher Déboulé Mine (21)

(Western Tungsten Copper Mines Limited)

by E. D. Kindle

References: Minister of Mines, B.C., Ann. Repts., 1911, p. 80; 1912, p. 113; 1913, p. 107; 1914, p. 185; 1915, p. 77; 1916, pp. 106-108; 1917, p. 101; 1918, p. 111; 1928, p. 158; 1929, p. 155; 1930, p. 138; 1950, p. 100. O'Neill, 1919, pp. 7-14. Kindle, 1940, pp. 50-54.

The Rocher Déboulé mine is on Rocher Déboulé Mountain near the head of Juniper Creek about 8 miles northeast of Skeena Crossing station. The property was acquired by Western Tungsten Copper Mines Limited in 1950. During 1951, the 1,200, 1,000 and 300 levels (*see* Figure 9) of the mine were rehabilitated. New mine buildings, bunkhouses, residences and a school were erected, a hydro plant of 1,600 H.P. was constructed and a mill rated at 200 tons per day capacity were built. The Delta Copper and Highland Bay groups of claims that adjoin the Rocher Déboulé ground on the east were acquired during the summer of 1951. The Victoria group, also company-owned, lies immediately north of the Rocher Déboulé group on the Skeena River slope of the mountain. The Red Rose tungsten mine, also operated by Western Tungsten Copper, lies 3 miles southeast of the Rocher Déboulé mine.

History and Production

The property, located by Munroe and Sargent, was transferred to Rocher Déboulé Copper Company, Limited, of Salt Lake City in 1911. During the next 2 years, the Nos. 2 and 4 veins were explored by an adit and copper ore was proven. In 1914, Montana Continental Development Company, of Butte, Montana, secured a 2-year lease on the deposit. A narrow gauge railway half a mile long, was installed at elevation 5,150 feet, from the portal of the 300-foot level to carry the ore across the mountain to an aerial tramway leading to the railway at Tramville. Ore from the No. 2 vein was hoisted up an inclined tramway from the portal of the lower adit (1,200-foot level) at elevation 4,167 feet to the ore bunkers at the 300-foot level. This tramline was rebuilt early in 1951. The former operators completed more than 2 miles of crosscuts and drifts, 2,200 feet of raises, and 330 feet of winzes.

In 1915, from May 17 to December 12, 17,000 tons of ore shipped to Granby smelter at Anyox, averaged 8 per cent copper, \$1.65 in gold, and 50 cents in silver to the ton. In 1916, mining was carried on by the Rocher Déboulé Mining Company, production being 16,800 tons of ore shipped containing 1,200 ounces of gold, 16,700 ounces of silver, and 1,619,145 pounds of copper. Smaller ore shipments were made the following 2 years, but in October 1918 all mining operations were suspended. From April 1915 until October 1918, the mine produced 39,833 tons of ore containing 4,214 ounces of gold, 62,865 ounces of silver, and 5,746,306 pounds of copper.

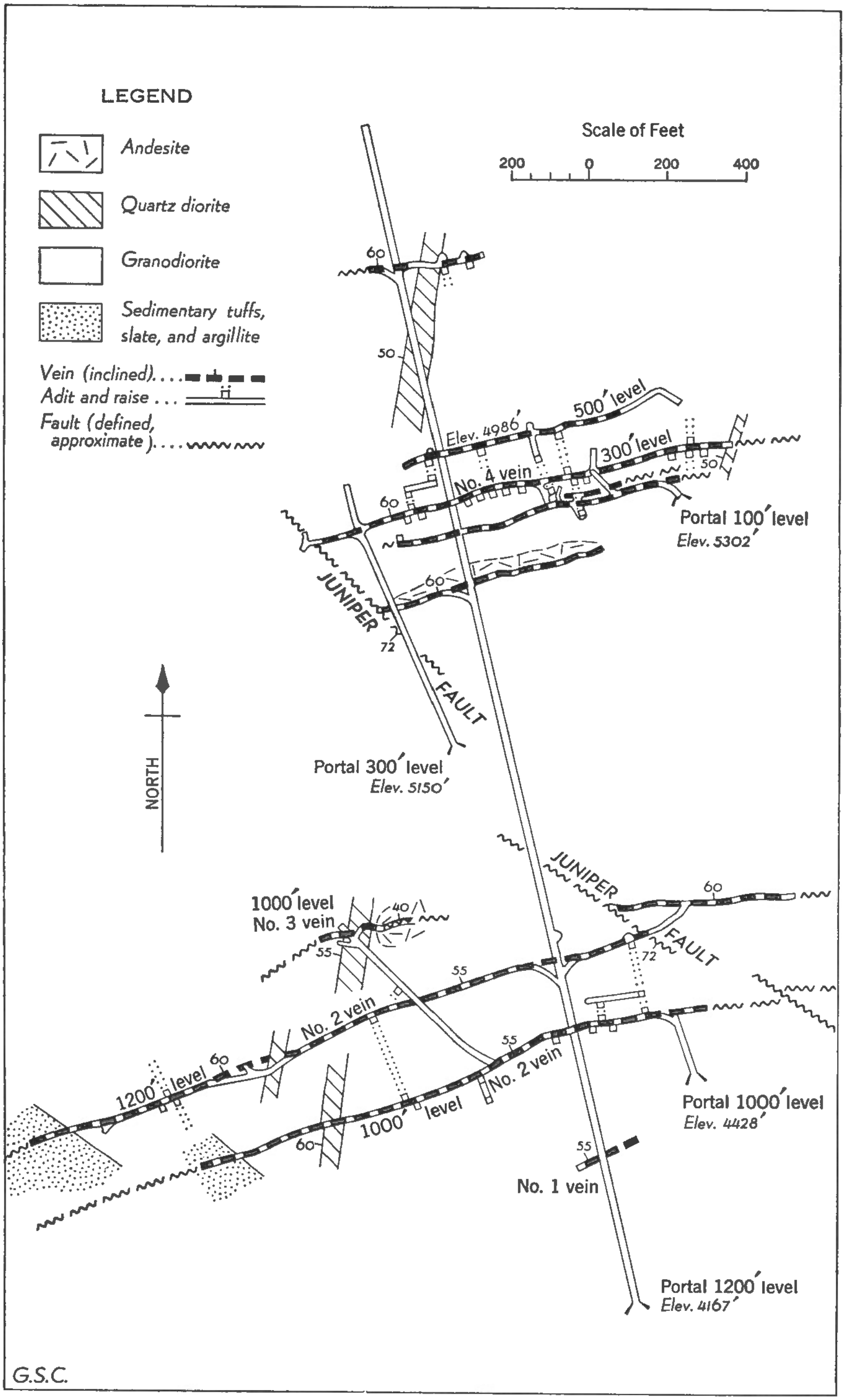


Figure 9. Composite plan of underground workings, Rocher Déboulé mine, Western Tungsten Copper Mines, Ltd., B.C. (From company plan, 1951.)

In 1929, Aurimont Mines, Limited, took an option on the property and shipped 72 tons of hand-sorted ore, which assayed: gold, 0.14 ounce a ton; silver, 40 ounces a ton; and copper, 4 per cent. Further work was done in 1930 by Hazelton Copper Mines, Limited, under the supervision of W. S. Harris.

Geology

The claims cover an area that includes the west contact of the granodiorite stock that forms the core of Rocher Déboulé Mountain. The granodiorite is a coarsely crystalline, mottled grey rock composed of 10 per cent orthoclase, 60 per cent andesine, 10 per cent quartz, 10 per cent biotite, and 10 per cent hornblende, with a little magnetite. The contact of the intrusion with sandstone, argillite, and tuff, runs northerly across the west part of the property. The granodiorite is traversed by four strong veins that are followed by the mine workings through a vertical range of 1,250 feet. The No. 2 vein on the lowest level (1,200-foot) has been drifted along for 2,100 feet, and the No. 4 vein for 1,100 feet on the 300-foot level. The latter has been traced at the surface an additional 1,200 feet easterly. The veins extend from the granodiorite into the adjacent sediments but only the No. 2 vein has been drifted along westerly into the sediments. The veins range from 1 foot to 8 feet in width. They strike easterly and dip from 35 to 65 degrees north into the mountain.

A fine-grained, grey, quartz diorite dyke 50 feet wide, that strikes a little east of north through the mine workings and dips 55 degrees northwest, is designated by the management, as the "Rocher Dyke". This dyke is offset a few feet where crossed by the veins, as on the 1,000-foot level where the apparent horizontal displacement is 6 feet. Roughly horizontal fault striations on the walls of the drift indicate that at least some movement along the fault planes was horizontal. Vein minerals are absent or scarce where the fissure is within this dyke and no ore is known where the Rocher Dyke forms the wall-rock. On the 300-foot level the east face of the drift is within the Rocher Dyke and ore shoots may be present along the fissure east of the dyke. An aplite dyke that lies along the south side of the No. 1 vein is also older than the fissure. The aplite adjacent to the vein carries a few bits of pyrite. On the 1,200-foot level a dyke of porphyritic andesite, from 8 to 15 feet wide, lies along or close to the north side of the No. 3 vein and this dyke is considered to be older than this vein.

General Character of Deposits

The veins are fissure fillings that formed along strong shear or fault zones. The deposits are unusual in that they are in part pegmatitic. The gangue is quartz, hornblende, actinolite and altered granodiorite. The gangue of No. 4 vein on the 1,200 level consists of quartz, hornblende, and plagioclase with some apatite. The apatite occurs as prismatic fibrous crystals of pale grey to greenish white some of which are up to $\frac{5}{8}$ inch in diameter and 6 inches long. Other gangue minerals include calcite, siderite, chlorite, titanite, tourmaline and rutile. Chalcopyrite is the most widely distributed ore mineral in the mine. Only high grade copper ore shoots were mined by the former operators. O'Neill (1919) states that in the upper part of the highest vein four bodies of high grade copper ore of irregular shape occurred at approximately the same elevation. These ore shoots were separated horizontally by 50 to 200 feet of material carrying only scattered chalcopyrite, or none at all. The copper ore contains in addition to chalcopyrite, variable amounts of magnetite, pyrrhotite, pyrite, scheelite, cobaltite, arsenopyrite, molybdenite, tetrahedrite, smaltite-chloanthite, glaucodot and some complex cobalt-nickel sulpharsenides. Some uraninite is also present. The minerals present suggest the veins formed at high temperature, and the presence of scheelite and cobaltite in increasing amounts westerly along the No. 2 vein towards the granodiorite contact with sedimentary rocks indicates zoning. This change of the proportion of different sulphides present is accompanied by a decrease in the amount of hornblende gangue and an increase in the proportion of vein quartz.

Veins of banded milky quartz containing small amounts of galena, sphalerite, tetrahedrite, pyrite, and chalcopyrite traverse the chalcopyrite-hornblende deposits or in some places, particularly along the easterly sectors of the No. 2 vein, lie along their hanging- or foot-wall side. The veins of milky quartz formed subsequent to a reopening of the copper-bearing fissures and are not known to contain hornblende, pyrrhotite and molybdenite, thus suggesting that the temperature at the time of deposition of these second-generation veins had decreased since the copper-hornblende bodies were deposited. The silver-lead-bearing veins of milky quartz are at most points less than half a foot wide but they may be several hundred feet long.

The ore shoots of No. 4 vein have a known vertical range of about 600 feet. Westerly dipping sedimentary rocks outcrop a short distance west of No. 4 vein and the projected easterly extension of these sediments would be only a few hundred feet above the outcrop of the vein. The known ore in No. 4 vein, therefore, occurs in the outer 1,500-foot-wide shell of the Rocher Déboulé batholith. After its consolidation, the outer part of the batholith apparently had a favourable influence on mineral deposition. The ore along No. 2 vein has a proven vertical range of over 500 feet and occurs in the granodiorite within 1,500 feet of its westerly dipping contact and within 1,500 feet below the projected position of overlying sediments at the time of ore deposition. Chances of finding ore at depth should be best near the granodiorite-sediment contact provided temperature was an important factor in mineral deposition. The formation of channels for the circulating of metal-bearing solutions through faulting and brecciation of the brittle granodiorite was widespread. The widest ore shoots up to 10 feet, are found where brecciation is the widest or where the main fault is joined by diverging shears. It is concluded that ore-finding chances along No. 1, No. 3 and No. 4 veins should improve as the outer or west contact of the granodiorite is approached. Chances of finding ore along No. 4 vein east of the "Rocher Dyke" are in part dependent on the assumed former position of the granodiorite-sediment contact and whether the contact places this sector within the 1,500-foot-thick outer zone of the batholith.

No. 4 vein is presently "lost" on the 300 level west of the Juniper fault (*see* Figure 9). This fault strikes northwesterly across the mine workings and dips 72 degrees southwest. Its presence is marked by about 2 feet of soft kaolinized fault gouge. On the 1,000 level, No. 2 vein was offset 100 feet north on the northeast side of the fault. No. 4 vein probably is offset in the same direction and a corresponding distance.

Occurrence of Tungsten

Scheelite is present in the west part of the No. 2 vein as white crystals, many of which are from 1 inch to 2 inches in diameter. On the 1,200 level, scheelite was noted in many places along the vein from 900 feet to 1,510 feet west of the main crosscut (face of drift is at 1,525 feet). On the 1,000 level, scheelite was seen 550 feet west of the crosscut entry and at intervals from there west to the face of the drift at 1,315 feet from the crosscut. The scheelite is unevenly distributed, occurring as local concentrations and streaks and constitutes up to 3 per cent of the vein matter. Such scheelite-rich shoots range from 5 to 50 feet long and from 6 inches to 24 inches wide; they are separated by vein material containing the average amount of copper and cobalt-bearing sulphides but in which scheelite is rarely seen. Some scheelite along the walls of the drift cannot be detected with the ultraviolet lamp because of a coating of mine dust that has accumulated over a period of 30 years. The scheelite nearly everywhere is in vein quartz or silicified granodiorite. The large euhedral crystals suggest a pegmatitic origin for the mineral. One scheelite crystal noted on the south wall of the 1,200 level, 1,100 feet west of the crosscut, measured 4 inches long and 2 inches wide. Before it was scraped clear of dust this crystal appeared under ultraviolet light as a spot only 1 inch in diameter. This occurrence emphasizes the need of cleaning the walls of the drift before estimating grade with an ultraviolet lamp. In general the scheelite-rich shoots are more plentiful near the granodiorite-sediment contact. Scheelite was deposited early in the sequence of vein minerals as is shown by the fact that it is fractured and some of the cracks are followed by veinlets of chalcopyrite and cobalt sulpharsenides.

A large solitary scheelite crystal was seen in the No. 3 vein on the 1,000 level. This is a quartz rich vein hence the percentage of scheelite may increase to the west towards the contact with sediments. Scheelite likewise might be found in No. 1 vein near the contact of the granodiorite and sediments. No scheelite was seen by the writer on the 300-level drift along the No. 4 vein. Scheelite does occur in the Delta East end workings farther east along the projected strike of this vein.

Occurrence of Cobalt

Small amounts of cobalt bloom colour the walls of the drifts along the No. 2 vein on both the 1,200 and 1,000 levels. This cobalt bloom is abundant west of the Rocher Dyke and decreases in amount in an easterly direction from this dyke. Westerly along the 1,000-level drift on No. 2 vein, bloom appears first 600 feet west of the crosscut and at intervals along the drift for 1,300 feet west from the crosscut, or to within 15 feet of the face of the drift. The amount of bloom increases towards the contact of the granodiorite with sediments at a point 1,225 feet west of the crosscut. For 70 feet west from this contact, a width of 6 to 15 inches of vein quartz carries abundant chalcopyrite and cobaltite and there the pink cobalt bloom is particularly well developed. At the face 20 feet farther west, the deposit consists of 4 inches of fault gouge containing only a small amount of sulphides. A channel sample taken across 12 inches of the vein 15 feet west of the contact, assayed: gold, 0.26 ounce a ton; silver, 2.25 ounces a ton; copper, 11.39 per cent; cobalt, 1.01 per cent; nickel, 0.02 per cent. A 14-inch long channel sample across the vein on the 1,200 level from a point 40 feet west of the Rocher Dyke, assayed: gold, 2.36 ounces per ton; copper, 0.37 per cent; tungsten trioxide, 0.38 per cent; cobalt, 2.30 per cent. At the point of sampling, a seam of solid cobaltite and other sulphides an inch wide follows the hanging-wall side of the deposit. The assay suggests that the gold content is unusually high where cobalt-bearing minerals are plentiful. Where sampled the vein also contains an $\frac{1}{8}$-inch-thick seam of uranium oxide that fluoresces yellow under the ultraviolet lamp in contrast to the blue-white of scheelite.

Glaucodot, the cobalt-iron arsenic sulphide, is more plentiful than cobaltite in the hornblende-chalcopyrite ore of No. 4 vein, but judging from the cobalt bloom showing there, the cobalt minerals constitute only a fraction of one per cent of the vein matter.

The cobalt-bearing minerals presumably will be recovered with chalcopyrite and, if so, cobalt must be separated from the matte by a chemical process. The average cobalt content of the No. 2 and No. 4 veins is estimated to be less than 0.5 per cent, but even this price of over $1.20 per pound, as in 1952, warrants its recovery as a by-product.

Uranite Occurrence

All the veins in the Rocher Déboulé mine are radioactive to some extent. No. 4 vein at the intersection of the main crosscut, gave a high count but a sample returned only 0.022 per cent uranium oxide equivalent. Bulk samples might give satisfactory indications of the average U_3O_8 content, but the data from 26 samples of the veins now exposed indicate only a low radioactive content. A thin section of a chip from a sample of the No. 4 vein shows a few minute, black, octahedral crystals of uraninite in the quartz, and altered hornblende and cobaltite.

Red Rose Mine (22)

by E. D. Kindle

References: Minister of Mines, B.C., Ann. Repts., 1914, p. 190; 1916, p. 113; 1926, p. 126; 1942, p. 78; 1943, p. 78. O'Neill, 1919, p. 18. Hurst, 1925. *Can. Inst. Min. and Met.*, Jubilee Volume, 1948, p. 129. Stevenson, 1943, pp. 60-66.

The Red Rose tungsten mine is in the Rocher Déboulé mountains on the north side of Balsam Creek, 8 miles east of Skeena Crossing railway station.

A good truck road extends from Skeena Crossing (altitude 650 feet) to the Red Rose mill (altitude 4,100 feet). The mine workings are situated near the mountain-top, between 5,500 and 6,300 feet above sea-level. The mine is serviced by a switch back tractor road, about 2 miles long, and ore is delivered to the mill by way of a mile-long aerial tramway.

History and Development

Western Tungsten Copper Mines Limited, leased the Red Rose tungsten mine early in 1951 from the Consolidated Mining and Smelting Company of Canada, Limited. The adits and drifts were cleaned out and reconditioned, camps were rebuilt, a new aerial tramline constructed, and a mill of 150 tons rated daily capacity was built. An initial shipment of 7 tons of tungsten concentrate was made in January, 1952.

This property was staked by C. Peterson and C. Ek about 1912. In 1914, a syndicate, headed by T. J. Vaughan-Rhys, secured an option and drove two adit drifts, at elevations of 5,450 and 5,690 feet, on a sheared zone that contains a little gold, silver and copper. At elevation 5,150 feet a crosscut-adit was driven 430 feet to intercept the downward continuation of the sheared zone, but it was not cut. In 1916 the Skeena Development Company continued the exploration extending the adit at elevation 5,450 feet to a length of 250 feet, and the upper adit to a length of 160 feet along the sheared zone. Later the owners, Messrs. Peterson and Ek, stripped a nearby large quartz vein and found tungsten. This tungsten-bearing quartz vein outcrops immediately above the sheared zone at an elevation of 6,000 feet, and continues up and along the shoulder of the mountain for 300 feet to elevation 6,300 feet, thence down beneath a covering of talus into the valley of Armagosa Creek which lies half a mile north of Balsam Creek. In 1940, the wartime demand for tungsten spurred the Consolidated Mining and Smelting Company of Canada to drill this tungsten-bearing vein. Drilling results were not encouraging, but the underground work, started in June 1941, disclosed a substantial tonnage of high-grade scheelite ore. Milling commenced in January 1942 and by the autumn of 1943, some 1,194,000 pounds of tungsten concentrate had been recovered. The mining ceased in November 1943 because of orders from the Metals Controller that no more shipments would be permitted.

The following table lists the mine levels and amount of drifting completed on each (August, 1951):

Level No.	Elevation	Length of Drift	Depth from Surface
	Feet	Feet	Feet
150	6236	330	50+
350	6130	480	156
600	5920	480	366
800	5660 (started 1951)	40	626

Geology and Character of Deposit

The tungsten-bearing vein starts in a fissured zone within a diorite stock and continues along the contact of the diorite and older sediments. The latter consist of hornfels, argillite, quartzite and greywacke. The diorite is fine grained and grey and probably represents a cupola of the granodiorite stock that forms the core of Rocher Déboulé mountain. The vein strikes north 45 degrees west and dips between 40 and 75 degrees southwest. The deposit is from 2 to 12 feet wide and consists of quartz, schistose diorite and altered sheared sediments. Scheelite occurs as individual crystals and as veinlets and bands, both in the quartz and in the sheared diorite. The scheelite is white, and can be recognized as such only with the ultraviolet lamp. Small amounts of ferberite, pyrite, magnetite and chalcopyrite are present. In some places the vein contains a little orthoclase, apatite, biotite and tourmaline. Where the walls of the vein are altered sediment, pyrrhotite was deposited with little or no associated scheelite. A dyke of diorite porphyry intrudes the diorite along the workings on the south slope of the mountain and forms the hanging-wall of the vein in the upper adit driven at elevation 5,690 feet in 1914. Scheelite is not known to be present in this adit because the portal is caved to prevent entry. The portal of the next lower adit, at elevation 5,450, also is caved out. This adit was examined in 1938 by the writer and follows a sheared zone along an irregular contact between fine-grained grey diorite and argillite. The shear consists of soft rusty pulverized rock leached of most of its sulphide content. This shear zone is the same one containing the tungsten-bearing vein outcropping at 6,000 feet elevation. Conditions are considered to be more favourable for ore farther north along the projected strike of the drift at elevation 5,450 feet, provided diorite is present. The highest known scheelite content is in the vein where it cuts diorite.

Size and Grade

The scheelite ore above the No. 150 level was stoped by the Consolidated Mining and Smelting Company in 1943 except for a small tonnage at the south end of the drift. At the southeast face the vein is 6 inches wide and contains up to 20 per cent scheelite. A local concentration of magnetite with some pyrite occurs north of the winze on the 150-foot level. A radioactive test made on a sample of the black, fine-grained magnetite showed a 0.009 per cent U_3O_8 equivalent.

On the No. 350 level, north end, a stope about 150 feet long and up one round, exposed a vein from 5 to 8 feet wide estimated to carry between 5 and 15 per cent of scheelite. The grey diorite is sheared to biotite schist. Near the southeast face of the drift, the shear branches. The main vein is 5 feet wide and is separated by 4 feet of schist from an 8-inch vein of quartz and scheelite in diorite.

On the No. 600 level the vein ranges from 2 to 12 feet wide and contains up to 20 per cent of scheelite in places across widths of 4 or 5 feet. The scheelite is present in thin bands of irregular shape and size and some of the bands of massive scheelite are up to 3 inches thick. Small branching veinlets of quartz and scheelite follow joints in the diorite at right angles to the main vein. At the southeast face of the drift, the vein is 24 inches wide and is estimated to contain 1 per cent of scheelite. At the northwest face, the vein is enclosed in hornfels and contains an abundance of pyrrhotite, but little scheelite.

Drifting on the No. 800 level commenced in August 1951 and had advanced 40 feet in September 1951. On this level the vein is within hardened sedimentary rocks and near the intersection of the drift and crosscut the scheelite content is low. If diorite is encountered to the southeast the scheelite content will increase, provided conditions are similar to those on the No. 600 level.

A sample, representative of a 4-foot vertical section of the old tailings pile, was collected by the writer 50 feet below the head of the tailings pile. This sample contained 0.16 per cent tungsten trioxide. Tested for radioactivity, the sample showed a U_3O_8 equivalent content of 0.006 per cent.

Black Prince Property (23)

by E. D. Kindle

References: Minister of Mines, B.C., Ann. Repts., 1913, p. 107; 1914, p. 205; 1916, p. 117; 1918, p. 113. Stevenson, 1943, pp. 67-70. O'Neill, 1919, p. 25. Hurst, 1925. Stevenson, 1943, pp. 67-70.

The Black Prince prospect is on Rocher Déboulé Mountain 6 miles south of New Hazelton. A branch road, 1 mile in length, leaves the highway about 6 miles southeast of New Hazelton and runs southwest to the foot of the mountain from where a pack-horse trail, 5 miles long, follows the north side of Mudflat Creek Valley to the prospect. The cabin is on a flat bench at elevation 4,150 feet between two small cirque-lakes and the workings are less than half a mile south on a steep shoulder of the mountain. The property consists of eight claims that are currently recorded as the Erikson group. Mrs. B. Sargent of New Hazelton is the owner.

Geology and Character of Deposit

A sheared zone containing tungsten- and molybdenum-bearing minerals occurs in the granodiorite about 1,500 feet southwest of the contact of the Rocher Déboulé granodiorite stock and sedimentary rocks to the east. The sheared zone strikes north 30 degrees west and dips from 50 to 70 degrees southwest. It is from 1 foot to 8 feet wide and is cut by from one to four parallel quartz veins ranging from 2 to 18 inches wide. The quartz veins and the sheared and altered granodiorite contain variable amounts of scheelite, pyrite, chalcopyrite, molybdenite, wolframite and ferberite.

The shear extends up steep rock bluffs (45 degree slope) between elevations of 4,650 and 5,000 feet. Below 4,650 feet talus is widespread but a narrow quartz vein, exposed by stripping, between altitudes of 4,500 and 4,550 feet may represent a downward extension of the sheared zone. Above 5,000 feet the shear follows fairly level ground for 500 feet. In this area the first 100 feet of vein is exposed by open-cuts but for the remaining 400 feet is covered by drift. The drift ends against a steep, granodiorite bluff and the sheared zone cannot be reached for examination above an elevation of 5,100 feet. The indicated overall length is 900 to 1,000 feet and the vertical range over 600 feet.

In a rock-cut at elevation 4,700 feet, the sheared zone is from 1 foot to 3 feet wide. It is rust stained, and, across 6 inches of the hanging-wall, is impregnated with pyrite and a little molybdenite and scheelite.

At elevation 4,900 an adit follows 35 feet along the sheared zone. This was driven by Frank Meryth for Privateer Mining Company in 1944. A channel sample taken by the writer, across 12 inches of vein at the face of the adit, assayed: tungsten trioxide, 0.38 per cent; molybdenum, 0.14 per cent; gold, 0.02 ounce per ton; and tin, none. The walls of the adit are dust-covered so that an estimate of the scheelite present could not be made with the ultraviolet lamp.

In a large open-cut at elevation 4,950 feet the sheared zone is about 6 feet wide. From east to west it consists of: 6 inches of sheared granodiorite replaced by quartz, the whole carrying from 1 to 2 per cent of scheelite, 48 inches of altered granodiorite; 12 inches of sheared granodiorite replaced by honeycomb quartz and containing pyrite, scheelite and ferberite; a 20-inch-wide porphyritic diorite dyke that pinches out at the top of the cut; and a 4-inch-wide vein containing a little pyrite and chalcopyrite. Sericite flakes up to an inch long, occur locally along the hanging-wall side of the 4-inch-wide vein. Several scheelite crystals, an inch in diameter, and a nodule of intergrown wolframite and scheelite, 2 inches in diameter, were found in the cellular quartz near the floor-level of the open-cut in 1938.

Description of Veins

In a 12-foot-long open-cut at the top of the rock bluffs, at elevation 5,000 feet, a vein 12 to 18 inches wide of sugary leached quartz contains a little molybdenite, chalcopyrite, pyrite, scheelite and ferberite. Most of the scheelite is within a 4-inch-wide zone along the foot-wall at the south end of the cut. A channel sample taken across 12 inches of the vein at the south end of the cut, assayed: tungsten trioxide, 0.38 per cent; molybdenum, 0.11 per cent; tin, none; and gold, 0.005 ounce per ton.

About 500 feet farther south on the face of the steep granodiorite bluff two parallel quartz veins about 6 feet apart follow the sheared zone. The hanging-wall vein ranges from 12 to 16 inches wide at elevation 5,100 feet, and the quartz vein on the foot-wall side is only a few inches wide. Both quartz veins contain scheelite, some pyrite and a little molybdenite. In the wider quartz vein the scheelite is concentrated along or near the foot-wall. The scheelite is white and occurs in grains up to an inch long. A channel sample 14 inches long and taken across the larger quartz vein, assayed: tungsten trioxide, 0.34 per cent; molybdenum, 0.21 per cent; and gold 0.035 ounce per ton.

A block of vein quartz 10 inches thick, that has fallen down from higher up the slope, is estimated to contain about 3 per cent of scheelite.

Another vein outcrops between the 4,300- and 4,400-foot contours about 1,500 feet south of the cabin. At elevation 4,300 feet, an adit was driven about

40 years ago for 110 feet southeast along this vein. The vein strikes south 30 degrees east and dips 65 degrees southwest and is exposed continuously in the adit. It is a quartz vein ranging from 2 to 10 inches wide. The quartz fills a narrow fault zone in the granodiorite and contains chalcopyrite, pyrite, and scheelite and also some cassiterite and uraninite. The chalcopyrite is plentiful where the vein is widest and scheelite is estimated to comprise 2 to 3 per cent of the vein throughout the length of the adit. Only a 12-foot-long area of the vein, beginning 10 feet from the portal, contains enough uraninite to affect the Geiger counter. A sample taken across the 3 inch-wide vein at a point 18 feet from the portal, assayed: tungsten trioxide, 2.37 per cent; tin, 0.8 per cent; gold, 0.03 ounce per ton; and U_3O_8 equivalent, 0.039 per cent. A sample collected in the adit 88 feet from the portal where the vein is 4 inches wide, assayed: tungsten trioxide, 1.10 per cent; tin, 1.3 per cent; gold, 0.155 ounce per ton; U_3O_8 equivalent, 0.005 per cent.

According to the Minister of Mines, B.C. for 1916 in the report of Galloway, an open-cut 100 feet above the adit exposes a 4-foot-wide vein slightly mineralized throughout, and with 10 inches of well-mineralized vein matter on the foot-wall. A sample collected by Galloway across the 10 inch zone, assayed: gold, 0.14 ounce per ton; silver, 2 ounces per ton; copper, 11.2 per cent. Galloway was doubtful if the adit and open-cut were made on the same deposit and no additional evidence on this problem is available.

Blue Lake Group (24)

by E. D. Kindle

The Blue Lake group of ten claims is on the east slope of Rocher Déboulé Mountain, about 7 miles south of New Hazelton station. The property is reached by way of a mile-long branch road that leaves the highway 5 miles southeast of New Hazelton, thence by 5 miles of pack-horse trail that follows the north side of Mudflat Creek to the Black Prince camp, at elevation 4,150 feet. The claims are owned by Louis A. Parent of New Hazelton and O. L. Skogland of Zeballos.

Two veins, slightly over 100 feet apart, are exposed in the wall of a steep granodiorite bluff between elevations 5,450 and 5,600 feet, at the head of a mountain valley a mile southwest of the Black Prince works (*see* page 54). The east, or No. 1, vein strikes north 75 degrees west and dips 65 degrees northeast. At the foot of the steep rock face, the vein consists largely of white milky quartz, from 4 to 10 inches wide, and this quartz is estimated to contain up to 10 per cent of tetrahedrite and less than 1 per cent chalcopyrite. The No. 2 vein is exposed for 150 feet up the bluffs and at intervals for about 500 feet south from the top of the bluffs along the top of the mountain. This vein strikes north 15 to 35 degrees west and dips at about 70 degrees to the southwest. Along the bluff No. 2 vein ranges from 1 foot to 3 feet wide and consists largely of sheared granodiorite and vein quartz that carries small amounts of molybdenite. On the steep slope the vein could not be reached to test for scheelite with an ultraviolet lamp. On the more gently sloping ground about 50 feet south of the top of the bluff, a shallow trench at elevation 5,600 feet, disclosed a 5-foot width of vein carrying scheelite, molybdenite and chalcopyrite. Farther south and at elevation 5,525 feet the vein is very well exposed for 100 feet on the strike. There, the deposit ranges from 6 to 14 inches wide, is composed largely of quartz and in most places is estimated to carry from 0.25 to 2.0 per cent of scheelite with roughly equal amounts of molybdenite and a little chalcopyrite. The scheelite is white and occurs as crystals, most of them less than ½ inch in diameter and many only ⅛ inch in diameter. Much of the scheelite is concentrated along one or more dark bands in the quartz. These dark bands are about an inch wide and represent a series of planes along which fault movement occurred parallel with the strike and dip of the vein. Some open cavities present in the dark bands are lined with small euhedral quartz and scheelite crystals. The dark colour probably is due to the presence of many minute, chloritized, hornblende crystals. A hand specimen typical of the vein material from the south part of this vein exposure assayed: molybdenum 0.85 per cent; tungsten trioxide, 1.00 per cent; and gold, a trace. The U_3O_8 equivalent is 0.004 per cent. Along the projected strike, approximately 300 feet south of the foregoing locality, a small outcrop of bedrock is cut by a hornblendite dyke, within which the vein is only 2 inches wide and carries crystals of white scheelite along a central fracture.

The No. 2 vein is in the Rocher Déboulé granodiorite but at elevation 5,525 feet lies 6 feet southwest of a 25-foot-wide dyke of feldspar porphyry. A 2-inch-wide stringer of quartz on the southwest wall of the dyke appears barren.

A third or No. 3 vein is exposed at a point about 2,000 feet northwest from No. 2, and at an elevation of 5,800 feet. This vein strikes north 15 degrees west and dips 75 degrees southwest and into the mountains. At an exposure in a rock trench at the top of a steep granodiorite bluff the vein consists of about 1 foot of vein quartz and 1 foot of sheared granodiorite separated by a trap dyke from 18 to 24 inches wide. The quartz is in part honeycombed and contains an abundance of scheelite, and a little molybdenite and chalcopyrite. The sheared granodiorite on the hanging-wall contains small amounts of scheelite, and in one place a little scheelite was seen over a width of 2 inches in the altered trap on the foot-wall side of the dyke. A hand specimen of the typical vein quartz collected by the writer from the hanging-wall, assayed: gold, 0.08 ounce per ton; tungsten trioxide, 11.31 per cent; and molybdenum, 0.06 per cent. A radioactive test made on the hand specimen prior to grinding, gave 0.004 per cent U_3O_8 equivalent. Pockets of dark coloured altered hornblende and chlorite occur in the vein and in some places these contain a little scheelite, and ferberite. A hand specimen of this dark material assayed: tungsten trioxide, 0.46 per cent; molybdenum, 0.21 per cent; manganese, none; iron, 19.48 per cent. A radioactive test of the specimen gave 0.002 per cent U_3O_8 equivalent.

Freshly broken surfaces of quartz from the hanging-wall show crystals of white scheelite up to 1 inch or more long. On weathered surfaces, however, some of the scheelite crystals display under ultraviolet light a yellow to yellowish green hue from the alteration products, tungstite and meymacite.

O. L. Skogland advises that another parallel tungsten-bearing vein was found late in the summer of 1951. This is reported as 200 feet above and about parallel with No. 3 vein. Skogland collected a sample across 15 inches of this vein and this sample assayed 5.5 per cent tungsten trioxide. A molybdenum-bearing vein is reported to occur another 100 feet higher on the mountain.

Another vein is exposed on a bluff and about 300 feet below No. 3 deposit. Skogland reports this vein is exposed for 75 feet on the strike across a width of from 5 to 10 feet. The strike is northwest and dips northeast about 60 degrees. He describes this deposit as composed mostly of a mixture of fine-textured milky white quartz with some granodiorite, the quartz containing small specks and streaks of grey copper (tetrahedrite). Skogland collected a representative sample and this assayed: gold, 0.02 ounce per ton; and silver, 55.4 ounces per ton.

Higgins (Haegan) Property (25)

References: Kindle, 1940, pp. 22, 23. Stevenson, 1943, p. 71.

The Higgins property is on the north slope of Netalzul Mountain at 4,500 to 6,000 feet elevation, 32½ miles east by trail from Hazelton. The showings occur within 500 feet of each other and on both sides of the contact of a granodiorite stock with sedimentary rocks of the Hazelton group. A small sulphide vein and several quartz veins are exposed.

One quartz vein in the granodiorite is 4 feet wide and has been traced for 100 feet. Sphalerite, galena, tetrahedrite, pyrite, and chalcopyrite are distributed erratically.

Down the slope 600 feet another quartz vein containing some sulphides strikes north 20 degrees east and dips 60 degrees east. It occurs in granodiorite, is 2 to 7 feet wide and is known to extend more than 2,000 feet, along the strike. A specimen collected by Kindle from this vein, contains some scheelite.

Whitewater Group (26)

References: Stevenson, 1943, pp. 71-73. Armstrong, 1944.

The Whitewater group of four claims was staked in 1942 by T. Blythman and J. Wilson of Telkwa. The property is on Silver Creek, near the headwaters of Telkwa River, about 40 miles west of Telkwa, from which it can be reached by 5 miles of road and 35 miles of pack-trail.

The bedrock is granite, in which a quartz vein 3 inches to 3 feet wide is exposed for about 350 feet. This vein strikes north 25 degrees east and dips 25 degrees southwest. Scheelite occurs only in small quantities except in a 10-foot adit that follows two lenses of quartz branching from the main vein to form an ore shoot 4 feet long and 4 feet down the dip. The assays of five samples from this ore shoot varied from a trace to 0.50 ounce in gold, *nil* to 2.3 ounces in silver, 0.1 to 5.6 per cent in lead, 0.9 to 20.2 per cent in zinc, and 5.85 to 20.28 per cent in WO_3. Stevenson recommended the locality as favourable for further prospecting.

Mohawk Mine

Stevenson (1943, p. 71), quoting Jolliffe, reported tungsten from this property on Four Mile Mountain, 5 miles east of Hazelton. E. D. Kindle of the Geological Survey of Canada subsequently examined the workings and found that a fluorescing mineral, willemite, occurs in the veins. (Personal communication.)

Deer Horn Mines, Limited (27)

by S. Duffell

In 1951 Deer Horn Mines, Limited, purchased the Harrison group of twenty-eight claims and one fraction on the south slope of Lindquist Mountain at the head of Whitesail Lake. The claims are best known for their possibilities as a gold property but they also contain a scheelite deposit of some promise.

Burns Lake on the Jasper-Prince Rupert line of the Canadian National Railways is the nearest rail centre. From Burns Lake the property is reached by road to Ootsa Lake thence by boat to the head of Whitesail Lake, from where a steep but good trail, 5 miles long, leads to the showings on Lindquist Mountain.

The gold deposit is in a wide, nearly horizontal quartz vein, that was explored by diamond drilling during 1945 and 1946 by Pioneer Gold Mines Limited. Scheelite, though not common, was noted in the core. The main scheelite deposit, however, is separate from this gold occurrence and lies 800 to 1,000 feet west of the most westerly pit exposing the gold-bearing vein. The scheelite deposit extends in a northwesterly direction for about a claim's length.

The claims lie astride the contact between the main mass of Coast Intrusions on the west, which here consist of granite, quartz diorite, and diorite; and metamorphosed tuff, greywacke, shale, slate and lava flows of the Hazelton group on the east. The shale and slate contain andalusite. Epidote, chlorite, zoisite are common in the volcanic rocks and silicification is widespread. Skarn is present in minor amounts, but none was noted in the vicinity of the scheelite showing. There epidote, chlorite and quartz are characteristic of the volcanic rocks and andalusite is characteristic of the slate.

At the scheelite deposit the strike of the batholithic contact turns sharply from west to north thus forming a small embayment of the Hazelton group rocks. The general effect of contact action on the sedimentary and volcanic rocks in this embayment is more marked than elsewhere in the vicinity. The volcanic rocks particularly appear to have been minutely fractured and in this zone a stockwork of quartz stringers that carry scheelite was formed. The stringers vary in width from a fraction of an inch to 4 inches but they are commonly 1 inch to 2 inches wide. Approximately 500 feet east of the main showing volcanic rocks, at one point, are cut by numerous stringers of quartz containing small amounts of scheelite, commonly along their borders. Two veins, up to 2 feet wide, that also cut the volcanic rocks at this point contain no scheelite. Assays of samples proved the average scheelite content of this occurrence to be much lower than that of the main deposit. In addition to scheelite and quartz only a few grains of pyrite and chalcopyrite were noted in the country rock and quartz stringers.

Although scheelite is present in all rocks it occurs most commonly where quartz stringers are plentiful. In diorite the scheelite is in a finely disseminated state whereas in volcanic rocks well-formed crystals up to 1½ inches long occur. The scheelite-bearing outcrops are mainly above timber-line and at most points are covered by talus that contains scheelite, to give a spectacular appearance under ultraviolet light at night. Little development work has been done so that the full extent and mode of occurrence of the deposit are unknown.

The main showing lies under a large talus deposit along the boundary between the Harrison No. 1 and No. 2 claims. In 1952, Deer Horn Mines under the field direction of Jack Ross, outlined the scheelite-bearing area of this talus and systematically sampled it. The open-cut was made at one point where the bedrock came close to the surface. The cut is 130 feet long and both ends of it are within scheelite-bearing talus. The known area of scheelite-bearing talus has a slope length of 1,590 feet and a width of 172.6 feet. For each 1-foot depth this area is estimated to contain 21,100 tons of scheelite-bearing talus. This scheelite-bearing talus area for the purpose of estimating grade and tonnage was divided into forty-eight rectangular sections each 50 feet wide but of varying length. The weighted average assay of grab samples from the rectangular areas gave 0.34 per cent WO_3. Samples of bedrock from the 130-foot cut averaged 0.84 per cent WO_3 across 60 feet at the west end and 1.55 per cent across 70 feet at the east end. As scheelite-bearing talus occurs for 800 feet on the slope above the trench, the probable size of the source body of the scheelite-bearing blocks in this vicinity is considerable. No diamond drilling or additional trenching has been done, but the chance to prove a substantial body of tungsten ore at this locality appears promising.

Silver Cup (28)

Reference: Stevenson, 1943, p. 73.

"The owner, Mathew Sam, of Topley, has found scheelite in quartz veins in the underground workings on this property on Friday Creek, about 7 miles northerly from Topley Station."

Fort St. James Area

Chuchi Lake Occurrence (29)

Reference: Armstrong, 1949, pp. 134, 193.

"The Chuchi tungsten showing is 9 miles south of the east end of Chuchi Lake, at the contact of a small granitic stock with andesite of the Takla group. The deposit consists of scheelite, powellite, molybdenite and chalcopyrite disseminated through a fracture zone at least 12 feet wide in silicified andesite at the granitic contact. Two grab samples assayed: 0.75 per cent WO_3; 0.015 per cent MoS_2; a trace of gold; and 0.70 ounce of silver a ton."

Parsnip River Area

Fox Pass Occurrence (30)

In a letter dated April 5, 1951, Andrew Jenson of St. Boniface, Man., reports scheelite in a specimen of sulphide ore he obtained from Fox Pass, 18 miles north-northwest of the mouth of Fox River. The country rock, according to Jenson, is mainly flat-lying garnetiferous gneiss, with some limestone and dykes of granite. Veins of quartz and possibly calcite are numerous. Some of the gneissic bands contain pyrrhotite, pyrite, chalcopyrite, scheelite and molybdenite.

North Fraser River Area

Ada Claim (31)

References: Minister of Mines, B.C., Ann. Repts., 1920, pp. 106, 107; 1922, p. 122; 1925, p. 448; 1926, p. 166; 1928, pp. 191, 192; 1935, pp. C30-C32; 1942, p. 56. Stevenson, 1941, pp. 51-53; 1943, pp. 74-76. Reinecke, 1920, pp. 106, 107.

The Ada claim is on the north side of Fraser River, at the sharp bend 28 miles northeast of Prince George. It was located by Oscar Eden of Prince George, and was developed by the North Point Mining Company of which he was president. The claim was Crown-granted in 1925, and three years later was acquired by Canadian Mining Company, Limited, as a scheelite prospect, but no development work was done. In 1942, Pioneer Gold Mines, Limited, optioned the property and extended the drift 50 feet, on the main vein in the lower workings.

The claim is underlain by quartz-mica schist, probably of late Precambrian age. Two quartz veins, 3½ to 4 feet wide respectively, striking north 57 degrees west and dipping 60 degrees southwest, are parallel with the schistosity of the host rock and contain pyrite, galena, and scheelite. These veins were explored by a shaft 15 feet deep and a drift 30 feet long now inaccessible. Some 210 feet lower in elevation and about 100 feet above the river, an adit has been driven north 48 degrees west. A small quartz vein was encountered 360 feet from the portal, and the main vein was reached at 690 feet. From this point, a drift was driven 85 feet southeast. Samples taken in 1928 and 1935 from the start of the drift assayed 2.5 and 4.05 per cent WO_3 respectively, with a trace of gold and silver. Farther southeast on the drift scheelite is present in short, narrow lenticular areas.

Silver Group (32)

References: Minister of Mines, B.C., Ann. Repts., 1922, p. 123; 1928, p. 192; 1935, pp. C31, C32. Stevenson, 1941, pp. 51-53; 1943, pp. 76-77.

The Silver group of seven claims is owned by Fred Peterson of Prince George, and was developed by the Granite Mining Company. It is 1 mile north of the mouth of Averil Creek that flows into Fraser River about 29 miles northeast of Prince George. The rock underlying the property is quartz-mica schist, probably of late Precambrian age. The schistosity strikes north 52 to 77 degrees west, and dips steeply southwest. Several quartz veins that are concordant with the planes of schistosity are known. Of these, one is up to 10½ feet wide and has been traced for 335 feet. An adit, 203½ feet long, follows the hanging-wall of this vein. The deposit consists of lenticular quartz masses in a shear zone. The quartz contains a little pyrite, galena and sphalerite, and graphite is abundant. Scheelite was observed at only one point in the outcrop, and not at all along the adit.

Cariboo Area

Hardscrabble Creek Property (Columbia Tungstens Company, Limited) (33)

From a report by W. E. Cockfield, (Field Investigation, 1941)

References: Minister of Mines, B.C., Ann. Repts., 1904, p. G49; 1917, p. 131; 1918, pp. 135, 136; 1922, p. 117; 1927, p. 171; 1928, p. 195; 1935, p. C40; 1936, p. C38; 1937, p. C34; 1938, p. C49; 1939, p. 101; 1940, p. 86; 1941, p. A81. Bureau of Mines, 1935, p. 224. Johnson and Uglow, 1926, pp. 210, 211; 1933, pp. 55, 56 AI. Uglow, 1923, pp. 86A, 87A. Walker, 1909, pp. 40-42. Lang, 1938. Davis, 1937.

Introduction

The Hardscrabble deposit has been developed because of its tungsten content. In the course of development several small but rich gold-bearing veins were encountered, but no attempt has been made to mine these. A small tonnage of scheelite ore has been found by means of considerable development work and an output of about 4 tons of scheelite concentrate is stated to have been made. Most of the ore was obtained above No. 3 level. An ore shoot has been developed on No. 4 level and ore has also been indicated by diamond drill-holes beyond the limits of the present slope on No. 4 level. The plan in 1941 was to mine the known ore and abandon the operation.

The scheelite occurs in stringers of quartz and carbonate cutting schist of the Cariboo series. Pyrite, galena and sphalerite also occur. The gold-bearing veins are not known to contain scheelite.

Location

The property of Columbia Tungstens Company Limited is situated on Hardscrabble Creek about one-half mile above its junction with Willow River, in the Cariboo Mining District, British Columbia. The shaft is about 5 miles from Wells, a local distributing centre. The scheelite concentrate was shipped by truck to Prince George, B.C., thence by Canadian National railways.

History and Production

Scheelite is stated to have been found in placer concentrate from Hardscrabble Creek in 1904 by W. C. Fry. The source, however, was soon discovered and, between 1904 and 1908, a drift was run 50 feet to explore the occurrence. This drift was just below the surface of bedrock. Between 1908 and 1917, little work appears to have been done. In 1917 the shaft and drift were cleaned out by J. A. Macpherson, of Stanley, B.C. and associates. In 1918, Galloway described the drift as extending northerly 153 feet from the shaft and in addition a winze 20 feet deep and from it a drift to the east for 49 feet. In succeeding years the property reverted to the Crown. In 1927, C. J. Seymour Baker leased the ground, repaired the shaft, and extracted 400 pounds of ore for testing. Nothing further was done until 1935 when the property was taken over by Columbia Tungstens Company Limited. This company shipped a sample of ore to the Ore Testing Laboratories of the Department of Mines, Ottawa, and by 1937 had completed a 50-ton rated daily capacity mill designed on the basis of the result of that test. In the meantime, a working shaft had been sunk and a second level started. About 100 tons of ore was mined and about 1½ tons of scheelite concentrate produced. In May, 1938, the mill and power-house were destroyed by fire. Up until then, 4 tons of concentrate had been shipped and this assayed from 75.5 to 78.08 per cent WO_3. The mill and power-house were rebuilt and two additional levels opened.

Property and Underground Workings

The property consists of eleven claims, two of which, the Mabel and Dawson, are Crown grants and the Hardscrabble scheelite deposit is on these claims.

The working shaft is vertical and 312 feet deep, of which 210 feet is in bedrock. Levels have been driven at depths of 103, 138, 189 and 300 feet, (*see* Figure 10). In addition, levels Nos. 2 and 3 are connected by a raise, and a winze has been sunk below No. 3 level, and a sub-level driven from the winze. No. 1 level is partly on and partly in bedrock, and includes a drain-tunnel driven in connection with placer mining. The original shaft lies about 150 feet southerly from the present working shaft and is connected with the drifts only on No. 1 level. The following is a summary of the main underground development to 1941, with measurements of length from the shaft or from the starting point along the drift or crosscut (*see* Figure 10).

Level	Depth in feet	Crosscut		Drive and drift		Remarks
		Length in feet	Direction	Length in feet	Direction	
No. 1	103	45 35	E W	50 45	N S	Lagged. W. crosscut blocked other workings caved and not listed
No. 2	138	30 24 15 60	E W S N	70 15	NW S	Backs in good condition or lagged in broken ground
				60		Connects NW drive and N-S crosscut and follows Fault B and scheelite-bearing zone with quartz veins
No. 3	189	80 70	W N	50 20 85	S E W	Workings in good condition, a raise and stope between No. 3, and No. 2 levels
No. 4	300	65 20	W W	550	NW	Fault B at 160 feet
		45 30 15 50	E W W E	70	S	Along Fault B and scheelite
						Quartz vein. Workings good condition. Three drill-stations and twelve drill-holes completed

General Geology

Bedrock at the mine consists of metamorphic members of the Cariboo series, Precambrian in age, according to Lang (1938, p. 5). Quartzite, argillite and limestone, slightly to strongly sheared, are the prevailing members of the series which is many thousand feet thick. The beds are folded into an anticline whose axis strikes northwest. The strata have been subdivided locally into three or more formations but, up to the present, these formations have not been recognized as such throughout any extended area occupied by the Cariboo series.

The Cariboo series is cut by the Proserpine intrusions represented by dykes and sills of quartz porphyry, probably pre-Mississippian in age. Late Palæozoic sediments known as the Slide Mountain series were deposited after the intrusions and still later the Mount Murray basic sills and dykes formed, possibly in the Jurassic period. The Tertiary and Quaternary periods were marked by the deposition of fluvatile and glacial deposits.

Geology of the Deposit[1]

On Hardscrabble Creek, rock outcrops are not known in the vicinity of the shaft and knowledge of the bedrock geology therefore is based entirely on underground observations. The rocks along the drifts and crosscuts are quartzite, argillite and impure limestone[2] that have been strongly sheared and altered. They are undoubtedly part of the Cariboo series but their position within this series is not known.

An attempt was made to map underground six varieties of sediment (*see* Figure 10). Of these, fissile quartzite and grey sericite schist are the most widespread and occur on all levels. The contacts between members of the different varieties are gradational, as between fissile quartzite and light grey sericite schist on No. 4 level. Near the shaft a quartzite bed appears to grade upward into a soft sericite schist and near the north end of the drive on this level a layer of sericite schist grades upward into quartzite. Quartzite is prevailingly light grey with considerable mica on the cleavage planes. A few beds are relatively massive but almost all quartzite is fissile. The sericite schist is also light grey, but is soft with abundant sericite and in many places contains well-developed metacrysts of ankerite. The limestone is a dark grey blocky rock that effervesces freely with hydrochloric acid and probably represents an impure sandy limestone or highly calcareous sandstone. Some beds of highly calcareous quartzite and argillite are interbedded with limestone. The dark, banded argillite is more massive than the sericite schist and carries in places, graphite and numerous thin stringers of carbonate. The calcareous rocks with interlayered massive argillite, thin bands of schist, and quartzite constitute the ore horizon in one section of the mine. The limestone lenses may be within this member. These beds are not repeated in the succession along their

---

[1] In discussing the geology of the deposit, certain unpublished information relative to the geology was left at the property by J. S. Stevenson of the Provincial Department of Mines, particularly with respect to the mapping of the geology. Use was made of this material but the subdivisions finally adopted by the writer (Cockfield) are not precisely the same as those of Stevenson.

[2] No microscopic determinations of thin sections of the rocks were made by Dr. Cockfield and the subdivision and nomenclature are based on field observations.

projected strike on No. 4 level, south of the shaft. The belt with lenses of limestone, however, probably is the downward continuation of similar strata on No. 2 and No. 3 levels. Stratigraphically above the interlayered limestone and quartzite zone, limestone is present at the northerly face on No. 4 level. This may represent a repetition of the beds by a tight fold. On account of displacement along faults on No. 4 level the succession of the different bands and their exact thickness are unknown.

Structure

The beds strike in a general westerly direction and dip northerly. In the mine the beds strike from north 40 degrees west to north 60 degrees east and dip from 10 degrees north to nearly vertical with 25- to 50-degree dips predominating. A few small drag-folds are developed.

Numerous faults cut the beds in the area explored by the workings and the scheelite deposits are situated along or near the junction of faults. The main fault, referred to as Fault A, trends northwesterly, and dips 60 to 80 degrees southeast. Fault A is actually a fault zone about 50 feet wide consisting of a series of sub-parallel fault planes. Many of these, however, are roughly parallel. The direction and amount of movement along this fault zone are unknown. The position and orientation of certain blocks of scheelite-bearing schist, probably dragged in the zone, suggest the beds on the western side of the fault moved south with respect to those on the east side. The amount of movement probably is some hundreds of feet.

A second fault, designated Fault B, is exposed on levels Nos. 2, 3 and 4, as well as the sub-level, and probably also on level No. 1. Fault B strikes about north 65 west and dips generally steeply to the northeast. This is the Hardwall fault of Rice's report[1].

In addition to Faults A and B a number of others cross No. 4 level. Most have a northwesterly trend and dip at various angles to the northeast or southwest. A few, however, have a northeasterly strike. Two faults, referred to as C and D, occur in the vicinity of the ore on No. 4 level. Fault C strikes about north 35 degrees west and dips 40 degrees southwest. The dip increases along the strike towards Fault B. Fault C is a thrust fault and may be displaced by Fault B. Fault D is practically parallel to Fault B, and some of these minor faults may be branches from Fault A.

Faults A, B, and C apparently affect the continuity of the ore zone (*see* Figure 10). At Fault A, the scheelite-bearing zone ends and no exploration has been undertaken south of the drift to locate the continuation west beyond the fault. The scheelite deposit also ends at Fault B, and beyond the fault has not been located with certainty. At the stope entrance on No. 4 level a body of scheelite-bearing schist, wedge-shaped in plan, is bounded by Faults A, B, and C. Scheelite-bearing beds in the hanging-wall of Fault C moved upward with respect to those in the foot-wall. Some exploration by diamond drill-holes for the extension of known deposits or for new deposits has been completed from

[1] Rice, H.M.A., Geol. Surv., Canada, Unpub. rept.

three stations on the No. 4 level, but in ground of this character, the size and true metal content of stringer zones of the type known in the mine might not be indicated. Diamond drill-core, unless A-size or larger, is not regarded as satisfactory in the exploration of stringer-zone scheelite deposits in broken or soft ground.

General Character of Deposits

Several of the quartz veins contain pyrite, galena, chalcopyrite and, in a few places, free gold. Some of these gold-bearing veins are of commercial grade, but none has as yet proved large enough to be profitably mined.

The scheelite in general occurs in small quartz stringers of two types: (1) a set that is transverse to the bedding; and (2) stringers or lenses that follow the bedding or schistosity.

The stringers traversing the bedding strike northeasterly and most of them dip steeply to the southeast. Many are under a few feet long and about one-quarter inch wide although a few are about 3 inches wide. The stringers following the bedding and schistosity (type 2) are in general discontinuous with individual veinlets about 1 foot long and 1 inch or less thick. In places, however, a zone 4 or 5 feet wide, contains numerous stringers. Quartz is the chief mineral of many stringers with varying amounts of ankerite, calcite, scheelite, sphalerite and galena. In many places scheelite forms lenses or layers in quartz-carbonate rock. The stringers and layers carrying scheelite are grouped to give a series of small discontinuous shoots and the one between No. 3 and No. 4 levels probably rakes at a low angle towards Fault A. If so, the ore in the back of No. 3 level just east of the winze, that in the west-wall of the winze for about ten feet below the floor of the level, and that on the sub-level about 30 feet from the winze, are parts of the same body.

Scheelite was also found along Fault B in the back of No. 3 level west of the winze. This ore in the stope lies between two quartz veins and continues almost vertically to No. 2 level. On No. 3 level to the west of the area stoped some scheelite is present but not enough to constitute ore.

Scheelite also was reported on No. 3 level within Fault A zone. This occurrence, however, may be pieces of scheelite-bearing material dragged to their present position by movement along the fault.

On No. 4 level, scheelite occurs at one place for a distance of about 10 feet along the drift (*see* Figure 10). This scheelite deposit is reported to end down the dip at a flat slip, about 3 to 4 feet below the level of the floor and in the stope above the level at Fault C.

On No. 2 level, although some scheelite occurs at a number of places, the main deposit probably is within Fault A zone. The back at this location is tightly lagged but nearby black argillite lies on the line of strike of massive limestone, thus indicating a fault, probably Fault A zone, and the ore there may be dragged to its present position.

From No. 3 level down to No. 4 level, the scheelite occurrences are in limy argillaceous and sandy beds probably representing a clayey, sandy limestone.

Argillite and quartzite are interlayered with this limestone and the ore in this group of limy beds seem to occur where the beds are low in lime and high in clay. Fault B follows this zone. This group of calcareous clayey beds apparently was favourable for the deposition of scheelite.

On No. 4 level, the formation has been crosscut for approximately 180 feet southerly from B fault, and for 350 northerly. The only scheelite occurrence encountered is at D fault. The north face of the crosscut exposes limestone.

The largest ore shoot known and exposed on a level is 50 feet long but the average length, measured at right angles to the rake, is 10 feet and the width 4 feet. If, as in certain gold deposits of the district, the small shoots occurred in a group closely enough spaced to be mined as one body, the structure would be attractive to explore. The amount of exploratory work completed on No. 4 level, however, indicates that the small scheelite occurrences probably are widely spaced. The limestone exposed in the face of the north crosscut is the only indication that further ore may be present on this level. This limestone, however, may or may not carry ore nearby.

Two explanations of the cause for the localization of the scheelite are: (a) that the scheelite-bearing solutions travelled along fault zones and, as the dip of these in general is greater than that of the beds, the solutions escaped from the fault channel only where favourable beds were crossed thus forming a number of discontinuous ore shoots; and (b) that the faults are younger than the deposits and cut them into a series of disconnected shoots.

Hypothesis (a) is advanced by Rice in his manuscript report, and he emphasizes the discontinuous nature of the ore shoots along Fault B. The writer, however, favours hypothesis (b) for although it is highly probable that some faults existed prior to scheelite deposition to serve as circulation channels for the solutions and that naturally these would spread from such channels more readily along favourable beds, nevertheless the present distribution of ore shoots is the result of post-ore faulting. Under this assumption, Fault A might have served as the channel for the entrance of tungsten-bearing solutions and movement may have been renewed along it after the deposit formed.

Island Mountain Mine (34)

References: P. C. Benedict, in "Structural Geology of Canadian Ore Deposits", 1948, pp. 149-162. Hanson, 1935*b*, pp. 19-22.

The Island Mountain property consisting of 32 claims and fractions, is on the north side of Jack of Clubs Lake, about 2 miles west of Wells. The mine produces gold and silver from both replacement sulphide bodies and from veins. Most of the production has been from gold-bearing veins that contain pyrite and arsenopyrite, with a little galena, sphalerite, and possibly cosalite in a gangue of quartz and ankerite. Scheelite is present (Hanson, 1935*b*, p. 20), but is sporadically distributed (Benedict, 1948, p. 155).

Cariboo Gold Quartz Mine (35)

References: Hanson, 1935*b*, pp. 22-25. F. Richards, in "Structural Geology of Canadian Ore Deposits", 1948, pp. 162-168. Stevenson, 1943, p. 81.

Cariboo Gold quartz mine is southeast of Jack of Clubs Lake, on the north slope of Cow Mountain. The portal of the main haulage level is nearly 2 miles south of Wells. The mine is operated by the Cariboo Gold Quartz Mining Company, Limited, and has produced over $15 million in gold. The ore is in fissile quartzite and argillite, and consists of pyrite replacement bodies and quartz veins containing ankerite, sericite and calcite, and abundant pyrite. Pyrrhotite, galena, sphalerite, cosalite, and galenobismutite are present in places. Scheelite is reported to occur in the deposits, but the quantity is not recorded.

Rand Group (Cariboo Thompson) (36)

References: Minister of Mines, B.C., Ann. Repts., 1938, p. C47; 1943, p. A78. Stevenson, 1941, pp. 57-58; 1943, pp. 90-92. Lang, 1940.

The Rand group of claims is near the headwaters of Cunningham Creek south of Barkerville. The claims were optioned to Cariboo Thompson Gold Mines Limited, but in 1938 reverted to the owners, J. Windle, W. Thompson, and R. Calder of Barkerville.

A detailed description of the property has been given by Stevenson based on his field examination in July, 1942.

"The scheelite claims are on Penny (Copper) Creek, on the southwesterly slope of Roundtop Mountain. They are reached by following the Cariboo Hudson mine road southeasterly from Barkerville for 16.5 miles to the Penny (Copper) Creek bridge.

"The showings are . . . at elevation near 4,900 feet, between 100 and 600 feet downstream from the Penny Creek bridge . . . (They) consist of lenticular quartz veins in a series of silver-grey schists, graphitic schists and grey limestone. In general the rocks strike northwesterly and dip steeply northeastward. The veins strike from north 10 degrees west to north 20 degrees east and dip steeply eastward, cutting the schist at small angles. They are north-south diagonal veins, and . . . in addition to scheelite, the quartz veins contain moderate amounts of tetrahedrite and very small amounts of sphalerite and galena.

" The first showing is approximately 100 feet downstream from the Penny Creek bridge. Stripping and blasting have exposed two scheelite-bearing quartz lenses. . . . The upstream lens ranges from 6 to 60 inches in width over a length of 14 feet. . . . The vein filling consists of quartz, ankeritic carbonate, and small amounts of galena and scheelite. The downstream lens, 7 feet distant, ranges from 12 to 15 inches in width. . . . At the creek it is 10 feet from the upstream lens, but 10 feet farther northeasterly, it is only 2 feet from this lens so that the two lenses presumably join a short distance northeasterly. The vein-filling consists of quartz, ankeritic carbonate, tetrahedrite and a moderate amount of scheelite. A sample taken across 12 inches of this vein-matter assayed: tungstic oxide (WO_3), 3.8 per cent.

"The second showing outcrops in the southeast bank of Penny Creek approximately 500 feet downstream from the first. Here an open-cut has been driven southeasterly for 6 feet to a face 6 feet high. The cut exposes a compound quartz zone 42 inches wide which consists of 2 lenses of quartz striking north 10 degrees west and dipping 65 degrees eastward. The hanging-wall-lens is 1 foot wide and the footwall-lens is 16 inches wide. They are separated by 14 inches of badly crushed, graphitic schist. The hanging-wall is grey, talcose schist, . . . the foot-wall is grey, massive limestone . . . (The lenses contain) quartz, scheelite and small amounts of tetrahedrite, galena and sphalerite. Most of the scheelite . . . is in the footwall-limestone immediately adjacent to the vein-wall. Here the scheelite occurs as high-grade patches . . . measuring up to 4 feet by 16 inches in surface area, but probably only a few inches in thickness. Insufficient work has been done to determine the continuity of these patches northerly along the strike of the zone. Smaller amounts of scheelite occur as ribbons of discontinuous grains in and near the foot-wall of the footwall-lens.

"A gouge seam, 1 inch thick, lies in the hanging-wall of the hangingwall-lens. The gouge and the abundant crushed rock within the zone indicate much post-mineral movement. The strike of the schist and its position relative to the limestone suggest that the west side of the zone has moved northerly.

"The following samples were taken on the showing:

Footwall-lens	*Tungstic Oxide*
3 feet from floor; 16 inches wide	0.2 per cent
5 feet from floor; 14 inches wide	Tr.
Footwall-limestone	
1 foot from floor; across 14-inch patch of mineralization, vertical	12.6 per cent
1 foot from floor; across 14-inch patch of mineralization, horizontal	18.2 per cent

"Seven other small veins of quartz within a radius of 1,000 feet of these showings were examined in ultra-violet light and seen to contain small amounts of scheelite.

"In particular, the area southeasterly and southerly from the showings seem to warrant prospecting. However, abundant overburden and the absence of outcrops will necessitate much stripping."

Cariboo Hudson Gold Mines, Limited (37)

References: Minister of Mines, B.C., Ann. Repts., 1922, p. 119; 1925, p. 150; 1929, p. 191; 1947, pp. 115-117; 1951, pp. 120-121. Bureau of Mines, 1939, pp. 30-42. Cockfield and Lang, 1937, p. 469. Johnston and Uglow, 1926, pp. 212-213; 1933, p. 57. Lang, 1936, pp. 17-18; 1938, pp. 27-30; 1940; and in "Structural Geology of Canadian Ore Deposits", 1948, p. 141. Stevenson, 1941, p. 57; 1943, pp. 81, 93-96.

The Cariboo Hudson property comprises the Cunningham, Cutler, Hudson and Shasta groups of claims south of Penny Creek. The Hudson group was staked and developed by Fred Wells and E. I. Moore, and produced gold in 1938-39 under the management of Cariboo Hudson Gold Mines, Limited. This company was reorganized in 1946, and refinanced in 1951 to reopen the deposit with the intention of producing scheelite.

The presence of scheelite in some of the small veins was recorded by Johnston and Uglow (1926). Lang (1936, p. 18) reported scheelite in the main vein along the adit, that had been driven into the south bank of Pearce creek. Scheelite was discovered in 1942 by an officer of the British Columbia Department of Mines on Cunningham No. 1 and Cutler No. 1 claims at the headwaters of Peter Gulch Creek and about three-quarters mile westerly from the main workings.

Cariboo Hudson mine is 18 miles by road southeasterly from Barkerville. The rocks are largely fissile quartzite and quartz-sericite schist, of which some, particularly around the main workings, are limy. The bedding and fissility strike northwesterly and dip from 65 to 80 degrees northeast. Within these sedimentary rocks are quartz veins divided into two types by Johnston and Uglow; type A, large and conspicuous but containing only specks of pyrite and little gold; type B, on the average smaller than Type A veins but with abundant pyrite, and in addition carbonates and scheelite in the gangue, as well as more gold. Scheelite is plentiful in certain lenses of quartz on the Cunningham No. 1 and Cutler No. 1 claims, Stevenson (1943, pp. 93-95) reports individual lenses 1.5 feet wide and 15 feet long. A channel sample across 42 inches assayed 14.1 per cent WO_3. Two ore shoots are reported to have been outlined during the summer of 1952.

Paxton Group (38)

References: Stevenson, 1941, pp. 70-72; 1943, pp. 96, 97.

The Paxton group of six claims, on Snowshoe Plateau, was examined by Stevenson in July, 1940. The property may be reached by 7 miles of poor road and trail from the Cariboo Hudson mine, which is 18 miles from Barkerville by good motor road.

Bedrock consists of fissile quartzite and a little graphitic argillite of the Richfield formation, which, according to Lang (1938, pp. 5-9), forms the southwest limb of an anticline. Granitic intrusions are not known in the vicinity.

The workings are at an elevation of 5,500 feet and consist of one open-cut and one adit. The open-cut exposes four quartz veins containing a little pyrite, chalcopyrite, pyrrhotite, and galena. Scheelite is not known to occur in these veins.

The adit, 50 feet long, has been driven south 43 degrees east from a point 15 feet below the open-cut and 25 feet in a direction north 70 degrees east from its northwest end. At a point 40 feet from the portal, the adit intersects another vein that extends for a distance of 8 feet diagonally across the back to the northeast corner of the face. This quartz vein strikes north 73 degrees west and dips 55 degrees southwest, and contains a little galena and pyrite, and clusters of scheelite. Little scheelite was seen in the vein, but quartz on the dump contains patches of scheelite from ½ inch to 2 inches in diameter. In outcrops of the vein at a point 25 feet above the level of the adit, no scheelite was visible.

The northwesterly extension of the scheelite vein is terminated by a fault at a point 8 feet northwest of the face in the hanging-wall of a large quartz lens; the southeasterly continuation on the surface is covered by drift, but the exposure in the adit, which is farther southeasterly along the strike, indicates that the vein continues in this direction.

Gold Coin Claim (39)

References: Stevenson, 1941, pp. 67-69; 1943, pp. 98-100.

The following is a summary of the report by Stevenson, who examined the property in July, 1940.

The Gold Coin claim is near the head of Little Snowshoe Creek, on Snowshoe Plateau at an elevation of 6,000 feet. The deposit may be reached either from Wells or from Keithley Creek. The route from Wells is by road 23 miles to the Cariboo Hudson mine, thence by a poor road 1½ miles in length and a good trail 4½ miles long.

The rocks are quartzite and sericite schist of the Precambrian (?) Cariboo series, forming the southwest limb of an anticline whose axis strikes northwest. The strata strike about north 15 degrees west and dip 50 degrees southwest. The beds are intersected by a fissure that strikes north 60 degrees west and dips 75 degrees southwest. This is followed by a scheelite-bearing vein of quartz that cuts three nearby veins that do not contain scheelite.

The scheelite-bearing vein is exposed by a trench and short shaft for 18 feet and is from 1 inch to 4 inches wide. The vein matter consists of large, poorly-defined crystals of quartz oriented with their long axes perpendicular to the vein walls and enclosing patches and crystals of scheelite, tungstite and stolzite. Stevenson did not see scheelite in the vein beyond the first 6 feet exposed. A 30-pound sample along a 4-foot vertical exposure of the vein in the shaft, and across its full 4-inch width assayed 26.2 per cent WO_3.

Cariboo Scheelite Group (40)

References: Minister of Mines, B.C., Ann. Rept., 1951, p. 121. Stevenson, 1943, p. 100.

The Cariboo Scheelite group of eight claims is at Limestone Point on the North Arm of Quesnel Lake, about 45 miles by boat from Likely. Scheelite was found in 1942 by Otto Baer of Likely in the limestone exposed on the bluff and in fragments of talus. A grab sample from one block assayed 4.5 per cent WO_3, but elsewhere, scheelite occurs only as scattered grains in narrow reticulating quartz veinlets that intersect the limestone in the talus and in the cliff face.

Bridge River Area

Tungsten Queen (Phillips' Tungsten) (41)

References: Minister of Mines, B.C., Ann. Repts., 1940, p. 87; 1941, p. A81; 1942, p. 78; 1943, p. 78. Cairnes, 1943, pp. 38-39. Stevenson, 1941, pp. 72-77; 1943, pp. 100-104. Eardley-Wilmot, 1942, pp. 443-444.

The Tungsten Queen property, formerly known as Phillips' Tungsten, is on the east side of Tyaughton Creek, 2.4 miles north of the Noaxe Creek crossing, and about 14.3 miles by road from Minto City. The ground was staked originally for cinnabar, but in 1939 scheelite was discovered, and cobbed ore was shipped. The property was optioned for one year from September, 1941 by the Consolidated Mining and Smelting Company of Canada, Limited.

The scheelite deposit occurs near the south end of a large body of carbonatized serpentine that intrudes greenstone and ribbon chert of the Fergusson group probably of Permian age. All these rocks are cut by irregular bodies and dykes of quartz porphyry. Outcrops of sandstone and shale occur on the property, but their relationship to the other rocks is not known.

According to H.M.A. Rice, who examined the property for the Geological Survey in September, 1940, innumerable dolomite veinlets, some of which contain quartz, traverse the altered serpentine. They vary in width from a fraction of an inch to a foot, but only eight are known to carry white to pale cream scheelite, and stibnite. Cinnabar was reported by the owner to occur on the property but none was seen in the scheelite-bearing veins by either Rice or Stevenson. The banded or crustified veins in which both the quartz and scheelite show a marked comb-structure, suggest deposition under low temperature conditions.

Two veins designated Nos. 1 and 2 and about 35 feet apart were examined by Stevenson. These are in serpentine about 30 feet southwest of its contact with a small body of feldspar porphyry. These veins strike a little east of north, dip 30 to 45 degrees east, and are terminated at their north ends by a fault and at their south ends by banded chert. No. 1 vein is 10 feet long and averages 2.05 inches wide, and No. 2 is 16 feet long and averages 1.84 inches wide. Eight feet to the west of No. 2 vein a discontinuous zone of stringers is known as No. 5 vein, and 4.5 feet beyond this is No. 3 vein that is 2.21 inches wide and 30 feet long. No. 4 vein is 0.59 inch in average width, 15 feet long, and 16.5 feet west of No. 3 vein.

At a few places scheelite forms as much as 75 per cent of the vein matter over lengths up to 3 feet. The scheelite is pure; a selected specimen contained only a trace of molybdenum.

No. 6, the principal vein, is 120 feet south of the other five veins. It strikes a little west of south and dips about 60 degrees east. This vein is 70 feet long and up to 7 inches wide, the average width being 1.71 inches. In 1940, the owner shipped to the Bureau of Mines, Ottawa, 1,639 pounds of cobbed ore from this vein, that assayed 55 per cent WO_3.

Thirty-five feet southeast of the south end of No. 6 vein a narrow, discontinuous stringer is known as No. 8 vein, and this contains a little scheelite. Twenty-five feet farther southeast, No. 7 vein strikes southeast, has been traced 20 feet and is 2 to 3 inches wide.

Tungsten King Group (42)

References: Minister of Mines, B.C., Ann. Repts., 1942, p. 79; 1943, p. 78. Cairnes, 1943, p. 38. Stevenson, 1943, pp. 100, 105.

This property, consisting of eighteen claims, is on the east side of Tyaughton Creek, about 15 miles by road from Minto City. The claims are owned by Egil H. Lorntzsen of Minto and Gunnar Lundborg of Gold Bridge.

The property is underlain by rocks similar to those on the Tungsten Queen. The scheelite is reported to occur in limestone within a fracture zone 6 feet wide. The deposit is developed by open-cuts and two short adits.

About a ton of high grade ore was shipped to Ottawa, and 30 tons of ore running about 5 per cent WO_3 was shipped to the Bralorne mill, from which a concentrate of 72 per cent WO_3 was obtained. In 1943, all the ore in sight had been mined.

Bralorne Mines, Limited (43)

References: Cairnes, 1937, pp. 54, 85. Cleveland, 1937, pp. 39-42. Cockfield and Walker, 1933, pp. 64, 65. Dolmage, 1934, p. 425. Joubin, in "Structural Geology of Canadian Ore Deposits", 1948, pp. 168-177. Stevenson, 1943, pp. 100, 101, 105.

Bralorne mine is on the east side of Cadwallader Creek, and the property consists of some 58 claims. It is one of the leading gold producers in British Columbia. The original claims were staked in 1897, but it was not until 1932 that regular production commenced.

The productive veins, with one exception, occupy fractures that intersect at about 45 degrees, and these according to Joubin may represent the shears within a strain ellipsoid plunging 45 degrees southeast. The veins occur mainly in augite diorite of Jurassic (?) age, and sedimentary and volcanic rocks of Triassic (?) age. The veins of milky quartz, commonly ribboned, contain carbonate, sericite and mariposite. Metallic minerals are pyrite and arsenopyrite, with, locally, chalcopyrite, tetrahedrite and free gold. Scheelite was reported in these veins in 1933 by Cockfield and Walker, and in 1937 Cleveland stated that it is distributed erratically, but that where scheelite occurs the vein is above average grade in gold. Cairnes reports a band of scheelite 20 feet long and up to 6 inches wide in the Empire vein, towards the east end of 6-level. A high grade shoot was later mined on 5-level, in 551 drift east. It was concentrated in a small plant built on the property, in which ore from Tungsten Queen and Tungsten King properties also was milled. A marketable scheelite concentrate could not be produced by riffling the tailing from the gold mill.

Pioneer Gold Mines of B.C., Limited (44)

References: Cairnes, 1937, pp. 115-124. Cleveland, 1938, pp. 12-27. Cockfield and Walker, 1933, p. 65. Dolmage, 1934, p. 425. Joubin, in "Structural Geology of Canadian Ore Deposits", 1948, pp. 168-177. Stevenson, 1943, pp. 100, 105. James, 1934, p. 346.

The property of Pioneer Gold Mines of British Columbia, Limited, is on the east side of Cadwalladar Creek. It is southeast of Bralorne mine, and consists of twenty-four claims and fractions. The mine is an important gold producer in British Columbia.

The veins of Pioneer mine occur mainly in sedimentary and volcanic rocks of the Fergusson series, of probably Permian age, and in soda-granite of Jurassic (?) age. The strata strike roughly northwest and dip steeply northeast. The main vein strikes north 60 degrees west and dips 75 to 80 degrees northeast. There are a number of branch veins.

The veins are composed essentially of quartz with minor amounts of such gangue minerals as calcite, ankerite, chlorite, sericite and mariposite. Metallic minerals are pyrite and arsenopyrite, with, in some places, pyrrhotite, sphalerite, chalcopyrite, marcasite, stibnite, and free gold. Scheelite was reported in the veins by Cockfield and Walker, and according to James, it is widespread. Where calcite occurs along the vein walls scheelite is commonly present. One such occurrence is on 14-level west, where flat veins of calcite and quartz that cut the main vein contain "a high percentage of scheelite". No attempt has been made to recover scheelite from the mill tailings.

BRX Consolidated Mines (45)

References: Cairnes, 1937, pp. 94-100. Stevenson, 1943, pp. 100, 105.

The property of BRX Consolidated Mines consists of forty-two claims and fractions that straddle the divide between Hurley River and Fergusson Creek, north of Bralorne mine.

The California vein, which strikes about northwest and dips 45 degrees northeast, follows roughly along the contact zone between greenstones of Triassic(?) age and augite diorite. The vein consists of quartz with disseminations of sulphides, and a little free gold. Scheelite occurs in the vein as small stringers and widely scattered grains but the grade apparently is low, and the occurrences too sporadic to be mineable.

Bristol Mines, Limited (46)

References: Minister of Mines, B. C., Ann. Repts., 1939, p. 72; 1940, p. 59; 1941, p. 58; 1946, pp. 114, 115; 1947, pp. 135, 136. Stevenson, 1943, p. 106. Warren and Mathews, 1943.

Bristol mine is on Tommy Creek, 3.5 miles by road from the Bridge River highway, about 12 miles east of Minto.

A shear zone from 15 inches to 20 feet wide, exposed over a length of 600 feet, intersects cherty quartzite and argillite of the Bridge River series, of Permian(?) age. The shear zone contains numerous veinlets of calcite and quartz, and a little pyrite, arsenopyrite and scheelite.

The scheelite distribution is described by Stevenson as follows:

"Moderate amounts of scheelite have so far been found only in the intermediate level. This level consists of a crosscut driven southeasterly for 250 feet and a drift driven 50 feet southwesterly and 90 feet northeasterly from the crosscut. Where the main crosscut joins the drift, scheelite is found over a width of 30 inches in the footwall side of the main shear-zone. A sample taken across this width assayed: Tungstic oxide (WO_3), 0.6 per cent; gold, 0.41 oz. per ton; silver, *nil*. At 43 feet northeasterly from the crosscut, scheelite is found in scattered grains over a width of 15 inches, in quartz stringers in the footwall-rock next to the shear. A sample taken across this width assayed: Tungstic oxide (WO_3), 6.5 per cent; gold, 0.26 oz. per ton; silver, 0.1 oz. per ton. Between 48 and 57 feet northeasterly from the crosscut, scheelite is found in association with higher than average amounts of gold, across the full shear width of 7 feet. A winze has been sunk for 25 feet on this ore-shoot. A 50-pound sample from a pile of stored muck taken from the winze assayed: Tungstic oxide (WO_3), 0.16 per cent; gold, 1.40 oz. per ton; silver, 0.6 oz. per ton."

A diamond-drilling program was carried out in 1946-47, but no production has been reported.

Chalco Group (47)

References: Cairnes, 1937, p. 88. Minister of Mines, B.C., Ann. Rept., 1948, pp. 98-102.

The Chalco group of ten claims and fractions lies north of the confluence of Piebiter and Cadwallader Creeks, and is owned by Mrs. D. C. Noel of Bralorne.

The deposits occur in skarn formed at and near the contact of sedimentary rocks and greenstones of the Fergusson series of Permian(?) age, and the Bender quartz diorite. The lime silicates are mainly green diopside and white wollastonite, with locally, garnet and epidote, into which are introduced quartz, chalcopyrite, pyrrhotite, and in some places scheelite and molybdenite. The property was developed principally as a copper prospect.

Scheelite has not been found in the underground workings on Peridot No. 1 and Peridot No. 2 claims. The known tungsten occurrences on the Chalco No. 12 claims that are on much higher ground to the east are described by Stevenson.

"Interesting showings of scheelite and chalcopyrite have been found on the north valley-wall of Piebiter Creek between 700 and 900 feet above the creek on the Chalco No. 12 claim. They are reached from the Chalco cabin by a route that follows up the north side of the creek for 600 feet and then proceeds northerly up a wide rock-slide to the foot of the rock bluffs, elevation 5,500 feet, about 600 feet above the creek.

"The showings, four in number, consist of lenses of mineralized lime-silicate rock that occur in laminated quartz-hornblende schist, strike north 60 degrees west and dip 80 degrees south-west, west of and within 1,000 feet of the northerly trending western contact of the Bendor batholith. The known lenses of lime-silicate rock appear to have been localized near the batholith by two tongues of granodiorite extending westerly from the main contact. The lime-silicate rock in the showings consists of quartz, green diopside, brown garnet, epidote, chalcopyrite, pyrrhotite, and scheelite. The quartz and the diopside are massive, but the garnet and epidote are strikingly well crystallized. The chalcopyrite and the pyrrhotite occur in patches of solid mineral up to several inches in diameter, but the scheelite occurs in widely scattered grains up to about 1 inch in maximum dimension.

"The mineralized lenses occur at widely spaced intervals for a distance of about 300 feet along and about an equal distance across the bedding of the schists. Although the showings are not known to be associated with any unaltered limestone, they most probably represent the replacement of small lenses either of limestone or of limy sediments bedded with more siliceous sediments now altered to quartz-hornblende schists..."

No. 1 showing is in an inaccessible rock chimney along a schist-granodiorite contact, at an elevation of about 5,600 feet, and about 100 feet above the base of bluffs on the north side of Piebiter Creek. Talus blocks of material from this showing are covered with a green stain, probably copper carbonate. No scheelite was reported from this showing.

"No. 2, the principal showing, elevation 5,710 feet is quite accessible and is....200 feet east of the chimney. The work on this showing consists of an open-cut, 15 feet wide at the mouth, driven north-westerly for 10 feet to a face 10 feet wide and 7 feet high. In the cut, numerous masses of chalcopyrite and smaller masses of pyrite and pyrrhotite are associated with blebs of clear, watery vein-quartz and light-green diopside rock, through all of which are scattered grains and crystals of scheelite. Because of its similarity in colour and lustre to the enclosing silicates, the scheelite is not readily recognizable in ordinary light, but it is clearly recognizable in ultra-violet light. It appears to be most abundant in a vertical 2-foot zone of light-green diopside-epidote rock, containing a little chalcopyrite, along the north-eastern end of the face of the cut. However, more widely scattered grains of scheelite may be seen elsewhere in the lime-silicates of the cut. The lens of lime-silicate in the cut extends for 15 feet north-westerly up the slope beyond the face of the cut before it pinches out and is succeeded along the strike by quartz-hornblende schist and extends south-easterly down the hill, narrowing at 36 feet from the cut to 3 feet of lime-silicate rock that contains a moderate amount of magnetite and a small amount of chalcopyrite. Farther south-easterly the lime-silicate rock is covered with overburden, and the next outcrops, about 100 feet distant, along the strike of the formation, are of the unmineralized, laminated schist. The lens of lime-silicate rock exposed in the cut is in quartz-hornblende schist, strikes north-westerly, about 500 feet west of the main contact of the batholith and 200 feet up the slope from the tongue of granodiorite near No. 1 showing.

"Descriptions and assays of samples across the mineralized lens of lime-silicate in this cut are given in the following table. Although a few flakes of molybdenite may be seen, the samples contain less than 0.3 per cent molybdenite.

Sample No.	Width	Location	Gold	Silver	Copper	WO_3 (Tungstic Oxide)
	Feet		Oz. per ton	Oz. per ton	Per cent	Per cent
1	9	Horizontally across face, 1 foot from floor..........................	Trace	1.7	4.7	1.2
2	9	A check sample horizontally across face, 1 foot from floor...........	0.01	1.6	4.1	1.2
3*	....	....	Trace	1.5	4.4	1.4
4*	....	....	Nil	1.1	3.5	0.3
5+	....	....	Trace	1.2	3.0	0.9
6+	....	....	Nil	1.5	3.9	0.5
7	4	Down south-west wall, across high-grade chalcopyrite portion........	0.01	2.2	5.7	0.9
8	5	Vertical, across centre portion of the face..........................	Trace	2.3	5.2	0.8
9	2	Across a vertical zone, north-east part of face, showing most scheelite....	Nil	1.4	4.1	1.8
10	....	Selected high-grade from dump......	Nil	2.5	6.6	1.5

*Sample Nos. 3 and 4 were cut as one large sample, taken horizontally for 11 feet across the face at 18 inches from the floor. Sample No. 3 consisted of scheelite-bearing material hand-sorted under an ultra-violet lamp, and represented about one-quarter of the original sample; Sample No. 4 was the scheelite-poor material and represented about three-quarters of the original sample.

+Sample Nos. 5 and 6 were also cut as one large sample, taken horizontally for 11 feet across the face, but at 3 feet from the floor. Sample No. 5 consisted of the scheelite-rich material and represented about one-third of the original sample; Sample No. 6 was the scheelite-poor material and represented about two-thirds of the original sample.

"No. 3 showing, elevation 5,750 feet, is in the face of a rock bluff on the west side of a small southerly flowing creek about 500 feet west-north-west of the cut at No. 2 showing. The showing is about 300 feet south-westerly across the strike of the lens of mineralization and enclosing schist in No. 2. At No. 3 showing a lens of lime-silicate rock up to 6 feet wide, strikes north 60 degrees west and dips vertical, is exposed for a slope distance of 30 feet, beyond which it narrows and peters out. The silicate-lens is enclosed in sugary grey quartz-hornblende schist, which lies about 50 feet northerly from the upper contact of a small patch of granodiorite about 50 feet wide. This granodiorite extends for about 100 feet southerly down the hillside into overburden and appears to be a tongue-like mass from the batholith to the east. As in No. 2 showing, the mineralization consists of scheelite grains scattered through the lime-silicate rock, chalcopyrite in patches up to 1 inch diameter, and water-white quartz in patches up to 1 foot in diameter. A small amount of molybdenite, but no pyrrhotite, was seen in this cut. A 1-foot sample taken across the south-western part of the face, where some blasting had been done, assayed: Gold, 0.01 oz. per ton; silver, 1.7 oz. per ton; copper, 3.4 per cent; molybdenite, trace; and tungstic oxide, 1.3 per cent. A 1-foot sample taken across the north-eastern part of the face assayed: Gold, *nil*; silver, 0.2 oz. per ton; copper, 0.8 per cent; molybdenite, trace; tungstic oxide, 0.9 per cent.

"No. 4 showing, at an elevation of 5,820 feet, is about 70 feet north-westerly from No. 3 showing, but is about 25 feet south-westerly across the strike of the formation as projected from No. 3. The showing consists of a lens of lime-silicate rock, which, as with the other showings, is enclosed in quartz-hornblende schist and is mineralized with disseminated scheelite and a few patches of chalcopyrite, up to 1 inch in diameter, associated with irregular patches of quartz up to 6 inches wide. A selected sample assayed: Gold, *nil*; silver, 0.1 oz. per ton; copper, trace; molybdenite, trace; tungstic oxide, 1.2 per cent.

"A patch, 5 feet in diameter, of rust-coloured wet muck occurs at the base of a granodiorite-outcrop in the creek between Nos. 2 and 3 showings and at about the same elevation as No. 2. This rust-coloured material has resulted from the oxidation of abundant pyrite in the granodiorite at this point, the process being accelerated by an abundance of spring water issuing at the base of the outcrop. Samples of the muck assayed *nil* in gold and silver.

"These showings, Nos. 1 to 4, are of particular interest, in that they demonstrate the presence of copper and of tungsten mineralization along the western contact of the Bendor batholith. They further demonstrate the localization of the tungsten-copper mineralization in limy beds in the sediments where close to projections or tongues of granodiorite extending up to 1,000 feet from the main contact. Consequently these two geological conditions may be used in prospecting the contact-zone of the batholith for further and perhaps more promising occurrences of scheelite or chalcopyrite."

Squamish Area

Ashloo Gold Mines, Limited (48)

References: Minister of Mines, B.C., Ann. Repts., 1935, pp. F1-F6; 1936, p. F63; 1937, p. 34; 1938, p. F68; 1939, p. 86. Stevenson, 1943, p. 106.

The property of Ashloo Gold Mines Limited comprises sixteen claims adjoining Ashlu Creek, a tributary of Squamish River. It is accessible from Squamish by 24 miles of road and 6 miles of trail.

The vein, which has been developed at intervals over a length of about 1,800 feet, is from 20 to 54 inches wide. It strikes north 5 to 35 degrees east and dips 20 to 30 degrees east. The host rock is granodiorite of the Coast Range intrusions, probably of Cretaceous age.

A small mill was built in 1936, and concentrates of gold, silver and copper were obtained from several thousand tons of ore mined during the succeeding two years. The mine closed in October 1939.

Stevenson states that a small quantity of scheelite had been reported on the property. B. T. O'Grady (Ann. Rept., 1935, p. F5) found small aggregates of scheelite in a winze near the south end of the vein. A selected specimen of this material assayed 44.41 per cent WO_3.

Hope-Princeton Area

Mammoth Group (49)

References: Cairnes, 1921, pp. 40-41; 1923, p. 112; 1940. Stevenson, 1941, p. 77; 1943, pp. 116-117. Minister of Mines, B.C., Ann. Repts., 1920, p. 171; 1923, p. 164; 1927, p. 210; 1929, p. 241; 1938, p. F9.

The Mammoth group of two claims is near the junction of Sumallo Creek with Skagit River, 23 miles east of Hope via the Hope-Princeton highway.

The claims are underlain by massive chert and greenstone of the Hozameen series, probably of Carboniferous or Permian age. These rocks are intruded at some distance from the property by post-Lower Cretaceous quartz diorite stocks. Within the intruded rocks is a belt, about 50 feet wide of lime silicate rock apparently formed from limestone. This belt contains the mineral bodies.

Scheelite was reported from this property in 1921 by C. E. Cairnes of the Geological Survey and R. W. Thomson of the British Columbia Department of Mines. Scheelite occurs with nickeliferous pyrrhotite in a vein about 3 feet wide that follows the west wall of the lime-silicate belt. Other minerals present in the zone are sphalerite, pyrolusite, strontianite, pyrite, chalcopyrite, galena, stibnite, jamesonite, boulangerite, some nickel minerals in addition to pyrrhotite, and probably grey copper. Some gold, silver, zinc and nickel are reported. No assays for tungsten have been obtained.

Granite Group (50)

References: Cairnes, 1923, p. 114. Stevenson, 1943, p. 116. Rice, 1947.

The Granite group of eight claims was staked in 1942 by S. Cunningham, R. Jameson, L. Marcotte, and A. A. Price, all of Coalmont. It is a few miles north of Hope Pass in the vicinity of Granite Mountain, and is reached by about 10 miles of trail from the end of the road up Whipsaw Creek, the end of the road being 22½ miles from Princeton.

The property is underlain by grey, slightly gneissic granodiorite and andesitic gneiss, cut by dykes and sills of granodiorite. Stevenson describes the workings in the following terms:

"Three old open-cuts, at elevations from 5,850 to 5,950 feet, spaced at intervals in a distance of 700 feet, exposed a vein (or veins), at the southern end following the contact between andesite and granodiorite and at the northern end entirely in granodiorite. In these exposures quartz, with some partly replaced wall-rock, ranges from a few inches to 3½ feet in width. The vein filling contains small amounts of pyrite, galena, sphalerite, and scheelite.

Assays of samples representing vein exposures at the time of examination (1942) ranged from: Tungstic oxide (WO_3), *nil* or trace to 0.05 per cent. Some grains of greenish scheelite up to ¼ inch long, were seen in pieces of quartz near the workings."

Merritt Area

The tungsten-bearing deposits of Merritt area were examined in 1943 by W. E. Cockfield of the Geological Survey and were described by him in Memoir 249. The following descriptions are reprinted from this publication.

"Last Chance Group (51)

(Swakum Mountain)

"*References:* B. C. Minister of Mines, Ann. Repts., 1917, pp. 233, 450; 1918, p. 239; 1924, p. 136; 1927, p. 213.

"The Last Chance group, consisting of thirteen claims, is located on the northern slope of Swakum Mountain, 13 miles by road north of Nicola. The property is in part a re-staking of the former Lucky Mike group, which had lapsed. The Lucky Mike claim was staked in 1916 as a copper prospect. A number of cuts were run on copper showings and a shipment of 22 tons of ore averaging 4.6 per cent copper was made from the surface showings in 1917. Granby Consolidated Mining, Smelting and Power Company, Limited, did a limited amount of diamond drilling on the claim that year, but dropped the option held on the property. The same year an option was taken by Northwestern Mines Limited, of Spokane, and a 50-foot shaft was sunk. The property subsequently lapsed, but was re-staked as a tungsten prospect in 1942, six claims, including the showings on the former Lucky Mike claim, being recorded by R. McD. Reid of Penticton. The property was optioned to W. B. Milner of Toronto in 1942 and additional claims were staked in 1942 and 1943 and registered in his name. The property was prospected by Mr. Milner, and some stripping was done and several cuts excavated. Fair values in tungsten were obtained at some points in the surface cuts, but as the surface material was oxidized a limited amount of drilling was undertaken for the Metals Controller in 1943 and in order to sample the showings. The claims have recently lapsed.

"The mineral deposits are situated on a small knoll that drops off sharply to the east, north, and west, but the area surrounding the knoll is only about 50 feet lower than the knoll itself. Most of this surrounding area is covered with drift.

"The deposit lies in a band of limestone that is included in the greenstones of the Nicola group. The contact of these rocks strikes northerly and dips steeply easterly. Swakum Mountain is probably the locus of an anticline with the limestone bands at the Last Chance located on the eastern limb of the fold. The limestone bands appear to be discontinuous and to consist of a series of lenses that outcrop at intervals for several miles to the south. The size of the limestone lens at the Lucky Mike is not known.

"The deposit is of the contact metamorphic type, being situated at the contact of the limestone and the greenstone and consisting of a gangue of lime-silicate minerals, chiefly garnet and epidote, carrying pyrite, chalcopyrite, and scheelite. The hanging-wall contact between the comparatively unaltered and altered limestone is quite irregular, and the deposit ranges from about 25 to about 75 feet in width (*see* Figures 11, 12). In the greenstone foot-wall are bands of calcareous material that are largely altered to epidote and garnet and that carry scheelite and copper minerals. These are believed to represent calcareous pods, now largely altered, within the greenstone. Granitic rocks are not known in the immediate vicinity of the deposit, nor were they encountered by drilling, which was carried to a maximum depth of 193 feet below the outcrop. A large batholith of granitic rocks outcrops between 2 and 3 miles east of the property, and isolated exposures of granitic rock occur in a drift-covered area on the north slope of the mountain some considerable distance from the mineral deposits. A number of quartz porphyry dykes cut the greenstones to the west of the mineral deposits, but the nearest is several hundred feet from the mineral deposits themselves.

"The deposit has an exposed length of 350 feet, but its extensions along strike are concealed by overburden at both ends. In the early trenching work the hanging-wall of the ore zone was not disclosed in the southern section owing to heavy drift cover, but it would appear from the drilling that the deposit is widest a short distance from its northern end and that it tapers rapidly from its central section towards the fault exposed in the trench near the southern end of the knoll; beyond this fault only one hole was drilled and the mineral zone appeared to widen again. The zone is thus from 25 to 75 feet wide, with an average width of about 40 feet. These figures then indicate a mineral zone of approximately 1,400 tons per foot of depth, and the deposit showed no change in character to a depth of 190 feet.

"The mineral zone consists of skarn rock composed very largely of garnet. Calcite and epidote are abundant, and chlorite and pyroxene occur. Locally quartz is present in irregular masses. Hematite is visible in much of the deposit, and is plentiful along fracture planes and joints in the skarn and in the greenstone. Chalcopyrite, pyrrhotite, and pyrite are present and in some places the chalcopyrite forms small masses that make up most of the drill core for short sections. The pyrrhotite and pyrite are generally disseminated through the rock. None of these sulphide minerals is confined to the skarn, and all may be found in the adjacent greenstones, where, however, they are most abundant in calcareous bands associated with abundant epidote. Scheelite occurs in grains, ranging from pin-point size to crystals about ¼ inch long. It is not confined to the main body of skarn rock, but occurs also in the limy bands within the greenstone foot-wall referred to above, and was observed in the old workings driven to explore the property for copper many years ago (*see* Figure 11). It was also observed in the greenstones on several surrounding properties, generally in calcareous bands, but not in amounts that would justify sampling.

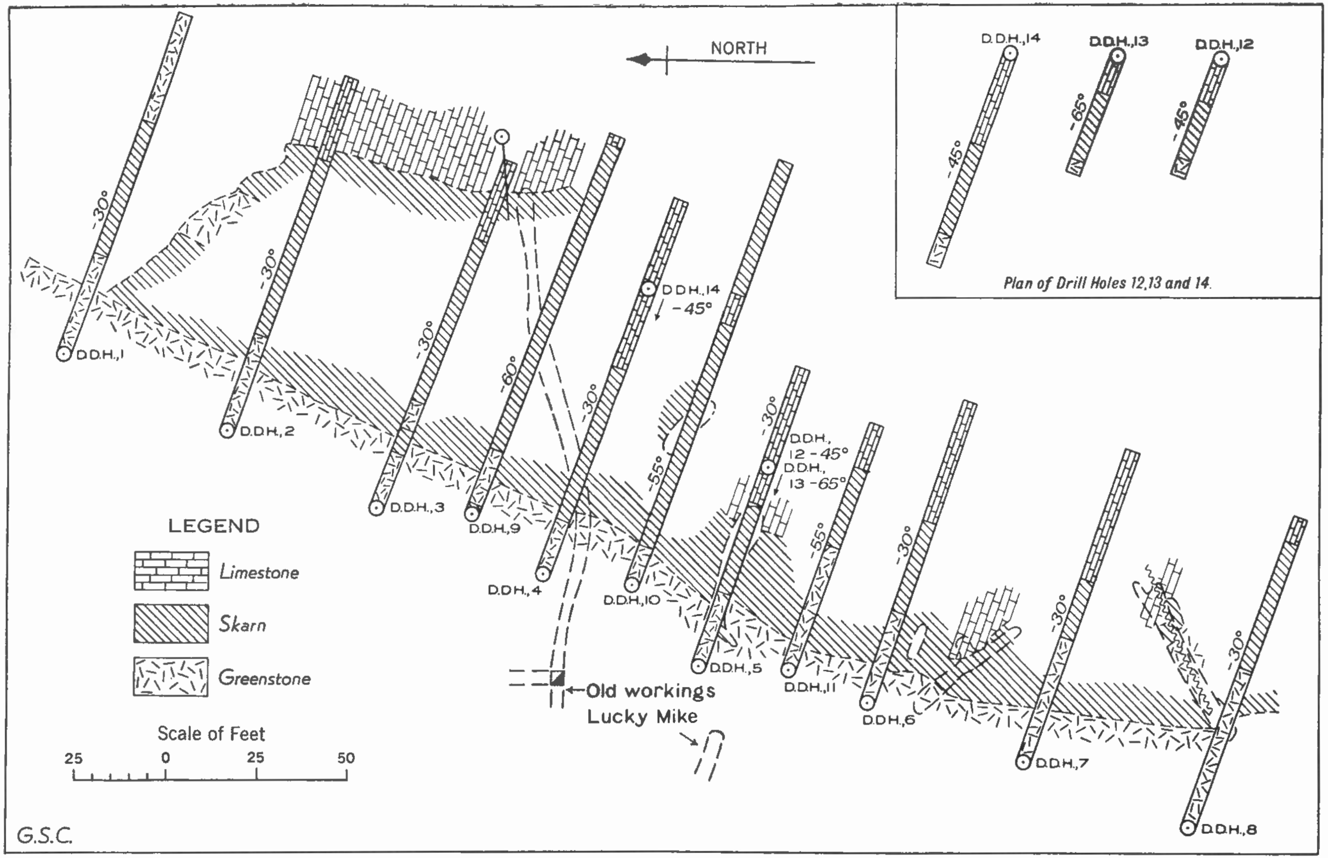


Figure 11. Last Chance group, Swakum Mountain, B.C., showing surface workings, drill-holes, and main geological contacts. (*After* W. E. Cockfield.)

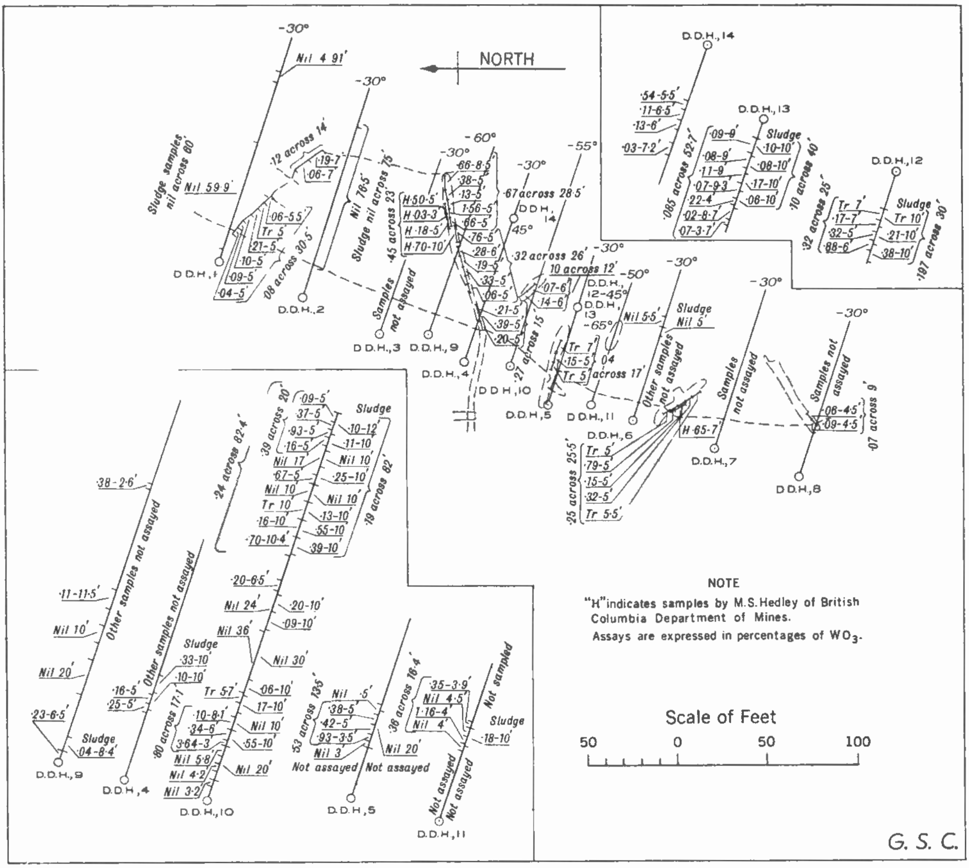


Figure 12. Assay plan, Last Chance group, Swakum Mountain, B.C. (*After* W. E. Cockfield.)

"Development work done on the property in the winter of 1942-43 consisted of a number of open-cuts and trenches (*see* Figures 11, 12) that partly outline the orebody. The southernmost cut does not expose the southern end of the orebody that is shown by drilling to extend beyond the fault in that cut, but the overburden in this direction was considered too thick to trace the body farther by means of trenches. Similarly, at the northern end the orebody is exposed in a working that is for the most part a face blasted from a rock outcrop. It consists of two bands of lime-silicate rock separated by a horse of greenstone. The other cuts show the orebody to be at its widest towards the northern end, tapering towards the fault in the southernmost cut. Assays by the operators and by Buffam and Hedley[1] are shown on Figure 12. The writer took no samples of the surface showings. The average of the surface samples taken by the operators and by W. S. B. Buffam indicates a value of 0.25 per cent WO_3 across an average width of 34 feet, or, including Hedley's samples, which are obviously character samples taken at some of the better showings, 0.28 per cent WO_3 when weighted for the widths across which the samples were cut.

[1]Hedley, M. S.: British Columbia Department of Mines, unpublished report.

"It was felt by Dr. Buffam that this figure did not necessarily represent the true value of the deposit, because some of the trenches did not reach the hanging-wall and because the shattered and oxidized character of the surface rock made it difficult to secure satisfactory samples. A program of drilling was recommended by him to consist of eight holes spaced at intervals of 50 feet along the strike of the deposit and drilled at angles of minus 30 degrees. These holes were drilled from the foot-wall side, because of better set-ups for the drill on that side of the deposit and because, owing to the steep dip of the formation, the holes would not be lengthened greatly (*see* Figures 11, 12).

"The drilling was done under the writer's (Cockfield's) supervision, and samples were taken of the core across the entire ore zone. The cores were examined with an ultraviolet light, but after the first few holes were drilled and complete assays made it was found unnecessary to assay sections of the core that did not show a fair amount of scheelite. Complete assays were made for holes, 1, 2, 10, 12, 13, and 14 (*see* Figure 12). For the remaining holes a number of samples were picked for assay, chiefly at those points where the ultraviolet light showed most tungsten in the cores. Hole 1 encountered a narrow band of skarn rock consisting largely of calcite, epidote, and limonite, and then continued in alternating bands of greenstone and calcareous rock carrying considerable epidote. At 65 feet the drill entered greenstone with comparatively few calcareous bands to 122 feet where drilling was stopped. A limestone hanging-wall was not found, although limestone occurs at the surface a few feet from the hole. It is believed that the limestone lens is pinching out in this direction, possibly to be replaced by another lens slightly farther to the east. The hole showed no scheelite. The other seven holes of this set, Nos. 2 to 8, showed the normal succession of greenstone, mineralized skarn rock, and then limestone. A number of soft porphyry dykes were encountered in the skarn rock. Hole 2 also showed nil across the ore zone, although the zone was massive garnetite. Holes 4 and 5 showed rather more scheelite than the other holes, and holes 9, 10 and 11 were drilled at steeper angles to test the possibility of an ore shoot occupying this part of the body. Holes 12, 13 and 14 were short holes drilled from the hanging-wall towards the foot-wall along the lines of holes 4 and 5 to test the orebody below the zone penetrated by these holes (*see* Figures 11, 12). The average of all samples assayed from the cores of the holes, properly weighted for the widths over which the samples were taken, is 0.15 per cent WO_3. If, however, those parts of the zone of which the samples were not assayed be included, and if it be assumed that these samples would show nil upon assay, the average content would become 0.095 per cent WO_3. The average content of WO_3 can, therefore, be assumed to lie between these two figures and probably closer to the lower than to the higher figure. The average of the sludge assays from all holes except No. 14, from which no sludge was recovered, was 0.046 per cent WO_3. However, the average values of those assays made from holes 4, 5, 9, 10, 11, 12, 13, and 14 was 0.217 per cent WO_3 across an average width of 25 feet, a figure approximating the average obtained in the surface cuts. If the same assumption be made as before, that those samples which were not assayed would yield *nil* upon assay, the average for this area would become 0.147 per cent WO_3. The average for this part of the deposit, therefore, lies between these two figures, probably more closely approximating the latter than the former. No samples were assayed for gold or for copper. The conclusion reached is that the average of this part of the zone is too low grade to be considered commercial, and that although streaks of good scheelite mineralization occur they cannot be related into ore shoots.

"*Genesis.* The ore deposit is so typical of the contact-metamorphic or pyrometasomatic type that little need be said with regard to its genesis. The alteration of limestone to skarn is commonly accepted as forming the type example of this class. In this particular case the deposit appears to be situated at some distance from the intrusive rock responsible for the metamorphism. Although the ore zone is situated at the contact between greenstone and limestone it is not thought that the greenstone is in any way genetically associated with the formation of the ore, although contact may have had a structural effect in localizing the mineralization. The greenstone is itself metamorphosed and carries some of the ore minerals. It is thought that the ore-bearing solutions emanated from an intrusive body that is not exposed at the surface, either because it lies in the drift-covered area or has not been bared by erosion. Although isolated outcrops of granitic rock appear in a drift-covered area several thousand feet to the north of the property and aplite dykes occur in the vicinity of the showings, it is believed that the intrusion responsible for the mineralization lies below the deposit, in which case the limiting factor might be the size of the limestone lens rather than the position of the granitic rocks."

"*Gold Gossan Group (52)*

"The Gold Gossan group consists of the Gloria No. 1 and Gold Gossan No. 2 claims, owned by Oscar A. Schmidt of Burns Lake, and the How claim, owned by M. H. Laidlaw of Merritt.

"Showings of the group are on the steep slope of a small ridge on the Gold Gossan No. 2 claim. Narrow veins and bunches of copper and silver-lead minerals appear at points on a small bluff of greenstone. At the northern end of the showings on the cliff face is a lode that varies from 6 to 14 inches in width striking west and dipping north at 17 degrees. The lode shows narrow veins of quartz and much silicified greenstone with bunches of pyrite and chalcopyrite. In the greenstone even at some distance from the lode are small irregular bands of calcareous material carrying considerable epidote and grains of these sulphides. A short distance south of this showing the lode shows two stringers of quartz with the foot-wall stringer showing masses of galena. Minor amounts of scheelite appear in the lode and in the adjacent greenstone, but in no place in sufficient quantity to be deemed worthy of sampling."

Pits, trenches and an adit have been made elsewhere on the property and these expose veins of quartz containing a little pyrite and chalcopyrite, but no scheelite.

"Consolidated Nicola Goldfields, Limited (53)

"The property of this company embraces a large tract of land extending from the eastern shore of Stump Lake to the hillside east of the Kamloops-Merritt highway. It is situated about half way between Merritt and Kamloops, and consists of upwards of one hundred and twenty claims, having an area in excess of 5,500 acres.

"Some of the claims in the vicinity of Mineral Hill were staked between 1882 and 1885. Work by Nicola Mining and Milling Company prior to 1890 included the sinking of the Joshua, Tubal Cain, and King William shafts, whereas the Star Company put down the Star (Enterprise) and Planet shafts. Work was suspended around 1890, and there appears to have been comparatively little work done until 1916 when Donahue Mines Company, Limited, of Seattle, started work on the Joshua and Tubal Cain veins. A mill was built by this company, but was only operated for a short time. Operations by the company were stopped in 1920.

"In 1925 Planet Mines and Reduction Company, Limited, started work on the Enterprise vein. The shaft was deepened to the level of the present crosscut adit (320 feet) and the adit itself was driven. A mill was built and operated from 1929 to early in 1931, when the company stopped work. Nicola Mines and Metals Company acquired the property of the Planet Company and in addition a number of other claims. The company did development work on the Joshua, Tubal Cain, and Enterprise veins and there was some production. In 1937 a reorganization took place whereby the present company, Consolidated Nicola Goldfields, Limited, acquired the holdings of Nicola Mines and Metals and the other groups. From 1939 to 1942 the company was developing the mine and rebuilding the mill. . . . .

"Figures supplied by the British Columbia Department of Mines show that the mines owned by this company have produced 77,605 tons of ore, which yielded 8,494 ounces of gold, 252,939 ounces of silver, 40,822 pounds of copper, 2,205,444 pounds of lead, and 367,869 pounds of zinc. This production was in the period from 1916 to 1944.

"The property contains several veins. Of these the Enterprise, King William, Tubal Cain, Joshua, Jennie Long, and Johannesburg have received the most attention. Nearly all of the ore mined covered by the figures given above came from the Enterprise and King William veins . . . "

The property is underlain by flows of massive basalt with interlayered tuff, volcanic breccia and sediments. The sediments contain fossils of late Triassic age. The strata lie in a syncline whose axis strikes a little west of north. A series of small folds probably is developed on the limbs of the major syncline. Intrusive rocks, chiefly quartz diorite, are present in the area 3 miles to the west and 8 miles to the northeast of the property. The lavas, sediments and intrusive rocks are overlain by flows of lava and cut by dykes of basalt probably Tertiary in age.

The mineral deposits are veins of quartz and calcite following fractures striking north to northwest and dipping east at from 50 to 80 degrees. Some veins have been traced continuously 1,500 feet along the strike. The width varies from an inch to 9 feet. Scheelite is present in many veins but its content is low except at a few points where this mineral is plentiful. The veins have been mined for their content of galena, sphalerite, tetrahedrite, chalcopyrite and bornite. Free gold occurs and pyrite, pyrrhotite and arsenopyrite are widespread.

Full details of the geology of the property and the amount of drifting and crosscutting completed prior to 1942 on the veins and the approximate size of the known lead-zinc-silver-gold ore shoots are given in Memoir 249 by Cockfield, pp. 47-57. The meager data with reference to the tungsten content of the veins are based on the report by Cockfield published in Bulletin No. 10 (revised) 1943. by the British Columbia Department of Mines.

All known dumps and underground workings where accessible were examined using an ultraviolet lamp. This method of indicating the possible content of tungsten, however, may not be satisfactory for other minerals may be present that carry little or no tungsten but fluoresce similarly to scheelite. Minerals that fluoresce are widespread and where strong fluorescence was had samples were collected for assay. On the basis of the few assays and the many lamp readings, the indicated average tungsten content of the deposits known at present is low.

The results of the preliminary study suggested that the King William, Jenny Long and Joshua veins were the most promising as a source of tungsten, accordingly these deposits were studied in some detail. A length of 10 feet of the King William vein on the 320-level contains abundant scheelite indicated by a fluorescence and there a width of 36 inches assayed 0.52 per cent WO_3 and 24 inches 0.29 per cent WO_3. Elsewhere in the part of the workings examined scheelite, although widespread, is not as plentiful as at the location sampled. Samples were collected from some twenty additional points of what was judged the best material exposed and these assayed from 0.02 per cent WO_3 to 0.15 per cent WO_3. Grab samples selected from the dump at the Jenny Long shaft assayed *nil* to 0.06 per cent WO_3. The quartz of some specimens on the dump at the Joshua shaft carries abundant scheelite, but most quartz is without scheelite. This dump has not been sampled. In the underground workings no scheelite is known on the 100-foot level; on the 200-foot level one occurrence is known; and on the 300-level grains of scheelite were observed at nine places. The source of the quartz carrying abundant scheelite was not located. Samples were cut at the points along the workings considered to represent the best grade material and these returned 0.01 to 0.08 per cent WO_3.

Don (Scottie) Group (54)

Reference: Cockfield, 1948, pp. 58-60.

The Don group of eight claims, staked by W. McMaster, Murray Doyle, and Don Matheson, covers the crest of a ridge overlooking Stump Lake Valley, at a point about 1 mile east of the Merritt-Kamloops highway.

The property has been explored by shallow shafts and open-cuts. Scheelite was noted only at an inclined shaft 50 feet deep. This shaft "follows a vein zone striking north 10 degrees west and dipping 35 degrees northeast. At the bottom of the shaft the zone is 5½ feet wide, and carries veins and stringers of quartz and calcite. At this point the hanging-wall shows 18 inches of vein quartz. Very little sulphide appears in the zone. Small amounts of scheelite appear in the quartz from the bottom of the lagging, which extends one-quarter of the way down the shaft, to the bottom of the shaft. Two channel samples, the first cut across 35 inches of the north wall of the shaft at the bottom, and the second across 34 inches 20 feet from the bottom, assayed 0.05 per cent WO_3 and 0.25 per cent WO_3 respectively."

Hedley Area

Jupiter Group (55)

Reference: Bostock, 1940.

The Jupiter group of seven claims and a fraction was examined by W. E. Cockfield of the Geological Survey in 1942, and the following account is summarized from his unpublished report.

The claims, owned by C. Tambeau, H. Glynne of Hedley and C. D. Collen of Oliver, were staked in 1942, and lie on both sides of Hedley Creek about 3 miles by road northeast of Hedley.

The mineral showings occur in limestone beds within the Hedley formation of Triassic age, at or near the contacts with diorite. The sedimentary rocks form one limb of an anticline, and the beds strike slightly west of north and dip 45 to 50 degrees west.

The mineral deposits are from less than a foot to 10 feet wide and occur in skarn consisting of garnet, epidote, and pyroxene, with pyrrhotite, pyrite, chalcopyrite, arsenopyrite, molybdenite, molybdian scheelite, and scheelite. Galena was noted in a group of veins exposed in a cut.

Some of the skarn beds persist for more than 100 feet along the strike, but others end within a few feet. Ore minerals are on the whole rather sparse.

The mineral deposits are exposed in cliff faces, in two short adits and in small trenches. Although scheelite and molybdian scheelite are sparsely disseminated at eleven localities, one sample taken for assay contained only a trace of WO_3; six other samples assayed *nil* WO_3. Molybdenite is more widespread and abundant in the showings than scheelite, but, although no assays were made for molybdenum, the skarn probably is not ore.

Nighthawk Group (56)

Reference: Bostock, 1940.

Scheelite was reported on this property, about a mile southeast of Nickel Plate mine, and W. E. Cockfield of the Geological Survey visited the locality in 1943. Although a fluorescent mineral resembling scheelite was observed sparsely disseminated in skarn near granodiorite, eight samples taken by Dr. Cockfield, assayed *nil* WO_3.

Good Hope Group (57)

Scheelite-bearing deposits were reported on this property on the southeast slope of Nickel Plate Mountain, adjoining the Nighthawk group. Examination of the property in 1943 by W. E. Cockfield of the Geological Survey revealed skarn deposits containing sulphides, a telluride (hedleyite?), free gold, and a fluorescent mineral resembling scheelite. Seven channel samples taken by Dr. Cockfield assayed *nil* WO_3.

Billy Goat Group (58)

References: Minister of Mines, B.C., Ann. Repts., 1900, p. 884; 1901, pp. 1074, 1160; 1902, p. 185; 1905, p. 254; 1906, p. 166; 1907, p. 117; 1909, p. 136; 1917, p. 207. Bostock, 1941*a*.

This property is on the summit of Riordan Mountain, about a mile east of Nickel Plate Lake. An examination of the property was made in 1943 by W. E. Cockfield, of the Geological Survey. In his unpublished report he states that rocks ranging in composition from granite to gabbro intrude rocks of the Wolfe Creek and Hedley formations. Limestone of these formations has been altered to skarn at and near the contacts with the intrusions. The skarn contains disseminations of pyrrhotite, chalcopyrite, and pyrite, and masses of quartz. A fluorescent mineral resembling scheelite occurs as fine disseminations and as buff to light brown masses up to 3 inches in diameter. No samples were taken for assay.

Ben Williams Prospect (59)

Reference: Bostock, 1941*a*.

In a communication to the Chief Geologist, dated November, 1942, W. E. Cockfield of the Vancouver office of the Geological Survey gives the following information about this property.

The deposit is situated near the junction of the Yellow Lake and Olalla-Penticton roads, about 1,900 feet above the valley, and was located by Ben Williams of Keremeos. The property has been optioned by Kelowna Exploration Company of Hedley. One trench is reported to expose garnetite, within a bed of limestone and selected specimens of garnetite are reported to assay from about 2 to about 5 per cent WO_3. A specimen selected from the find by a prospector is of an altered rock containing hornblende, actinolite, quartz, pyrrhotite, and scheelite.

Vernon Area

White Elephant Group (60)

References: Cairnes, 1932, pp. 79, 87. Stevenson, 1941, pp. 77, 78; 1943, p. 117. Rice, 1946.

The White Elephant property, owned by Pre-Cambrian Gold Mines, Limited, is 2 miles west of Okanagan Lake and about 17 miles south of the head of this lake. The workings have been inaccessible for many years.

The lenticular mass of vitreous, white quartz 50 feet wide and 60 feet long on the surface, but longer underground, lies within granitic rocks of late Mesozoic age. Near the walls the quartz has been mineralized by pyrrhotite, pyrite, chalcopyrite, tetradymite, and gold. Cairnes states that scheelite was reported to be associated with quartz of the outcrop.

Beaverdell Area

Elite Claim (61)

References: Reinecke, 1915, p. 742. Stevenson, 1941, pp. 78, 79; 1943, pp. 117, 118.

This property was examined in August, 1940 by J. S. Stevenson of the British Columbia Department of Mines, who described it as follows:

"This prospect consists of the Elite mineral claim staked in July, 1940, and owned by Victor F. Locke, of Kelowna.

"The claim is on the west side of Arlington Mountain, approximately 5 miles north of Carmi. Carmi is on the Beaverdell-Kelowna road 5 miles north of Beaverdell. The workings are 1½ miles west of the highway.

"The workings, at an elevation of 3,500 feet, may be reached by following a compass-line on a bearing (astronomic) of north 30 degrees west for 1½ miles from a point, elevation 2,900 feet, on the Carmi-Kelowna road that is 5 miles north of Carmi.

"The hillside in the vicinity of the showings is the gentle westerly slope of Arlington Mountain. It is densely wooded and although covered by only a foot or two of overburden in many places, outcrops in the vicinity of the workings are scarce.

"The scheelite showing consists of an area approximately 15 feet in diameter of calcic-silicate rock that contains scattered grains of scheelite. Quartz-diorite occurs 50 feet northerly from the workings.

"The calcic-silicate rock consists of light green, dense diopside, granular, brown garnet and some granular calcite and epidote and quartz.

"The scheelite occurs as grains disseminated throughout the rock, showing a preference for areas of quartz and, occasionally, as short-hair-like veinlets in quartz. The amount of scheelite is so small that samples of selected specimens in excess of 5 pounds are usually too low in scheelite to give a recordable assay in tungstic oxide, WO_3.

"All the workings are old, apparently antedating the year 1915, the date of publication of a report by Reinecke in which he mentions the scheelite occurrence. No recent work other than sampling of the small dumps has been done on the showings.

"The workings consist of three pits. An upper one 6 feet in diameter by 6 feet deep; a second one 5 feet lower and 15 feet westerly from the first and 5 feet in diameter by 4 feet deep, and a third one, 10 feet below the second and 40 feet in a direction south 20 degrees west from it. All these pits show small amounts of scheelite."

Kettle River Occurrence (62)

References: Stevenson, 1941, pp. 79, 80; 1943, pp. 118-119.

The Kettle River scheelite occurrence is on the east bank of Kettle River, opposite the Beaverdell-Carmi road, 5 miles from Carmi. The deposit was shown to Stevenson in August, 1940 by Victor F. Locke, owner of the Elite claim. It occurs in a band of garnetiferous limestone 100 feet thick and 500 feet long, throughout which scheelite is sparsely disseminated, though it is a little more abundant in places, where clusters of brown garnet occur. It is too low grade to be of economic interest.

Knob Hill Occurrence (63)

References: Stevenson, 1941, p. 80; 1943, p. 119. Reinecke, 1915.

The Knob Hill scheelite occurrence is about 7 miles northeast of Beaverdell. The shaft and pit, at an elevation of 4,300 feet, are west of the road up Beaverdell Creek.

Bedrock is metamorphosed sedimentary rocks of the Wallace group of Permian (?) age, intruded by granite of late Mesozoic age. A band of lime silicate rock is exposed in a shaft, a pit and a trench. The age of the deposit is unknown. Scheelite occurs sparsely disseminated throughout the lime silicate rock, but Stevenson judged the average grade to be low.

Revelstoke Area

Ole Bull and Orphan Boy (64)

Reference: Stevenson, 1943, p. 120.

"Small amounts of scheelite have been found in these properties which were prospected for gold in the 1890's. The area is reached by following an old pack horse trail which leaves the Big Bend highway 54 miles north of Revelstoke. From the highway the trail follows the north side of Goldstream River for $4\frac{3}{4}$ miles to McCulloch Creek, thence northeasterly up the creek for $5\frac{3}{4}$ miles to the Ole Bull cabin, elevation 6,100 feet.

"The rocks on the property include quartzite and mica schist. These rocks are cut by a number of prominent quartz veins.

"Several of the quartz veins on the property contain small amounts of scheelite. The veins are lenticular and range in width from a knife edge up to 7 inches within a few feet. The scheelite is usually found as pin-points, occasionally in grains the size of rice, and, in one place, in patches 2 inches in diameter.

"Specks and small patches of scheelite have been found in quartz veins and lenses cut by the adit on the Orphan Boy claim, adjacent to the Ole Bull.

"None of the veins so far exposed on these properties contains sufficient scheelite to be mined."

Columbia Lead and Zinc Mines, Limited (*65*)

References: Minister of Mines, B.C., Ann. Repts., 1917, p. 182; 1918, p. 155; 1919, p. 140; 1925, p. 259; 1926, p. 270; 1927, p. 289; 1928, p. 312; 1929, pp. 331-333; 1930, p. 259; 1938, p. E44; 1940, p. 87; 1941, p. 81; 1949, p. 209; 1950, pp. 158, 159; 1951, p. 193. Gunning, 1929, pp. 182-187. Alcock, 1930, pp. 313, 314. Bureau of Mines 1932*a*; 1938*b*; 1943*b*. Stevenson, 1941, pp. 82-92; 1943, pp. 120-130. Lord, in "Structural Geology of Canadian Ore Deposits", 1948, pp. 197-199.

The property of Columbia Lead and Zinc Mines, Limited, comprises the Snowflake and Regal Silver (Woolsey) groups of claims, near the headwaters of Clabon Creek about 5 miles north of Albert Canyon. The camp is connected to the main line of the Canadian Pacific Railway at Silver Siding by 7½ miles of road.

The original group of four claims was staked by C. E. Kennedy. In 1917, D. Woolsey leased these claims and in the following year added three claims to form the Woolsey group. Development work and a small production from hand-picked lead-zinc-silver ore were continued through the summer of 1919. In 1925, the property, expanded to thirty-six claims, was acquired by Bernier Metals Corporation. In 1928 Morton-Woolsey Mines, Limited, acquired the property and subsequently Regal Silver Mines, Limited, held the claims. The deposit was operated in 1939 by A. S. MacCulloch and associates. Additional development and tests continued until 1941.

In 1949, Stannite Mines, Limited acquired the Regal Silver and Snowflake groups. The latter group was staked in 1918 by Ole Sandberg and Gus Hedstrom on the Regal Silver lead above and to the west of the Woolsey (Regal Silver) group, and the deposits were operated by Snowflake Mines Limited. These two properties were acquired in 1951 by Columbia Lead and Zinc Mines, Limited, and exploration of the veins by diamond drilling was undertaken and the campsite enlarged. A mill to produce tungsten concentrate was planned to commence operation in 1953.

The rocks exposed on the property are siliceous and calcareous slate within a thick sedimentary assemblage probably of Precambrian age. The strata strike about northwest and dip 30 to 60 degrees northeast, and form part of the southwest limb of a synclinorium. In the mine at depth, the dip flattens and minor folds are unknown.

The veins occupy strike-faults, and traverse faults displace them up to 115 feet. Two main veins are known; these are roughly parallel, about 250 feet apart, strike northwest, and dip about 35 degrees northeast. Lord describes the upper, or northeast vein as the "A" vein, and the other the "B" vein. These veins vary in width from a few inches to 25 feet, and have been explored for a length of 850 feet.

The main, or "A" vein, is developed 320 feet up the dip from the 10th to the 8th level, and probably is continuous 1,000 feet farther up the dip to the 3rd level. "B" vein is less extensive and on the 10th level is terminated on the northwest by a strike fault.

The veins contain numerous inclusions of slate and show ribbon structure. They consist mainly of banded, white quartz within which sulphide minerals are distributed parallel to the banding, and, in a few places, as small masses filling vugs in the veins.

Stannite, a tin-bearing sulphide, was discovered in "A" vein on the Snowflake group, and this mineral is most abundant in the vein on the Regal Silver group above the Snowflake level. Scheelite occurs in small amounts throughout the larger veins, but only a few specks have been found in the smaller veins. It is most abundant below No. 5 level. Sufficient ore, averaging about 0.5 per cent WO_3, is reported[1] on Nos. 8, 9, and 10 levels for one year's operation at 100 tons a day.

Lardeau Area

United Victory Group (66)

References: Minister of Mines, B.C., Ann. Repts., 1942, p. 79; 1943, p. 78. Stevenson, 1943, pp. 130, 131. Walker, Bancroft, and Gunning, 1929, Map 235A.

The United Victory group is on the east side of Incomappleux River, at an elevation of about 3,000 feet, between Boyd and Kelly Creeks. It can be reached from Beaton by 12 miles of road and 5 miles of trail.

The claims were located in late August, 1942, by Bert Oakey and Henry Gunterman of Beaton. Bralorne Mines, Limited optioned the property in 1942, and the Consolidated Mining and Smelting Company of Canada, Limited the following year. The latter option was dropped in November, 1943.

The deposit is in a bed of skarn about 5 feet thick, and is exposed in outcrops for 1,000 feet along the strike. Above the skarn is limy schist and limestone, presumably of the Lardeau series of Precambrian (?) age, and below is a sill of granite. Samples from the showing were examined by A. W. Joliffe, who state[2]: "Most of the samples submitted are mainly massive garnet with disseminated specks of scheelite up to $\frac{1}{20}$ inch across. One sample shows scheelite crystals in a medium-grained mixture of amphibolite (?), garnet and other lime silicates. The scheelite fluoresces yellow-white to white and probably contains some molybdenum replacing tungsten."

No assays have been reported from this property.

Lucky Boy Group (67)

References: Minister of Mines, B.C., Ann. Repts., 1902, p. 140; 1903, pp. 123, 125; 1904, pp. 117, 118; 1905, p. 154; 1906, p. 138; 1912, p. 151; 1914, p. 317; 1929, p. 337; 1930, p. 266; 1933, p. 216; 1942, p. 79; 1943, p. 79. Brock, 1904, pp. 71-72. Walker, Bancroft, and Gunning, 1929, pp. 83, 84. Stevenson, 1943, pp. 131-133.

The Lucky Boy group, consisting of eight claims, is owned by C. H. Tillen of Trout Lake, and is 3 miles due west of that village, from which the claims are accessible by good pack-trail. The Horseshoe claim, owned by L. Hillman

[1] *Can. Inst. Min. Met.*, Bulletin, vol. 46, No. 489, p. 32. (Jan., 1953.)
[2] Brief report in the mineral files of the Geological Survey.

of Ashcroft, adjoins the group on the west. Both properties were worked originally for lead and silver. From the Horseshoe claim, 31 tons of silver-lead ore were mined and shipped from 1904 to 1912. The Lucky Boy group, up to 1912, produced 434 tons of ore that ran between 200 and 300 ounces silver a ton, and between 20 and 35 per cent lead. Exploration and sampling were carried out in 1914, 1929, 1930, and 1933, but no further shipments are recorded.

Scheelite was discovered in the vein in 1942, and the property was described by S. S. Holland of the British Columbia Department of Mines (Stevenson, 1943, pp. 131-133).

"The vein strikes slightly north of east, dips 20 to 30 degrees southward and crosses the steeply north-dipping formation almost at right angles. The host rock is predominantly schist, but on the lowest level a bed of limestone forms the walls. The vein ranges from 6 inches to 6 feet in width and throughout probably averages between 1 foot and 2 feet. The gangue is white drusy quartz; sulphide mineralization consists of galena, tetrahedrite, sphalerite, chalcopyrite and pyrite; a little native silver occurs locally. Scheelite is present in the vein in small grains and masses up to several square inches in area.

"The vein was traced on the surface for about 500 feet by several open cuts and two old caved adits. The underground working on the Lucky Boy is an incline shaft close to the Horseshoe line sunk on the dip of the vein for 190 feet. From it three levels have been driven as drifts on the vein at distances of 65, 85, and 155 feet respectively from the collar of the shaft.

"The highest, No. 1, level is driven westerly from the shaft and a small stope put in above it. The vein as exposed is narrow and contains little sulphide. There is little or no scheelite in the vein on this level.

"The No. 2 level was driven east and west from the shaft; the east drift, for a distance of 230 feet with several short raises up the dip; the west drift for 120 feet and most of the ground up to No. 1 level was stoped. At 57 feet from the shaft scheelite mineralization is present in the remaining pillars along the drift and extends westerly for about 40 feet. It shows in the backfill in a raise 85 feet west, and on the west side of a second raise 100 feet west of the shaft. The scheelite mineralization makes an attractive display on the west side of this raise from 5 to 14 feet up from the level. Four samples in this section averaged 3.67 per cent tungstic oxide across an average width of 29 inches.

"On the lowest level, No. 3, a drift has been driven east for 130 feet and a raise put through to No. 2 level but most of the vein remains unmined. At the corner of the shaft and the No. 3 level, scheelite mineralization extends 23 feet east on both walls of the drift on the No. 3 level and extends 30 feet up the shaft from the bottom level. Six samples from the No. 3 level east of the corner averaged 0.41 per cent tungstic oxide across 33 inches and seven samples up the shaft on the east wall for 30 feet averaged 0.63 per cent tungstic oxide across 35 inches.

"No. 3 level is driven 140 feet west of the shaft and most of the vein up to No. 2 level has been explored or mined. Scheelite occurs in the vein in a raise 70 feet west of the shaft as well as in pillars and unmined vein between No. 2 and No. 3 levels. There is no scheelite in No. 3 level in the west end.

"Scheelite also occurs in the same vein on the Horseshoe claim in a surface exposure between the two shafts, also along the wall of the easternmost shaft and for a length of 12 feet in a drift driven east from the same shaft.

"The distribution of the scheelite mineralization falls within the limits of a shoot raking eastward from the surface exposure on the Horseshoe through the raise on the west end of No. 2 level to the area between No. 2 and No. 3 levels. The exposure of scheelite on the east side at the interesection of the shaft and No. 3 level appears to be separated by a barren section suggesting that it is the apex of another shoot. No faulting was observed that would displace the vein were it part of the same shoot.

"There is no development below the No. 3 level. At that depth the vein fracture crosses a limestone bed but its persistence through, and mineralization within the limestone are not proven by the present workings.

"Most of the scheelite-bearing shoot was mined in the course of the earlier work. There was about 4,000 tons of material on the dump which at the time of examination (September 20, 1942) was being sorted at night under an ultra-violet light for scheelite. Up to that time 25 tons of ore had been sorted and sacked for shipment. A grab sample of the rough sorted ore assayed 1.41 per cent tungstic oxide and 0.63 per cent phosphorous. In spite of the fact that much of the scheelite-bearing vein had been mined it is estimated that above the third level there is possibly 200 tons in pillars and unmined sections of the vein, an unknown but small amount of broken material as backfill in stopes, and an unknown tonnage (possibly 100 tons or more) in the section west of the high-grade spot on the westernmost raise on the second level and extending to the Horseshoe workings.

"The complete extraction of the underground material is probably impossible owing to the poor condition of the workings and not economic owing to the amount of rehabilitation work necessary. However, several underground sections which could be reached easily and safely could produce a small tonnage of scheelite ore."

A few tons of the hand-cobbed ore mentioned above was sent to Ottawa for treatment, early in 1943.

Copper Chief Claim (68)

Reference: Walker, Bancroft, and Gunning, 1929, p. 84.

The Copper Chief claim adjoins the Lucky Boy group and Horseshoe claim on the southwest. Three veins are exposed, from which a few tons of silver-lead-zinc-copper ore have been shipped. Scheelite was reported in 1942 by the owner, A. D. Oakey, and was said to be particularly abundant in a bedded vein of pyrrhotite, 8 to 14 feet wide. Samples sent to the Metals Controller in 1943, however, had a low tungsten content.

Erdahl and Pinchbeck Group (69)

Reference: Minister of Mines, B.C., Ann. Rept., 1945, pp. 107, 108.

This property, consisting of five claims, staked in 1945 by R. E. Erdahl and J. E. Pinchbeck of Trail, is on the northeast side of Duncan River near Cockle (Bear) Creek, about 10 miles north of the head of Duncan Lake, from which it can be reached by boat or trail.

The rocks on the property are greyish green and brown schist, gneiss, limestone, and quartzite of the Hamill series, probably of Precambrian age. Veins, stringers and lenses of quartz, striking north 5 to 25 degrees east and dipping 40 to 80 degrees east, intersect the foliation at large angles. The veins vary in width from less than 1 inch to 17 inches and occupy a zone about 500 feet long. The vein-matter consists of glassy quartz, tourmaline, amphibole, mica, and carbonate, and is commonly banded parallel with the walls. Sulphides are pyrite, pyrrhotite and galena. Scheelite is sparsely disseminated in the veins.

Assays prove the presence of a small amount of gold, silver, copper, tin and beryllium, and a little lead. Four assays for tungsten yielded *nil* to a trace WO_3, and two yielded 0.03 per cent and 1.90 per cent WO_3, respectively.

Slocan Area

Scranton Consolidated Mining Company, Limited (71)

References: Cairnes, 1935, pp. 241-244. Stevenson, 1941, p. 94; 1943, p. 156. Minister of Mines. B.C., Ann. Rept., 1951, p. 163.

The property of this company is on Pontiac Creek in Kokanee Glacier Park, and is served by a private road 11 miles long up Woodbury Creek, from the Nelson-Kaslo highway. The claims include those of the Pontiac, Scranton, and Sunset groups and are underlain by porphyritic granite of the Nelson batholith. The granite is traversed by a shear zone that strikes north 25 degrees east and probably crosses claims of the three groups. Within the shear zone quartz veins contain galena, pyrite, sphalerite, and silver minerals. Scheelite occurs in the veins, but no indication of the quantity present has been published.

Meteor Group (72)

References: Minister of Mines, B.C., Ann. Rept., 1903, p. 138. Cairnes, 1935, pp. 179, 180. Stevenson, 1941, p. 94; 1943, pp. 155, 156.

The Meteor group of three Crown-granted claims is on the northwest slope of the divide between Springer and Lemon Creeks, at an elevation of 6,700 to 7,000 feet. A branch road from that along Springer Creek passes a few hundred feet below the workings. The property has produced a few hundred tons of gold-silver ore, but has been inactive since 1940, when it was worked by leasors.

The rock is sheared, coarse-grained, porphyritic granite of the Nelson batholith, in which a vein of irregular shape strikes north 75 degrees west and dips about 35 degrees north. The vein is of quartz, with some sphalerite, galena, tetrahedrite, stephanite, argentite, and native silver. About 500 pounds of scheelite was removed from the vein in 1903, where it occurred as lenses 2 to 3 inches wide and 1 foot to 3 feet long. This was the first discovery and production of tungsten in the province. Cairnes states that this scheelite was on No. 2 level, and reports another small kidney of scheelite, weighing about 25 pounds, on No. 4 level.

Lower Arrow Lake Area

Groundhog Group (73)

References: Minister of Mines, B.C., Ann. Rept., 1942, p. 82. Stevenson, 1943, pp. 152, 153.

This property was examined by Stevenson in October, 1942, and the following is, in part, his description:

"This group of 5 claims was staked by Joe Gallo of Nelson in 1942, and was optioned by Bralorne Mines Ltd. who relinquished the option after doing a small amount of stripping. It is on the east side of Arrow Lake, 6 miles from Deer Park by logging road and 2,000 feet in elevation above the lake.

"Sedimentary rocks, possibly including some greenstone, dip northwestward and are intruded by diorite. The contact trends northerly and appears to truncate the formation at a small angle, but the scarcity of exposures makes this point obscure. The mineralized zone lies about 100 feet west of the diorite and about 50 feet south, in a vague embayment in the contact.

"The mineralized zone consists of skarn and a little garnetiferous limestone, and is bounded laterally by blocky argillites. The zone is imperfectly exposed but appears to be about 60 feet wide and can be seen for a length (strike northeast) of 125 feet, to the south side of a small knoll. The skarn contains much garnet and sulphides, including chiefly chalcopyrite and pyrrhotite, which are locally plentiful. Scheelite occurs as disseminated grains, some of which are very small, in the skarn and particularly where sulphides are abundant.

"An old 30-foot shaft on the small knoll passes vertically through 20 feet of skarn and 10 feet into diorite. An open-cut 35 feet north of the shaft and 40 feet long is driven across the strike and shows scheelite throughout its length, but most is within the eastern 25 feet of length. Light stripping north-east of the trench and south of the shaft shows skarn at a few points. Systematic stripping was attempted by bulldozer but, except on the knoll, the over-burden proved to be too deep.

"Distribution of scheelite within the zone cannot be clearly seen owing both to imperfect exposure and to heavy oxidation. Many specimens on the shaft dump would assay nearly 1 per cent tungstic oxide, and a few specimens from the open-cut could assay about 2 per cent, whereas some exposed parts of the zone contain very little scheelite. The shallow depth to unmineralized diorite in the shaft, although it does not prove that the exposed section bottoms at a depth of 20 feet, does make the available tonnage limited in this section.

"Stripping already referred to at the southern base of the knoll imperfectly exposes skarn, not all of which is mineralized. Completion of this stripping should prove whether or not interesting mineralization persists to any distance south of the shaft; over-burden farther to the south-west is deep, and systematic stripping or trenching would be expensive."

Grand Forks Area

Wyoming Property (74)

Reference: Minister of Mines, B.C., Ann. Rept., 1943, p. 79.

"This property is on Granby River, 14 miles north of Grand Forks and near Miller Creek. It was optioned by the Consolidated Mining and Smelting Company of Canada, Limited. The work done included detailed prospecting for scheelite and some 300 lineal feet of trenching. The option was dropped in June, 1943".

Rossland Area

Santa Rosa Group (75)

Reference: Minister of Mines, B.C., Ann. Rept., 1943, p. 79.

"This property is on the west side of Big Sheep Creek, 1 mile south of the main Cascade Highway. It was held under option by the Consolidated Mining and Smelting Company of Canada, Limited. During the summer of 1943 the property was prospected and 75 lineal feet of trenching was done. The option was dropped in July, 1943".

Velvet Mine (76)

References: Minister of Mines, B.C., Ann. Rept., 1946, p. 136. Drysdale, 1915, pp. 154-158. Stevenson, 1943, p. 154.

The Velvet mine is near the Cascade highway on the west side of Big Sheep Creek, about 12 miles west of Rossland. The initial claims were staked in 1896, and the property was active intermittently until 1946, during which time it produced gold, silver and copper concentrates.

The veins are in large bodies of serpentine enclosed by Coryell syenite of Tertiary age and they are of the replacement type consisting of quartz, calcite, specularite, pyrite, chalcopyrite and malachite. Molybdenite also occurs locally. Scheelite has been reported in small amounts both in the underground workings and on the dump.

Commander (Major) Property (77)

Reference: Minister of Mines, B.C., Ann. Rept., 1942, p. 81.

"This property is on the Trail-Rossland Highway, about 1½ miles from Rossland. It was optioned by the Jason Mines, Limited, late in the fall of

1942. A small portable gasoline-driven compressor was installed and the shaft was dewatered to the 100-foot level for sampling and examination. As a result of this the option was dropped. Seven men were employed under the direction of C. Rutherford. Scheelite was detected on the shaft-dump."

St. Elmo, St. Elmo Consolidated, and Cliff Claims (78)

References: Minister of Mines, B.C., Ann. Rept., 1942, p. 81. Drysdale, 1915, pp. 132-135.

These claims are less than a mile northwest of Rossland, at an elevation 3,900 to 4,800 feet. They were operated for a short time in the summer of 1942 by the Consolidated Mining and Smelting Company of Canada, Limited. Six men were employed to do 47 feet of trenching and 221 feet of diamond drilling. The property was examined by the writer in September, 1951.

The claims are underlain by augite porphyry and minor, interbedded fine-grained, massive argillaceous quartzite of the Rossland group, of early Mesozoic age. These rocks are transected by a shear zone that strikes north 85 degrees west and dips 65 degrees north. Quartz veins within the shear pinch and swell along their strike. These have been traced westward and uphill from the Cliff workings, through the St. Elmo claim to the workings on St. Elmo Consolidated claim. The veins were explored by a number of trenches and pits, nine adits, of which seven are short, and a shaft, that is inaccessible.

The vein matter is quartz, with abundant sulphides, mainly pyrrhotite and pyrite. Small amounts of chalcopyrite, galena, sphalerite and molybdenite occur locally. Drysdale reports that the ore grades: copper, 1.4 per cent; gold, 0.23 ounce a ton; silver, 0.7 ounce a ton. Scheelite, which for the most part shows blue fluorescence, occurs in many parts of the vein and for inches into the wall-rock. It is mainly finely disseminated, but, in some places, forms streaks and patches 2 to 3 inches wide. However, the average WO_3 content across mineable widths probably is low.

Blue Moon (Blue Eyes) Group (79)

References: Minister of Mines, B.C., Ann. Repts., 1942, p. 81; 1943, p. 79. Stevenson, 1943, p. 154.

The Blue Moon (Blue Eyes) property is 3½ miles north of Rossland, from which it may be reached by road. It was optioned by Bayonne Consolidated Mines, Limited, from November, 1942 to June, 1943, and during this period, several hundred feet of underground workings were driven. The property was examined by the writer in September, 1951.

The property is underlain by non-porphyritic granodiorite similar to that of the Trail batholith of Cretaceous (?) age. The granodiorite contains small shears and joints along which quartz veins are exposed by a long adit driven westward at an elevation of 4,500 feet, and by trenches above the portal. In the trenches five or more such veins, up to 4 inches wide, contain crystals of scheelite, some of which are three-quarters of an inch long. In general, these large crystals are in clusters and give a high tungsten content over a few square inches. The average grade of the veins, however, probably is low.

The adit follows a series of small shears and joints that contain quartz veins bearing pyrite. Scheelite, most of which fluoresces blue, is present almost the whole length. Some of the veins are a foot wide, and in these wider veins almost all the scheelite is along the margins. The smaller veins occupy joints in the granodiorite and in them scheelite is plentiful and also in many places is disseminated for several inches in the wall-rock. A channel sample across 12 inches of vein and wall-rock, taken at a point about 400 feet from the portal, assayed 0.33 per cent WO_3 and 0.17 per cent MoS_2.

Nelson Area

Bunker Hill Group (80)

References: Minister of Mines, B.C., Ann. Repts., 1934, p. E25; 1942, p. 81. Walker, 1934, p. 89. Stevenson, 1943, pp. 153, 154.

The Bunker Hill group of two claims, on the east side of Limpid Creek, a tributary of Pend-d'Oreille River, is about 10 miles by road from either Nelway or Waneta. The claims were owned by Waneta Gold Mines Limited.

The property was worked intermittently for gold until 1940. In 1942, scheelite was reported in open-cuts several hundred feet above the underground workings. These were examined by M. S. Hedley of the British Columbia Department of Mines in 1942 and in 1951 by V. L. Eardley-Wilmot of the Mines Branch, and the writer. Scheelite has not been reported in the old workings, but some occurs in open-cuts 400 feet above, and 1,000 feet from them, at an elevation of about 4,500 feet.

Bedrock consists of argillaceous quartzite and micaceous schist, and minor skarn, of Lower Cambrian age. These are intruded by granite, probably Nelson intrusions of Cretaceous (?) age.

The scheelite occurs in granitized argillaceous quartzite just west of a granite body. The bedding in the quartzite strikes north 4 degrees east and dips 83 degrees east. Most of the pyrite is weathered to yellow iron oxide.

In trenches Nos. 1 and 2 (*see* Figure 13) no scheelite is known in place, and only a little is present in trench No. 3. In trench No. 4 and in the pits at either end, finely disseminated scheelite is distributed evenly. A chip sample from this trench taken across 35 feet assayed 0.33 per cent WO_3, with no detectable MoS_2. This represented the best scheelite-bearing material observed, except over narrow widths. There is very little scheelite in trench No. 5 but in the pit at the southwest end the grade was estimated to be about one-quarter of one per cent WO_3 across 3 feet.

In trench No. 6 a lenticular vein of quartz about 10 inches wide is estimated to contain 2 to 3 per cent WO_3, but the vein ends to the north, and to the south passes under drift. This vein to the south in the pit in trench No. 5, is low

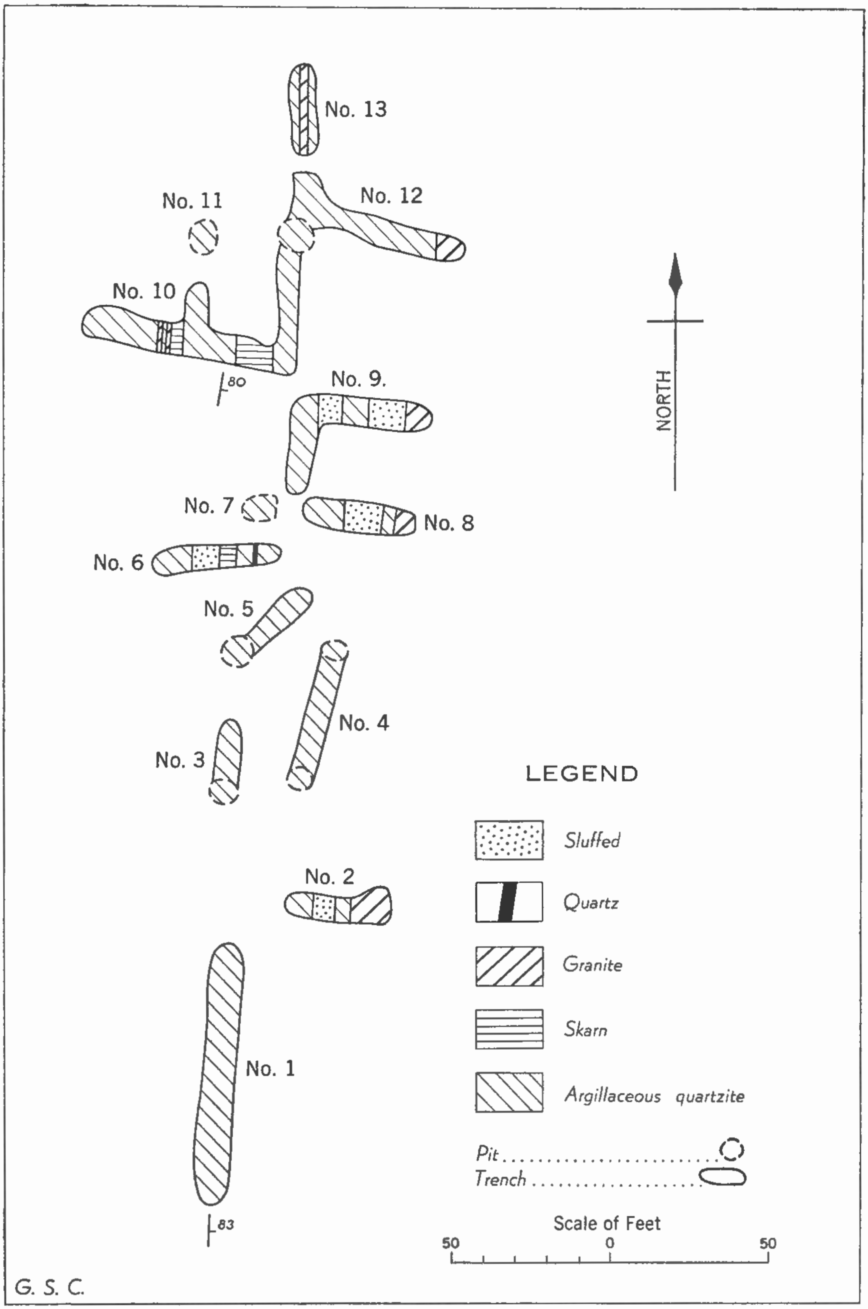


Figure 13. Plan of pits, trenches and geology, Bunker Hill scheelite deposit, Nelson area, B.C.

grade. The skarn exposed in trench No. 6 and at two points in trench No. 10 probably represents calcareous, argillaceous quartzite. The skarn exposed contains little scheelite and almost all of the scheelite in the two trenches is in the quartz vein.

Pit No. 7 exposes argillaceous quartzite that contains only a few specks of scheelite. A small quartz vein is barren. In trench No. 8 only a few specks of scheelite are present at the west end. Only one or two small crystals of scheelite were noted in trench No. 9.

In trench No. 10, scheelite occurs only in the skarn and this is estimated to grade about 0.1 per cent WO_3. In pit No. 11, a few specks of scheelite occur in the northeast corner. The remaining pits and trenches show little scheelite.

Molly Group (81)

References: Minister of Mines, B.C., Ann. Rept., 1942, pp. 77, 80. Walker, 1934, pp. 84, 85. Stevenson, 1943, pp. 146-148. Little, 1950.

The Molly group of ten Crown-granted claims is on the south side of Lost Creek. A logging road, about 3½ miles long, follows the creek valley from the Nelson-Nelway highway to the cabins below the workings, that are at an altitude of 4,100 feet, about 600 feet above the creek. The property is owned by the Consolidated Mining and Smelting Company of Canada, Limited, and in 1952 was leased to Pacific Gold and Uranium Mines, Limited.

Some 200 tons of molybdenum ore has been shipped from one deposit. The scheelite deposit is 1,000 feet east and 400 feet above the molybdenite occurrence. The deposits were examined in 1951 by V. L. Eardley-Wilmot of the Mines Branch, and the writer.

The property is underlain by argillite, slate and limestone of the Laib group of Lower Cambrian age, and granite of the Nelson intrusions of probably Cretaceous age. The scheelite occurs in skarn bordered on three sides by granite. Where the skarn is coarse grained, the WO_3 content is usually highest. The skarn is, in many places, in sharp contact with crystalline limestone. Some silicified limestone contains a little scheelite.

The larger trenches are roughly parallel with the strike of the beds. The main or most easterly trench is 108 feet long and 10 to 20 feet wide, with four cross-trenches up to 40 feet long. At the east end, two bands each 2 feet wide and 6 to 7 feet long, are estimated to average slightly less than 0.5 per cent WO_3, and one band, 4 feet wide, probably slightly over 0.5 per cent WO_3. The scheelite in these bands has a blue to white fluorescence. These bands are bordered on the west by 48 feet of limestone and skarn containing little scheelite but in the following 8 feet a band of coarse skarn, 4 feet wide, is estimated to contain from 1.5 to 2 per cent WO_3. This band widens to 10 feet to the west but here contains little scheelite. From 78 to 85 feet from the east end of the trench the skarn carries little scheelite except for a zone 2 feet wide and 6 feet long that was estimated at 0.5 per cent WO_3. This scheelite fluoresces yellow. From there to the west end of the trench, at 108 feet only a few coarse crystals of scheelite were observed.

The second trench begins 10 feet west of the first and is 32 feet long. At no place is the WO_3 content estimated to exceed 0.3 per cent. From there the line along which the trenches are distributed changes direction to northwest and the third trench is about 50 feet distant from No. 2 trench. This trench is small, and exposes skarn, estimated to contain little WO_3. The ends of the fourth trench, about 25 feet distant are caved but limestone and skarn are exposed on the east side. There is a little scheelite and molybdenite present here. Northwest 80 feet a small pit exposes granite, and 45 feet beyond limestone, skarn and granite are exposed in No. 5 trench. At the west end of this trench a band, a few inches wide is estimated to contain 0.75 per cent WO_3, but the average WO_3 content across the trench probably is low. The scheelite is in large grains and fluoresces blue. The sixth trench is 130 feet farther northwest and exposes cherty limestone. Fifty feet farther, the seventh trench is in limestone across which is a band of skarn. The WO_3 content is low. The last trench, 60 feet west of the previous one, is in granite.

The trenches expose what is probably the same limestone bed. The strike of bedding in the first trench is south 70 degrees west and in the sixth trench south 50 degrees west. The dip is north away from the granite. In summary the scheelite content and width of the deposit as exposed at the east end of the main or east trench are promising. In the other known exposures, the scheelite-bearing parts of the skarn estimated to be ore are narrow.

Jumbo Group (82)

References: Minister of Mines, B.C., Ann. Repts., 1942, p. 80; 1943, p. 80. Walker, 1934, pp. 85, 86. Stevenson, 1943, p. 148.

The Jumbo group of three Crown-granted claims is on the north side of Lost Creek, at an elevation of about 5,000 feet. The property is most easily reached by trail from the pipeline road of the Emerald mine. The claims are underlain by slaty argillite, argillaceous quartzite, and minor limestone of the Laib group of Lower Cambrian age. The sedimentary rocks are intruded by Nelson granite of probably Cretaceous age, and the scheelite deposits occur in altered rocks bordering the granite.

The deposit was examined in July, 1951, by V. L. Eardley-Wilmot of the Mines Branch, and the writer. The underground workings consist of an adit driven through granite 85 feet northwesterly into argillite. A branch tunnel from the adit on the north side and about 50 feet long, curves westward and likewise terminates in argillite. From this branch a second branch goes 20 feet northwest and intersects a quartz vein, which it follows north 30 feet across the contact of granite and skarn. Near the end, a winze, now full of water, was sunk. The skarn is rusty and altered, and carries scheelite that has a yellowish fluorescence. A channel sample across 5 feet, vertically, of this material assayed 0.50 per cent WO_3 and 0.03 per cent MoS_2.

In the area about 250 feet west of this portal, ten trenches were cut across the granite contact. These are distributed northeast and north for several hundred feet. These trenches expose argillaceous quartzite, granite, and some skarn and limestone. In the south trench and five others, scheelite was not recognized and in three trenches scheelite is present in scattered grains. One trench exposes a few streaks and patches of scheelite, but the average WO_3 content is estimated to be small.

Tungsten King Group and Ballanger's Claims (83)

References: Minister of Mines, B.C., Ann. Repts., 1942, p. 80; 1943, pp. 80, 81. Stevenson, 1943, p. 149. Little, 1950.

The Tungsten King group of nineteen claims and fractions owned by L. R. Clubine of Salmo, and the adjoining Calcite, Contact and Comet claims, owned by Mrs. Ballanger of Salmo, are on the north side of Lost Creek and adjoin on the south the property of Canadian Exploration Limited. It is understood that these groups were sold to Canadian Exploration Limited in August, 1951. They were examined in July, 1951 by V. L. Eardley-Wilmot of the Mines Branch, and the writer.

The claims are underlain by sedimentary members of Lower Cambrian age including argillaceous quartzite, schist and argillite of the Reno formation, and argillite and limestone of the Laib group. Parts of the limestone beds are altered to skarn, consisting of andradite[1], diopside, calcite, tremolite, quartz, and minor amounts of pyrrhotite, biotite, apatite, titanite, scheelite, and molybdenite. The beds strike about north 10 degrees east and dip steeply, probably representing the limbs of an isoclinal anticline that plunges gently southward. These rocks are intruded by small bodies of granite, probably of Cretaceous age.

The workings consist of open-cuts and trenches, made by the Consolidated Mining and Smelting Company of Canada, Limited in 1942. The lowest, most southerly, trenches are on the Alfie claim, across which a logging road beside Lost Creek passes. The trenches are in and adjacent to a small intermittent stream, and skarn and interbedded argillite are exposed. The bedding strikes north 30 degrees west and dips 35 to 45 degrees southwest, and the strata form a part of the east limb of an anticline. Yellow-fluorescing scheelite and molybdenite are disseminated throughout the skarn exposed in the trenches. The WO_3 content was estimated to be about 0.1 per cent WO_3 except for a few bands up to 4 feet wide that contain more scheelite. A grab sample of what appeared to be the highest grade ran 0.46 per cent WO_3 and Mo was not detected.

Eight hundred feet northeast of the trenches on the Alfie claim four trenches expose skarn carrying a few small crystals of scheelite and 1,200 feet west of the trenches on the Alfie claim, a large cut exposes argillaceous quartzite and some skarn, the latter containing a little scheelite. About 2,000 feet north of this cut seven trenches on the Comet, Den and Contact claims expose skarn, argillite and some argillaceous quartzite along the strike for 400 feet and across a width of about 120 feet. The beds strike north 20 to 30 degrees east, dip steeply east to vertical, and lie on the west limb of an anticline. Scheelite that fluoresces yellow is present in much of the skarn but the material was estimated as low in WO_3. About 1,000 feet northeast of these trenches, a group of eight trenches on the Contact claim are in a band of limestone and skarn up to 39 feet wide.

[1] Determined by the Mineralogy Division, Geological Survey of Canada.

This band lies between quartzite beds that strike north 10 degrees east and dip vertically. The limestone and skarn have been exposed for 200 feet along the strike. Most of the scheelite present fluoresces yellow. Bands up to 6 inches wide were estimated to carry up to 2 per cent WO_3, but the average grade across 4 feet or more is low.

Canadian Exploration, Limited (84)

References: Minister of Mines, B.C., Ann. Repts., 1941, p. 80; 1942, p. 80; 1943, p. 79; 1947, pp. 163, 164; 1948, p. 135; 1951, pp. 140, 141. Stevenson, 1943, pp. 135-146. Little, H. W., 1950. Little, J.D., Ball, Whishaw, and Mylrea, 1953. Ball, 1954.

Property, Location and History

The property of Canadian Exploration, Limited, comprising forty-one Crown-granted claims and fractions, is on the divide between Lost and Sheep Creeks. The mine is accessible by two roads, one leaving the Nelson-Nelway highway at Sheep Creek, and the other from the same highway near the lead-zinc mill, about 2 miles south of Sheep Creek. In addition to a lead-zinc deposit the property contains three tungsten deposits, known as the Emerald, Feeney and Dodger. The Emerald deposit and the north part of the Dodger were examined in 1951 by the writer, accompanied by Q. G. Whishaw, geologist for the Company.

The old Emerald mine, owned by Iron Mountain Limited, produced lead ore from 1907 to 1925. Walker described this deposit in 1934.

In 1942, specimens of skarn from the property were submitted for molybdenum assay to the British Columbia Department of Mines, who reported scheelite in them. In May of that year, Harold Lakes discovered high-grade scheelite ore in an adit that had been driven some years ago to explore a vein of milky quartz that cut limestone. In August, 1942, the property was taken over by the federal government, and developed by the Crown Company, Wartime Metals Corporation of Montreal. The Emerald and north end of the Dodger deposits were explored by diamond drilling, and underground development proceeded on two levels. A mill and tramway were constructed. The mill was operated from August 1, to September 10, 1943, at the rate of about 200 tons a day. At this time abundant foreign tungsten became available and to prevent its going to the enemy, requirements were met from this source. The property remained idle until 1946, when it was purchased from the Crown by Canadian Exploration, Limited. The Emerald was estimated to contain about 250,000 tons of ore averaging 1.25 per cent WO_3[1]. Tungsten concentrate was produced from 1947 to January, 1949, when the price decreased owing to competition from foreign sources. The mill then was converted to concentrate lead and zinc sulphides from the Jersey deposit.

In 1950, the Chinese sources of tungsten, which ranked first in world production, were cut off. The federal government in 1951 purchased from Canadian Exploration, Limited two selected areas containing the tungsten orebodies that had been proven by Wartime Metals Corporation, and erected a 250-ton mill which began production of tungsten concentrates on November 27, 1951.

[1] Mineral Statistics of Canada, 1947–48, p. 137.

In the meantime, tungsten ore had been discovered on Canadian Exploration, Limited ground and this Company took over the mill from the Crown, enlarging it to treat 600 to 700 tons a day and agreeing to treat 250 tons a day of Government ore. In October, 1952 the selected areas that contained the Government ore were purchased by Canadian Exploration, Limited.

General Geology

The property is underlain by sedimentary rocks of the Reno formation and Laib group, both of Lower Cambrian age, and intruded by Cretaceous (?) granite (*see* Figure 14). The lowest member of the Reno formation known at this locality is thin-bedded white quartzite that is overlain by schistose argillaceous quartzite and minor argillite, with a little crystalline limestone and skarn. Some of the skarn appears to have been formed by alteration of calcareous, arenaceous argillite. A thickness of more than 500 feet of the upper part of the Reno formation is exposed. This formation is overlain conformably by the thick, basal, banded limestone member of the Laib group. Most of the scheelite orebodies occur within this limestone or its altered equivalent. The most widespread alteration of the limestone is dolomitization, but this does not appear to bear any relationship to the scheelite orebodies. Ball (1954, p. 628) has estimated the thickness of the Laib limestone to be from 500 feet to more than 1,000 feet. On the east side of the property, this limestone is in fault contact with a thick assemblage of argillite and argillaceous quartzite that the writer (Little, 1950) believes to be the upper part of the Laib group, but which Ball suggests is the Active formation, of Ordovician age. On the west side, the limestone is bounded by a conformable succession of argillite and argillaceous quartzite. This, according to J. T. Fyles and C. G. Hewlett, of the British Columbia Department of Mines (personal communication), represents the upper part of the Laib group, as shown by detailed mapping to the north and south of the property.

The sedimentary rocks are cut by four irregularly shaped bodies of granite and many dykes of granite and lamprophyre. The granite is fine grained and consists essentially of quartz, orthoclase, plagioclase, and biotite. According to Ball, quartz forms from 20 to 50 per cent of the rock, orthoclase 40 to 70 per cent, plagioclase (oligoclase) about 10 per cent, and biotite 2 to 10 per cent. In specimens taken by the writer, probably from nearer the periphery of the body near the Emerald deposit, the potash feldspar is largely microcline. This mineral is albitized, the albite forming irregular zones across it. Biotite is largely altered to chlorite, the oligoclase is saussuritized, and sericite has been formed, in part at the expense of microcline.

Near the contact with limestone, the alteration of the granite is marked, and the product has been termed "greisen" by Ball. It differs, however, from typical greisen in that neither topaz nor lithium micas have been identified in the thin sections examined by the writer. Abundant tourmaline has been introduced, the biotite is altered to green hydromica, the oligoclase completely saussuritized, the microcline converted to sericite, and much of the rock is silicified

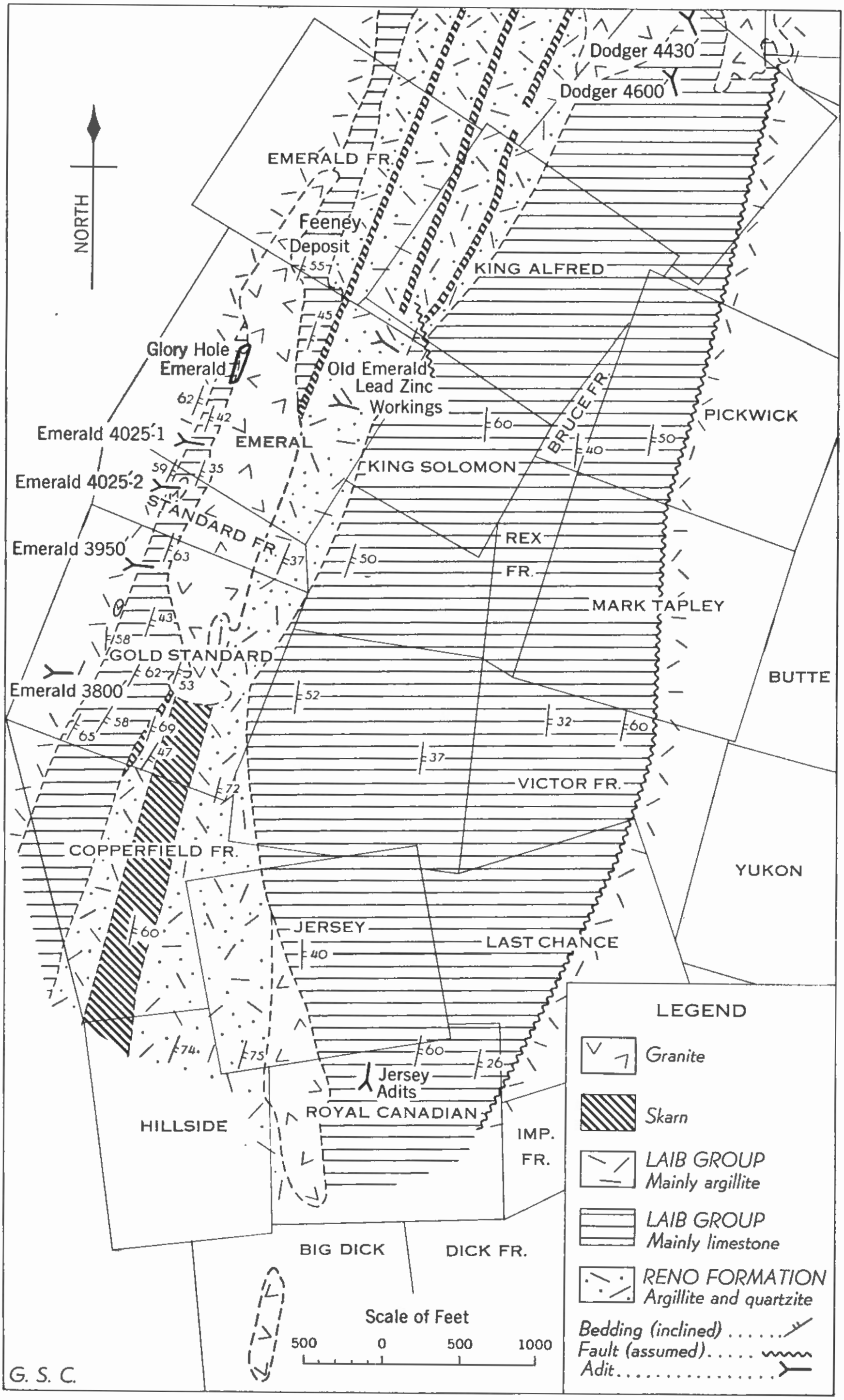


Figure 14. Plan of part of the property of Canadian Exploration, Limited, showing the Emerald, Feeney, and Dodger tungsten deposits. (*Modified after* C. W. Ball.)

and traversed by veinlets of quartz. The quartz veinlets contain buff dolomite, crystals of scheelite, a few flakes of molybdenite, and orange-fluorescing crystals that were determined by Miss Anne Sabina of the Geological Survey to be apatite.

Structure

The Lower Cambrian strata strike about north 20 degrees east, and most dip 45 to 70 degrees east; many of the beds in the west part of the property are overturned. On the east side, the Laib limestone is thrust over younger argillite and argillaceous quartzite. A synclinorium about half a mile wide lies west of the thrust fault and within this major fold the subsidiary folds are gentle, and plunge about 14 degrees south. Within the synclinorium and near the base of the Laib limestone, the lead-zinc orebodies occur. Below the Laib limestone are argillite, argillaceous quartzite and skarn beds of the Reno formation. The skarn contains the scheelite orebodies of the Dodger "trough" and these lie 200 to 500 feet stratigraphically below the lead-zinc orebodies, and not far above intrusive granite.

Farther west the granite appears at the surface as an elongated stock, and west of this are argillite, quartzite and skarn bands of the Reno formation, which forms an isoclinal anticline overturned to the west. According to Ball (1954, p. 630) some of the skarn was formed from Laib limestone that lies in a small synclinal infold at the crest of the larger anticline. Much of this skarn contains a little scheelite and molybdenite. The Laib limestone is on the west limb of this anticline, and dips 25 to 70 degrees east, terminating at depth against granite. It is succeeded on the west by argillite of the upper Laib group that likewise dips east.

Description of the Deposits

Emerald. The Emerald deposit is on the west side of the property (*see* Figure 14) mainly within a trough of limestone. The trough is flanked on the west by the overturned argillite of the upper Laib group that there dips 40 to 60 degrees east, and is flanked on the east by a body of granite whose long axis is roughly parallel with the strike of the limestone beds. The trough thus formed is truncated at the north end by the granite, which here transgresses the trough. The axis of the trough plunges about 7 degrees in a direction south 10 to 20 degrees west, but steepens at the north end. This structure, as pointed out by Hedley, apparently controlled the distribution of the orebodies, which, because the angle of plunge is greater than that of the slope of the surface, are found at greater depth at the south end of the trough than at the north. Along the west flank of the trough, where the argillite and limestone are in contact, a band of skarn up to 5 feet wide is commonly developed. Elsewhere in the trough, little skarn has been formed from the Laib limestone, which is locally dolomitized or silicified. The limestone is banded with fine black and white laminæ about $\frac{1}{8}$ inch thick. This feature probably is primary because the banding is parallel with the argillite contact. The laminæ are crossed by many small fractures, and are drag-folded.

The granite body is elongate in a direction almost parallel with the trough, and the western side of the granite is remarkably straight, except at a point about midway between the north and south ends of the trough where a broad, irregular apophysis of granite extends westward and northward, forming the west flank of the trough for some hundreds of feet (*see* Figure 15). This is referred to as the "Flange dyke" by Hedley. The granite is highly altered adjacent to the contact, and this zone of alteration in places extends at least 40 feet into the granite.

The tungsten minerals in the Emerald deposit are scheelite and molybdian scheelite, the latter being much less abundant than the former. Within the deposit, four distinct types of ore can be recognized, namely, in descending order of abundance, sulphide, "greisen", skarn, and quartz ores.

The sulphide type includes the irregularly shaped replacement bodies in limestone and dolomite, consisting of pyrrhotite, calcite, biotite, and scheelite. Locally quartz, pyrite, molybdenite, and chalcopyrite may be present. These bodies were referred to by Hedley as skarn, though he pointed out that they differ greatly from typical skarn. Garnet, pyroxene, and tremolite are rarely present in them. As shown in thin sections, calcite is the first mineral to crystallize, followed by scheelite, quartz and biotite, and pyrrhotite. Where garnet and pyroxene are present, they appear to have crystallized early.

The "greisen" type of ore is in altered granite and extends as much as 40 feet into the granite from the contact with limestone. The ore consists of potash feldspars, in some places completely kaolinized, abundant quartz, sericite, pyrite, tourmaline, and scheelite. Locally, calcite or ankerite, apatite, pyrrhotite, or molybdenite may be present. Some of the quartz is an original constituent of the granite, but most of it was introduced in the final stages of ore deposition. Sericite and kaolin appear to have been formed before scheelite, which was followed by tourmaline, carbonates, quartz, and pyrite.

The skarn type of ore, most of which is at or near the contact of limestone and argillite, consists of garnet, diopside, calcite, and quartz, with small amounts of pyrrhotite, pyrite, scheelite, and molybdenite. The skarn is fine grained, and appears to be formed from the original constituents of the rock. Much of the calcite crystallized early, but some of it cuts garnet and diopside, which were formed before the scheelite, sulphides and quartz.

The quartz type of ore grades in many places into "greisen", and is silicified limestone intersected by numerous veins of quartz containing abundant ankerite, large crystals of scheelite, a few flakes of molybdenite, and orange-fluorescing crystals of apatite. Such quartz veins occur throughout the Emerald deposit, but are much more numerous in the silicified limestone. Near the veins, the silicified limestone contains disseminated scheelite and pyrite, and in some specimens, pyrrhotite and fibres of tremolite.

Except in the veins, where scheelite crystals exceeding one-half inch in length are common, the scheelite is finely disseminated. In the silicified limestone, blebs of scheelite are generally less than 2 mm. in diameter, and in the other types of ore, few crystals exceed 1 mm.

Almost all the Emerald ore-zone is at the base of the trough formed by argillite and granite. At the north end, where little or no limestone is present, ore occurs mainly in altered granite. This ore had been almost entirely removed in 1943 by open-pit mining (*see* Figure 14). Hedley stated that the open-cut was 450 feet long, and up to 50 feet wide. The body is narrow and shallow for 70 feet along the strike and commences to widen and deepen where the limestone wedge of the trough begins. This limestone was assumed by Hedley to be faulted to its present position but the results of subsequent underground development prove that it is due to down-warping rather than to faulting. To the south the trough deepens and ore has been proven and indicated by diamond drill-holes for an additional 1,900 feet south. At the north end, the orebodies are mainly concentrated along the east or granite flank of the trough, at the centre, the orebodies are about evenly distributed on both flanks, and at the south end almost all are on the west or argillite flank (*see* Figure 15).

The scheelite probably was deposited under conditions of high temperature for the deposits formed close to and within granite and contain the high temperature minerals, pyrrhotite and tourmaline. In the "greisen" type scheelite was deposited before tourmaline, but the "greisen" is intersected by scheelite-bearing quartz veins. Hedley concluded that there may be two periods of scheelite deposition, but probably scheelite was deposited over a long period of time, and the final phase, represented by the quartz veins, also took place at medium to high temperature.

No minor structural control to localize ore deposition is apparent. Hedley suggested that bedding was important and that drag-folds played a minor role, but the writer was unable to confirm this. The many faults of small displacement have exerted only a local control. At some places ore ends at such faults, but a few feet away it may cross them or be confined to the opposite side. Lamprophyre dykes, some of which have been traced for several hundreds of feet, cut the ore. A few are several feet thick, and the rock is schistose.

The Emerald ore-zone may extend south, but in this direction the trough is broad and several hundred feet below the surface, so that the search for more ore would be costly.

Feeney. The Feeney scheelite deposit is the continuation to the north of the Emerald deposit, from which it is separated by about 600 feet of granite (*see* Figure 14). An orebody was indicated in 1951 by diamond drilling, and subsequently was developed underground. The deposit has been described by Little, Ball, Whishaw, and Mylrea (1953) and by Ball (1954). Like the Emerald deposit, the orebodies trend northward and have been explored for 250 feet of the length of the deposit. Two cross-sections of the deposit have been published, and these are reproduced in Figure 16. The Feeney deposit resembles the Emerald except that both flanks of the trough are bounded by granite, a condition that occurs only in the central part of the Emerald trough. In the Feeney deposit, the sulphide type of ore is more abundant than in the Emerald, but all four types are represented.

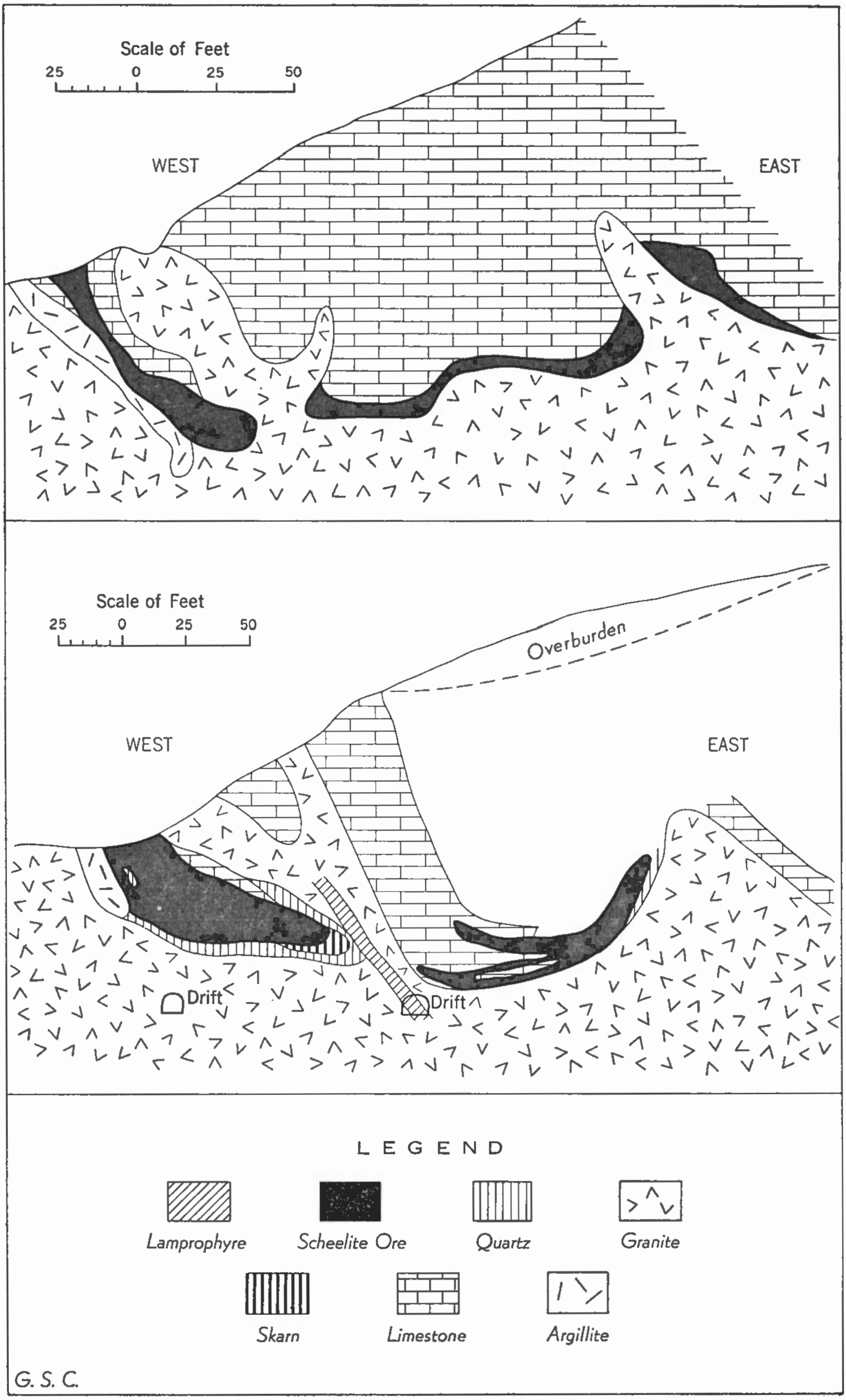


Figure 16. Cross-sections of the Feeney tungsten deposits, *after* Little, Ball, Whishaw, and Mylrea (top) and Ball (bottom).

Dodger. The Dodger tungsten deposit is about half a mile east of the Emerald and Feeney deposits (*see* Figure 14). Only the north end of the deposit was explored by Wartime Metals Corporation in 1942, and the remainder of the deposit, which is at least 4,000 feet long, was explored in 1951 and later by Canadian Exploration, Limited. Underground development of the deposit was begun in September, 1951.

The north end of the Dodger deposit lies within limestone, skarn and argillite that occupy an embayment in granite, with the open side to the south. From this point, the trough extends at least 5,000 feet about south 15 degrees west, and the average plunge is about 5 degrees in this direction. The intrusive contact of the granite that forms the floor of the trough at the north end slopes towards the south at an angle greater than that of the plunge of the orebodies, so that in this direction a thick band of argillite separates the limestone and skarn from the granite. Much of the limestone is dolomitized, and skarn is abundant (*see* Figure 17).

According to Ball, the orebodies are lenticular in cross-section, but are irregular in shape and tend to "split and splay out at their margins". Most of the orebodies lie near the base of the trough; their distribution was controlled to some extent by small faults and slips that are subparallel with the axis of the trough. Most of the orebodies lie in skarn, and are composed of disseminated scheelite, with pyrrhotite, biotite, quartz, and molybdenite. Most of the ore is practically free from molybdenite, but in some places, molybdian scheelite is fairly abundant. Some of the orebodies are in altered granite below the main orebodies, and in these most of the scheelite is coarse.

In addition to the known scheelite ore deposits, there are extensive bands of skarn, described by Hedley at some length, that occur east of the Emerald and Feeney deposits. These skarn beds are up to 50 feet wide and 4,000 feet long, and large areas contain an average of about 0.2 per cent WO_3 with some small areas of nearly 0.5 per cent WO_3. In addition, molybdenite is sparsely disseminated throughout this skarn, and most of the scheelite is a molybdian variety.

Victory Tungsten Limited (85)

References: Stevenson, 1943, pp. 149, 150. Walker, 1934, p. 86. Minister of Mines, B.C., Ann. Repts., 1942, p. 81; 1943, p. 80; 1946, p. 147; 1951, p. 138; 1952, pp. 146, 147.

The property of Victory Tungsten Limited consists of nine claims acquired in 1952 from Boleen Mines, who had purchased it from J. Sapples of Salmo. The claims formerly were known as the Little Keen group and are on the west side of Bennet (Bear) Creek, a tributary of Sheep Creek. The north part of the property is served by a short road from the Sheep Creek road. The known deposits were examined in 1951 by V. L. Eardley-Wilmot and the writer.

The rocks are argillite, schist, and limestone of the Laib group, of Lower Cambrian age. The beds strike in general southwest up the mountain side and dip steeply northwest. The orientation of the axial planes of numerous drag-folds indicates the east limb of an anticline. The sedimentary rocks are

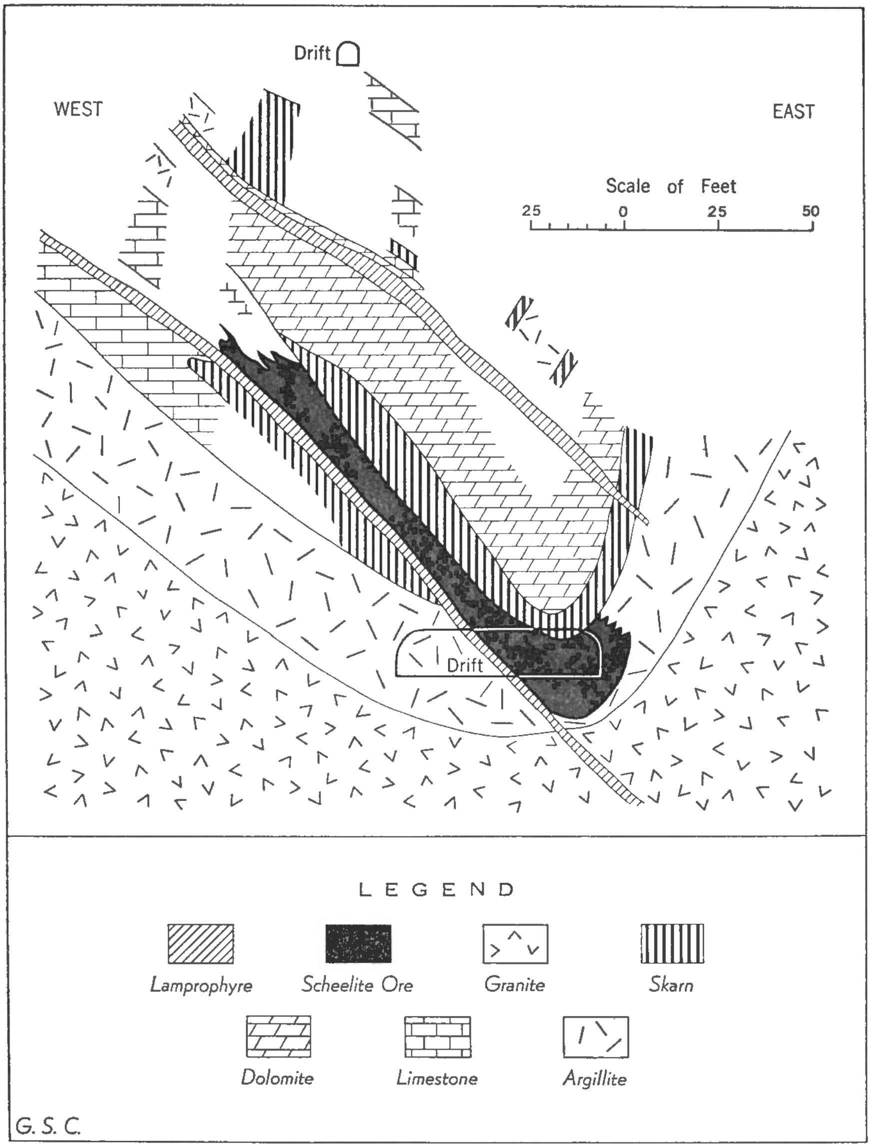


Figure 17. Cross-section of Dodger tungsten deposit. (*After* Ball.)

intruded by a small stock of granite that occupies the area between the north and south showings. Near the granite the argillaceous rocks and limestone have been altered to skarn, composed of andradite, diopside, quartz, calcite, and tremolite.

The north deposit is developed by a shaft, now caved, a short adit, and some pits and trenches. In the dumps at the adit and shaft, several tons of molybdenite ore contain a little scheelite, powellite, and pyrrhotite in quartz and skarn. In the adit streaks up to 8 inches wide and 10 to 12 feet long of scheelite, molybdian scheelite, and powellite are present. One of these, which occurs in limestone at the turn in the adit, was estimated to grade nearly 2 per cent WO_3. Nearly all the scheelite fluoresces yellow. The other bands contain a little scheelite, but more powellite and molybdenite.

In pit 1, the contact between a dyke of granite and argillite is exposed. Only a few specks of scheelite occur in the argillite, and some in the dyke. In pit 2, molybdenite and powellite occur with a few grains of scheelite. In trench 1, argillite and skarn are exposed. Very little scheelite is present at the east end, but in the skarn for 30 feet north, patches of quartz contain coarse scheelite, and in places, small patches of quartz contain abundant finely disseminated scheelite. Little scheelite is seen across the trench at the west end. In trench 3, argillaceous quartzite contains narrow bands of skarn with blebs and streaks of molybdian scheelite estimated to grade about 5 per cent WO_3 across a few inches, for a length of 1 foot to 2 feet. The overall grade, however, is low.

In trench 4, near its east end a band about 10 inches wide and several feet long carries scheelite crystals $\frac{1}{16}$ to $\frac{1}{8}$ inch across that fluoresce blue. This material was estimated to grade 0.5 per cent WO_3. In the west end of the trench, a band of skarn 1 foot or more wide contains finely disseminated crystals with yellow fluorescence, and is estimated to grade nearly 1 per cent WO_3. The adjacent quartzite contains a little scheelite. In trench 5, molybdenite and powellite are present but no scheelite is known to occur.

The most northerly trench (No. 6) of the south deposit is about 2,000 feet, south 10 degrees west of the most southerly trench (No. 5) of the north deposit. The south trenches expose argillaceous quartzite and calcareous beds, the latter containing lime silicates. Scheelite, most of which fluoresces yellowish, is sparsely disseminated in the quartzite, except in trench 10 where a band 8 feet wide was estimated to grade 0.4 to 0.5 per cent WO_3. In trench 13, scheelite is abundant in a narrow band $1\frac{1}{2}$ inches wide. A little scheelite was seen in several trenches.

Since 1951, some diamond drilling has been done under the direction of Dr. Victor Dolmage, and it is reported that 200,000 tons of material averaging 0.4 per cent WO_3 has been indicated.

Kootenay Belle Mine (86)

Reference: Walker, 1909, pp. 37, 38.

Kootenay Belle gold mine is in Sheep Creek mining camp. Walker reports that in the veins, black wolframite, light brown or buff scheelite, and tungstite occur. The minerals were determined by analysis. A sample of concentrate from a small tungstite-bearing vein assayed 0.66 per cent WO_3, and concentrate from other veins assayed 0.55 and 0.44 per cent WO_3.

Queen Mine (87)

Reference: Walker, 1909, p. 38.

Queen gold mine is in the Sheep Creek gold camp. In its early history, tungstite was seen on the Wilfley tables, but Walker was unable to detect any tungsten in samples of mill concentrates taken in 1908.

Reno Mine (88)

Reference: Stevenson, 1941, p. 93.

Reno gold mine is at the north end of the Sheep Creek camp. Stevenson stated that tungsten has been recovered from the tables of the old Reno mill.

Jack Pot Mine (89)

References: Stevenson, 1943, p. 150. Minister of Mines, B.C., Ann. Rept., 1942, p. 80.

The Jack Pot property is owned by New Jersey Zinc Explorations Limited, who in recent years have explored the property as a zinc-lead prospect. In 1942, the south part of the property was staked by Ed Haukendahl and associates as a tungsten prospect. The deposit is on the summit of the mountain at elevation about 5,800 feet, south of Porcupine Creek, from which it is accessible by private road.

The tungsten showings were examined in 1951 by V. L. Eardley-Wilmot of the Mines branch and the writer. The scheelite is in skarn that occurs along the contact of granite with limestone tentatively correlated with the Laib group of Lower Cambrian age (Little, 1950). This contact strikes about north 60 degrees east. The deposit was exposed by six trenches, over a length of nearly 300 feet, but at the time of examination the walls had caved. Skarn up to a few feet wide is impregnated with small amounts of pyrrhotite, chalcopyrite, and pyrite along the contact of granite and limestone. Very little scheelite was seen in the skarn, and nearly all gave a yellowish fluorescence.

Arrow Tungsten Mines, Limited (90)

References: Stevenson, 1943, pp. 150-152. Minister of Mines, B.C., Ann. Repts., 1942, p. 79; 1943, p. 80; 1951, p. 137; 1952, p. 145. Mulligan, 1952, p. 36.

The property of Arrow Tungsten Mines, Limited, formerly known as the Stewart, is on the south side of Stewart Creek, about 3 miles west of its junction with Salmo River. It is served by a private road from the Nelson-Salmo highway near Porto Rico railway station. It was staked in 1942 by Ed Haukendahl and partners, of Ymir, and was optioned in 1942 by Premier Gold Mining Company, Limited, and in the following year by the Consolidated Mining and Smelting Company of Canada, Limited. From 1943 to 1951 no exploration was done, but in 1951 the claims were acquired by Arrow Tungsten Mines, Limited, who drifted 190 feet and drove a raise 90 feet. The operation was abandoned in March, 1952, and the equipment removed. The property was examined in 1951 by V. L. Eardley-Wilmot and the writer, before the underground development was begun. At that time, the workings consisted of a number of trenches and an adit that had been driven many years ago.

The rocks are argillaceous quartzite and argillite and skarn of the Jurassic, Hall group, intruded south of the property by a stock of pegmatitic granite. The workings expose one apparently continuous band of skarn, and two or more short ones. A plan of these workings was kindly supplied by the Company (*see* Figure 18). The bedding strikes north 5 degrees east to north 5 degrees west, and dips 85 degrees east to 65 degrees west. According to Mulligan, the strata form the east limb of an anticline, the core of which is occupied by volcanic rocks of the older Elise formation.

The skarn exposed in the lowest trenches (Nos. 2 and 3) contains only a few grains of scheelite but in Nos. 4, 4A, and 5 (and the adit), the skarn was estimated to grade about 1 per cent WO_3, across 3 to 5 feet. In trench No. 6, little skarn was seen, except at the east end where a narrow band of quartzite carries perhaps 0.5 per cent WO_3, and in the west end the quartzite across about 2 feet was estimated to contain enough scheelite to grade about 1 per cent WO_3.

In trench No. 7, the skarn band is 12 feet wide, and in it a band of scheelite 3 feet wide is estimated to grade about 1 per cent WO_3. Trench No. 9 follows the skarn band continuously for more than 200 feet, but the WO_3 content is estimated at less than 0.5 per cent, except for a few narrow, lenticular bands. In trench 9A, the WO_3 content is about 0.5 per cent across 18 inches, but in 9D bands estimated at over 0.5 per cent WO_3 were observed, the two highest being about 1.5 per cent WO_3 across 15 inches and 0.7 per cent WO_3 across 3 feet.

There is little scheelite in trenches Nos. 9F, 9I, 9G, and 9H, but in 10W, which follows the strike of the skarn, a grade of more than 1 per cent WO_3 was estimated across 5 feet. A little sphalerite was observed there also. Very little scheelite was seen in the remaining trenches except in No. 13D, where a band 2 feet wide, containing coarse crystals of scheelite, was estimated to grade 0.75 per cent WO_3. Nearly all the scheelite lamped on the property has a blue fluorescence. Molybdenite was seen in only one place.

About 300 feet south of these workings and on the crest of the ridge a shaft was sunk on a lenticular vein of milky quartz about 5 feet wide and 10 to 15 feet long. At a few places this quartz contains crystals of scheelite about 1 inch long, many of which are in part altered to tungstite. The shaft contains water and little scheelite-bearing quartz is present in the material on the dump. In some pieces, there is abundant fine-grained molybdenite.

At about 500 feet west of the main skarn bands another band of skarn was uncovered by two small trenches. Very little scheelite is known in this band.

Porto Rico Mine (91)

References: Walker, 1909, p. 38. Mulligan, 1952.

Porto Rico gold mine is at the head of Porto Rico Creek, which flows into Salmo River about 4 miles north of Ymir. In the early days of the operation of the mine, considerable quantities of tungstite were reported on the concentrating tables. No further reports on the occurrence of tungsten minerals on this property have been published.

Spotted Horse Claim (92)

References: Stevenson, 1941, p. 93; 1943, p. 155.

The Spotted Horse claim is a short distance northeast of Porto Rico mine. H. C. Hughes, the resident mining engineer at Nelson, reported the presence of tungstite on this property.

Mammoth Group (93)

Reference: Mulligan, 1952.

The Mammoth group of claims is on the ridge between Porto Rico and Hall creeks, at an elevation of about 5,800 feet. A reported occurrence of scheelite on the property was investigated in 1951 by V. L. Eardley-Wilmot of the Mines Branch and the writer. The group consists of eight Crown-granted claims as follows: Mammoth, Mammoth Nos. 1, 2, 3, and 4, Mammoth fraction, T.N.T., T.N.T. fraction, and two located claims, Mammoth No. 5, and Mammoth No. 6 fraction.

The workings consist of a vertical shaft reported to be 120 feet deep but flooded at the time of examination, an adit 8 feet long, a pit, and a number of trenches. The rocks are agglomerate, and minor flows of the Beaver Mountain formation, of Jurassic or Cretaceous age. These are intruded by numerous dykes of porphyritic diorite and a granitic batholith to the west, all of probable Cretaceous age. The volcanic rocks are chloritized.

All the accessible workings were examined, and most of them contained very sparsely disseminated fine crystals of scheelite that fluoresced blue. At no place examined was scheelite abundant. A little chalcopyrite was seen along the walls of some of the workings and in rock on the dumps.

Old Timer Mine (94)

References: Stevenson, 1941, p. 93. Drysdale, 1917, pp. 97, 98.

Old Timer mine is near the head of Clearwater Creek, which flows into Salmo River about a mile south of Apex. It was developed as a lead-zinc prospect, but has been idle for many years. According to Stevenson, scheelite has been reported from the mine.

Euphrates Mine (95)

References: Stevenson, 1941, p. 93; 1943, p. 155.

Euphrates mine, which during the 1930's produced gold, is on the east side of Salmo River about 2 miles south of Apex. The ore shoots occur in narrow quartz veins in volcanic rocks probably of Triassic age, and contain gold, with a little silver, lead, and zinc. Scheelite occurs in small amounts in the veins, but an attempt in 1941 to save it as a by-product in the mill apparently was unsuccessful.

Golden Eagle and T. S. Group (96)

References: Minister of Mines, B.C., Ann. Rept., 1943, p. 80. Mulligan, 1952, p. 32.

This group of claims, owned by W. Rozen of Nelson, is on the Hall Creek slope of the ridge separating that creek from Fortynine Creek, from which the claims are accessible by road. Auriferous quartz veins in granitic porphyry have been developed by a tunnel and trenches. Scheelite is said to be present in the veins.

Royal Canadian and Nevada Group (97)

References: Stevenson, 1941, p. 93. Mulligan, 1952.

On this group, which is between Kootenay River and Fortynine Creek, two auriferous quartz veins occur in pseudodiorite. H. C. Hughes, the resident mining engineer at Nelson, in 1941 reported the presence of scheelite on this property.

Venango Mine (98)

References: Stevenson, 1941, p. 93; 1943, p. 155. Mulligan, 1952, pp. 26, 27.

Venango gold mine is about three-quarters mile east of the Royal Canadian and Nevada group. Two veins, and the probable faulted extension of one of them, have been developed by shafts and drifts. The veins occur in pseudodiorite, strike north 20 degrees west and dip 40 degrees northeast. The veins are of quartz, with pyrite, galena, sphalerite, chalcopyrite and free gold. Buff scheelite occurs in the veins in significant amounts as scattered grains and as nodules up to 5 inches long. None has been recovered.

Granite-Poorman Mine (99)

References: LeRoy, 1912, pp. 146-148. Mulligan, 1952, pp. 25, 26.

Granite-Poorman gold mine, owned by Kenville Gold Mines, Limited, is on Eagle Creek about half a mile east of the Venango. The veins are in pseudodiorite, and the main ones strike north 10 to 30 degrees west and dip 45 degrees northeast; some offshoots dip less than 45 degrees. The vein matter is milky to glassy quartz, with small amounts of pyrite, galena and chalcopyrite. Scheelite occurs in the Poorman vein as small, pale brown crystals, but is sparingly present.

Alpine Mine (100)

References: Minister of Mines, B.C., Ann. Repts., 1896-1948. Stevenson, 1941, p. 94; 1943, p. 156.

Alpine gold mine is at the head of Sitkum Creek, which flows into Kootenay River about 8 miles northwest of Nelson. The rocks are porphyritic granite of the Nelson batholith, of probably Cretaceous age. The vein is up to 6 feet wide and it has been developed on several levels. It strikes roughly north and dips east at a low angle. The vein matter is quartz, with pyrite, galena and sphalerite. The deposit has produced mainly gold, with some silver, lead and zinc. A small amount of scheelite is present in the vein.

Kootenay Lake Area

Bayonne Mine (101)

References: Rice, 1941, pp. 62, 63. Stevenson, 1943.

Bayonne gold mine is on Bayonne Creek, a tributáry of Summit Creek, which flows into Kootenay River a few miles below Creston. The host rock is granodiorite in which a single, long, branching vein contains the ore shoots. The vein is of quartz, with pyrite, galena, sphalerite, chalcopyrite, tetrahedrite, hessite and petzite. Stevenson lists the Bayonne mine on his map of tungsten properties, but gives no details of the occurrence.

Gold Basin Group (102)

Reference: Rice, 1941, pp. 67, 68.

The Gold Basin group is in German Basin on the south side of Akokli Creek, which flows into Kootenay Lake north of Sanca Creek. The claims are underlain by granitic rocks related to the Nelson batholith, near its contact with Proterozoic sedimentary rocks. The quartz vein strikes north and dips about 30 degrees west and is explored by a long adit and a shorter one above. The deposit has been traced for 300 feet, and is 3 to 8 feet wide. The quartz is milky white, and carries a little pyrite, galena, and chalcopyrite, and is said to contain gold. Some orange-yellow scheelite was seen in the vein by Rice.

Cranbrook Area

Moyie River Occurrence (103)

Reference: Minister of Mines, B.C., Ann. Rept., 1943, p. 81.

"This property on the Moyie River, just west of Lumberton, was staked by the Consolidated Mining and Smelting Company of Canada, Limited. An old shaft about 90 feet deep, sunk by the Moyie River Development Company, was unwatered and sampled for scheelite. The results were not encouraging."

Leader Group (Wellington) (104)

References: Minister of Mines, B.C., Ann. Repts., 1915, p. 113; 1932, pp. 162, 163; 1950, p. 155. Cairnes, 1933, pp. 92-94. Rice, 1941, pp. 70, 71. Leech, 1952, p. 5.

The Leader group of fourteen claims was owned in 1952 by Estella Mines, Limited. The workings are at an elevation of 5,700 to 5,900 feet, east of Angus Creek, which flows north into St. Mary River. The property was successively known as the Mascot, Wellington, Old Glory and Leader. The workings consist of a caved shaft and adit and several trenches which are largely slumped.

The vein occupies the Sawmill Creek fault that has brought the Kitchener-Siyeh formation on the east into contact with the Creston formation on the west. These formations are part of the Proterozoic Purcell series. The vein is of quartz, 6 inches to 2 feet wide, at least 1,000 feet long, and with a vertical extent of at least 200 feet. The quartz contains galena, pyrite, chalcopyrite, sphalerite, hematite, scheelite, and stolzite.

St. Mary River Occurrence (105)

Reference: Walker, 1909, pp. 39, 40.

Walker reports that a specimen of coarsely crystalline wolframite was brought in by a prospector from a claim on the upper part of St. Mary River, the exact location being unknown.

Southern Vancouver Island Area

Victory Claim (Westbank) (106)

Reference: Minister of Mines, B.C., Ann. Rept., 1952, pp. 215, 216.

A group of twelve claims, including the Victory, straddles San Juan River about 22 miles west of Shawnigan Lake. The first work was done on the west side of the property, but recently development has been concentrated on the east claims. The west side deposit is in a carbonate zone in greenstone, and consists of quartz veins carrying gold, with some stibnite and scheelite. The east showings are in impure limestone and marble, interbedded with greenstone. Here occurrences have been explored by two adits, and a number of open-cuts and trenches. The limestone and marble are cut by irregular veins and veinlets of quartz up to 3 inches wide, containing scheelite in numerous small masses, and a few masses up to 1 inch across, the larger ones being surrounded by buff coloured carbonate. The veinlets contain also a little pyrite, and, in places, abundant stibnite.

The veins and veinlets form a stockwork, and in some places are more closely spaced than in others. Nine samples were taken, but only two contained appreciable scheelite. One, at the crosscut in the upper adit assayed 0.22 per cent WO_3 across 2 feet; the other, taken 40 feet from the portal of the upper adit, assayed 0.30 per cent WO_3 across 3 feet. The others assayed less than 0.02 per cent WO_3.

NORTHWEST TERRITORIES

The known tungsten occurrences of Northwest Territories are confined to Yellowknife Mining Division of the District of Mackenzie (*see* Figure 19) from which more than a thousand tungsten-bearing veins have been reported. Only a few of these, however, are known to contain sufficient scheelite to be of economic interest. Tungsten minerals probably occur in other parts of the Territories, for up to the present prospecting activity has been largely concentrated in Yellowknife Mining Division.

Placer deposits of heavy minerals are reported from the mountainous South Nahanni River area, but none is known or likely to exist within the Canadian Shield (Lord, 1951, p. 48), owing to the extensive continental glaciation that the region has undergone.

Except for disseminated scheelite in granite and basic dykes at Upper Ross Lake, all tungsten deposits are quartz veins, in many of which feldspar or tourmaline, and small amounts of sulphides and gold, occur. With the exception of the deposits on Outpost Islands (Tungsten Corporation of Canada, Limited) in which ferberite predominates, scheelite is the only tungsten-bearing mineral reported in the veins.

The tungsten production of Northwest Territories up to the end of 1951 was 140,910 pounds of concentrate, valued at $37,674. This was produced during 1941 to 1943, and came almost entirely from the gold-copper-tungsten property on Outpost Islands.

According to the data at present available, only a few properties could produce tungsten concentrate alone at a profit and the quantity would be relatively small. The main production would come as a by-product of other operations, such as gold mining, or copper and gold mining, as on Outpost Islands. Jolliffe and Folinsbee (1941), estimated that in 1942 as much as 90,000 pounds of contained tungstic oxide might pass through the mills at Negus and Con and Rycon gold mines at Yellowknife. How much of this material, if any, would be recoverable, is not known. A few other properties, were regarded by the authors as also showing possibilities of production of scheelite as a by-product of gold operations.

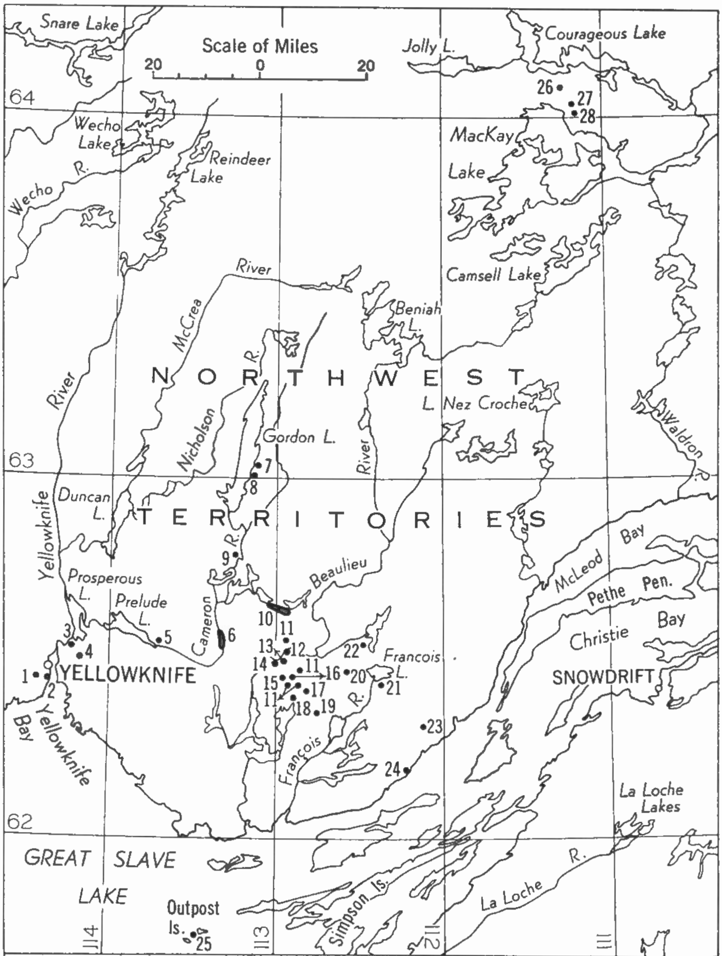
LODE DEPOSITS

Yellowknife Area

Con and Rycon Mines (1)

References: Ridland, 1941. Lord, 1941, pp. 105-112; 1951, pp. 99-108. Jolliffe and Folinsbee, 1941.

The Con and Rycon mines are on the west side of Yellowknife Bay about 2 miles south of Yellowknife. The Con group consists of fourteen claims staked for the Consolidated Mining and Smelting Company of Canada, Limited. The Rycon mine, consisting of four claims, adjoins the Con mine on the east, and is



INDEX TO LOCALITIES

YELLOWKNIFE AREA
1. Con and Rycon mines
2. Negus Mines, Ltd.
3. Ted group
4. Ptarmigan mine
5. M. T. group
6. Tibbitt Lake occurrences

GORDON LAKE AREA
7. Goodrock Gold Mines, Ltd.
8. Storm group
9. Dome Lake occurrences
10. Victory-Trout Lakes occurrences

GILMOUR LAKE AREA
11. Arctic Circle Syndicate
12. Storm group
13. Dick group
14. WO_3 group
15. Lucky group
16. Dot and Eva claims
17. July group
18. Consolidated Beaulieu Mines, Ltd.

FRANCOIS LAKE AREA
19. T. A. group
20. Ruth group
21. C. O. D. group
22. Desperation Lake occurrences
23. Doubling Lake occurrences
24. Moose group
25. Tungsten Corporation of Canada, Ltd.

COURAGEOUS LAKE AREA
26. Salmita Consolidated Mines, Ltd.
27. Bulldog Yellowknife Gold Mines, Ltd.
28. Homer Yellowknife Mines, Ltd.

G.S.C.

Figure 19. Index map showing location of tungsten deposits in Northwest Territories. For explanation *see* page 121.

owned by Rycon Mines, Limited, controlled by Consolidated Mining and Smelting Company which operates both mines from a common mining and milling plant and camp. Some of the veins on the properties contain scheelite but the mines produce only gold and silver.

The Con and Rycon mines are in a belt of greenstone forming part of the Yellowknife group of Archæan age. The flows consist of dark green, basalt and andesite, and are massive, pillowed or variolitic, with a few layers of tuff and coarse fragmental volcanic material. The general strike of the flows and tuff is about north 60 degrees east, and the dip vertical or steeply southeast, with tops facing southeast. The flow rocks are cut by fine- to medium-grained basic dykes.

The ore deposits occur within four groups of shear zones, all probably contemporaneous and pre-diabase, of Late Proterozoic age. The first of these groups is known as the Con system, which contains the greater part of the gold ore, and scheelite. These shear zones are wide, and contain ramifying quartz veins that form an irregular pattern. The veins have a northerly strike and generally dip more gently than the main shear which dips about 70 degrees west.

The second group of shear zones is the Shaft group, which lies west of the Con system. These shear zones are commonly only 2 or 3 feet wide and follow the borders of basic dykes. The average strike of these shears is more westerly than the Con system, and dips 45 degrees or less. The veins that occupy these shear zones are up to 650 feet long, and at only a few points are more than 1½ feet wide.

The Rycon group of shear zones is east of the Con system. Like those of the Shaft group, the Rycon shears are narrower than those of the Con system, and the strike is more westerly, but the dip is steeper. Quartz veins within these shear zones are long—up to 2,000 feet—and the southern end of some of them extends into the Negus property. The average width of the veins is perhaps 1½ feet, the largest veins having in general a greater average width.

The fourth group of shear zones, the Campbell system, is the most easterly, and does not outcrop. Where explored underground the schistose zone is about 600 feet wide, and the east side terminates against a major fault. Little information is available about the Campbell system on the Con-Rycon property, but operations in 1952 of Negus Mines, Limited were centred about its southern extension.

The veins occupying all these groups of shear zones consist mainly of dull grey, cherty quartz ribboned with sericite schist, or of mottled black, grey or white quartz. Metallic minerals, which rarely comprise more than 2 or 3 per cent of the vein matter, are arsenopyrite, pyrite, gold, hematite, sphalerite, chalcopyrite, gudmundite, boulangerite, jordanite, guitermanite, jamesonite, galena, pyrrhotite, altaite, stibnite, tennantite, chalcostibite, marcasite, leucopyrite, nagyagite, chalcocite, and covellite.

Scheelite is present in several of the veins, more particularly in the C4 and C34 veins of the Con system, the C17 vein of the Shaft group, and R51 vein of the Rycon group, but the average WO_3 content does not exceed 0.1 per cent.

In some of the veins, a few lenses and shoots carry about 1 per cent WO_3. In such veins, the scheelite-rich shoots are low in gold, and vice versa. The south part of the C4 vein was examined in the C410 S drift by E. D. Kindle of the Geological Survey in 1942. The south 48 feet of the vein averages 0.4 foot in width. The grade of this part, obtained by lamping, was 0.30 per cent WO_3. To the north, the vein is cut off by a diabase dyke 26 feet wide, but beyond the dyke where the vein is 12 feet long and 2 feet wide, it was estimated to average 0.34 per cent WO_3.

In the workings examined up to 1942, at only a few places, if any, could scheelite be extracted at a profit even as a by-product of gold production. Additional information regarding the scheelite content of the veins on the deeper levels was received by the writer in February, 1952, from A. B. Irwin of the Geological Survey of Canada at Yellowknife. An examination of B2720 drift south, on the 2,750-foot level, showed that scheelite occurs in a shoot 25 feet long and 7.5 feet wide. The average assay over this length and width is 0.09 per cent WO_3, and the gold content here is low.

Negus Mine (2)

References: Ridland, 1941. Jolliffe and Folinsbee, 1941. Lord, 1941, pp. 112-118; 1951, pp. 206-215.

The Negus mine is on the west side of Yellowknife Bay, south of Yellowknife. The claims adjoin those of the Con and Rycon properties on the southeast. The six claims comprising the group were formerly owned by Negus Mines, Limited, but the property was purchased early in 1953 by the Consolidated Mining and Smelting Company of Canada, Limited.

As at the Con and Rycon mines, the rock at the Negus is greenstone of the Yellowknife group. Two groups of shear zones intersect the greenstone. All reported scheelite-bearing veins of the property occur in the west group of shears and were mined prior to 1948. The veins in this group are tabular or lenticular masses that consist mainly of mottled grey quartz, and, here and there, rusty weathering carbonate. They are up to 400 feet long and up to 12 feet wide, but the average width is much less. Metallic minerals make up about 1 per cent of the matter and have been identified (Ridland, 1941) as pyrite, arsenopyrite, sphalerite, gold, jordanite, pyrrhotite, stibnite, tennantite, nagyagite, sylvanite, jamesonite, covellite, and chalcopyrite. Only gold and silver have been produced.

According to Jolliffe and Folinsbee, scheelite occurs on the 550-, 425-, and 300-foot levels, within a radius of about 300 feet of No. 2 shaft, and in a raise about 1,250 feet south southeast of No. 2 shaft, 140 feet below the surface. Most of the scheelite forms crystals or aggregates from one-sixteenth to one-quarter inch across; a small proportion is in veinlets. The aggregates and veinlets are commonly concentrated in lenticular patches up to 8 inches across and 6 feet long, irregularly distributed in the veins. Some scheelite is in veins that can be mined at a profit for gold, but almost all occurs in vein sections that are submarginal as gold ore.

Jolliffe and Folinsbee estimated that on the 425-foot level in vein 339 a scheelite-bearing shoot 70 feet long and 6 inches wide contained 1.4 per cent WO_3 (Lord, 1951, p. 211). In May, 1942 this section was re-studied and on the basis of the new results this 70-foot section was estimated to average 0.22 per cent across 1 foot. In other parts of the vein, values up to 2.8 per cent WO_3 by lamping and 3.5 per cent by assay, were obtained. In all, the authors estimated that 645 tons, averaging 0.46 per cent WO_3, could be produced from vein 339 alone, and that four times this tonnage was possible.

Ted Group (3)

Reference: Jolliffe, 1946.

The Ted group, owned in 1942 by E. J. Stewart, is east and south of the rapids at the outlet of Prosperous Lake, about 8 miles northeast of Yellowknife. The rock in nodular quartz-mica-chiastolite schist and hornfels derived from greywacke, slate and phyllite of the upper division of the Yellowknife group of Archæan age. Within these are small, discontinuous, quartz lenses containing aggregates of light brown garnet and white scheelite. About 20 such occurrences have been discovered on and adjacent to the Ted group, but none is known to be of commercial importance.

Ptarmigan Mine (4)

References: Jolliffe, 1946. Lord, 1951, pp. 247-249.

The Ptarmigan mine, owned by the Consolidated Mining and Smelting Company of Canada, Limited, consists of a group of twenty-four claims located 6 miles northeast of Yellowknife. The property is underlain by metamorphosed sedimentary members of the Yellowknife group, in which one vein has been developed. The mine was operated from 1941 to 1942, when it produced gold and silver. Jolliffe (1946) reported scheelite in the vein, which is 1,300 feet long and up to 25 feet wide. Lord, (1951, p. 249) stated that the vein contained "a very little scheelite".

Prelude-Hidden Lake Area

M. T. Group (5)

In 1942, J. S. Turner discovered scheelite between the east end of Prelude Lake and the southwest end of Hidden Lake. Twelve claims were staked by Mr. Turner for J. McAvoy of Edmonton.

The claims are underlain by greywacke and slate, much of which is altered to knotted quartz-mica schist and hornfels. These rocks are part of the Yellowknife group, of Archæan age.

The property was examined in 1942 by E. D. Kindle of the Geological Survey of Canada, and his report is quoted below.

"Scheelite occurs on an island and on the northeast and northwest shores of a small lake one-quarter mile north of the east end of Prelude Lake. On the northeast shore of the lake there is altered schistose greywacke striking north

75 degrees west with a vertical dip. The mica schist is cut by numerous quartz stringers, and in a zone 35 feet wide the rock contains up to 20 per cent of vein quartz. The quartz carries a small amount of finely disseminated small grains of scheelite and a few large crystals of scheelite. In one place two crystals of white scheelite were seen a few inches apart, each of which measured 1 inch by 1 inch, and nearby another measured 1½ inch by 1 inch. On the whole, however, the grade of this quartz-rich zone is probably not over 0.05 per cent WO_3.

"Roughly 400 feet farther west on the south side of a small island, altered greywacke and hornfels are invaded by quartz stringers. In a zone 8 feet long and 2 feet wide, large crystals of white scheelite are present and the grade, as determined by lamping, is 0.45 per cent WO_3. This zone passes under the lake on the west and toward the east the grade decreases. (At the time of my visit the easterly extension was much hidden by soil and moss cover.) A little scheelite was also seen on the west side of the island in altered greywacke at its contact with a small stock of aplitic granite.

"On a hillside about 1,000 feet west of the island, there are good exposures of the altered greywacke. Here the sedimentary rocks also strike northwest and dip vertically. At the east end of a quartz vein 1 foot wide, there is scheelite mineralization for a length of 15 feet."

Tibbitt Lake Occurrences (6)

Reference: Lord, 1951, pp. 290-291.

The Tibbitt Lake scheelite occurrences scattered throughout an area of 4 or 5 square miles, are about 33 miles east northeast of Yellowknife. The veins were examined in 1942 by E. D. Kindle, of the Geological Survey of Canada, whose report has been summarized by Lord. This summary is reprinted, with the addition of Figures 20 and 21 prepared from Kindle's maps.

"The most abundant rocks in the area are argillite, greywacke, and other strata of the Yellowknife group (of Archæan age). These lie in tight folds, the axial planes of which strike about north and dip steeply east. The strata are cut by altered basic dykes and sills that trend about north and occupy much of a zone, ½ to 1 mile wide and 6 miles long, that extends north along the east side of Peninsula Lake, Tibbitt Lake, and Cameron River (*see* Figure 20). Probably the dykes and sills were originally gabbro; many are now amphibole schists. They range from a few feet to 1,000 feet in width, and some have been traced several thousand feet. They are cut by aplite dykes and pegmatitic quartz veins.

"About one hundred and fifty quartz veins containing scheelite were found during the summer of 1942. Those of best grade occur in the altered gabbro bodies and were examined in detail; but others were noted in the sedimentary strata. All known scheelite-bearing veins in the altered gabbro are narrow, and less than 50 feet long. Most of these are in dykes or sills less than 300 feet wide. Some are pegmatitic quartz veins containing clinozoisite crystals up to 4 inches long, and garnets up to 1 inch in diameter. Others may have resulted from the replacement of the gabbro along narrow zones of fracturing or shearing. These veins consist mainly of clinozoisite, garnet, and chlorite, with a little plagioclase, quartz, and carbonate; and form brown to grey altered parts of the dykes or sills, with gradational boundaries up to a few inches wide separating them from the gabbro. Scheelite in both types of veins is white or light grey and closely resembles weathered feldspar and clinozoisite. Groups of scheelite crystals in the larger pegmatitic veins range up to 2 inches in diameter, but elsewhere vary from ⅛ to ¾ inch. The grade of one hundred and fifteen veins was determined: forty-one carry more than 0.3 per cent WO_3, and twelve of the forty-one contain more than 1.0 per cent WO_3.

"Most of the known scheelite occurs in Zone A, Zone B (*see* Figure 20), and in a group of veins on Peninsula Lake. Zone A is half a mile north-northeast of the north end of Tibbitt Lake. It is part of a gabbro sill (?) wherein scheelite-bearing veins are unusually numerous. The zone is about 600 feet long, 30 to 40 feet wide, and occurs along the east edge of the sill. The sill is there about 200 feet wide, strikes about north 25 degrees west, and, at its northeast edge, dips about 70 degrees northeast. Most of the scheelite-bearing veins strike between north and north 25 degrees west, and dip between 65 degrees northeast and vertically. They range in length from 5 to 30 feet, in width from 0.2 foot to 5 feet, and contain up to 1.6 per cent WO_3. The average grade of all the tungsten-bearing parts of the veins is about 0.25 per cent WO_3. The most promising part of the zone is near the north end where a block 110 feet long, 4 feet wide, and 55 feet deep includes many veins and may contain 0.15 per cent WO_3.

"Zone B is about 300 feet east of the south end of Zone A. It comprises three quartz veins at the south end of a gabbro sill (?). The 'sill' is about 50 feet wide and strikes north. The veins outcrop within an area 30 feet long and 12 feet wide, strike about northwest, and are vertical. One is at the contact of the gabbro and greywacke; others are within the gabbro. One vein is 30 feet long, averages 2.7 feet in width, and contains 0.36 per cent WO_3; another is 17 feet long, averages 0.5 foot in width, and contains 0.40 per cent WO_3; and the third vein is 12 feet long, has an average width of 0.5 foot, and contains 0.10 per cent WO_3.

"Numerous scheelite-bearing veins occur in a gabbro sill (?) at the south end of Peninsula Lake (*see* Figure 21) about 4 miles south of Zones A and B. The 'sill' is about 40 feet wide, strikes south, and extends about 340 feet south from the lake. The best known vein is 100 feet south of the lake and strikes north 20 degrees east: it is 46 feet long, 0.8 foot wide, and contains 0.43 per cent WO_3."

About 600 feet farther west quartz veins occur in sedimentary rocks. Most of these veins are barren, but several contain a little scheelite. Of these, only two are of possible economic interest; one, 19 feet long and 0.8 foot wide, contains 0.28 per cent WO_3, the other, 11.5 feet long and 0.6 foot wide, contains 0.39 per cent WO_3.

Kindle has estimated that the amount of possible ore, on the basis that individual vein depth equals half the length of each ore shoot, is 1,242 tons containing 6,543 pounds WO_3.

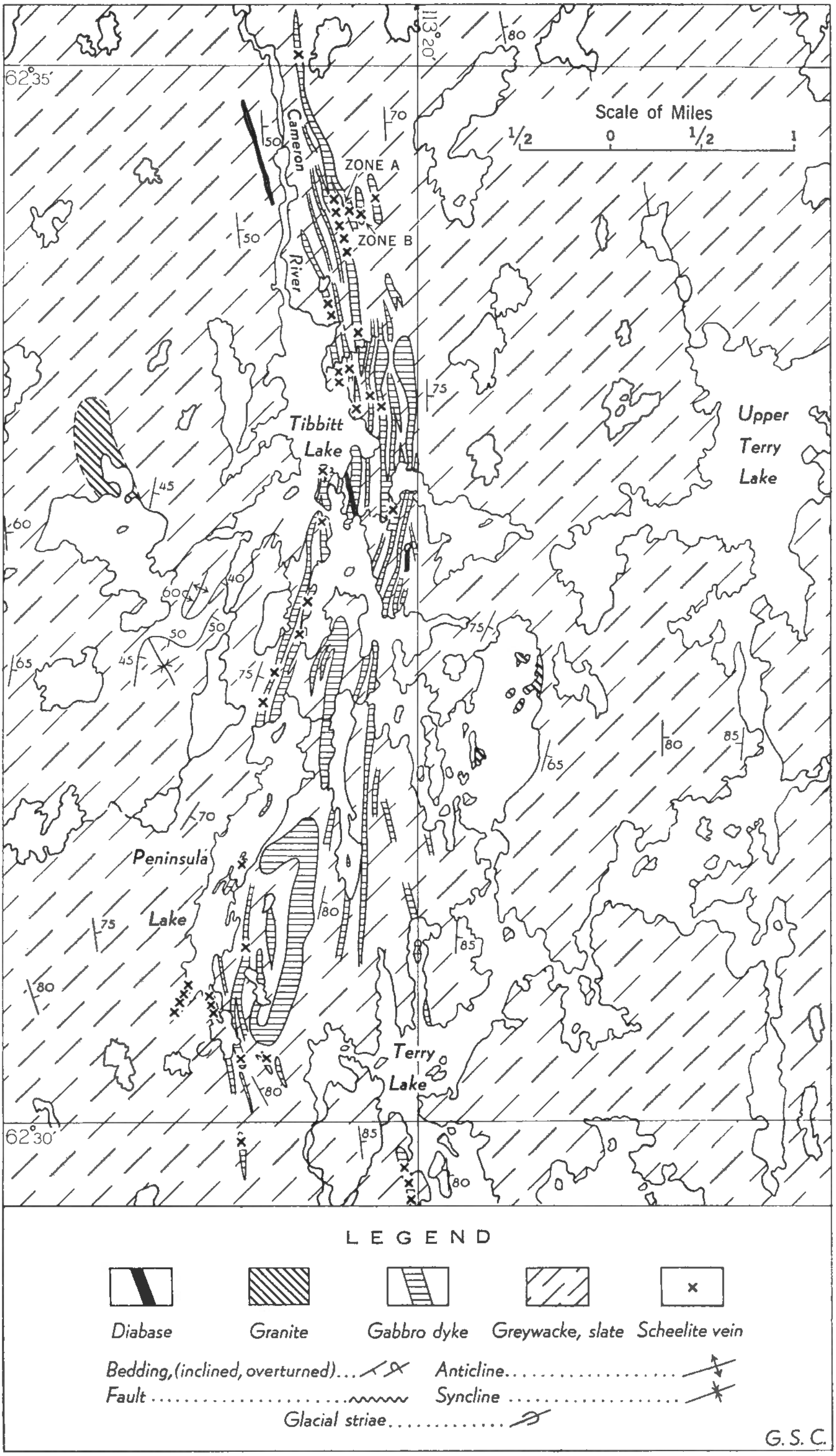


Figure 20. Plan showing location of scheelite-bearing veins near Tibbitt Lake, 33 miles northeast of Yellowknife, Northwest Territories. (Geology *by* E. D. Kindle, 1942.)

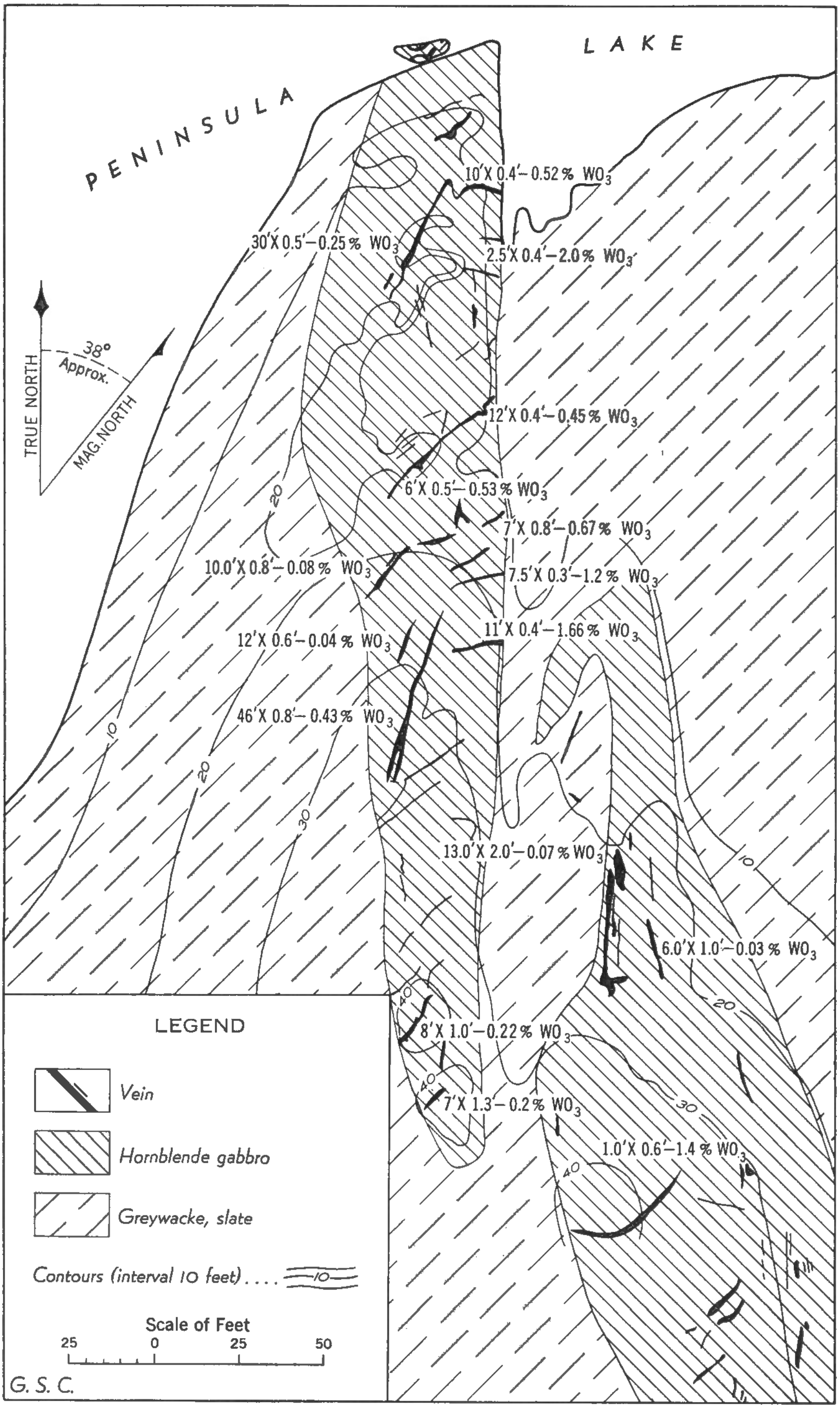


Figure 21. Plan showing grade of scheelite veins in gabbro dyke at south end of Peninsula Lake, a mile southwest of Tibbitt Lake, Northwest Territories. (*After* E. D. Kindle, 1942.)

Gordon Lake Area

Goodrock Gold Mines, Limited (7)

References: Lord, 1941, pp. 67-68; 1951, pp. 174-175.

This property is on the east side of Gordon Lake, west of Bars Lake, and adjoins the Storm group on the north. The ground had been previously explored by Galloway Gordon Lake Mines, Limited, incorporated in March, 1938, and was acquired in 1942 by Goodrock Gold Mines Limited. Scheelite was detected in parts of the veins, and these parts were examined for the Geological Survey by A. W. Jolliffe in July, 1942.

The property is underlain by greywacke and slate of the Yellowknife group, of Archæan age. Discontinuous quartz lenses occur along the ruptured axis of an anticline that strikes about north 30 degrees east, the flanks of which dip 75 to 90 degrees southeast. This vein, known as No. 1, consists of quartz, containing a few grains of pyrrhotite, pyrite, chalcopyrite and, in places, scheelite. It has been traced intermittently for more than 1,000 feet by means of a shaft and several trenches. A short distance south of the shaft, along 115 feet of the vein, two sections totalling 75 feet in length, and 2 to more than 3 feet in width, average, by lamping, 0.1 per cent WO_3; the gold content is not reported.

About 1,400 feet north 30 degrees east of the north end of No. 1 vein, what may be its continuation has been exposed by trenches for more than 600 feet. In the south end, the vein is estimated, by lamping, to grade 0.1 per cent WO_3. In a pit 300 feet north of this section, a grade of 2 per cent WO_3 was indicated by lamping, and a cobbed sample of about 50 pounds assayed 1.21 per cent WO_3.

In two other veins, described by Lord, no scheelite is reported.

Storm Group (8)

Reference: Lord, 1951, pp. 272-273.

"The Storm group of eleven claims is a tungsten (scheelite) prospect on the east shore of Gordon Lake. . . . The claims were staked by C. Brock, G. E. McLeod, and H. Campbell, on behalf of the Consolidated Mining and Smelting Company of Canada, Limited, during the summers of 1941 and 1942. Exploratory work done between August 1 and December 31, 1942, comprised stripping, pitting, sampling on Nos. 2 and 3 veins, and the sinking of two shallow prospect shafts on No. 2 vein. At about the latter date the owners concluded that the erection of a mill for extraction of scheelite was not economically feasible.

"The claims are underlain by fresh argillite and greywacke of the Yellowknife group. The strata are strongly folded along northeasterly trending axes. A granitic batholith intrudes similar rocks about 8 miles east of the property; and a few post-granite diabase dykes have been noted on the claims. Several quartz veins, and gold and scheelite, have been found; but so far as is known the most important mineral occurrences are No. 2 and No. 3 scheelite-bearing quartz veins.

"No. 2 vein strikes north 55 degrees east and probably dips about 85 degrees southeast. The vein was explored at the surface for about 600 feet; to the southwest it passes beneath a lake, and to the northeast it branches and probably ends within 250 feet. The vein commonly comprises 10 to 15 feet of nearly solid quartz, but displays many embayments and tongue-like protuberances, and here and there contains angular fragments of sedimentary rock. It is probably nearly parallel with the enclosing strata. The wall-rock is not sheared, nor is it notably altered by the quartz. The vein is intersected by several narrow shear zones, some of which are faults. The quartz is mainly mottled grey and white. It contains minute amounts of pyrite, pyrrhotite, chalcopyrite, and galena, but, so far as is known, no significant amount of gold. Scheelite occurs in the quartz as aggregates ranging from minute grains to others measuring several inches in longest dimension. It is commonly associated with a carbonate, and is most abundant near the southeast (hanging) wall. It occurs in patches, the quartz beyond the patches being nearly devoid of the mineral. The mottled quartz is cut by veinlets of white, coarse-grained quartz carrying a little feldspar but no scheelite. Two mineralized bodies were identified by surface sampling to October 21, 1942: one, at No. 2 shaft 250 feet northeast of the lake, was 61 feet long, 7.0 feet wide, and contained 0.38 per cent WO_3; the second, at No. 1 shaft, about 375 feet northeast of the lake, was 69 feet long, 5.9 feet wide, and contained 0.51 per cent WO_3. A sample comprising 215 pounds of material from No. 1 shaft to a depth of 12 feet assayed: tungstic oxide, 0.32 per cent; phosphorus, 0.12 per cent; gold, trace.

"No. 3 vein, found by a Geological Survey party on August 25, 1942, is about 1 mile north 35 degrees east from the south end of No. 2 vein, and about 200 feet south of the north boundary of the property. The maximum dimensions of quartz exposed in place were 30 by 3 feet, and large blocks of loose quartz suggested that the total width was at least 10 feet, rather than 3 feet. Coarse scheelite was observed in many places. Single aggregates of scheelite up to 10 square inches were noted, and clusters of aggregates made up as much as 30 square inches in less than a square foot of vein surface."

Dome Lake Occurrences (9)

At Dome Lake, about halfway between Tumpline and Gordon Lakes, Jolliffe[1] reported two scheelite occurrences. The first, near the inlet to the lake, is stringers, lenses and patches of quartz and chalky white feldspar that follow the trend of an anticlinal fold striking north-northwest. The rock is argillite of the Yellowknife group. Gossan is abundant in places in the outcrop of the vein. Scheelite, in crystals up to one-eighth inch across, occurs only in a few vuggy patches.

The second occurrence is near the south end of the S-shaped lake about a mile north of the inlet of Dome Lake. This deposit consists of a number of

[1] Jolliffe, A. W.: Report to the Chief Geologist for July, 1942; and Field Notes, 1942.

stringers and lenses of quartz making up about one-quarter of an area 20 by 40 feet, in which at least two areas, about 15 feet apart, contain small aggregates of scheelite crystals up to one-quarter by three-eighths inch. Elsewhere on the property small carbonate stringers contain a little scheelite.

Ross Lake Area

Reference: Fortier, 1947, p. 4.

Near the east shore of Upper Ross Lake, about 1 mile from its southeast end, disseminated scheelite occurs in basic dykes and granitic rocks. Fortier mentions also that scheelite has been reported at the Thompson-Lundmark mine at Thompson Lake west of Ross Lake.

Victory-Trout Lakes Occurrences (10)

A Geological Survey party under the direction of A. W. Jolliffe, spent part of the field season of 1942 prospecting for scheelite in the vicinity of Victory and Trout Lakes. Scheelite was found along the canoe route from Tumpline Lake via Trout, Victory, Ross and Pensive Lakes and Cameron River to Gordon Lake at almost every place at which the party stopped to prospect. The area is underlain by metamorphosed sedimentary and volcanic rocks of the Yellowknife group of Archæan age. The greatest number of occurrences[1] are in the belt of gossans extending from the Ruth group on Victory Lake southeasterly for 7 miles along the north shore of Trout Lake to its east end. The gossans make up perhaps 5 per cent of the area of a zone several hundred feet wide for this length. They overlie bodies of disseminated sulphides and sulphide-rich quartz veins, that contain galena, sphalerite, arsenopyrite, pyrite, pyrrhotite, and chalcopyrite, that occur along and near the contacts of lava and sedimentary rocks. The iron cap of the gossans had been trenched at two places, one near the northeast corner of Trout Lake, and the second on the Ruth group. At the former locality, scheelite was found in the majority of twelve pits across widths up to 40 feet in quartz-sulphide bodies, over a length of 1,000 feet. One crystal 1 inch square was seen, but no 5-foot width showed more than 0.2 per cent WO_3 under the lamp. Conditions for lamping were not good, however, as considerable rust had formed since the pits were put down.

The Ruth group was described by Henderson (1939, pp. 13-14; Lord, 1951, p. 253) before the discovery of scheelite. Jolliffe examined the east showings which consist of three trenches and three pits extending west-northwest from the southeast end of Victory Lake. The first trench, about 110 feet long, exposes the gossan across widths from 6 to 14 feet. The second, about 20 feet northwest, exposes 6 feet of gossan, and the third, extending 100 feet southwest from a point 90 feet northwest of the second pit, shows gossan for its entire length. The material of all three trenches contained only a trace of scheelite.

[1] Jolliffe, A. W.: Letter to the Chief Geologist, July 29, 1942; and Field Notes, 1942.

The first pit, 130 feet west-northwest of the southwest end of the third trench, showed 0.07 per cent WO_3 across 5 feet. The remaining two pits, 120 and 150 feet northwest of the first pit, yielded 0.01 and 0.02 per cent WO_3 respectively, each across 3 feet. All grades were obtained by lamping.

Gilmour Lake Area

Arctic Circle Syndicate (11)

Reference: Lord, 1951, pp. 75-76.

"The Arctic Circle Syndicate staked the following claims near Gilmour Lake, 45 miles east of Yellowknife, during the spring and summer of 1941: (1) A. C. Nos. 1 to 27, east from the north end of Gilmour Lake; (2) A. C. No. 28, 6 miles east of the north end of Gilmour Lake; (3) A. C. S. Nos. 1 to 17, near the southwest tip of Gilmour Lake; (4) A. C. S. Nos. 19 to 30, 2 miles southeast of Gilmour Lake; and (5) Victory group of claims, 4 miles north of the north end of Gilmour Lake.

"The Syndicate prospected these claims with ten men, under M. P. Manolovici and S. Walker, from about May until about August 1, 1941. Subsequently some prospecting was done on unstaked ground north of Gilmour Lake. Several scheelite-bearing quartz veins were found during 1941, and three of these, occurring in Yellowknife sedimentary rocks, are described below. Development work was confined to trenching and stripping.

"*Vein 57* (McDonald vein) is on A. C. No. 17 claim, and parallels the bedding of the enclosing slaty rocks. It strikes north 45 degrees west, dips 75 degrees northeast, and is exposed for 80 feet. The southern 56 feet averages 6 inches in width and contains about 0.5 per cent WO_3 as scheelite. Nine feet northwest of this shoot the vein is offset 2 feet by a fault, and so far as is known the quartz north of this fault does not contain scheelite.

"*Vein 109* is on A. C. No. 27 claim, about 2½ miles east-southeast of the northeast tip of Gilmour Lake. The vein is parallel with the enclosing sedimentary rocks, and strikes north 65 degrees west and dips 35 to 65 degrees northeast. It is exposed for about 230 feet, with an average width of 30 inches. For 155 feet the vein contains 0.15 per cent WO_3 across an average width of 2.3 feet.

"*Vein 120,* also known as the 'V' vein, is on Victory No. 1 claim, about 4 miles north of the north end of Gilmour Lake. The vein outcrops in the form of a 'V' with the apex towards the south: the west limb trends about north 25 degrees west and is exposed for about 65 feet; the east limb trends about north 5 degrees east and is exposed for about 65 feet. The vein is thickest near the north end of the east limb where for 9 feet it averages 4.4 feet in width and contains 1 per cent WO_3. About 15 tons of scheelite-bearing quartz were mined from this body.

"*Vein 141* is on A. C. No. 28 claim. A 34-foot section of the vein averages 1.3 feet in width and contains 1.1 per cent WO_3. About 5 tons of vein material were mined from this part of the vein."

Storm Group (12)

Reference: Lord, 1951, p. 272.

"The Storm group, comprising Storm Nos. 1 to 6 claims, is on the east side of Consolation Lake about 1 mile northwest of the north tip of Gilmour Lake. The claims were staked in the spring of 1940 by J. Irwin and H. Lang, and in 1941 were controlled by Storm Yellowknife Syndicate. In 1942, J. D. Mason and W. L. McDonald, operating under the name of Tungsten Developers, erected a small mill on the property. By September when work stopped, they reported having milled 11 tons of ore. The resulting concentrates, amounting to 1,917 pounds, were shipped to the Bureau of Mines, Ottawa, and contained about 35 per cent WO_3 as scheelite.

"The ore probably came from Vein 25 on Storm No. 5 claim. The vein strikes north, dips steeply east, and crosses the bedding of the Yellowknife group rocks. It is 60 feet long, has a maximum width of about 5 feet, and narrows to a thin seam of quartz at each end. An ore shoot 15 feet long averaged 2.7 feet in width and contained 2.5 per cent WO_3 as scheelite."

Dick Group (13)

Reference: Lord, 1951, pp. 123-124.

"The Dick Group comprises sixteen claims staked by the owner, G. D. DeStaffany, in June, 1940. Dick Nos. 8 to 12 claims are at the south end of Gilmour Lake. Dick Nos. 1 to 7 claims and Nos. 13 to 16 lie northwest from the north end of Gilmour Lake.

"The claims were staked following a discovery of gold-bearing quartz, and scheelite was later found in the quartz veins. Prospecting and trenching were undertaken from June to September, 1940, and some work was done during 1941. Several quartz veins have been found.

"Vein 4 is on the Dick No. 4 claim. It strikes north 40 degrees west, dips steeply northeast, and lies parallel with the enclosing Yellowknife sedimentary beds. The vein for 110 feet averages 1½ feet in width and contains 0.3 per cent WO_3 as scheelite.

"Vein 17 is on the Dick No. 3 claim and parallels the enclosing Yellowknife sedimentary beds. It strikes north 25 degrees west, dips 80 degrees northeast, and is exposed at intervals for 600 feet or more. Twenty-seven feet of the vein averages about 6 inches in width and contains about 0.5 per cent WO_3 as scheelite."

WO_3 *Group (14)*

Reference: Lord, 1951, p. 298.

"The WO_3 group of claims is about 2 miles west of the north end of Gilmour Lake. The WO_3 claims Nos. 1 to 6 were staked by A. Woyna in April, 1941, and Nos. 7 to 10 were staked later.

"Vein 56 was the principal vein known in 1941. It occurs in sheared tuffaceous rocks of the Yellowknife group and is parallel with the bedding. The vein is exposed in many places along a length of about 650 feet, with an average strike of about north 70 degrees east. Two hundred and thirty-seven feet of the vein averages 1 foot in width, and contains 0.3 per cent WO_3 as scheelite. The strike of this part of the vein ranges from north 70 degrees east at the west end to north 55 degrees east at the east end; and the dip ranges from 35 to 50 degrees northwest."

Lucky Group (15)

References: Jolliffe and Folinsbee, 1941. Lord, 1951, p. 200.

The Lucky group of nine claims, about one-half mile west of Gilmour Lake, was staked in 1940 by A. Woyna.

The group is underlain by folded sedimentary rocks of the Yellowknife group. Several scheelite-bearing quartz veins, all striking north-northwest and dipping steeply east, were found on the property.

Vein 5 has been exposed at intervals for 300 feet, and 29 feet of this length averages 6 inches in width and assays about 1.4 per cent WO_3.

Veins 6 and 7, also on Lucky No. 2 claim, are narrow, from 5 to 18 feet apart, and 200 and 300 feet long, respectively. The shorter vein averages between 3 and 4 inches in width, the values are erratic, and the overall grade is low. The longer vein is wider, but the overall grade is lower. Vein 35, which is 650 feet south-southeast of these veins, is probably a continuation of one of them. It is 100 feet long, about 7 inches wide, and the grade is low.

Vein 33, on Lucky No. 6 claim, is over 300 feet long, and extremely variable in width. The highest assay, obtained by lamping, is 0.5 per cent WO_3.

Dot and Eva Claims (16)

References: Jolliffe and Folinsbee, 1941. Lord, 1951, pp. 139, 140. Bureau of Mines, 1941.

The Dot and Eva Claims were examined by A. W. Jolliffe of the Geological Survey in 1940 and 1941, and his report has been summarized by Lord. This summary is presented, together with assay plans drawn up by Jolliffe.

"Dot Nos. 1 to 6 claims, and Eva Nos. 1 and 2 claims are on the west shore of Gilmour Lake (veins 1-3, 36, 37, 39 and 41-53, *see* Figure 22) about 45 miles east of Yellowknife. They were owned by the A. M. Mining Syndicate in 1941. Scheelite found in the Discovery vein on Dot No. 5 claim in 1940 was the first occurrence of this mineral in Northwest Territories to receive widespread attention; and its discovery resulted in an intensive search for scheelite in 1941.

"Gold was the first metal discovered on the claims, which were staked by Alex. Mitchell on June 12 and 13, 1940. The claims were prospected until September, and scheelite was discovered in the Discovery quartz vein on Dot No. 5 claim. A selected sample from this vein, sent to the Bureau of Mines, Ottawa, for assay, contained 35 per cent tungstic oxide (WO_3). Four men commenced development work on this vein in January, 1941, and during the first 3 months of the year excavated a trench 50 feet long to a maximum depth of 15 feet. About 30 tons of vein material, containing 2.18 per cent WO_3, was piled near the trench. A 200-pound presumably cobbed sample of vein material from this trench contained 8.90 per cent WO_3 (Bureau of Mines, 1941, p. 2). The remainder of the spring, and the summer, were spent in prospecting the claims, and other scheelite-bearing quartz veins were found. Work on the claims stopped in September, 1941.

"The veins occur in folded sedimentary rocks of the Yellowknife group. The axes of many of the folds trend a little west of north and in most places the rocks dip more steeply than 75 degrees. Most veins are parallel with the beds.

"The Discovery vein (*see* Figure 23) lies along a bedding plane in altered sedimentary rocks. It strikes north-northwest and dips steeply east. Most rocks in the vicinity are quartz-mica schist and slate. Those bordering the vein contain actinolite and graphite and may be altered calcareous and tuffaceous beds. The vein lies about 50 feet east of, and about parallel with, an axis of an anticline, which plunges about 85 degrees south. A trench 50 feet long exposes 50 feet of vein that averages 0.9 foot in width and contains about 2 per cent WO_3. The vein narrows to the south, and about 10 feet south of the trench passes under drift and muskeg. North of the trench, quartz lenses and stringers are exposed for 24 feet, followed by a body of quartz 20 feet long and 4 inches wide, containing about 1 per cent WO_3. Other quartz bodies, some of which contain a little scheelite, occur farther north along the strike of the vein. The quartz is glassy to milky white, and contains reddish brown to light grey scheelite, carbonate, clinozoisite (?), actinolite, arsenopyrite, pyrite, and other sulphide minerals. The scheelite occurs as aggregates that range in size from small specks up to about 12 square inches. The sulphides comprise less than 1 per cent of the ore and contain gold."

In addition to the Discovery vein, 34 other scheelite-bearing veins have been found, but all are small. The two best are Veins 2 and 3 (*see* Figure 22) on Dot No. 5 claim. One of these veins is well exposed for more than 200 feet, but only 70 feet of this vein carries scheelite, grading about 1 per cent WO_3 across 3 inches. The other vein is poorly exposed and the tungsten values are erratic.

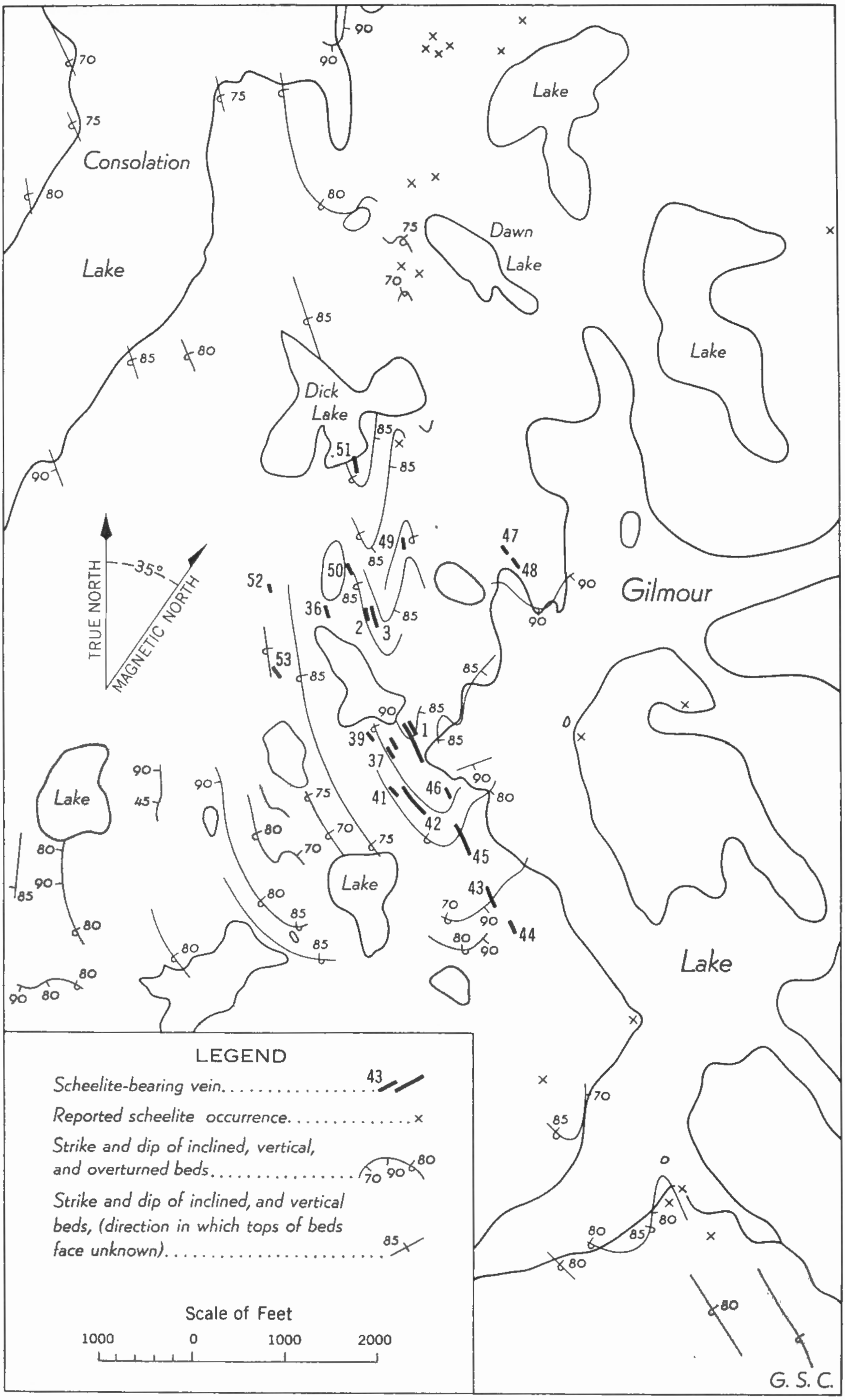


Figure 22. Scheelite-bearing veins, Gilmour Lake area, Northwest Territories. (*After* A. W. Jolliffe, 1941.)

July Group (17)

References: Jolliffe and Folinsbee, 1941. Lord, 1941, p. 120; 1951, pp. 190-191.

The July group of seven claims is about 4 miles southeast of Gilmour Lake, near an arm of Desperation Lake that extends 14 miles southwest from the main lake. It is one of four gold prospects in the Gilmour Lake area, examined by the Geological Survey in 1941, that showed possibilities of producing scheelite as a by-product. There is insufficient scheelite to be of economic interest.

According to Lord, four lodes were found by diamond drilling in 1946, one of which contains encouraging amounts of gold, and another yielded high-grade samples reported to carry visible gold. The other two lodes are either narrow and lenticular, or low grade.

Consolidated Beaulieu Mines, Limited (18)

References: Jolliffe and Folinsbee, 1941. Lord, 1951, pp. 79-84.

Consolidated Beaulieu Mines, Limited, known prior to March, 1949, as Beaulieu Yellowknife Mines, Limited, controls the Norma group of twelve claims, which lies about 4 miles south of Gilmour Lake.

Jolliffe and Folinsbee (1941) reported that in the main (Norma) vein, over 800 feet of its length contained 0.1 per cent WO_3 across an average width of 0.7 foot. Gold values are apparently rather low, as 252 tons of vein material, milled in 1947, yielded only 7½ ounces of gold bullion (Lord, 1951, p. 79).

François Lake Area

T. A. Group (19)

References: Jolliffe and Folinsbee, 1941. Lord, 1951, pp. 277-278.

The T. A. group of twenty claims, owned by the Consolidated Mining and Smelting Company of Canada, Limited, is 4 miles west of the north end of Buckham Lake. A brief examination of the property for scheelite was made by A. W. Jolliffe of the Geological Survey of Canada on July 3 and 4, 1941.

According to Lord:

"The claims were staked in September, 1939, by C. S. McDonald and U. J. Arsenault. A little hand-sorted ore, reported to have contained about 10 ounces of gold a ton, was mined at the property during the winter of 1940-41 and sent by airplane to the Con mill at Yellowknife. Six men were at the property early in 1941, but work ceased early in the summer. So far as is known, no additional work has been done at the property.

"Many parts of the property are reported to have been explored by trenches or diamond drill-holes, or both. Veins 3 and 4 have been stripped and trenched, and these and adjacent parallel veins were explored by seventeen diamond drill-holes. A two-compartment shaft, inclined about 70 degrees east-northeast, was sunk on Vein 4 on T. A. No. 7 claim. About 80 feet of drifting is said to have been done from this shaft at a depth of about 50 feet. Apparently neither power tools nor mechanical hoist were used.

"The claims are underlain by sedimentary strata of the Yellowknife group. They were originally greywackes and minor interlayered argillites, but, where examined, the greywackes have been altered to brown weathering, nodular, schistose greywackes, and the argillites to phyllites or nodular fine-grained mica schists. Near Veins 3 and 4 the beds form a gentle arc convex toward the northeast and dip 65 or 70 degrees east or northeast. In the southern part of this structure, near Vein 4, they strike about north 10 degrees west, and in the northwestern part, near Vein 3 about north 60 degrees west. Quartz veins and seams are numerous. They commonly parallel the enclosing strata and some are minutely folded and greatly fractured...

"Vein 3 is on T. A. No. 2 claim near its south boundary. It strikes north 60 degrees west and dips 65 degrees northeast about parallel with the adjacent formation. Except for a gap of 35 feet it is continuously exposed by trenches for a length of 190 feet, the southeast end being 150 feet north of the shaft on No. 4 vein. The average exposed width is about 1 foot. The southeastern part of the vein, and its wall-rocks, are involved in several drag-folds up to about 1 foot across. The quartz in this part of the vein is cleaved along planes that strike about north 40 degrees west and dip 65 degrees northeast, perhaps parallel with the axes of the drag-folds. The quartz in the vein is very fine-grained and grey to white. It contains a little pyrite and feldspar. Surface sampling is reported to have indicated a gold content of 0.58 ounce a ton (uncut) or 0.46 ounce a ton (cut) across a width of 1.1 feet for a length of 60 feet. Diamond drill-holes have probed beneath the exposed vein, and along its possible strike to the northwest and southeast, for a total distance of about 600 feet."

Lamping of this vein by Jolliffe[1] showed up to about 4 per cent WO_3, but only locally; the greater part of the vein contained *nil* to a trace of scheelite.

"Vein 4 probably crosses the boundary between T. A. No. 7 claim and the more northerly T. A. No. 2 claim. The vein strikes north 15 degrees west and dips easterly at 65 to 80 degrees. It is almost continuously exposed for a length of about 475 feet except that a 110-foot length near the north end is covered by broken rock and quartz from the shaft. The north end of the vein is about 50 feet south of the most southeasterly exposure of Vein 3. South of the shaft dump it ranges in width from less than 1 inch to about 1 foot, averaging about 3 inches . . . Beneath the shaft dump the vein is reported to widen gradually, from a few inches near the shaft, to 5 feet or more at the north edge of the dump. The vein is exposed for about 30 feet north of the dump. Here it swells greatly, branches, and includes much wall-rock; however, a rectangular area measuring 20 feet on each side contains about 30 per cent vein quartz. The adjacent beds are sharply folded, but in plan are generally convex towards the northeast and

[1] Jolliffe, A. W.: Field Notes, 1941.

dip about 65 degrees in that direction. The vein walls are sharp and tight. The vein narrows abruptly and probably ends about 30 feet north of the dump. The quartz is medium to fine grained, and white to grey. It contains feldspar, biotite, fragments and seams of wall-rock, and a very little pyrite, pyrrhotite (?), and visible gold. Surface sampling is reported to have indicated a high-grade ore shoot, 6 inches to $6\frac{1}{2}$ feet wide, that extends about 60 feet north from the shaft to include the swollen part of the vein."

This vein yielded only a trace WO_3[1], but another vein about 100 feet north-northeast of the shaft contained up to 0.2 per cent. Other veins contained *nil* or trace except for a few very erratic values.

Ruth Group (20)

References: Jolliffe and Folinsbee, 1941. Lord, 1951, pp. 250-253.

The property, consisting of fourteen claims owned by the Consolidated Mining and Smelting Company of Canada, Limited, is 12 miles east of Gilmour Lake. The claims were staked during the summer of 1940, and development work was begun early the following year. In 1942, a 25-ton mill was erected, and from August 1 to 12, 186.8 tons of ore were treated, yielding 152.45 ounces of gold and 23.14 ounces of silver. By means of a picking belt, equipped with an overhead ultraviolet light, scheelite-rich fragments were sorted, and about 30 per cent waste rock was rejected.

The geology is described by Lord:

"The property is underlain, except for minor dykes and sills, by greywacke and slate of the Yellowknife group. The greywacke occurs in beds up to many feet in thickness. It is a buff weathering, dark grey rock. On suitably broken surfaces it displays a slight sheen due to mutually parallel biotite flakes. Many beds grade from coarse grained at the bottom to fine grained and slaty at the top. The slate beds are black and commonly well cleaved. Here and there they exhibit numerous tiny spots or aggregates of micaceous material, each about $\frac{1}{16}$ inch in diameter. Near Nos. 1, 2 and 4 veins the beds strike about north 10 degrees east and dip 75 to 85 degrees east, or are vertical. They form a tight anticline, the axial plane of which strikes about parallel with the beds and dips about 80 degrees east. A few hundred feet south of No. 2 vein the beds bend around the fold axis and indicate an almost vertical plunge. Elsewhere the axial part of the fold is marked by a zone of broken rock cut here and there by irregular quartz bodies, or is covered with drift.

"The greywackes and slates are cut by a few sills or dykes of white weathering quartz-feldspar porphyry, up to 6 feet or more in width. These bodies outcrop 100 to 200 feet or more east of, and nearly parallel with, the anticlinal axis. They contain a little arsenopyrite, and are cut by transverse irregular veins of glassy quartz."

[1] Jolliffe, A. W.: Field Notes, 1941.

Four veins are known. These strike between north and north 20 degrees east, and dip steeply east. Veins Nos. 1, 2 and 4 are mainly on Ruth No. 3 claim, and vein 3 is about a mile to the north. Except for vein 4, which is discontinuous, the veins are strong and each contains an ore shoot. The best ore shoot is in vein 2, and is 300 feet long, 0.62 foot wide, and contains 3.69 ounces of gold a ton (uncut grade) or 2.86 ounces of gold a ton (cut grade). All veins consist mainly of quartz, with inclusions of slate wall-rock, and a little arsenopyrite, scheelite, and gold. Pyrite, feldspar, and an unidentified soft, grey mineral are also present in vein 2.

Jolliffe and Folinsbee (1941) regarded the Ruth property as one that might produce scheelite as a by-product of gold, particularly from vein 3. In this vein, the overall grade over the 300-foot length of the shoot is only 0.08 per cent WO_3, but the crystals of scheelite are in erratically distributed aggregates, and it was felt that cobbing would produce a product carrying 1 to 2 per cent WO_3 with negligible gold values. It was pointed out that concentrate from this material would be high in arsenopyrite.

C. O. D. Group (21)

Reference: Lord, 1951, p. 94.

"The C.O.D. group of twenty-one claims lay about 1½ miles south of François Lake and about 65 miles east of Yellowknife. The claims were staked in June and August, 1941, following discoveries of scheelite-bearing quartz veins by H. Drever and A. D. Tidsbury for the Consolidated Mining and Smelting Company of Canada, Limited. The claims subsequently lapsed.

"The underlying rocks are argillite and greywacke of the Yellowknife group. About 4 miles to the northeast the metamorphosed equivalents of these strata are intruded by a granitic batholith.

"At least thirty scheelite-bearing quartz veins . . . occur in bands of thin-bedded argillite and, although relatively persistent and uniform in width, . . . are irregular in outline and relatively short. The distribution of scheelite-bearing shoots within the veins is erratic. The scheelite is white, or, rarely pale buff, and in addition to quartz, is accompanied by grossularite (?), garnet, feldspar, actinolite, a carbonate, and epidote. The garnet comprises 30 to 60 per cent of the gangue material in many of the better grade scheelite-bearing bodies and might be a source of trouble were mining and milling attempted. Veins 7 and 8 are perhaps the most promising.

"Vein 7 is on C.O.D. No. 12 claim. It lies approximately parallel with the bedding of the crumpled slaty rocks in which it occurs, strikes about north 65 degrees east, and dips about 60 degrees southeast. Three disconnected, irregular bodies of quartz contain scheelite and occur within a length of 36 feet. The western body, 16 feet long, is barren at each end but 10 feet of it averages about 2 feet wide and contains more than 1 per cent WO_3. The eastern body is 7 feet long, averages 7 inches wide, and contains 0.7 per cent WO_3. The central body is 7 feet long, averages 15 inches wide, and contains 0.8 per cent WO_3. Other, barren quartz outcrops east and west of the scheelite-bearing bodies.

"Vein 8 is on C.O.D. No. 19 claim. It lies parallel with the bedding of the enclosing sedimentary rocks, strikes north 55 degrees west, and dips steeply southwest. It is exposed for 115 feet with an average width of about 10 feet. Both ends of the vein are covered by drift, but rock exposed 50 to 100 feet northwest and southeast of the vein contains only barren quartz stringers. Scheelite occurs near the northwest end of the exposed part of the vein in a shoot 25 feet long and 5 feet wide, containing 0.2 per cent WO_3."

Desperation Lake Occurrences (22)

Three properties, owned by Tungsten Corporation of Canada, Limited, in the Desperation Lake area, have been reported to contain scheelite[1], but their exact location is not given.

The Strategic group of seven claims is said to contain a vein 900 feet long and 1 foot to 8 feet wide, averaging 2.5 feet. Some surface diamond drilling has been done.

Two miles west, the CC group of four claims and the adjoining X-L group have not yet been developed.

Doubling Lake Occurrences (23)

In 1942, Dave Foster, a prospector, in a letter to A. W. Jolliffe of the Geological Survey, reported that he had discovered four quartz veins a short distance west of the outlet of Doubling Lake. One of these he wrote was 30 feet long and 2 to 3½ inches wide, and estimated to contain a good grade of scheelite. Two other veins, though larger, contained little scheelite, and the fourth vein was said to be barren.

Moose Group (24)

Reference: Lord, 1951, p. 118.

The Moose group of fifteen claims, on the north side of Hearne Channel, in the east arm of Great Slave Lake, is part of the holdings of DeStaffany Tantalum Beryllium Mines, Limited. Moose Nos. 1 and 2 claims were staked in July, 1942, to cover scheelite occurrences found by G. D. DeStaffany and A. Greathouse. The following year the group was enlarged to include two pegmatite dykes carrying rare-element minerals, and activity was diverted from the tungsten-bearing veins. For this reason very little is known about them. Five veins are reported. These strike about north-northeast, roughly parallel with nodular quartz-mica schist and hornfels of the Yellowknife group. No information as to their size and grade is available.

[1] *Financial Post*, December 15, 1951; *Northern Miner*, February 14, 1952.

Tungsten Corporation of Canada, Limited (25)

References: Bruder, 1941, 1942. Buffam, 1942. Bureau of Mines, 1938*a*, 1938*c*, 1940, 1942*f*. Hawley, 1939. Jolliffe, 1942. Lord, 1941, pp. 125-126; 1951, pp. 236-240.

The Fox group of eighteen claims on Outpost Islands, has produced almost all of the tungsten concentrates shipped from Northwest Territories. It is owned by Tungsten Corporation of Canada, Limited. The history of the property has been outlined by Lord.

"The claims were staked in July 1935 for Athabasca Syndicate by W. D. Brady, M. J. Shunsby, and H. D. Tudor, and were later acquired by Slave Lake Gold Mines Limited. The claims were explored by N. A. Timmins Corporation, which held the property under option from November 1935 to March 1938. Work ceased at the latter date, and at that time the main (No. 1) shaft was about 450 feet deep, and drifts and crosscuts, opened on five levels, totalled about 1,700 feet. The mine was then abandoned and remained idle until it was reopened by Slave Lake Gold Mines, Limited, on September 5, 1940, with J. C. Bryne as manager. It was dewatered to the 200-foot level by November 17, and mining commenced on December 5, 1940, Erection of a 50-ton mill had begun in the meantime and milling started about February 1, 1941. Only gold was recovered at first, but on May 1, 1941, the recovery of tungsten concentrates commenced. The operators were handicapped by lack of working capital and were, consequently, unable to do sufficient development work to maintain ore reserves. The mill was shut down on August 9, 1942, at which time the No. 1 (main) oreshoot was essentially exhausted between the 425-foot level and the surface. Underground work continued until the property was closed in October 1942. During this production period the efforts of the company were devoted chiefly to the recovery of gold; but some tungsten was recovered . . . International Tungsten Mines, Limited, incorporated in 1942, acquired the property of Slave Lake Gold Mines, Limited, and optioned it to the Consolidated Mining and Smelting Company of Canada, Limited, during part of 1943. Philmore Yellowknife Gold Mines, Limited, incorporated in 1945, acquired the assets of International Tungsten Mines, Limited, in April, 1946. So far as known no significant work was done at the property between October 1942 and December 31, 1948."

In 1950, the property was acquired by Marwood Mining Corporation, Limited, who sold it to Tungsten Corporation of Canada, Limited, which was incorporated in 1951. This company reconditioned the 50-ton mill, and it started regular operations in October, 1951. Initial mill feed was drawn from the tailings dump, estimated (Lord, 1951, p. 238) to contain 10,000 tons, carrying about 0.26 ounce gold a ton, and 0.48 per cent WO_3. The plan is to gradually supplement the mill feed from the tailings with ore from underground. It was later reported[1] that delay in the delivery of a boiler reduced the effective production of tungsten concentrate, but that a copper-gold concentrate is being produced. Unwatering of the mine has proceeded to the 200-foot level, and surface drilling is being carried out.

[1] *Northern Miner*, February 14, 1952.

Lord (1951, pp. 238, 239) has described the geology and deposits as follows:

"The islands are underlain by metamorphosed sedimentary rocks of early Precambrian age, and belong to the Wilson Island phase of the Point Lake-Wilson Island group. They are mostly quartz-mica schist and gneiss, quartzite, and conglomerate. Crossbedding is common and knots of andalusite and staurolite occur in places. The strata are cut by a few narrow basic dykes, and by small bodies of quartz containing mica, andalusite, and rare grains of blue corundum (sapphire). Near the mineralized shear zones the strata strike about north 70 degrees east and dip about 80 degrees southeast. Here and there drag-folds offset the beds to the right and pitch about 70 degrees east-northeast. One such drag-fold lies immediately east of No. 1 orebody.

"Sheared and silicified zones with disseminated metallic minerals occur in quartz-mica schist and gneiss and lie parallel with the bedding, or nearly so. Some work has been done on eight or more zones that outcrop on a group of four islands. The zones outcrop within an area that trends about north 70 degrees east and is 7,300 feet long and 750 feet wide. This area covers parts of the four islands and the intervening channels. Most of the zones strike between north 65 and 85 degrees east and dip southerly at angles between 75 and 85 degrees. They are exposed at the surface for lengths up to 1,550 feet and range in width up to about 10 feet. In places the beds within the shear zones are thinner than those bordering the zones or are crossbedded. The rock in the zones is slightly sheared along closely spaced fractures parallel with the walls, or is brecciated, but none of it is strongly sheared. The sheared and fractured rock of the zones grades into the wall-rock. A few bodies of quartz with mica and andalusite occur in the shear zones. Some of the sheared and fractured rock is cut by quartz veinlets and is cemented and partly replaced by quartz, chalcopyrite, and pyrite, with which are associated a little ferberite, magnetite, specular hematite, ilmenite, marcasite, bornite, chalcocite, covellite, molybdenite, chlorite, white mica, and gold. Chalcopyrite and pyrite constitute up to 20 per cent of the mineralized zones. Scheelite is said to be common in the tungsten concentrates, and has been detected in the tailings; it has not (June 1942) been identified in place. In 1937 the Bureau of Mines detected 0.20 per cent tin, probably as cassiterite, in a shipment of 1,063 pounds of ore from the 50-foot level of No. 1 shaft.

"In most places the mineralized material in the shear zones is readily recognized as an altered sediment. Gold occurs within the shear zones: (1) as leaves on nearly flat joints in quartzite or in introduced quartz and sulphides; (2) in quartz veinlets; (3) in quartz bodies with mica and andalusite; (4) in seams of gouge; and (5) disseminated in impure quartzite without apparent introduced quartz. Tungsten, as ferberite, has been found in four shear zones and may occur in others. Ferberite is a dark brown to black mineral and occurs as plates up to one-eighth inch across in quartz surrounding fragments of rock.

"Almost all underground work has been done on the west zone. This zone outcrops 30 feet southwest of No. 1 shaft and thence 260 feet south 65 degrees west to the lake shore. The zone extends beneath overburden to the shaft and dips about 80 degrees south. A zone that may be a continuation of the west zone outcrops 100 feet east of the shaft and extends 250 feet north 75 degrees east to the east end of the island. The width of the zone west of the shaft ranges up to about 7 feet; the width east of the shaft is not known because the zone is not well exposed. All ore mined came from No. 1 ore shoot in the west zone. This ore shoot outcropped about 125 feet west of the shaft and has been explored by drifts to a depth of 525 feet, and by drill-holes for an additional 175 feet. It pitches about 70 degrees east, approximately parallel with the pitch of the drag-fold immediately east of it. The following are the approximate drift lengths of gold ore as indicated by stope plans to June 1942: 50-foot level, 230 feet; 125-foot level, 250 feet; 200-foot level, 230 feet; 325-foot level, 170 feet; 425-foot level, 140 feet. Gold ore was also found on the 525-foot level. Drift lengths of tungsten-bearing material (grade 0.5 per cent or more) are commonly greater. The average width of the ore shoot is about 2 feet. The average grade of the ore mined from this orebody probably averaged between 0.60 and 0.75 per cent WO_3 and between 0.5 and 1.0 ounce gold a ton.

"An ore shoot at No. 2 shaft is said to be 185 feet long at the surface where it has an average width of 1.4 feet, and contains 0.65 ounce gold a ton and a little tungsten."

Total production in 1941 and 1942 was 9,805 ounces gold, 75 ounces silver, 112,863 pounds copper, and tungsten concentrates containing 27,700 pounds WO_3. Two products were obtained from a Wilfey table, one averaging 35 to 50 per cent WO_3, and the other 11 to 15 per cent WO_3. Tungsten recovery was very low—a little more than 10 per cent of the heads.

Courageous Lake Area

Salmita Consolidated Mines, Limited (26)

References: Folinsbee, 1947, Lord, 1951, pp. 254-257. Henderson, in "Structural Geology of Canadian Ore Deposits", 1948, p. 243. Folinsbee and Moore, 1950.

Salmita Consolidated Mines, Limited, reorganized in October, 1949, from Salmita Northwest Mines, Limited, is a gold prospect of thirty-one claims. The property is in the barren lands on the east side of Matthews Lake, between MacKay and Courageous Lakes, 150 miles northeast of Yellowknife.

During the summer of 1951, a shaft was sunk. From it on the 125-foot level a crosscut to the B vein and short drifts on this vein north and south were driven. Previously, development work had been confined to surface stripping and diamond drilling, and a geophysical survey was made in 1947. Scheelite, the presence of which was reported (Henderson, 1948) in the quartz veins of the area, was found in the B vein on the 125-foot level[1], but complete sampling has not yet been done.

[1] Irwin, A. B.: Geological Survey of Canada, personal communication.

According to Lord:

"The claims are underlain by volcanic and sedimentary rocks of the Yellowknife group. These strike about north-northwest parallel with the east shore of Matthews Lake, and are vertical or dip steeply east-northeast. The contact between the volcanic rocks on the west and the sedimentary strata on the east lies a few hundred feet inland from the east shore of the lake for a length of about 2½ miles, nearly coincides with the medial line of the Salerno group of claims. The volcanic rocks are part of a belt, 1 mile to 3 miles or more in width, that extends many miles north-northwest and south-southeast of the property. A granitic batholith borders this belt on the west, and the sedimentary strata, invaded here and there by granitic stocks, extend east from the belt for many miles. Although the volcanic belt is mainly greenstone, that part exposed on the claims is mainly white to light green weathering rhyolitic or dacitic lava, tuffs or agglomerates; locally these rocks are interbedded with dark green, garnetiferous members, probably altered andesitic tuffs, and slate or phyllite. The sedimentary strata east of the volcanic rocks are greywackes or derived fine-grained quartz-mica schists, and slates or phyllites. A vertical strike fault with a left-hand displacement of about 1,400 feet cuts the sedimentary members. The known gold deposits are quartz veins in sedimentary or volcanic rocks close to their contact."

Five veins are described by Lord, but, as scheelite has been reported from the B vein only, which is in the north part of the property, the description of this vein is quoted.

"*B Vein* strikes north 20 degrees west and is nearly vertical. Its west wall is mainly dark grey slate that lies parallel with the vein. Its east wall is a dark green and brown, banded, medium-grained feldspar-amphibole rock, probably an altered tuff. In places this rock also appears on the west wall of the vein and there contains a few garnets. The vein is exposed for a length of 71 feet by a rock trench 91 feet long, and drift lies north and south of the trench. The vein varies from a narrow seam near the south end of the trench to a body 9 feet wide near the north end; and at the north end of the trench it is about 6½ feet wide. The walls are in places sharp and free, but elsewhere quartz grades into a pink and green altered rock cut by quartz veinlets. The vein quartz is coarse grained, grey, and mottled, or fine grained and white. It contains partings of rock and a little pink feldspar, tourmaline, yellowish green mica, pyrite, arsenopyrite, galena, sphalerite, and possibly unidentified soft grey metallic minerals. The metallic minerals comprise less than 1 per cent of the vein matter, but pyrite and arsenopyrite are plentiful in some inclusions of rock. Gold was not seen. Chip samples were cut by the writer (Lord) 7.5, 28 and 54.5 feet south of the north end of the trench. These represented widths of 9.0, 6.0, and 4.3 feet, and contained 0.60 ounce, 0.75 ounce, and 1.35 ounces gold a ton, respectively. A selected sample of quartz and galena, 58.5 feet south of the north end of the trench, contained 2.89 ounces gold a ton."

Bulldog Yellowknife Gold Mines, Limited (27)

References: Lord, 1951, pp. 185-187. Folinsbee and Moore, 1950, p. 10.

A total of fifty-four claims in the Matthews Lake area, between MacKay and Courageous Lakes, including the Jeja, R.E.P., and Mad groups, are owned by Bulldog Yellowknife Gold Mines, Limited, incorporated in January, 1948. Most of the work, which consists of trenching, stripping, and several thousand feet of diamond drilling, has been done on the Matthews vein, in Jeja No. 2 claim.

The property is underlain by sedimentary and volcanic rocks of the Yellowknife group. The southerly showings are in ropy and fragmented lavas, which in places have been altered to garnetiferous schist. Gold occurs in sheared lava that has been silicified, tourmalinized, and impregnated with arsenopyrite. Scheelite is a minor constituent in the quartz lenses.

Homer Yellowknife Mines, Limited (28)

References: Lord, 1951, pp. 187, 188. Folinsbee and Moore, 1950, p. 10.

A group of twenty claims, about 2 miles south of Matthews Lake, is owned by Homer Yellowknife Mines, Limited, incorporated in 1944. The property, which adjoins that of the Bulldog Yellowknife on the south, was acquired from Jacomat Mines, Limited, in June, 1950.

The claims are underlain by the same band of volcanic and sedimentary rocks of the Yellowknife group that extends southward from the Salmita property. Lenticular bodies of quartz, up to 1 foot across occupy a shear zone. The quartz is coarse grained, white to dark grey, and contains a very little pyrite, arsenopyrite, visible gold, and scheelite.

SASKATCHEWAN AND MANITOBA

Scheelite is the only tungsten mineral reported in these two provinces. It has been reported from a few localities within the Precambrian Shield from Lake Athabasca in northwest Saskatchewan to Falcon Lake in southeast Manitoba. No recorded shipments of tungsten ore have been made from Saskatchewan; Manitoba has shipped 1,592 pounds of tungsten concentrate, valued at $1,358. In most localities, the scheelite occurs in quartz veins, but in a few places it occurs as disseminations in schist, and at one place it is in pegmatite.

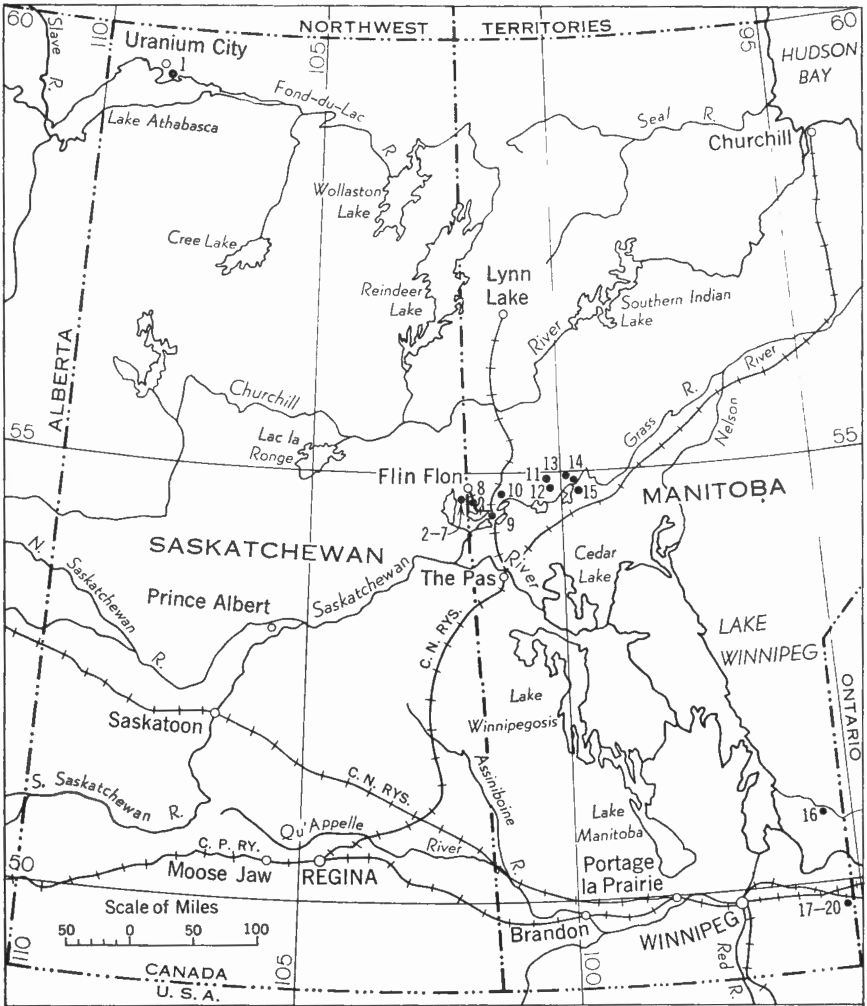
LODE DEPOSITS

Lake Athabasca District

Radiore Uranium Mines Limited (1)

Reference: Christie, 1953, p. 115.

Radiore property is in the Goldfields area and lies south of St. Louis fault about 3 miles east of Ace Lake. The veins are in small fractures in gneiss of



INDEX TO LOCALITIES

SASKATCHEWAN

LAKE ATHABASCA DISTRICT
1. Radiore Uranium Mines Ltd.

AMISK LAKE AREA
2. Moody's property
3. Dion Lake occurrences
4. Phantom Lake occurrences
5. Property of Mosher, Lundmark, and Ward
6. Thompson's property
7. Man -Sask property

MANITOBA

SCHIST LAKE AREA
8. Scheelite occurrences

CRANBERRY PORTAGE AREA
9. Gold Hill Development Syndicate
10. Gurney Gold Mines, Ltd.

SNOW LAKE AREA
11. Northern Tungsten Ltd.

EDWARDS LAKE AREA
12. Wow No. 1 claim

HERB LAKE AREA
13. Herblet Lake deposits
14. Apex mine
15. Rex mine

WALLACE LAKE AREA
16. Scheelite occurrences

FALCON LAKE AREA
17. M. J. T. Group
18. P. M. W. Group
19. Lake claims
20. Black claims

G. S. C.

Figure 24. Index map showing location of tungsten deposits in Saskatchewan and Manitoba.
For explanation *see* page 147.

Archæan age and consist of quartz and carbonate containing blebs and stringers of pitchblende, with pyrite and a little galena. Scheelite was reported by Christie in the vein material, but this occurrence must be local, because Robinson[1] did not detect scheelite in specimens he collected.

Amisk Lake Area

Moody's Property (2)

References: Tanton, 1944, p. 43. Geol. Surv., Canada, Map 314A.

The following is abstracted from an unpublished report on this property prepared by T. L. Tanton of the Geological Survey of Canada.

The locality is on the east side of Mosher Lake, 100 feet inland from a point on the shore that is about 1,000 feet northeast of the outlet of the lake. It may be reached by boat from the termination, on Mosher lake, of a road that connects with the road between Flin Flon and Denare Beach.

The property, owned by R. H. Moody of Beaver Lake, Sask., is underlain by greenstone and schist of the Wekusko group, of Archæan age. Small bodies of granite and diorite occur in the area between Mosher Lake and a large granite batholith 2 miles to the east.

The vein, which lies within greenstone, is said to contain gold. At the time of Dr. Tanton's inspection, the deposit was exposed in a pit 8 feet deep. The quartz vein is lenticular, 2 feet wide, and bordered by branching veinlets, up to one-half inch wide, of quartz and ferruginous carbonate. Scheelite is sparsely disseminated in the vein and wall-rock of the hanging-wall side.

Immediately north of the pit a dump contains blocks of vein quartz. One specimen of one cubic foot of this material was estimated by lamping to contain 0.89 per cent WO_3.

Dion Lake Occurrence (3)

References: Tanton, 1944, p. 43. Geol. Surv., Canada, Map 633A.

Near Dion Lake, which is about a mile west of Phantom Lake, scheelite was noted at or near the copper occurrences shown on Map 633A. The scheelite is not known to occur in commercial quantities.

Phantom Lake Occurrences (4)

References: Tanton, 1944, p. 43. Geol. Surv., Canada, Map 633A.

On the west side of Phantom Lake opposite the narrows leading into the northwest part of the lake, a little scheelite was observed on properties held by A. Kirkland, by the Hudson Bay Mining and Smelting Company, and by R. Lundmark. These occurrences are in small veins near the contact of granite and diorite.

[1] Robinson, S. C., Geol. Surv., Canada: Personal communication.

Property of Mosher, Lundmark and Ward (5)

References: Tanton, 1944, p. 43. Geol. Surv., Canada, Map 633A.

On the east shore of Phantom Lake opposite the portage to Dion Lake, a group of claims is held by M. Mosher, R. Lundmark and H. Ward. The claims are underlain by greenstone of Archæan age intruded by bodies of diorite and granite. Sparsely disseminated scheelite was noted in greenstone and diorite at many points around the periphery of a granite body. At the north end of this body, where it is in contact with greenstone a vein, known as No. 13, on claim W.O. 13, warrants further exploration as possible source of scheelite. The vein strikes north-northeast and dips steeply southeast. It is composite, the main vein averaging about 8 inches wide, with branch veins extending from it through a zone of fissured rock about 3 feet wide. The deposit is in silicified greenstone and is exposed on a cliff 6 feet high on the lake shore and inland towards the north for 20 feet.

Representative samples of the scheelite-bearing quartz vein taken from the surface carried from 2 to 3 per cent WO_3. A specimen 6 inches wide of the vein grades 4 per cent WO_3.

It was reported by M. Mosher that a chip sample taken by R. Lundmark along a length of 20 feet where the vein had been blasted to a fresh surface assayed 7.01 per cent WO_3.

Thompson's Property (6)

References: Tanton, 1944, p. 44. Geol. Surv., Canada, Map 633A.

This property, owned by Hawley Thompson, is on the east side of Phantom Lake about a mile from the south end. It is underlain by greenstone of Archæan age and a small stock of granite. Molybdenite-bearing veins on the property contain a little molybdian scheelite.

Man-Sask Property (7)

References: Tanton, 1944, p. 43. Geol. Surv., Canada, Map 633A.

The Man-Sask property, owned by George Thompson of Cranberry Portage, is at the south end of Phantom Lake. Scheelite occurs in outcrops of a gold quartz vein, and in some pieces of drill core in a cabin on the property. The scheelite is sparsely distributed.

Schist Lake

Scheelite Occurrences (8)

References: Geol. Surv., Canada, Map 633A. Tanton, 1944, p. 44.

On October 10, 1948, T. L. Tanton of the Geological Survey made an examination of ground around an elongated body of quartz porphyry, the south tip of which is near the east shore of Schist Lake, opposite Mandy Mine. Scheelite was found at three localities[1].

---

[1] Tanton, T. L.: Personal communication.

The first locality is near the railway, a few hundred yards north of the south tip of the quartz porphyry body. There in sheared and silicified greenstone a number of quartz veins are exposed, one about one-half inch wide bearing molybdian scheelite, and another bearing a single speck of scheelite.

At the north end of the intrusive body, a number of veins up to 2 inches wide were noted in greenstone. In many of these scheelite was seen, but it was not abundant in the wider veins. North 500 feet from this locality an irregular network of quartz veinlets was observed over an area of a few square feet. Nearly half the volume of some of the narrowest stringers consists of scheelite.

Cranberry Portage Area

Gold Hill Development Syndicate (9)

References: Manitoba Dept. of Mines and Natural Res., Ann. Repts., 1937, p. 27; 1938, p. 36; 1939, p. 41.

Almost all of the data of the following account are taken from an unpublished report by T. L. Tanton of the Geological Survey, based on his examination of October, 1942.

The property of Gold Hill Development Syndicate consists of eight mineral claims adjacent to and southeast of Cranberry Portage townsite, Manitoba. These claims were staked in 1941 by A. G. H. Mast, president of Gold Hill Development Syndicate.

The original claims were staked in 1934, and were developed in 1936 by Bergold Development Company Limited and in 1937 by a subsidiary company, Crangold Mines, Limited. This exploration consisted of 500 feet of diamond drilling, the sinking of an inclined shaft to a depth of 135 feet and the driving at the 65-foot level of a short drift, and a 93-foot crosscut 95 feet south of the shaft from the 125-foot level. From these workings 44 tons of ore was shipped to the smelter at Flin Flon and this yielded 34 ounces of gold and 117 ounces of silver, valued at $1,234.

The property is underlain by greenstone of Archæan age and by intrusive granite in the central and western parts. The shaft in October, 1942 was flooded, but the dump consisted of blocks of greenstone, with some of pink felsite, quartz, and ferruginous dolomite. Only one speck of scheelite was detected in this material.

About 1,000 feet southwest of the shaft a pit 6 by 10 feet and 5 feet deep was full of water when visited. A shallow trench extends 35 feet both north and south from this pit. The rock consists of granite, with small inclusions of greenstone schist. Quartz veins up to a few inches wide and a few feet long form a network in the rock. The wall-rock for several inches from the veins is silicified and pyritized. At the north end of the trench, scheelite is disseminated in the veins and adjacent silicified schist. In an area 2 feet square, embracing the greater part of the scheelite showing, the grade, estimated by measurement, is 0.012 per cent WO_3.

In the dump beside the pit and trench, scheelite is more abundant in some of the blocks. In those consisting of siliceous granite, vein quartz, and chlorite schist cut by veins, scheelite crystals up to 2 square inches in area were noted, but in no single block more than 6 inches in diameter does the grade exceed an estimated 0.1 per cent WO_3.

Gurney Gold Mines, Limited (10)

References: Manitoba Dept. of Mines and Natural Res., Ann. Repts., 1937, pp. 67, 68; 1938, pp. 76-79; 1940, pp. 57-61. Hage, 1944.

The claims, originally staked in 1919, were developed in 1933 by Wylie-Dominion Gold Mines, Limited, and acquired in 1936 by Gurney Gold Mines, Limited. Production of gold bullion commenced in 1938, and continued to 1939. The company surrendered its charter in December, 1948.

The property is 3 miles southeast of Mile 12 on the Sherridon branch of Canadian National Railways. It is underlain by volcanic and sedimentary rocks of Archæan age, forming a narrow belt between two granitic stocks. The gold ore occurs as replacement bodies, mainly of pyrite and pyrrhotite, and as quartz veins containing sulphides.

The property was examined by T. L. Tanton of the Geological Survey in October, 1942. He reports, in a letter to the Chief Geologist, "several occurrences of tiny grains of scheelite, observed at 9 places in the dump, a few places in the vein on surface, and at a few places in the underground workings.

"The occurrences are of a grade much too low to be of value as a source of tungsten."

Snow Lake Area

Northern Tungsten Limited (11)

Reference: Harrison, 1949, pp. 75, 76.

The following account is taken from an unpublished report by J. C. McGlynn of the Geological Survey who examined the property in September, 1951.

The property, consisting of sixteen claims including the Juliana group staked by J. Hutt in 1949, was acquired in 1951 by Northern Tungsten Limited. The Juliana claims are on the west shore of Snow Lake. The Squall Creek sulphide deposit on these claims was described by Harrison.

The property is underlain by three rock types: hornblende-plagioclase gneiss, garnetiferous hornblende-biotite-plagioclase gneiss, and garnetiferous biotite-plagioclase-quartz gneiss.

Hornblende gneiss forms three narrow bands that trend about north. The westerly band is a fine-grained, black, hornblende-plagioclase gneiss in which compositional banding is barely distinguishable. The central and easterly bands are medium-grained hornblende gneiss in which compositional banding is easily recognized. Locally, lenses of quartz measuring 1 foot to 2 feet in length and about 2 inches wide are numerous. They parallel the foliation and plunge with the lineation. The hornblende gneiss is considered by Harrison to represent a metamorphosed basic volcanic rock.

Garnetiferous hornblende-biotite-plagioclase gneiss occurs in two bands between the three hornblende gneiss bands. In addition, one small outcrop of this rock occurs at the southeast corner of the property. The rock consists of hornblende and biotite in varying amounts, with some plagioclase, and quartz. Garnets are irregularly distributed and locally they are abundant up to ¼ inch in diameter. Compositional banding is pronounced.

The garnetiferous biotite gneiss is found in the central part of the property. This gneiss is a medium-grained aggregate of biotite, plagioclase, quartz, and garnets. The garnets are evenly distributed and plagioclase and quartz are more plentiful than the hornblende-biotite gneiss. Garnetiferous gneisses of this type are widespread in File Lake map-area and Harrison considered them to be granitized equivalents of Amisk volcanic rocks.

The strike of the foliation varies from north 10 degrees west to north 30 degrees east, but averages north 15 degrees east. Foliation dips average about 50 degrees east, and the long axis of hornblende grains plunges 30 degrees to the north. Cross-fractures consistently strike north 70 degrees west and dip vertically. Details of folds are unknown. Three faults have been observed. One along Squall Creek probably swings east under Snow Lake as a part of the Snow Lake normal fault mapped by Harrison (1949, p. 45), the second fault is in the hornblende gneiss, and possibly joins the Snow Lake fault north of the property. Some of the movement along this fault plane may have been horizontal. A third fault occurs near the west boundary of the claims and extends north to and beyond a small lake.

The scheelite-bearing veins occur in the east band of hornblende gneiss at a point about half a mile north of Snow Lake. The veins have been traced on surface and underground for a length of about 150 feet, and the south face of the drift exposes the vein. The scheelite occurs in two veins, each about 3 inches wide, that parallel the foliation, dipping with it at an angle of about 45 degrees. They are separated by about 3 feet of wall-rock. In a few places the veins widen to about 5 inches for lengths of about 2 feet, and in several places they pass along the strike into a zone, 4 to 5 inches wide, consisting of a series of branching, narrow veinlets in silicified wall-rock.

Scheelite occurs in the quartz veins as follows: seams up to ¼ inch wide and 7 inches long; irregular patches up to 1 inch in maximum dimension; and in one known occurrence a mass that forms up to 75 per cent of the vein for a length of 6 inches. In general, the distribution of the scheelite in the quartz veins is irregular and sections of vein up to 10 feet in length do not contain scheelite. Scheelite does not occur in the wall-rock. Picked samples are reported to assay 25 per cent WO_3. The white, medium-grained quartz of the veins is cut by narrow veinlets of glassy, fine-grained quartz. Sulphides are rare in the scheelite-bearing quartz veins.

A sample of 100 pounds of hand picked ore containing 25 per cent WO_3 was shipped to the Mines Branch in Ottawa for mill tests. The results of these tests indicated the possibility of successful concentration and the absence of detrimental elements.

Edwards Lake Area

Wow No. 1 Claim (12)

Reference: Harrison, 1949, p. 57.

"The showing on the Wow No. 1 claim consists of an irregular vein of white, glassy quartz that trends about northwest and dips steeply northeast to vertically. It follows roughly along a contact between a dyke of 'quartz-eye' granite and feldspathized basic lava. The rocks for more than 200 feet east and west of the vein consist of a mixture of 'quartz-eye' granite, pink felsite, and feldspathized andesite. A rather hurried examination of the vein revealed only some sparse pyrite, but the owners reported (August 1945) that some scheelite is present. The vein pinches and swells abruptly, and was traced for less than 100 feet."

Herb Lake Area

Herblet Lake Deposits (13)

References: Wallace, 1925, p. 434. Man. Dept. Mines and Natural Res., Ann. Repts., 1943, p. 53; 1944, p. 95.

The occurrence of scheelite "associated with pegmatites on the west shore of the north arm of Little Herb (Herblet) Lake, in irregular quartz veins carrying values in gold" was noted by Wallace in 1925.

These deposits were explored in 1942 by Herblet Tungsten Prospecting Syndicate, Tiger Tungsten Prospecting Syndicate, and Hecker Tungsten Prospecting Syndicate, and subsequently by Tungold Mines Limited.

Trenching and drilling were carried out, and although scheelite was reported both on the surface and in diamond-drill core, the quantity and grade are not reported.

Apex Mine (14)

References: Wright, 1931, pp. 88-92. Wallace, 1925, p. 434. Man. Dept. Mines and Natural Res., Ann. Repts., 1941, p. 89; 1943, p. 14; 1944, p. 95. Alcock, 1920, p. 37. Armstrong, 1941.

The Apex group of claims is near Rex Lakes, inland from the east shore of Wekusko (Herb) Lake, 4 miles north of the settlement of Herb Lake. It was first staked in 1918. The first extensive development work, which consisted of stripping and trenching, was done by the Consolidated Mining and Smelting Company of Canada, Limited, in 1930.

The deposit consists of a stockwork of quartz veins and stringers that, for the most part, follow joints in somewhat schistose granite. The quartz contains pyrite and a little free gold, but although the deposit is fairly large, the grade is low. Scheelite was discovered[1] in the veins in 1942, and the property was acquired by Tungold Mines Limited. A drilling program was carried out and scheelite was reported from the core, but the grade is not known.

Rex Mine (15)

References: Man. Dept. Mines and Natural Res., Ann. Rept., 1928, p. 65. Wright, 1931, pp. 78-81. Stockwell, 1937, pp. 28-31. Armstrong, 1941.

The Rex mine formerly operated by Laguna Mines Limited, is on the east side of Wekusko (Herb) Lake north of the settlement of Herb Lake. Prior to 1939, when the mine was shut down, it produced gold to a value of about $2,000,000. Scheelite was reported in the veins (Man. Dept. Mines and Natural Res., Ann. Rept., 1928) at an early date, but subsequent reports have made no mention of it.

Wallace Lake Area

Scheelite Occurrences (16)

Reference: Russell, 1948, p. 11.

In summarizing the economic geology of the Wallace Lake area, Russell says: "The Wallace Lake and Conley Bay faults at Wallace Lake have been the seat of deposition of a wide variety of minerals including gold, silver, pyrite, chalcopyrite, galena, arsenopyrite, molybdenite, and sphalerite, plus small amounts of scheelite. Gangue minerals include quartz, carbonates, and tourmaline."

No further details as to the occurrence of scheelite or its quantity are given.

Falcon Lake Area

M. J. T. Group (17)

References: Bruce, 1919, pp. 14, 15. Mines Branch, 1920b, pp. 60, 61. Wright, 1932, pp. 131-135. De Lury, 1918, pp. 186-188; 1944. Bateman, 1943, pp. 4-7. Springer, 1952, pp. 17-18.

The M. J. T. group of claims was staked for gold in 1937 and scheelite was discovered in several localities in 1939. The group was acquired by Thor Gold Mines, Limited who carried out trenching and sampling in 1942. The company subsequently became inactive, and was dissolved in December, 1948.

The group is about a mile north of Barren Lake, and a mile west of Sunbeam Kirkland mine. The claims cover a band of greenstone of Archæan age between a large body of porphyritic granodiorite on the west and a smaller body of quartz monzonite on the east. According to Bateman the greenstone forms the south limb of a syncline containing minor folds that plunge northeast 25 to

[1] *The Miner*, Vol. 15, No. 8, pp. 62, 64.

60 degrees. The silicified greenstone along two lenticular shear zones contains garnet, secondary amphibole, epidote and disseminated scheelite. The north lens is 32 feet long and varies in width from 1.2 to 4.2 feet, and the south lens, which is 1,100 feet southwest of the first, is 18 feet long and from 0.8 foot to 3.3 feet wide. Three channel samples from the north lens averaged 0.33 per cent WO_3 across 1.6 feet. In the south lens three samples averaged 0.14 per cent WO_3 across 2.4 feet.

P. M. W. Group (18)

References: **Bateman, 1943, pp. 6, 7. Springer, 1952, p. 18.**

The P. M. W. group includes the former M. J. T. No. 14 and the former Felrite No. 1 claims, both of which are southwest of the M. J. T. group. On the P. M. W. No. 2 claim a shear zone 52 feet long and 4 to 22 inches wide, striking north 34 degrees east and dipping 80 degrees southeast is exposed at the northeast side of a large outcrop in a muskeg. Within the zone there is much epidote and small amounts of glassy quartz and secondary hornblende. The grade was estimated to be less than 0.1 per cent WO_3. In 1918 scheelite ore was shipped from this deposit.

On P.M.W. No. 8 claim, formerly Felrite No. 1, about a half-mile northwest of Barren Lake, there are two shear zones in the greenstone. The north shear zone contains five scheelite-bearing pods, arranged *en échelon* and distributed over a length of 165 feet. The sheared, silicified greenstone contains scheelite, epidote, garnet and minute amounts of pyrite and chalcopyrite. The WO_3 content of 30 tons of material was estimated at 0.56 per cent WO_3.

The lens in the south shear zone is 90 feet long, strikes north 35 degrees east, and dips 85 degrees southeast. Three scheelite-bearing pods are present, and these contain epidote, garnet, calcite, pyrrhotite, chalcopyrite, and small amounts of cherty and glassy quartz. Three samples averaged 0.17 per cent WO_3.

Lake Claims (19)

References: **Bruce, 1919, pp. 14, 15. Wright, 1932, pp. 131-135. Bateman, 1943, p. 7.**

The Lake claims are southwest of the P. M. W. group, and on the same belt of Archæan greenstone. The Lake 10 claim was known formerly as the Empress claim, and a deposit on this claim was the source of most of the tungsten ore shipped in 1918. It is reported that 380 tons of material were quarried, from which 2 tons of ore, averaging 1.65 per cent WO_3 were shipped to the Mines Branch, Ottawa. Bateman estimated that by hand sorting, an additional 2 tons of ore, running about 1 per cent WO_3, could be obtained from the dump.

The open-cut from which this material was obtained is 50 feet long, 8 to 15 feet wide, and consists of two benches, on the lower of which a pit was sunk 15 feet. This pit follows a shear zone that strikes northeast, dips 85 degrees southeast and plunges 35 degrees northeast. Hornblende, biotite and epidote are present, but scheelite is limited in distribution to an area of 60 square inches and this is estimated to grade less than 0.1 per cent WO_3.

Black Claims (20)

Reference: Bateman, 1943, p. 7.

Black 4 and 5 claims are immediately north of Howe Bay, West Hawk Lake, and were examined by T. L. Tanton of the Geological Survey. The claims are underlain by greenstone schists of Archæan age. On Black 4 claim, four pods of scheelite-bearing material were found over a length of 70 feet. About 12 tons of this material, which is much less than 1 per cent grade, was estimated to be present.

On Black 5 claim three pods, each 6 feet long and 1.5 feet wide, and weighing about 5 tons, contain scheelite in patches. Two shipments of the material were sent to the Ore Dressing Laboratories, Ottawa, in 1942. The first, weighing 1,328 pounds, contained 0.45 per cent WO_3, and the second, weighing 1,866 pounds, contained 0.51 per cent WO_3.

Other Occurrences

The scheelite occurrences of the Falcon-West Hawk Lakes area occur in a belt of greenstone in which intermittent shear zones extend in a northeast direction for 2½ miles. In addition to the deposits described many others contain scheelite in small quantities and widely disseminated. Such occurrences are reported on the M. J. T. 13 claim, Sheba 2 claim, L. L. claim near Star Lake, Tungsten and Scheelite claims northwest of Star Lake, M. J. T. claim north of the Black 4 and 5 claims, several places west of Falcon Lake, and Felrite 6 claim. In all except the last locality, the scheelite occurs in sheared, altered greenstone. On the Felrite 6 claim, the scheelite is in a pegmatite dyke in porphyritic granodiorite.

ONTARIO

The tungsten occurrences of Ontario are in the Precambrian rocks of the Canadian Shield. All such occurrences are scheelite in quartz veins in or near gold camps, but in those veins that contain appreciable scheelite, gold is sparse or absent. The scheelite-bearing veins appear, for the most part, to have been formed at higher temperatures than those containing gold. The production of scheelite concentrate in Ontario has been entirely from gold mines. Scheelite production has been relatively small except for Hollinger mine which in 1940-43 and 1952 produced concentrate containing more than 200 tons of WO_3.

LODE DEPOSITS

Fort Francis Mining Division

Corrigan Property (1)

T. E. Corrigan of Emo, Ont. in December, 1942, submitted to A. W. Jolliffe[1] of the Geological Survey samples of vein quartz containing scheelite, from the southwest part of Farrington township, near Swell Bay, Rainy Lake,

[1] Memorandum to the Chief Geologist, December 14, 1942.

and about 25 miles east of Fort Francis. The samples were said to have been obtained from quartz veins in a shear zone 40 feet wide. The five samples weighed about 3½ pounds and a weighted average grade of 2 to 3 per cent WO_3 was calculated from areal measurement of the scheelite present on the surface of the specimen.

Kenora Mining Division

Lake of the Woods Area

Wendigo Gold Mines, Limited (2)

Reference: Thomson, 1935, pp. 34-39.

The property of Wendigo Gold Mines, Limited, is on the north shore of Witch Bay, Lake of the Woods. It is underlain by alternating bands of basalt and altered diorite intruded by small masses of quartz porphyry. These rocks are highly sheared, and within the shear zones are veins of auriferous quartz with a small amount of ankerite and sulphides. Scheelite was reported in the veins by Jolliffe (1942). The property was a gold producer.

Manitou Lakes Area

Gaffney Claims (3)

Reference: Thomson, 1933, p. 30.

Ten claims, staked by Frank Gaffney and associates, cover the northeast part of Manitou Island, and include the former Bee-hive mine. The area is underlain by andesite and chlorite schist, cut by dykes of quartz porphyry, both of Archæan age. A quartz vein, traced for 140 feet on the surface, and dipping vertically, has been explored by a shaft. The vein matter consists of fractured quartz, containing pyrite, chalcopyrite, and tourmaline. Visible gold is also present. V. L. Eardley-Wilmot of the Mines Branch reported[1] a very little scheelite in the vein.

Dryden-Red Lake Property (4)

Reference: Thomson, 1933, p. 31.

Four claims, owned by Dryden-Red Lake Prospecting Partnership, are located north of Lower Manitou Lake. The main showing is quartz veins in a shear zone in andesite. The quartz and adjacent schist contain a little pyrite and carbonate. V. L. Eardley-Wilmot of the Mines Branch reported[1] a little scheelite in the showing.

Gold Rock Mines, Limited (5)

Reference: Thomson, 1933, pp. 32, 33.

The property of this company is on the west shore of Upper Manitou Lake. The rocks are chiefly altered quartz diorite with lesser andesite and agglomerate.

[1] Unpublished report for Mines Branch files, April, 1943.

The vein, which is $1\frac{1}{2}$ feet wide, is in the quartz diorite, and has been explored by a shaft and a crosscut 170 feet long. The vein consists of quartz that carries some pyrite and a trace of chalcopyrite and native gold. Scheelite was reported by V. L. Eardley-Wilmot[1] of the Mines Branch, but is present only in minute amounts.

Dinorwik Area

Sandybeach Lake Property (6)

Reference: Satterly, 1941, pp. 58, 59.

The property of Sandy Beach Lake Syndicate is 1 mile southeast of Sandybeach Lake in McFie township. The rocks are sheared and carbonatized greenstones of Archæan age with bands of quartz porphyry. Quartz veins have been exposed by trenching for a length of more than 1,000 feet. The quartz is glassy and contains little sulphide. A small amount of gold was produced in 1941 and 1942. Tungsten is present in the ore[2], but the grade is not reported.

Red Lake Mining Division

Red Lake Area

Madsen Red Lake Gold Mines, Limited (7)

References: Hurst, 1935, pp. 35-37. Horwood, 1940, pp. 174-182.

Madsen Red Lake property is southeast of Russet Lake in Baird and Heyson townships. The rocks are of volcanic origin of Archæan age, intruded by at least five ages of granite, granodiorite, diorite, gabbro and quartz and feldspar porphyries. The orebodies are lenses in sheared tuff with sulphide mineralization, from which up to 1952, several million dollars in gold and silver have been produced. Scheelite is reported (Jolliffe, 1942) to be present in the ore.

Scheelam Mines, Limited (8)

References: Western Miner, vol. 24, No. 12, p. 74. *Can. Mining J.,* vol. 72, No. 12, p. 98.

Scheelam Mines, Limited was formed in 1951 to develop the Campbell-Dome Creek group of eleven claims, which is $2\frac{1}{2}$ miles north of the Madsen Red Lake property, in Baird township. It is reported that values in both gold and tungsten have been obtained, and a diamond-drilling program was initiated.

Hasaga Gold Mines, Limited (9)

References: Hurst, 1935, pp. 32-35. Horwood, 1940, pp. 123-128.

The property of Hasaga Gold Mines, Limited is in Heyson and Dome townships and consists mainly of the former holdings of Red Lake Gold Shore Mines, Limited, and McIntyre-Porcupine Mines, Limited.

---

[1] Unpublished report for Mines Branch files, April, 1943.

[2] Mineral Map of Ontario, No. 1953-A.

The rocks are massive volcanic breccias intruded by diorite, quartz porphyry, and granite. The quartz porphyry forms a single large dyke within which are lenticular quartz veins bearing pyrite, sphalerite, galena, chalcopyrite, tellurides and gold. Scheelite has been reported in the ore by Jolliffe (1942, p. 26).

Howey Gold Mines, Limited (10)

References: Hurst, 1935, pp. 26-32. Horwood, 1940, pp. 138-146.

Howey mine, which was the first producing mine in the Red Lake area, adjoins Hasaga property on the east, and represents an eastward extension of that ore zone. The veins are distributed in a large dyke of quartz porphyry, and have a similar mineral assemblage to that at Hasaga. Scheelite was reported in the veins by Hurst (p. 28), but is present only in minor quantity.

Gold Eagle Gold Mines, Limited (11)

References: Hurst, 1935, pp. 17, 18. Horwood, 1940, pp. 109-115.

Gold Eagle mine is on the east shore of McKenzie Island, which is the largest in Red Lake. The rocks underlying the property are mainly sedimentary rocks of Archæan age and, in the eastern claims, the south part of a granitic stock. The orebodies are confined to two shear zones that intersect both sedimentary and granitic rocks. One shear zone strikes north 65 degrees west and dips 52 degrees southwest, and the other strikes north 75 degrees west and dips 44 degrees south. Both shear zones are occupied by quartz veins; those in the latter zone being smaller, more discontinuous, but more numerous than in the former. The quartz veins contain only small amounts of sulphides except in certain localities where the quartz is greatly fractured. The sulphides are arsenopyrite, pyrite, pyrrhotite, chalcopyrite, galena, and sphalerite. Tourmaline, tellurides and gold are also present. According to Hurst, scheelite is erratically distributed, and forms masses, in a few places up to several inches in diameter.

McKenzie Red Lake Gold Mines, Limited (12)

References: Hurst, 1935, pp. 156-167. Horwood, 1940, pp. 11-17.

The property of McKenzie Red Lake Gold Mines, Limited is on McKenzie Island, and adjoins the Gold Eagle claims on the north. The property is underlain by diorite and granodiorite in which lenses and veins of quartz occupy fractures and shear zones. The most important orebodies lie in a shear zone that strikes north 5 degrees east and dips 30 to 55 degrees west. The veins consist of fractured quartz containing sulphides, tellurides and gold. Scheelite is present in the veins and some of it was shipped in 1945[1].

[1] Ont. Dept. of Mines, Ann. Rept., vol. 55, Pt. I, p. 35.

McMarmac Red Lake Gold Mines, Limited (13)

Reference: Horwood, 1940, pp. 168-174.

McMarmac mine is half-way between the north end of McKenzie Island and the northeast corner of Dome township. It is on the east shore of Red Lake, in Dome Township.

The rocks are chiefly basic to intermediate volcanic rocks of Archæan age, with minor interbedded slate and iron-formation, and dykes of quartz porphyry. The orebodies consist of large zones of carbonate that contain masses of cherty quartz, bearing arsenopyrite and gold. Scheelite has been noted in table concentrates in the mill, and Horwood (p. 171) suggests that it may have been emplaced in the ore zones at the same time as the cherty quartz.

Other Occurrences

Scheelite has been reported[1] in small amounts on five additional properties of Red Lake area: Durham Red Lake, Humblin claims, Rugged Red Lake, May-Spiers, and Cole Gold Mines, Limited.

Casummit Lake Area

New Jason Mines, Limited (14)

Reference: Horwood, 1937, pp. 17-25.

Argosy mine, owned by New Jason Mines, Limited, is at the east end of Casummit Lake. The rocks include greenstone, greywacke, slate, iron-formation, and volcanic breccia, of Archæan age, intruded by dykes of diorite. The most important veins occupy fractures in a lenticular band of highly folded and sheared greywacke and slate. The fractures that contain the veins strike about north 10 degrees west and dip 31 to 54 degrees west. The veins consist of quartz of two ages. The younger quartz contains albite, carbonate, sulphides, gold, and some scheelite (Jolliffe, 1942, p. 26).

Uchi Lake Area

Uchi Gold Mines, Limited (15)

References: Thomson, 1938, pp. 74-77. Bateman, 1939, pp. 34-37.

The property of Uchi Gold Mines, Limited, is west of Uchi Lake in Earngey township, and is underlain by alternating bands of greenstone, meta-gabbro, rhyolite, and cherty tuff. The main quartz veins occur at three localities on the property and occupy shear zones containing quartz and sulphides. The limits of the orebodies are determined by assay. The veins and schist contain carbonate, minor sulphides, gold and scheelite (Jolliffe, 1942, p. 26).

[1] *Can. Mining J.*, vol. 72, No. 12, p. 98 (Dec., 1951).

Patricia Mining Division

Pickle Lake Area

Central Patricia Gold Mines, Limited (16)

Reference: Thomson, 1938, pp. 36-49.

Central Patricia mine is east of Pickle Lake and south of Crow River. The property is underlain by andesitic lava of Archæan age, minor interbedded iron-formation and irregular bodies of sheared quartz porphyry and sericite schist.

Two vein systems are developed by separate shafts. The west vein strikes east and dips 75 degrees north. The strike of the east veins is variable but in general is east and the dip roughly 65 degrees north. The orebodies of the west deposit are in iron-formation, and the vein matter consists of quartz, chlorite, siderite, chert, and secondary carbonate, with pyrrhotite, arsenopyrite, magnetite, ilmenite, pyrite, chalcopyrite and gold. The east deposit is in irregular quartz veins, bearing tourmaline and carbonates, with very small amounts of sulphides. Scheelite has been reported in the ore by Jolliffe (1942, p. 26). All known ore was mined by the end of 1952.

Pickle Crow Gold Mines, Limited (17)

References: Thomson, 1938, pp. 52-62. Ont. Dept. Mines, Ann. Rept., vol. 52, Pt. I, p. 173.

The property of Pickle Crow Gold Mines, Limited adjoins that of Central Patricia Gold Mines, Limited on the northeast. The rocks are chiefly lava of andesitic composition and Archæan age. Breccias, tuff and agglomerate, and interbedded iron-formation occur between the lava flows. A few small dykes, and a larger, sill-like diorite body also have been mapped.

Several veins are known of which the most important is the Howell. This occupies a strong fraction that strikes north 65 to 75 degrees east and dips about 75 degrees northwest. The vein is more than 1,600 feet long and averages 3 feet in width. In many places the quartz contains much chlorite schist; chlorite, sericite, tourmaline, and carbonate are widespread. Sulphides, which are not abundant, comprise pyrite, chalcopyrite, pyrrhotite, arsenopyrite, galena, and sphalerite. Free gold, visible in a few localities, is widespread. Scheelite was found in the ore (Jolliffe, 1942, p. 26), and in 1942 some 4,000 pounds of scheelite-bearing material was hand-picked from the sorting belt. Concentration of this material on a table installed for the purpose yielded 120 pounds of tungsten concentrate.

Fort Hope Area

Rich Lake Patricia Syndicate (18)

Reference: Prest, 1942, p. 24.

"The Rich Lake Patricia Syndicate holds a large group of unsurveyed claims lying between Rich creek and Opikeigan lake. The property has received attention owing to the presence of a quartz body carrying coarse scheelite.

The workings are located in a band of contorted Keewatin greenstone and tuffs on the north side of the large outcrop immediately south of the camp. This location is a high hill covered with a thin drift mantle and heavy windfall. The quartz-scheelite vein extends from the west end of the outcrop eastward for 250 feet, terminating in a quartz bulge about 6 feet in width. It is reported to be similarly widened in the three pits along the strike. The bodies are evidently pipe-like and connected along the strike by a smaller vein. The scheelite occurs irregularly distributed through the quartz mass, and there are associated low gold values. Arsenopyrite is abundant but is not associated with the gold content. Pyrrhotite and pyrite are also present. A persistent small quartz vein from 8 to 10 inches in width parallels the larger irregular mass a few feet north of it. This is also reported to carry low values. Elsewhere on the outcrop there are many small quartz stringers which carry low values in gold and in which visible gold has been reported. These stringers are related to crosscutting shear zones and fractures and the crests of drag folds.

"Work during the summer of 1941 was confined to surface-stripping and trenching. Diamond-drilling had been carried on in the past on the scheelite vein. A description of the original workings, known as the Irish-Wording claims, has been given by E. M. Burwash."

Dome Mines, Limited (19)

Reference: Prest, 1942, pp. 25-27.

The property of Dome Mines, Limited is on the north side of Reserve Creek and overlaps the east boundary of the Indian Reserve. Trenching in 1941 revealed a shear zone 40 feet wide and 300 feet long in volcanic rocks of Archæan age. Within the shear zone, which strikes north 70 degrees east and dips 70 degrees north, quartz stringers and mineralized rock carry pyrite, pyrrhotite, gold, and some chalcopyrite and disseminated scheelite. Subsequently, twenty diamond drill holes were completed and the results of extensive sampling both of drill core and surface exposures were published by Prest and are summarized here.

Seven channel samples showed a grade of 0.3707 per cent WO_3 across an average width of 6.86 feet and a length of 45 feet. Sixty feet east of this part of the zone, another channel sample assayed 0.2522 per cent WO_3 across 9.0 feet.

Bulk samples were taken from four trenches in the same zone. These gave an average grade of 0.936 per cent WO_3 across a width of about 6 feet, and a length of 80 feet.

Ten diamond drill holes were placed to intersect the scheelite-bearing zone at a depth of 25 feet, and over a length of 205 feet. Four holes intersected the zone at a depth of 75 feet, and two others were placed to intersect the zone at depths of 150 and 230 feet, respectively. The cores were lamped and the grades were estimated in all cases to be lower than those on the surface.

For a geological diagram of the workings and drilling, together with an assay plan, the reader is referred to the report by Prest (1942, p. 26).

Port Arthur Mining Division

Beardmore Area

Sand River Gold Mining Company, Limited (20)

References: Laird, 1936, pp. 109-112. Bureau of Mines, 1942*e*.

The Sand River property, consisting of twenty-two claims, is in Eva township, south of Standingstone River and near Lake Nipigon. It is underlain by greywacke of Archæan age, intruded by a few dykes of diorite and diabase. Two veins are known on the property, the more important occupying a shear zone that strikes north 60 to 70 degrees east. This vein is discontinuous and is displaced by a number of small transverse faults. The vein matter is quartz, of two generations and sparsely mineralized with pyrite, tetrahedrite, and gold. Carbonate, sericite, and chlorite are also present in the vein. The vein is exposed at intervals for a length of 2,100 feet, and averages 13 inches in width.

In May, 1942, a shipment of 50 pounds of Deister table concentrate was sent to the Bureau of Mines, Ottawa, for tests. This sample assayed 0.23 ounce a ton gold, 0.20 per cent WO_3, 3.21 per cent sulphur, 0.72 per cent arsenic, and 0.07 per cent phosphorus.

The results of tests indicated that in making a high-grade tungsten concentrate a low recovery only was possible, but concentrates of 6 to 9 per cent WO_3 could be obtained with recoveries of from 31 to 54 per cent of the original WO_3. The low WO_3 concentrate is suitable for chemical treatment, but probably could not be treated at a profit.

Leitch Gold Mines, Limited (21)

References: Laird, 1936, pp. 101-105. Bureau of Mines, 1942*d*. Ont. Dept. Mines, Ann. Repts., vol. 52, Pt. 1, p. 137; vol. 53, Pt. 1, p. 123.

The property of Leitch Gold Mines, Limited is in Eva and Summers townships, near Beardmore, and adjoins the Sand River mine on the east. The rocks are greywacke, interbedded iron-formation, and a little conglomerate and greenstone, all of Archæan age. Four veins have been discovered. These occupy narrow, irregular shear zones, so that the veins are for the most part sinuous and have a random orientation. The quartz contains sericite, pyrite, tetrahedrite, sphalerite, scheelite and native gold.

A shipment of hand-sorted scheelite ore was sent to the Bureau of Mines, Ottawa, in March, 1942, for flotation tests. The sample weighed 6,206 pounds and assayed as follows: 2.15 ounces a ton gold; 2.19 per cent WO_3; 0.029 per cent phosphorus; and 0.38 per cent sulphur. The result of tests indicated that concentrates of 20 and 31 per cent WO_3, containing 97 to 90 per cent of the WO_3 in the heads, respectively, could be obtained by flotation. This product would be suitable for chemical treatment.

Two additional lots, totalling 4 tons, were subsequently sent to the Bureau of Mines for further tests, and 25.5 tons were stockpiled to await treatment in the plant at Little Long Lac Gold Mines, Limited. To this was added, in

1943, sufficient hand-sorted ore to bring the total to 64.3 tons, averaging 3.95 per cent WO_3. From this lot, 1,600 pounds of concentrate averaging 62 per cent WO_3 and 8,200 pounds averaging 20.90 per cent WO_3 representing a recovery of 53.13 per cent of the WO_3, were obtained. The production of tungsten concentrate was discontinued in September, 1943.

Little Long Lac Area

Jellicoe Mines (1939), Limited (22)

Reference: Bruce, 1935, p. 52.

"The Jellicoe Gold Mining Company holds a large group of claims lying west of Magnet Lake and extending westward to Wild Goose Lake. The extensive stripping done, especially on those claims lying immediately west of Magnet Lake, has indicated the occurrence of a mass of very acidic intrusive, in which traces of gold have been found. Some diamond drilling has been done along the margins of this mass where it is in contact with sediments."

Subsequent to the reorganization of the company in 1939, gold ore valued at more than $200,000 was shipped. The property has been idle since 1941. Jolliffe (1942, p. 26) has reported the presence of scheelite on the property.

Tombill Gold Mines, Limited (23)

References: Pye, 1951, pp. 125, 131-134. Matheson, 1948, pp. 401-406.

Tombill Gold Mines, Limited holds three groups of claims, the most important being the former Elmos group on the east side of Lindsley township, where underground operations have been undertaken.

The rocks are greywacke, slate, iron-formation, and lava, steeply dipping, and folded into an east-west trough surrounded by younger granite, and are intruded by masses of diorite and porphyry. The ore occurs in mineralized zones in sheared greywacke and porphyry in which arsenopyrite, pyrite, pyrrhotite, sphalerite, chalcopyrite, galena, grey copper and ilmenite have been identified. Some of these minerals are present also in some of the quartz and quartz-carbonate veinlets that intersect the mineralized zone. Scheelite is also reported by Jolliffe (1942, p. 26).

Bankfield Consolidated Mines, Limited (24)

References: Bruce, 1935, pp. 46-56. Matheson, 1948, pp. 401-406. Pye, 1951, pp. 70-82.

The property of Bankfield Consolidated Mines Limited is in Errington township, bordering that of Tombill Gold Mines, Limited, on the east. The rocks are lavas and greywackes of Archæan age intruded by diorite and porphyry. The mineralized shear zone is the extension of the Tombill zone and contains the same minerals, including scheelite (Pye, 1951, p. 81).

Magnet Consolidated Gold Mines, Limited (25)

Reference: Pye, 1951, pp. 100-113.

The Magnet property, consisting of thirty-nine claims in Errington township, adjoins the Bankfield property on the south and east. The claims are underlain by Archæan conglomerate, iron-formation, greywacke and slate, intruded by diorite, diorite porphyry, albite porphyry, and diabase. The bedding strikes north 70 degrees west and dips 75 to 80 degrees south, but is much contorted. The strata form the south limb of a syncline.

The orebodies are in quartz veins of three systems and consist of fracture fillings and replacements in minor faults that are roughly parallel with the Tombill-Bankfield major fault zone, which crosses the Magnet property to the south of the veins. The vein matter is largely quartz, with some carbonate and sulphides including arsenopyrite, pyrite, pyrrhotite, chalcopyrite, sphalerite, and galena. Gold is also widely distributed.

Scheelite was not noted in the upper levels, but is reported[1] on the 17th level, where grab samples, assaying up to 49 per cent WO_3, are reported to have been collected. Scheelite is reported to occur for a length of 300 feet and a vertical distance of 80 feet. Three quartz stringers on the 17th level carry scheelite within a width of 3 feet. A bulk sample of 10 tons averaged 0.25 per cent WO_3.

Talmora Longlac Gold Mines, Limited (26)

Reference: Pye, 1951, pp. 124-131.

This property, which comprises thirteen claims, is on the south side of Barton Bay, Lake Kenogamisis, about 2½ miles southwest of Geraldton. The rocks are mainly greywacke with interbedded iron-formation, intruded by a large mass of diorite and dykes of albite porphyry and quartz diabase. The sedimentary rocks form an anticline that plunges westerly, the core of which is occupied by an elongated stock of diorite. The greywacke and diorite are traversed by irregular fractures and shear zones that are occupied by stringers and veins of quartz containing some carbonate, sulphides, antimony, and gold. A small amount of scheelite has been reported in the vein.

Little Long Lac Gold Mines, Limited (27)

References: Bruce, 1935, pp. 33-43. Pye, 1951, pp. 84-100. Bureau of Mines, 1942*c*.

Little Long Lac mine, adjoining Talmora mine on the north, is on the south side of Barton Bay, Kenogamisis Lake. It is about 2 miles south of Geraldton.

The property is underlain by greywacke, slate, conglomerate, iron-formation, and arkose, of Archæan age, cut by bodies of diorite, diorite porphyry, lamprophyre, and quartz diabase. These rocks form a syncline, on the limbs of which two large drag-folds are superimposed, one of these folds, on the north limb of the syncline, appears to control the localization of the orebodies.

[1] *Northern Miner*, vol. XXXVII, No. 32 (November 1, 1951).

The main vein system consists of two parallel veins 150 to 200 feet apart. These are joined at their west end to form one vein roughly sigmoid in outline. Two smaller, parallel veins occur 500 feet southeast of the main vein. All the veins, except the connecting part of the main vein, strike north 75 degrees east and their dips are mainly vertical. The main vein has a total length of 1,200 feet and an average width of 3 to 4 feet. Many small veinlets branch off from, or parallel the main vein. The vein matter is largely quartz with small amounts of carbonate, scheelite, sulphides, and gold.

Early in 1942 an examination of the veins, with a view to determining whether scheelite concentrates could be produced as a by-product, was made by H. C. Cooke and R. E. Folinsbee of the Geological Survey. Samples were hand-picked under their direction and a shipment totalling 4,383 pounds was sent to the Bureau of Mines, Ottawa. The shipment consisted of three lots, described as follows:

Lot No. 1 weighed 2,086 pounds. Every piece of muck containing visible scheelite was picked from the belt, but the muck was not stirred to reveal covered pieces.

Lot No. 2 weighed 2,157 pounds. In this case the muck was stirred and only the higher grade material was selected.

Lot No. 3 weighed 140 pounds. It contained only high grade material.

The results of sampling and analysis are tabulated below:

	Lot No. 1	Lot No. 2	Lot No. 3	Lots Nos. 2 and 3 composite
Gold, ounces per ton	2.27	2.06	2.93	2.12
Tungstic oxide, (WO_3) per cent	1.27	2.70	14.30	3.42
Iron, per cent	4.22	3.01	2.26	2.92
Sulphur, per cent	0.80	0.62	0.45	0.60
Arsenic, per cent	—	0.13	0.13	0.13
Acid insoluble, per cent	68.95	75.72	66.66	74.48

The results of the tests showed that by flotation a product containing 10.06 to 14.43 per cent WO_3 could be obtained, and that these concentrates were of suitable grade for chemical treatment. A recovery of 90.3 per cent of the WO_3 was attained.

A pilot plant was installed in the mill of Little Long Lac Mine, and was operated in 1943 from January 4, until October 31. A total of 1,353 tons of hand-picked ore was treated, of which 64 tons was from Leitch Gold Mines, Limited. Up to April 5, 1943, 9,459 pounds of scheelite concentrate containing 61.67 per cent WO_3 and 193,433 pounds containing 6.85 per cent WO_3 had been produced from 852 tons of ore.

MacLeod-Cockshutt Gold Mines Limited (28)

Reference: Bruce, 1935, pp. 45, 46.

The MacLeod-Cockshutt mine is 1½ miles south and east of the Little Long Lac mine. The property is underlain by greywacke and interbedded iron-formation, which dips steeply north. Gold occurs both in veins that occupy fractures and in small lenses of quartz in greywacke. These veins and lenses are of quartz with only a small amount of sulphides, mainly pyrite, and gold. According to Jolliffe (1942, p. 26) scheelite is present in the veins.

Hard Rock Gold Mines, Limited (29)

References: Bruce, 1935, p. 51. Matheson and Douglas, 1948, pp. 406-413.

The property of Hard Rock Gold Mines, Limited borders on the east the MacLeod-Cockshutt property. Bedrock is greywacke and minor volcanic rocks that form an elongated, tightly folded trough surrounded by porphyry. Minor folds are complex, but they plunge uniformly 15 to 30 degrees west. Although many minor faults are present, the orebodies are closely related in distribution to the folds. These orebodies are of two types: quartz ore and sulphide ore. The composition and form of the latter is not recorded, but the former consists of quartz veins in which pyrite is sparsely disseminated. Scheelite is also present in small quantity, together with a little tourmaline, pyrrhotite, chalcopyrite, arsenopyrite, and native gold.

Sault Ste. Marie Mining Division

Michipicoten-Goudreau Area

Cline Lake Gold Mines, Limited (30)

Reference: Bruce, 1948.

Cline Lake mine is 6 miles from Lochalsh on the Canadian Pacific railway and 12 miles from Goudreau on the Algoma Central railway. The rocks in the vicinity of the mine are lavas and tuffs with interbedded iron-formation of Archæan age. The flows and beds strike roughly east and dip nearly vertically. They are intruded successively by diorite, granodiorite, quartz and feldspar porphyries, felsite, and diabase.

Several veins are exposed in the workings and these occupy either a large fault, known as the "A" fault, or smaller fractures that branch off from it or from a broad shear zone that terminates "A" fault. The fault and fractures traverse greenstone, granodiorite, quartz porphyry and felsite, and generally strike about south 70 degrees east and dip nearly vertically.

The veins are mainly of quartz, other gangue minerals being chlorite, sericite, carbonates, and tourmaline. Metallic minerals are pyrite, pyrrhotite, sphalerite, arsenopyrite, chalcopyrite, molybdenite and gold. Scheelite is said to be present in the veins (Jolliffe, 1942, p. 26).

Fenlon Claims (31)

In an unpublished report dated April, 1943, V. L. Eardley-Wilmot of the Mines Branch described scheelite showings on a group of claims staked by M. Fenlon of Michipicoten River, and located in township 32, range 23, near Bear River, 1½ miles north of the north shore of Lake Superior, 9 miles west of Michipicoten. The showings were examined in 1942 by engineers of Pioneer Gold Mines, Limited, and of Hollinger Gold Mines, Limited. Scheelite is reported to occur as isolated patches in quartz in a strong shear zone in granite. Samples assayed as high as 3.60 per cent WO_3 across 1½ feet, but many samples assayed only a trace. Molybdenite and powellite are also reported.

Sudbury Mining Division

Sudbury Area

Victoria Mine (32)

Reference: Walker, 1909, pp. 33, 34.

In 1904 a specimen, which was shown by chemical analysis to be scheelite, was picked up on the rock dump of Victoria mine of the Mond Nickel Company, now International Nickel Company of Canada, Limited. No additional scheelite has since been reported from this locality.

Fielding Property (33)

The following account is taken largely from an unpublished report, dated August 1, 1942, by R. E. Folinsbee of the Geological Survey.

Scheelite occurs on the property of C. A. Fielding, Lot 2 of Concessions 5 and 6, township of Waters, 2 miles southwest of Copper Cliff. The property is underlain by massive, greenish black gabbro, which forms a thick sill bounded by greywacke that outcrops beyond the property. Within the gabbro coarse-grained lenticular masses, up to 20 by 60 feet, are composed of amphibole, grey feldspar, pink or white calcite, quartz, and disseminated grains of scheelite. The last three minerals may be deuteric, or may have been introduced at a later stage.

A pit 15 feet square and 8 feet deep was blasted into the lens showing the highest scheelite content. From about 100 tons of rock, 4 tons of material was cobbed, which was estimated to average about 0.3 per cent WO_3, the highest grade specimens carrying perhaps 0.6 per cent WO_3. The scheelite is fine, therefore mill recovery probably would be low. A diamond drill-hole was directed to intersect the main lens at depth, but in 120 feet of core only traces of scheelite were found.

Another lens 20 by 60 feet occurs 150 feet southwest of the first. The grade was estimated to be 0.01 to 0.03 per cent WO_3, and a diamond drill-hole 100 feet long drilled to intersect the lens at depth was likewise disappointing.

Porcupine Mining Division

De Santis Porcupine Mines, Limited (34)

References: Dunbar, 1948, p. 444. Ont. Dept. Mines, Ann. Repts., vols. 37-52, Pts. I.

The property of De Santis Porcupine Gold Mines, Limited consists of twenty-four claims in Ogden township. Operations were begun in 1927 and discontinued in 1942, during which period 35,784 ounces of gold and 3,142 ounces of silver were produced. During World War II, scheelite concentrate containing 193.31 pounds of WO_3 was obtained.

Delnite Mines, Limited (35)

References: Taylor, 1948. Ont. Dept. Mines, Ann. Repts., vol. 53, Pt. I, p. 93; vol. 55, Pt. I, p. 35.

Delnite Mines, Limited, a subsidiary of Sylvanite Gold Mines, Limited, owns eight claims in the northwest part of Deloro township. The property is underlain by greenstone of Archæan age, intruded by quartz porphyry. Much of the greenstone is carbonatized, and within it are wide zones of talc-chlorite schist. The carbonatized greenstone contains narrow, persistent quartz-ankerite veins that contain tourmaline, scheelite, pyrite, arsenopyrite, and gold.

In 1945 the Bureau of Mines, Ottawa, shipped 785 pounds of tungsten concentrate valued at $714, produced from ore from Delnite and McKenzie Red Lake mines.

Aunor Gold Mines, Limited (36)

References: Buffam, 1948. Dunbar, 1948, p. 444.

Aunor mine is in Deloro township about 3 miles southeast of Timmins. The property, consisting of eleven claims, is underlain by massive and pillowed andesite, and one band of tuff, all of Archæan age and intruded by an irregular body of diorite and dykes of quartz-feldspar porphyry. The ore zone, like that of the adjoining Delnite mine, is in a series of parallel and branching veins that form a type of ladder structure. The ore zone is very persistent and the vein matter consists of quartz, grey carbonate, brown tourmaline, pyrite, minor chalcopyrite, gold, and a little scheelite. According to Dunbar, scheelite concentrate with a total of 1,209.73 pounds of contained WO_3 was produced.

Hollinger Consolidated Gold Mines, Limited (37)

References: Burrows, 1912, pp. 231-235; 1924, pp. 54-60. Allen and Folinsbee, 1944. Jones, 1948. Dunbar, 1948, p. 444.

Hollinger gold mine is adjacent to Timmins, in Tisdale township. Most of the scheelite concentrate produced in the Precambrian Shield has been from its ores.

The rocks are lavas of Archæan age with thin interbedded bands of carbonaceous tuff, intruded by pipe-like stocks of quartz porphyry. The lava flows and tuff form the north limb of an easterly plunging syncline, on which a subsidiary anticline is developed and the main ore zone is along this anticline. The porphyry stocks are distributed along the axis and limbs of this anticline, which has exerted some control on their emplacement. A zone of faults strikes north 57 degrees east and dips 67 degrees southeast, and roughly parallels the attitude of the formations.

These faults are occupied by numerous sinuous, branching veins that are quite continuous. Most of the veins are in the lava, but many are found in the porphyry. The wall-rocks of the veins are greatly altered, though whether this be due to dynamic, thermal, or hydrothermal action is not known.

Three stages of mineralization have been recognized. The first is indicated by the deposition of ankerite, followed closely by quartz-scheelite-tourmaline, and albite. The second resulted in the deposition of quartz and ankerite, together with arsenopyrite, pyrrhotite, chalcopyrite, sphalerite, galena, tellurides, and gold. In the third, a little quartz and calcite were deposited.

The presence of scheelite in the veins was noted in 1912 by Burrows. During World War II, the shortage of tungsten made necessary a domestic source, and in December, 1941, H. C. Cooke of the Geological Survey examined the principal known scheelite occurrence in the mine. As a result of his report, steps were taken by the management to add a 70-ton mill to the property for the recovery of scheelite. R. E. Folinsbee of the Geological Survey spent from February to December, 1942, in cooperation with C. C. Allen, assistant geologist for the mine, in the examination of the accessible workings to delineate the higher grade scheelite veins.

Nearly all the scheelite-bearing veins are in or near two of the quartz porphyry bodies, known as the Millerton and Pearl Lake stocks. Those within or about the Millerton stock are composed mainly of quartz and ankerite, are generally wide, rather continuous, though irregular in detail, and have a fairly consistent strike. The largest veins are entirely within the Millerton porphyry. Some of the veins have continuous leads of scheelite, but many contain irregular patches and lenses, varying in dimensions from half an inch to 1 foot across by 10 feet in length. In the veins, the scheelite is a sandy colour, but in the wall-rocks it is sometimes brown or orange. Small crystals of sphalerite occur with the scheelite, and a little pyrite is present in the veins.

The scheelite-bearing veins near the Pearl Lake stock are narrow, irregular, sigmoid lenses, occurring *en échelon*. They occur only near or between apophyses of the stock, and consist of quartz and ankerite, with abundant tourmaline, some pyrite and apatite, and a little gold.

Gold is more abundant in the Pearl Lake veins than in the Millerton veins, but in general, the higher grade gold veins contain little or no scheelite. The scheelite is pure, containing no molybdenum or copper, and only traces of iron.

Production of scheelite concentrate began in March, 1942, when a mill of 70 tons daily was put into operation. The capacity of this mill was increased by September, 1942, to 150 tons a day, and its operation was continued until September 4, 1943, when scheelite production was suspended on instructions from the Metals Controller. During this period, 52,776.6 tons of ore from the Hollinger mine was milled, yielding two products, one consisting of almost pure scheelite, averaging about 78 per cent WO_3; the second, a flotation concentrate, containing about 8 per cent WO_3, and suitable for chemical treatment. The average grade of mill-heads was about 0.5 per cent WO_3, and a 70 per cent recovery was attained, yielding a total of 355,519.03 pounds of contained WO_3.

Relatively small amounts of scheelite ore from the McIntyre, Dome, Coniaurum, De Santis, Preston East Dome, and Aunor mines were milled on a custom basis.

McIntyre Porcupine Mines, Limited (38)

References: Burrows, 1912, p. 223; 1924, pp. 60-64. Dunbar, 1948, p. 444. Furse, 1948.

The property of McIntyre Porcupine Mines, Limited consists of a group of claims totalling 145 acres including the bed of Pearl Lake and ground to the north and southeast of it. It adjoins the east border of the Hollinger property.

The geology of the McIntyre is similar to that of the Hollinger mine. Steeply dipping, south-facing volcanic rocks, strike about north 50 to 70 degrees east, and form the north limb of a major syncline whose core is occupied by the Pearl Lake quartz porphyry stock.

The veins are grouped mainly about the Pearl Lake porphyry and strike north 65 degrees east, and dip steeply. They occupy well-defined fractures, from which short branch veins occur locally. In some places, where the veins pass from fine-grained sheared rock into coarse fractured rock, sulphides become much more abundant. The veins consist of quartz, ankerite, tourmaline, sulphides, and gold.

Three phases of mineralization are recognized. In the first, barren quartz-tourmaline veins were formed. In the second, the main period, quartz, sulphides, tellurides, gold, sericite, ankerite, chlorite, albite, siderite, selenite, and anhydrite were deposited. In the final stage, barren quartz-calcite veins were formed.

Scheelite was first reported in the veins by Burrows in 1912. It is far less abundant than in the Hollinger. A small production of scheelite concentrate was obtained, containing, according to Dunbar, 566.61 pounds of WO_3.

Preston East Dome Mines, Limited (39)

References: Hawley and Hart, 1948. Dunbar, 1948, p. 444.

Preston East Dome gold mine is in Tisdale township, about 5 miles southeast of Timmins. The property, consisting of seven claims, borders that of Dome Mines, Limited, which is to the north.

The rocks are mainly lavas of Archæan age, intruded by two stocks of quartz porphyry. The volcanic rocks form the south limb of a major syncline upon which is superimposed a smaller anticlinal fold that trends northward. The main fault strikes northeast, but northerly trending faults also occur.

The ore is of two main types: (1) stockworks of quartz-ankerite stringers; and (2) quartz veins with or without tourmaline. The stockworks vary in size from small pods to lenticular zones 100 feet wide and 200 feet long, but of irregular outline. The veins occur in both porphyry and volcanic rocks. They vary greatly in length and in attitude. The vein matter is largely quartz, with varying amounts of tourmaline, pyrrhotite, pyrite, sphalerite, galena, gold and scheelite. The manner of occurrence of scheelite in the veins, or its quantity, is not reported, but Dunbar states that concentrate containing 1,475 pounds of WO_3 was produced.

Other Occurrences

Scheelite has been reported at the Buffalo Ankerite, Broulan Reef, Pamour, and Hallnor mines by Jolliffe (1942, p. 26), and at the Coniaurum and Dome mines by Dunbar (1948, p. 444). In all these mines, no reference to the occurrence of scheelite in the veins has been made in subsequent publications, so it is assumed that the mineral is present in small quantity, or locally. Dunbar reports a production of 9.58 pounds of WO_3 from ore from the Dome mine.

Larder Lake Mining Division

Sesekinika Area

Republic Tungsten Mines, Limited (40)

Reference: Can. Inst. Mining Met., Bull. No. 366, October, 1942, p. 469.

Republic Tungsten Mines, Limited, in conjunction with Columbiere Mines, Limited, late in 1942 examined a showing of scheelite at Sesekinika, Maisonville township. According to V. L. Eardley-Wilmot of the Mines Branch, who examined the property in April 1943[1], surface trenching and diamond drilling indicated only small patches of fine-grained scheelite.

[1] Unpublished report for Mineral files.

In the same report, Eardley-Wilmot noted the presence of a little scheelite elsewhere in the Sesekinika area, at the Golden Summit and Kiryan properties. The latter had also been reported by Jolliffe (1942, p. 26).

Kirkland Lake Area

Bidgood Kirkland Gold Mines, Limited (41)

Reference: Todd, 1928, pp. 155, 156.

Bidgood gold mine is in the central part of Lebel township, and is about 6 miles east of Kirkland Lake.

The rocks are lava, tuff, greywacke, and conglomerate intruded by bodies of syenite, diorite, and feldspar porphyry. The beds and flows strike north 60 degrees west, and the rocks are for the most part carbonatized. Several shear zones 3 to 6 feet wide, striking north 50 degrees east and dipping steeply northwest, occur mainly in syenite. These are impregnated with pyrite, irregular stringers of quartz, and calcite, barite and gold. Some scheelite was reported by Jolliffe (1942, p. 26).

Morris Kirkland Gold Mines, Limited (42)

References: Todd, 1928, pp. 158, 159. Ont. Dept. Mines, Ann. Rept., vol. 45, Pt. I, p. 141.

The property of Morris Kirkland Gold Mines, Limited is in Lebel township and lies immediately south of the Bidgood Kirkland property. It is underlain by volcanic rocks of Archæan age, intruded by bodies of porphyry. The vein occupies a break which follows the northwest side of a porphyry dyke 40 feet wide. The vein strikes north 40 degrees east and dips 80 degrees southeast. It is up to 10 feet wide and consists of quartz, pyrite, galena, and chalcopyrite. Jolliffe (1942, p. 26) noted scheelite in the vein.

Bulldog Mine (43)

Reference: Ont. Dept. Mines, Ann. Rept., vol. 53, Pt. I, p. 98.

Bulldog mine is in Boston township, about 12 miles southeast of Kirkland Lake. The property was acquired late in 1942 by the Donhurd Prospecting Syndicate after scheelite had been discovered in material on the dump. The mine was dewatered to the 250-foot level and some sampling completed. The results were not published, and in September, 1943 the workings were allowed to fill.

Larder Lake Area

Upper Canada Mines, Limited (44)

Reference: Thomson and Griffis, 1941, pp. 23-26.

Upper Canada gold mine is in the central part of Gauthier township, about 6 miles west of Larder Lake.

The property is underlain by sedimentary and volcanic rocks of Archæan age, intruded by a stock and satellitic bodies of syenite. There are four orebodies, and these occur within shear zones wherein alteration is pronounced. These zones cross both syenite and lava. The ore zones contain sulphides and tiny stringers of quartz and carbonate. Pyrite is the principal sulphide, but chalcopyrite, galena and molybdenite, with specularite are widespread. According to Jolliffe (1942, p. 26) scheelite is also present.

Omega Gold Mines, Limited (45)

References: Thomson, 1941, pp. 82-87; 1948.

Omega gold mine is in McVittie township, about a mile north of the town of Larder Lake. Lava, tuff and greywacke underlie most of the property; only in the southern part does syenite occur, and this is part of a large body that intrudes the sedimentary rocks. The beds dip at high angles southerly, though less steeply at depth. A major fault follows the bedding closely to form a broad shear zone consisting of talc-chlorite schist, and a thinner zone of carbonatized rock cut by numerous stringers of quartz and fuchsite. The ore lies mainly in two dacitic flows between the shear zone and the carbonate zone. The deposit is a series of large, irregularly-shaped replacement bodies composed of silicified dacite, mineralized with fine-grained sulphides and gold, and cut by stringers of quartz and calcite.

In August, 1942, R. E. Folinsbee examined the underground workings and reported[1] that scheelite occurs in several localities in the mine. At a point where scheelite is most plentiful the grade estimated from areal measurement, is 0.1 per cent WO_3 in an area of 64 square feet.

Kerr-Addison Gold Mines, Limited (46)

References: Thomson, 1941, pp. 64-75. Ont. Dept. Mines, Ann. Rept., vol. 52, Pt. I, p. 126.

Kerr-Addison gold mine is north of the northeast arm of Larder Lake near the centre of McGarry township. The property, comprising thirty-four claims, is underlain by basic to intermediate lavas (Keewatin) unconformably overlain by sedimentary rocks (Timiskaming) both of Archæan age. The flows and beds strike northeast and dip steeply. On the south the contact between the Keewatin and Timiskaming rocks is along a fault and the lava, agglomerate, and tuff, south of the fault also have a southeast trend, and are intruded by syenite. This fault marks the north boundary of the ore zone wherein the rocks are highly altered for an area about a mile long and about 500 feet in average width.

The ore zone is largely carbonate rock formed by the alteration of lava, syenite, tuff, and talc-chlorite schist. Fuchsite and chlorite are widely distributed in the zone, giving it a greenish colour, and abundant quartz veins form a number of stockworks within the zone.

[1] Letter to the Chief Geologist, August 15, 1942.

The orebodies are irregularly outlined shoots containing abundant auriferous quartz veins. In these veins pyrite is sparsely disseminated with some arsenopyrite, chalcopyrite, sphalerite, and galena. Scheelite has been found in quartz veins cutting tuff, but these veins contain little or no gold. According to R. E. Folinsbee[1] a few pieces of vein containing enough scheelite to be ore of commercial grade were cobbed from a chute below the 516 stope, but no further production is reported.

Chesterville Larder Lake Gold Mining Company Limited (47)

References: Thomson, 1941, pp. 59-63. Buffam and Allen, 1948.

Chesterville mine is in central McGarry township, and borders the Kerr-Addison mine on the east. The older Archæan volcanic rocks (Keewatin) do not appear on the property; only the younger Archæan sedimentary and volcanic rocks (Timiskaming) are represented. These trend northeast and the Timiskaming rocks are separated from the Keewatin lavas by the main fault that traverses the area.

Some of the orebodies are in the carbonate zone extending eastward from the Kerr-Addison property, which in this locality is much narrower and lies north of the main fault. Other orebodies occur south of the fault, and are replacement sulphide bodies, formed in massive, fractured basalt. In these bodies, pyrite is the abundant sulphide, with some chalcopyrite, arsenopyrite, sphalerite, galena, marcasite, and gersdorffite.

Scheelite occurs in the latter type of ore, and is most abundant in "A" orebody R. E. Folinsbee[1] states that by areal measurement "the best showing graded 0.2 per cent WO_3 across a 5-foot width, but probably is not more than a few feet long".

Montreal River Mining Division

Matachewan Area

Matachewan Consolidated Mines, Limited (48)

References: Hopkins, 1921, pp. 35, 36. Hopper, 1942. Derry, Hopper, and McGowan, 1948.

The property of Matachewan Consolidated Mines, Limited is west of Montreal River in Powell township. Bedrock includes lavas, arkose, and greywacke, of Archæan age (Keewatin and Timiskaming), intruded by dykes of syenite porphyry and quartz diabase. The lava and sedimentary rocks form a belt that trends roughly east and is on the south flank of a major syncline that plunges steeply west.

Two types of orebodies occur on the property. Those of the first type occur in volcanic rocks, and are irregular sulphide replacement bodies containing many quartz-albite stringers. Pyrite is the most abundant sulphide.

[1] Letter to the Chief Geologist, August 15, 1942.

The orebodies of the second type are mainly in syenite porphyry and consist chiefly of stockworks of auriferous veins of quartz, albite, and calcite. Sulphides are not plentiful and include pyrite, chalcopyrite, sphalerite, and galena, with specularite and free gold.

Scheelite occurs in the second type of orebody, and was reported in 1921 by Hopkins. It does not appear to be sufficiently abundant to warrant consideration for recovery and the average gold content of these deposits is small.

Young-Davidson Mines, Limited (49)

References: Dyer, 1935, pp. 31-35. North and Allen, 1948.

The Young-Davidson gold mine is in the southwestern part of Powell township, and adjoins the Matachewan Consolidated property on the west. The mine is operated by Hollinger Consolidated Gold Mines, Limited. Keewatin agglomerate and tuff, overlain unconformably by Timiskaming sedimentary rocks, both intruded by bodies of syenite porphyry and younger diabase dykes, are exposed. The ore occurs in a body of syenite porphyry along the southern contact of Keewatin and Timiskaming rocks; gold is associated with pyrite that is disseminated in red syenite, but ore occurs only where the pyritiferous syenite has been fractured and enriched by minute veinlets of gold. Associated minerals are chalcopyrite and galena, with a little molybdenite, specularite, and scheelite.

Pigeon Lake Area

Tyranite Mines, Limited (50)

References: Ont. Dept. Mines, Ann. Repts., vols. 45-51, Pts. I.

The property of Tyranite Mines, Limited, consists of nine claims in Knight and Tyrrell townships. Operation of the mine began in 1939 and ceased in 1942, during which period 223,810 tons of ore was mined and gold and silver to the value of $1,166,640 were produced. Jolliffe (1942, p. 26) reported the presence of scheelite in the mine.

Duggan Property (51)

This property, owned by Howard Duggan is in the northwest part of Tyrrell township, 15 miles west of Gowganda. It was examined by H. C. Cooke of the Geological Survey and the following account is from his brief report[1].

The rock is mainly greenstone, with a little fine-grained porphyry. The vein is exposed in outcrops and trenches for a length of 400 feet. For most of its length it is from *nil* to 3 or 4 inches wide, but in one place at the east end where a pit 14 feet deep has been sunk, the vein is 3 feet wide. About 20 feet west of this pit a high-grade sample was taken, and this included all the scheelite in the exposed part of the vein, except for two masses, each about 4 inches long and ⅛ inch wide, near the west end of the vein.

[1] Letter to the Chief Geologist, August 4, 1942.

Lennox and Addington County

Addington Mines, Limited (52)

Reference: Harding, 1942, pp. 70-72.

The property of Addington Mines, Limited is on lots 24 and 25, concession VI, Kaladar township. Deposits on the property were operated intermittently under various names for nearly 60 years. It is underlain by volcanic and sedimentary rocks of Archæan age that trend northeast and dip steeply. The main deposit is along, or close to, the contact between volcanic and sedimentary rocks and consists of altered lavas and sedimentary rocks cut by veins and stringers of quartz that are auriferous over parts of their length. The vein matter consists of quartz, ankerite, calcite, tourmaline, pyrite, chalcopyrite, pyrrhotite, arsenopyrite, and scheelite.

Frontenac County

Star Gold Mine (53)

Reference: Meen, 1942, pp. 24, 44-47.

The Star gold mine, formerly the Star of the East, is in Barrie township. The property comprises two groups of claims but only in the east group, in lots 24 to 26, concession X, and lot 25, concession IX, has any development been undertaken.

The deposit is in crystalline dolomite of Archæan age, and consists of two parallel quartz veins, about 120 feet apart, that strike north 60 to 75 degrees east and dip 85 degrees northwest. The veins are narrow, and pinch and swell along the strike which is parallel to that of the dolomite, that is cut by small dykes of granite. The vein matter is largely quartz, with tourmaline, actinolite, pyrite, chalcopyrite, and scheelite.

The property was examined by H. C. Cooke who reported[1] that the scheelite is in the form of tiny specks so widely disseminated that the vein matter would most likely assay only a trace WO_3.

QUEBEC

Except for those in the Eastern Townships and Gaspé, which are in Palæozoic rocks, the tungsten occurrences of Quebec are in the Precambrian rocks of the Canadian Shield. All of the latter are of scheelite in quartz veins, usually in or near gold camps. At Mine Hill, Frontenac county, scheelite-bearing quartz veins contain a little stibnite and tungstite. The deposit on the property of Gaspé Copper Mines, Limited also contains scheelite, but is a contact metamorphic deposit and contains sulphides of copper, iron, and molybdenite in skarn.

A small production of scheelite concentrate has been obtained as a by-product of gold mining.

[1] Letter to the Chief Geologist, September 9, 1942.

LODE DEPOSITS

Abitibi County

La Reine Township

Manley Quebec Gold Mines, Limited (1)

References: Que. Bureau of Mines, Ann. Rept., 1934-35, Pt. A, p. 92. Ross, 1938, p. 3. Dresser and Denis, 1949, p. 72.

The property of Manley Quebec Gold Mines, Limited consists of lots 28 to 30, range IV, and lots 30 and 31, range V, La Reine township. These lots are about 4 miles southwest of Duprey village. The workings comprise two shafts with some drifting. The property was optioned in 1937 by True Fissure Mines, Limited, who completed 3,280 feet of diamond drilling. The property is underlain by volcanic rocks of Archæan age, which are intruded by albite granite at a point about one-half mile south of the deposit.

Near the deposit a body of grey biotite granite, 800 by 2,000 feet, is cut by many alaskite dykes that also cross the volcanic rocks. The numerous quartz veins that strike north 35 degrees east and dip 50 to 75 degrees southeast are apparently related to the alaskite dykes. Seven of these veins have been explored. They are for the most part sparsely mineralized and contain pyrite, chalcopyrite, and some gold.

V. L. Eardley-Wilmot of the Mines Branch examined the property in 1943[1], at which time the underground workings were flooded. He reports that scheelite occurs sporadically in small patches. On the surface exposures of the veins, seven such patches were found, which, by areal measurement, graded from 0.07 to 2.8 per cent WO_3 across about 8 inches and a length of up to 5 feet. The best material was said to occur underground and some of this together with material from the dump, was crushed to pea-size and roughly concentrated. A few hundred pounds of concentrate grading from 15 to 20 per cent WO_3 was produced in this manner in 1942.

Dalquier Township

Kayrand Mining and Development Company, Limited (2)

References: Ross, 1938, pp. 9-11. Dresser and Denis, 1949, p. 102.

Kayrand Mining and Development Company, Limited property, owned previous to 1940 by Nortrac Mining Company, Limited, consists of twenty claims and one mining concession, 7 miles north of Amos. The claims are underlain by greenstone of Archæan age, intruded by bodies of quartz diorite and granite, and by dykes of olivine gabbro and diabase. The largest body is a granite stock that occupies the western part of Dalquier township.

[1] Unpublished report dated September, 1943.

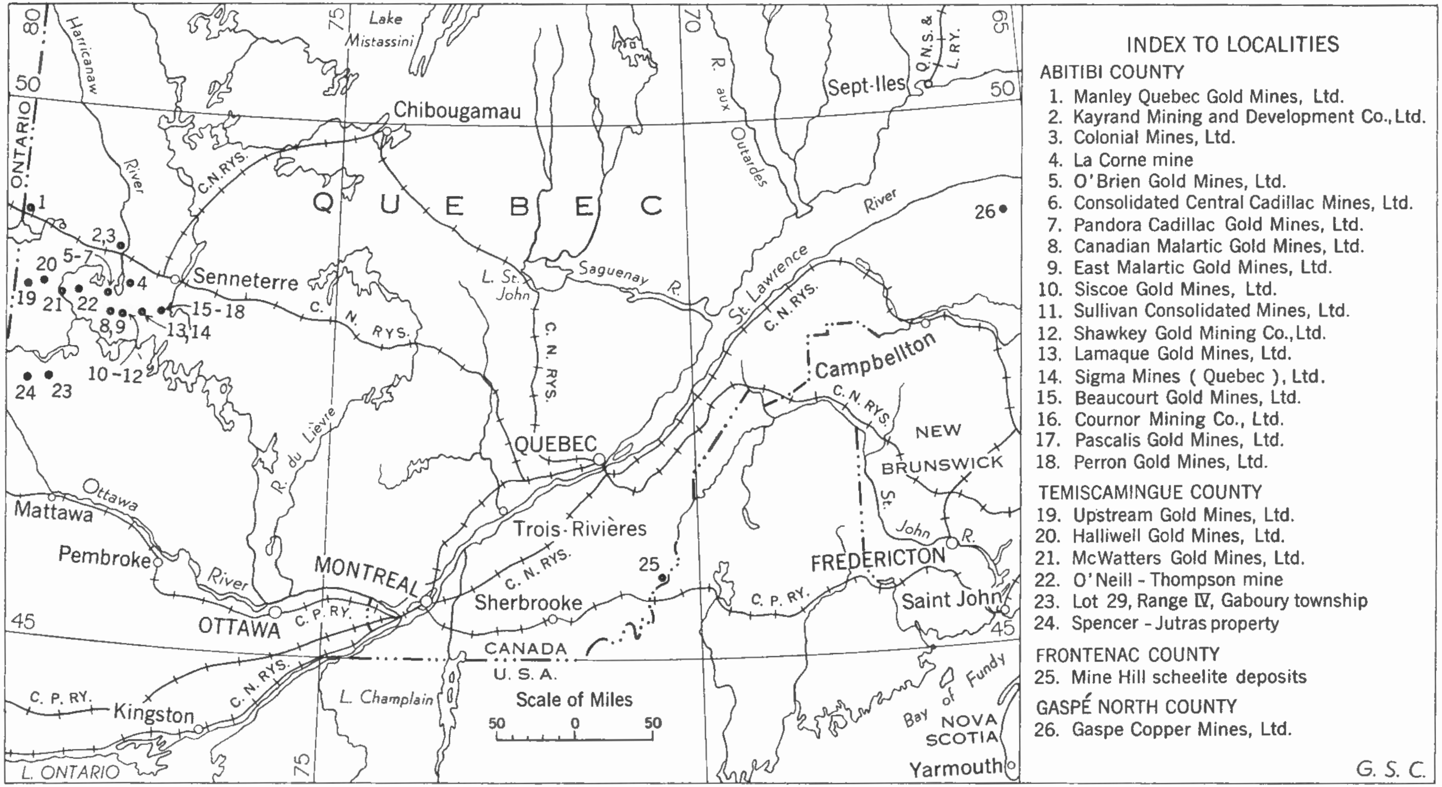


Figure 26. Index map showing location of tungsten deposits in Quebec. For explanation *see* page 178.

Two types of deposits are known on the property: one sulphide replacement body, and eleven quartz veins. Four of the veins have been explored underground. Scheelite has been reported from No. 9 vein. This vein which strikes north 30 degrees east and dips vertically, cuts granite and varies from 4 to 9 feet in width for 900 feet across the Kayrand property, and an additional 600 feet in the adjoining Colonial property.

Colonial Mines, Limited (3)

References: Ross, 1938, p. 11. Dresser and Denis, 1949, p. 102.

The Colonial property comprises lots 10 and 11, ranges VI and VII of Dalquier township and is immediately west of the Kayrand property. Greenstone and granite, in which there are several auriferous veins, extend across the property. The largest known vein is the continuation westward of the Kayrand No. 9 vein. There is no underground development. Scheelite is present in the vein exposed in some trenches.

In 1942, the property was under option to Toburn Gold Mines, Limited, who stripped a large area with a bulldozer. This prospect was examined in 1942 by H. C. Cooke[1] who reported that several veins carry a little scheelite. The scheelite in the vein carrying the largest quantity is pale brown and forms a few lumps up to 2 inches in diameter. This vein crosses the granite-greenstone contact and is 20 feet wide at this point, and there is estimated to average 0.09 per cent WO_3. Scheelite might be recovered by hand picking, but at high cost. The vein is irregular in shape and has been traced to the boundary of the Kayrand property.

La Corne Township

La Corne Mine (4)

References: Dresser and Denis, 1949, p. 414. Tremblay, 1950.

La Corne mine is in the southwest corner of La Corne township, 22 miles northwest of Val d'Or. It is owned by the Molybdenite Corporation of Canada, Limited. The rocks are mainly biotite schists intruded by small bodies of granodiorite that are offshoots from the La Corne batholith, the border of which is about 2 miles east of the mine.

Quartz veins of four ages have been recognized, but only the veins of the two intermediate ages contain scheelite. These are in two sets, one of which strikes north 20 to 40 degrees west, and the other north 60 to 80 degrees east. The latter set contains a greater abundance and variety of minerals including feldspar, muscovite, and molybdenite, with a little pyrite, chalcopyrite, bismuthinite, bismuth, fluorite, tourmaline, apatite, beryl, and scheelite.

[1] Letter to the Chief Geologist, August 4, 1942.

Cadillac Township

O'Brien Gold Mines, Limited (5)

References: Gunning, 1937, pp. 49-55. Bell, 1937, pp. 34, 35. Dresser and Denis, 1949, pp. 197-199.

The main property of O'Brien Gold Mines, Limited consists of fifteen claims on which one deposit since 1933 has produced gold and arsenic to the value of several million dollars. The property is underlain by a succession of volcanic and sedimentary rocks of Archæan age, cut by sill-like bodies of diorite and quartz albitite. The beds strike about east and dip steeply south.

The property is crossed by a broad shear zone, known as the "Cadillac break" and the two productive veins are south of this. The No. 1 vein is up to 12 feet wide, and up to 1,350 feet long; the No. 4 vein is 2 to 3 feet wide and the productive part is up to 440 feet long. Quartz comprises most of the vein matter, with tourmaline, albite, carbonates, and mica, as well as arsenopyrite, pyrite, pyrrhotite, chalcopyrite, galena, and gold. Jolliffe (1942, p. 26) reports the occurrence of scheelite in the veins, but it is apparently only a minor constituent.

Consolidated Central Cadillac Mines, Limited (6)

References: Gunning, 1937, pp. 57-60. Bell, 1937, pp. 35, 36. Dresser and Denis, 1949, pp. 200-202.

Consolidated Central Cadillac Mines, Limited holds twenty-four claims comprising the former holdings of Cadillac Exploration, Limited, Canadian Enterprises, Limited, and Wood Cadillac Mines, Limited. This property is east of O'Brien, and the Cadillac shear zone crosses the south claims of the group and also the formations adjacent to the O'Brien orebody.

Most of the ore from the Consolidated Central Cadillac claims is greenstone cut by quartz veins, and it occurs on both sides of a band of iron-formation. The veins are of quartz, with tourmaline, arsenopyrite, and pyrite. Jolliffe (1942, p. 26) reported scheelite on both Central Cadillac and Wood Cadillac ground; Dresser and Denis (1949, p. 436) reported a small production of scheelite from both sections in 1942.

Pandora Cadillac Gold Mines, Limited (7)

References: Gunning, 1937, pp. 60-66. Bell, 1937, pp. 36, 37. Dresser and Denis, 1949, pp. 202-204.

This property of thirty-six claims is east of the Central Cadillac property. It is underlain by greenstone, greywacke, and conglomerate of Archæan age cut by gabbro, albite porphyry, and quartz albitite, the last forming small plug-like bodies and a sheet as much as 100 feet thick. The belt of sedimentary rocks trends east and the strata lie in a sharp fold that plunges 65 degrees west These rocks are traversed by a large fault striking north 40 degrees east, and several small faults.

Numerous veins have been found, both on the surface and in underground workings. Six of the principal veins are in a plunging syncline, and these are grouped about a large pipe-like body of quartz albitite. The vein matter is largely quartz, with ankerite and tourmaline, and minor amounts of arsenopyrite and pyrite. The presence of scheelite in the veins was mentioned by Jolliffe (1942, p. 26).

Fournière Township

Canadian Malartic Gold Mines, Limited (8)

References: Gunning and Ambrose, 1940, pp. 57, 68-71. Dresser and Denis, 1949, pp. 213-217.

Canadian Malartic mine is in the north-central part of Fournière township. The rocks are greywacke, locally silicified, and intruded by bodies of quartz syenite-porphyry. The orebodies are replacements in the silicified greywacke, in which the principal sulphide is pyrite, with chalcopyrite, sphalerite, galena, and gold. The replacement bodies are cut by a network of quartz veins, bearing minor tourmaline, muscovite, feldspar, and sulphides.

At depth in the mine, pegmatitic veins cut a porphyry body that enlarges at depth. The veins are composed of coarse-grained, white to watery quartz and albite, with minor mica, chlorite, specularite, pyrite, chalcopyrite, molybdenite, fluorite, rutile, and scheelite. These pass, in places, into ordinary auriferous quartz veins. Some scheelite ore, presumably from these veins, was shipped for treatment to the Mine School at Val d'Or in 1942[1].

East Malartic Gold Mines, Limited (9)

References: Gunning and Ambrose, 1940, pp. 81-88. Dresser and Denis, 1949, pp. 220-226.

This property is in the northeast quarter of Fournière township, east of the Canadian Malartic property. Volcanic rocks trend east across the property and these are flanked on the north and south by sedimentary rocks, all of Archæan age. Small intrusive bodies of diorite and syenite porphyry are common in the central and southern parts of the property.

The main orebodies occur chiefly in the sheared volcanic and intrusive rocks, and are of large size. They consist of sheared, silicified rock, mineralized with sulphides, mainly pyrite, and traversed by veins of quartz. Small amounts of magnetite, specularite, pyrrhotite, galena, chalcopyrite, sphalerite, and molybdenite are common to all orebodies. In some, particularly in pegmatitic quartz veins, rutile, tourmaline, graphite, beryl, biotite, feldspar, and scheelite have been identified.

[1] The Mining Industry of Quebec in 1942; Que. Dept. Mines, 1943, p. 20.

Dubuisson Township

Siscoe Gold Mines, Limited (10)

References: Mailhiot, 1919, pp. 138-140, 148-150. Auger, 1947*a*, pp. 20-31. Dresser and Denis, 1949, pp. 239-247.

Siscoe gold mine is on Siscoe Island in DeMontigny Lake. The rocks are lava flows of Archæan age, intruded by a stock of granodiorite and dykes of granodiorite and porphyry. A broad shear zone lies along the contact between granodiorite on the north and greenstone on the south. Four sets of fractures, apparently related to this shear zone, are occupied by auriferous quartz veins. They occur in both granodiorite and in greenstone, and a few lenticular veins are in the shear zone. The veins are of quartz, with varying amounts of tourmaline, pyrite, and chalcopyrite. Scheelite is present in most of the veins, and appears to be most abundant in the C vein, and in the Siscoe vein where it forms a few aggregates. Scheelite was not produced and the known gold ore was mined out in 1949.

Sullivan Consolidated Mines, Limited (11)

Reference: Dresser and Denis, 1949, pp. 239, 247, 248, 436.

The property of Sullivan Consolidated Mines, Limited is south of Siscoe property. The deposits occur in granodiorite, near the southwest margin of the Bourlamaque batholith. There are two principal veins that strike roughly northwest, and a number of smaller ones. The wall-rock is altered with the introduction of albite, carbonate, and pyrite. The vein matter consists of quartz, carbonate, tourmaline, pyrite, and a little chalcopyrite, sphalerite, and galena. The occurrence of scheelite in the veins has not been described, but a small tonnage of scheelite ore was sent to the Mines School at Val d'Or for concentration.

Shawkey Gold Mining Company, Limited (12)

References: Mailhiot, 1919, p. 140. Dresser and Denis, 1949, p. 249.

The Shawkey property is south of DeMontigny Lake. It is underlain by greenstones of Archæan age cut by dykes of syenite porphyry. The main deposit consists of a central quartz vein from 6 inches to 2 feet wide and more than 1,000 feet long, with parallel stringers over a total width of from 1 foot to 4 feet. Sulphides are sparingly present. Scheelite was reported in the veins by Mailhiot in 1919, at which time the property was known as the Martin prospect. No scheelite has been produced.

Other Occurrences

Auger (1947*a*, p. 21) stated that in addition to the Siscoe mine, scheelite occurs, in minor amounts, at the Siscoe-Extension, "and, indeed, at all the producing gold mines in this section of Western Quebec".

Bourlamaque Township

Lamaque Gold Mines, Limited (13)

References: Dresser and Denis, 1949, pp. 239, 258-264, 436. Wilson, H. S., 1948.

Lamaque gold mine is in the west-central part of the township, 6 miles east of the Siscoe. The oldest rocks are agglomerate and tuff, with thin, interbedded flows, of Archæan age. These are intruded by a stock of albite granodiorite, grading outwards to diorite, and by dykes of porphyry. The principal veins are within, or near the stock, and occupy thrust faults of small displacement. The veins are composed of quartz, tourmaline, ankerite, and scheelite, with a little pyrite, gold and tellurides. A small shipment of scheelite ore was made in 1943 to the Mine School at Val d'Or.

Sigma Mines (Quebec), Limited (14)

References: Bell, 1937, pp. 61, 62. Dresser and Denis, 1949, pp. 239, 264, 265, 436.

The property of Sigma Mines (Quebec), Limited, a subsidiary of Dome Mines, Limited, is immediately north of the Lamaque property. The rocks are Archæan lavas with lenticular beds of breccia. These strike a little north of east, dip steeply north and are cut by numerous dykes of fine-grained diorite-porphyry.

Seven roughly parallel veins occur within an area of 700 by 1,600 feet. They strike about north 80 degrees east and dip, with one exception, 70 degrees south. The vein matter is largely quartz, with tourmaline, carbonate, and a little pyrite. Scheelite was reported[1] in the veins in 1935, and during World War II, a small production was attained.

Louvricourt and Pascalis Townships

Beaucourt Gold Mines, Limited (15)

Reference: Dresser and Denis, 1949, pp. 275, 276.

This property is in the west-central part of Louvricourt township, about 10 miles east of the Sigma and Lamaque mines. The southern part of the property is underlain by volcanic rocks of Archæan age, and the northern part by granodiorite of the Bourlamaque batholith. Several veins occur on the property, both in the volcanic rocks and in the granodiorite, but the main vein, which is actually a zone of lenses and stringers of quartz, is in the granodiorite about 200 feet north of the south contact of the batholith. The average width is 3 feet, widening in places to 12 feet, and the length of the body is 600 feet. In addition to quartz, the vein contains some sericite, carbonate and pyrite. Jolliffe (1942, p. 26) reported that scheelite was also present.

[1] Que. Dept. Mines, Ann. Rept., 1934-35, Pt. A, p. 116.

Cournor Mining Company, Limited (16)

Reference: Dresser and Denis, 1949, pp. 272-274.

The property of Cournor Mining Company, Limited is in the northwest corner of Louvricourt township and the southwest corner of Pascalis township, and includes the former Beaufor property. The orebodies are in granodiorite of the Bourlamaque batholith and occur in two parallel shear zones 100 to 250 feet wide and 1,000 feet long. The orebodies are up to 30 feet wide, 50 to 300 feet long and 30 to 175 feet down the dip, and are of quartz, with much black tourmaline, coarse pyrite, and visible gold. In the Beaufor mine, more normal quartz veins are encountered, which are similar to those on the adjacent Perron property. Scheelite has been reported in both the Cournor and Beaufor mines by Jolliffe (1942, p. 26).

Pascalis Gold Mines, Limited (17)

Reference: Dresser and Denis, 1949, pp. 271, 272.

The Pascalis property is bordered on the west by Cournor and on the north by the Perron property. It consists of a large group of claims in Louvricourt and Pascalis townships. It is underlain by volcanic rocks of Archæan age on the east side of the property, and younger granodiorite of the Bourlamaque batholith on the west. Previous to 1940, quartz-tourmaline veins in the lavas in the southern part of the group were investigated by trenching and diamond drilling. More recently development was concentrated on the northwest part where a shaft 1,565 feet deep was sunk to explore veins in granodiorite. Little information is published on these veins which are presumably similar to those of the Perron mine. Jolliffe (1942, p. 26) reported scheelite on this property.

Perron Gold Mines, Limited (18)

References: Ames, 1948. Dresser and Denis, 1949, pp. 267-270.

This property is in the southwest corner of Pascalis township and adjoins the Beaufor and Pascalis properties on the north. The orebodies are in quartz veins, entirely within a mass of granodiorite that projects from the Bourlamaque batholith into greenstones of Archæan age. The north boundary of this mass is marked by a strong shear zone.

There are three sets of gold-bearing veins. The first set occupies shear zones that strike east and dip 55 to 60 degrees south, and parallel andesite dykes. The second set of veins occurs in shear zones striking north 45 to 60 degrees west, and dipping 35 to 40 degrees south. The third occupies joint planes that strike north 62 degrees east and dip 35 to 40 degrees southwest. The largest orebodies occur in veins of the second set. The veins are composed largely of quartz, with tourmaline, carbonate, coarse pyrite, and local pockets of scheelite. During 1942 and 1943, small shipments of scheelite ore were made to the Provincial Mine School at Val d'Or and to the Bureau of Mines, Ottawa.

Temiscamingue County

Dasserat Township

Upstream Gold Mines, Limited (19)

Reference: Auger, 1947*b*, p. 22.

This property is on the narrow neck of land separating the west arm of Desvaux Lake and the southeast arm of Dasserat Lake. A few quartz-pyrite veins occur in quartz diorite near the northern contact with greenstones of Archæan age. One of these veins is a lenticular mass of quartz 2 inches wide and 4 feet long containing scheelite and pyrite. The grade over this area was estimated, by lamping, to be about 0.5 per cent WO_3. No other scheelite-bearing veins have been found, either by trenching or by diamond-drilling.

Beauchastel Township

Halliwell Gold Mines, Limited (20)

References: McKenzie, 1941, pp. 17-23. Dresser and Denis, 1949, pp. 142-436.

This property which was last explored in 1938, is located in the central part of the township The rocks are mainly andesite of Archæan age, intruded by quartz diorite. A conical replacement body of sulphide ore occurred on the contact of andesite and quartz diorite. The ore, now mined, consisted of chloritized andesite containing crystals of pyrite, chalcopyrite, and a little pyrrhotite, sphalerite, molybdenite, and scheelite. Lenticular masses of quartz and quartz-calcite veinlets cut the ore and at depth the deposit was cut off by aplite. Chalcopyrite in some places formed lenses up to several feet in length, but no copper was recovered. Gold values were erratic, but averaged less than half an ounce a ton. A small shipment of scheelite ore was made to the Provincial Mine School at Val d'Or in 1943, but the source of this was not reported.

Rouyn Township

McWatters Gold Mines, Limited (21)

References: Wilson, 1948. Dresser and Denis, 1949, pp. 162-165, 436.

McWatters gold mine is in the east-central part of the township, about 6 miles east of the town of Rouyn. Production began in 1934 and ended in 1944 when the known ore was exhausted.

The rocks are agglomerate, lavas, tuff, greywacke, and conglomerate of Archæan age, striking north 65 degrees east, dipping about 60 to 70 degrees north, and forming the south limb of a plunging syncline. The strata have been intensely folded, faulted, and altered, and intruded by dykes of rhyolite-porphyry and later diabase.

The main ore zone occurred within a band of sheared and altered conglomerate and was a stockwork of veins and aggregates of quartz. The zone was 15 to 30 feet wide, up to 200 feet long, and extended downwards 550 feet from the 650-foot level. The veins had been folded, shattered and healed with later introduced quartz. Tourmaline, ankerite, and pyrite were abundant constituents of the veins, as well as minor amounts of albite, mica, arsenopyrite, pyrrhotite, chalcopyrite, molybdenite, galena, sphalerite, hessite, native gold, and scheelite. A small shipment of scheelite ore was made in 1942 to the Provincial Mine School at Val d'Or.

Joannès Township

O'Neill-Thompson Mine (22)

References: Gunning, 1941, pp. 88-94. Dresser and Denis, 1949, pp. 175-177.

The O'Neill-Thompson gold mine is owned by New Rouyn Gold Mines, Limited. The property is west of Kinojevis River, on the west side of Joannès township. The rocks are conglomerate and greywacke, forming a band that trends northeast, which is bordered by volcanic rocks, all of Archæan age. These rocks are traversed by the Thompson Creek fault and by other smaller faults, and are intruded by bodies of quartz diorite and later quartz gabbro dykes.

Two types of mineral deposits occur on the property. Of these the more southerly is a replacement body on which the earlier work was done. The second type is veins and the largest of these occur in diorite along a strong shear zone from 3 to 18 feet wide and at least 350 feet long. The veins within this shear are lenticular, up to 4 feet wide and 25 feet long. They are mainly of quartz, with abundant tourmaline, and some ankerite, pyrite, pyrrhotite, arsenopyrite, galena, and native gold. Gunning (1941, p. 92) noted that veins of the zone farthest northeast contain a small amount of scheelite.

Gaboury Township

Lot 29, Range IV (23)

Reference: Retty, 1930, pp. 78, 79.

The mineral deposits of lot 29, range IV, were described by Retty as on the Pedlow claims. Scheelite was discovered in the deposits in 1941, and in 1942 a test shipment of 4,500 pounds was made to the Provincial Mine School at Val d'Or by A. Guinard who had leased the property. This shipment assayed 0.037 per cent WO_3 and a trace of gold. The property was examined in 1941 by V. L. Eardley-Wilmot, and the following information is taken from his unpublished report.

The showings are about 2 miles northwest of Timber Lake and 20 miles east of Ville Marie. They are in volcanic rocks of Archæan age, half a mile south of their contact with a granite batholith. The volcanic rocks are cut by dykes and lenses of feldspar porphyry and the rocks of both groups are sheared and altered. In one shear zone disseminations of pyrite and scheelite occur within or near quartz veinlets. This zone is exposed in seven trenches and an open-cut at intervals for about 450 feet in a general east direction. The scheelite is erratically distributed, and assays of chipped samples taken in all the trenches indicate only a trace WO_3. Samples taken across from 8 to 12 feet in the open-cut ran from 0.03 to 0.31 per cent WO_3.

Laverlochère Township

Spencer-Jutras Property (24)

This property, owned by Arthur Jutras and George Spencer of North Bay, Ont., is on lot 20, range X. It was examined in June, 1951 by V. L. Eardley-Wilmot and T. H. Janes of the Mines Branch and the following is extracted from their unpublished report.

The rocks are grey and pink, medium-grained granite containing bands of hornblendite. The scheelite occurs in a pegmatite dyke in the hornblendite, and is exposed in a pit, from which nearly 500 pounds of hand-picked scheelite ore is said to have been removed. Scheelite was observed in a zone 7 inches wide and 4 feet long in the dyke. The grade was estimated by lamping to be 4.25 per cent WO_3. No other occurrences of scheelite were observed on the property.

Frontenac County

Marlow Township

Mine Hill Scheelite Deposits (25)

References: Walker, 1909, pp. 31-33. Faessler, 1939, pp. 5, 14, 16, 17.

The Mine Hill scheelite showings are on the north slope of Mine Hill, lot 1, range VII, near the southern boundary of Marlow township. The deposit has the distinction of being the first in which tungsten minerals were found in place in Canada, the discovery having been made in 1890 by W. F. Ferrier in specimens collected from the deposit in 1879.

The largest vein, which is about a foot wide and 500 feet long, was regarded by Ferrier as the most promising, but Faessler found only a little stibnite and scheelite in the quartz. Two trenches whose walls are caved are 500 feet south of this vein and on the dumps pieces of quartz contain lumps of scheelite from one-sixteenth to one-eighth inch wide and one-quarter to one inch long. One piece of 20 cubic inches was estimated to contain 1 to 2 per cent scheelite. The scheelite is brownish grey and does not fluoresce. Meymacite was reported in cracks in the quartz by Ferrier, but Walker regards this mineral as tungstite.

Gaspé North County

Holland Township

Gaspé Copper Mines, Limited (26)

Reference: Bell, 1951.

The property of Gaspé Copper Mines, Limited is at the headwaters of the south fork of York River, and is 26 miles from the port of Mont Louis. The deposit was staked in 1921; it has been developed since 1937 by Noranda Mines, Limited, of which Gaspé Copper Mines is a subsidiary.

The rocks are Lower Devonian siltstone, sandstone, chert, and limestone intruded by stocks and dykes of porphyry. The sedimentary rocks are altered to quartzite, porcellanite, wollastonite rock, and garnetite. The folds are relatively gentle, and the beds dip less than 45 degrees. The folds trend generally northeast to east.

Four orebodies have been discovered. The most northerly is low grade and consists of chalcopyrite and pyrite deposited as seams in altered and brecciated limestone. The other three lie one above another, and the highest comprises disseminated chalcopyrite and pyrrhotite in altered siliceous rocks. Below this is a zone of replacement bodies containing chalcopyrite, with some pyrrhotite, in areas between wollastonite-bearing rock and slightly altered limy rock. The lowest orebody occurs in limestone that has been altered to marble, garnetite, and skarn. This body averages 1,000 feet wide, 2,500 feet long and 100 feet thick. The gangue consists of garnet, diopside, quartz, tremolite, and a little scapolite and sanidine. The sulphides present are chalcopyrite, varying amounts of pyrrhotite, bornite, and molybdenite. Molybdenite increases in quantity with depth and might be produced economically as a by-product. Scheelite is erratically distributed, but is fairly abundant in parts of the orebody.

NEW BRUNSWICK, NOVA SCOTIA, AND NEWFOUNDLAND

The tungsten occurrences of New Brunswick, Nova Scotia, and Newfoundland occur in Proterozoic (?) and Palæozoic rocks of the Appalachian region. The tungsten ores occur in quartz veins, pegmatite, and greisen. The tungsten minerals may be one or more of wolframite, hübnerite, scheelite and tungstite. Prior to 1919, Nova Scotia and New Brunswick may have produced fairly large amounts of tungsten ore and concentrate, but no accurate records of early production have been kept. Since that year, only Nova Scotia, in 1940, and 1942 to 1943, has produced tungsten concentrate, amounting to 32,260 pounds valued at $27,757.

LODE DEPOSITS

New Brunswick

Queens County

Square Lake Tungsten Deposits (1)

References: Dept. of Lands and Mines, N.B., Ann. Rept., 1932, pp. 42, 43; 1933, p. 49; 1940, p. 67. Poitevin, 1933. Wright, 1940*b*.

Square Lake is about 2 miles a little south of west from Welsford, which is about 20 miles northwest of Saint John. In 1932 molybdenite and wolframite were discovered in greisen about Square Lake and upper Tully Lake 1 mile to the northwest. Wolframite was found in greisen in 1940 about 2 miles north of Square Lake.

The area is underlain by biotite granite, forming the northeast end of a batholith about 8 miles wide and 50 miles long. The granite varies in grain size from fine to fairly coarse, and is of Devonian age. Within the granite are zones of greenish greisen composed of quartz, mica, and topaz, with small amounts of wolframite, molybdenite, arsenopyrite, pyrite, chalcopyrite, pyrrhotite, green fluorite, and galena. These zones are traversed by quartz veins, up to 2 inches wide and more than 10 feet long. Such veins have been observed in seventeen trenches, but in only seven of these is wolframite known to be present. The quartz veins containing wolframite, molybdenite, bismuthinite, native bismuth, specularite, and topaz, strike roughly north 70 degrees west (magnetic). One vein contains crystals of wolframite up to one-half inch or more in length. A sample, weighing 10.5 pounds was tested by the Mines Branch, Ottawa, and assayed 0.68 per cent WO_3.

York County

Burnt Hill Tungsten (2)

References: Dept. of Lands and Mines, N.B., Ann. Repts., 1911, p. XXIII; 1915, p. XXII; 1916, p. XX; 1917, pp. 32, 33; 1918, pp. 15, 16; 1920, p. 97; 1939, p. 77; 1940, p. 66; 1941, p. 15; 1942, pp. 74-76. Walker, 1911*a*; 1911*b*, pp. 21, 22. Brock, 1912. Camsell, 1917, pp. 247-249. Cairnes, 1917. Young, 1918, pp. 11-14. Mines Branch, 1918. Bureau of Mines, 1942*g*. Wright, 1940*a*.

The Burnt Hill tungsten deposit is on Southwest Miramichi River, near the mouth of Burnthill Brook about 10 miles northeast of Napadogan, and 35 miles northwest of Fredericton. The deposit is included in a mining concession of 2.4 square miles, within which at least thirty tungsten-bearing veins are known.

Molybdenite-bearing veins have been known in this locality since 1868, and some development was carried out prior to 1910, when T. L. Walker identified wolframite in them. In 1916 and 1917, one of the veins was explored by a shaft 167 feet deep and 567 feet of lateral workings. Lack of good transportation facilities precluded the possibility of profitable production, and the property lay idle until 1939. During this and the two succeeding years some exploration was completed and in 1953 Burnt Hill Tungsten Mines Limited explored the main vein from an adit and commenced to build a 150-ton mill.

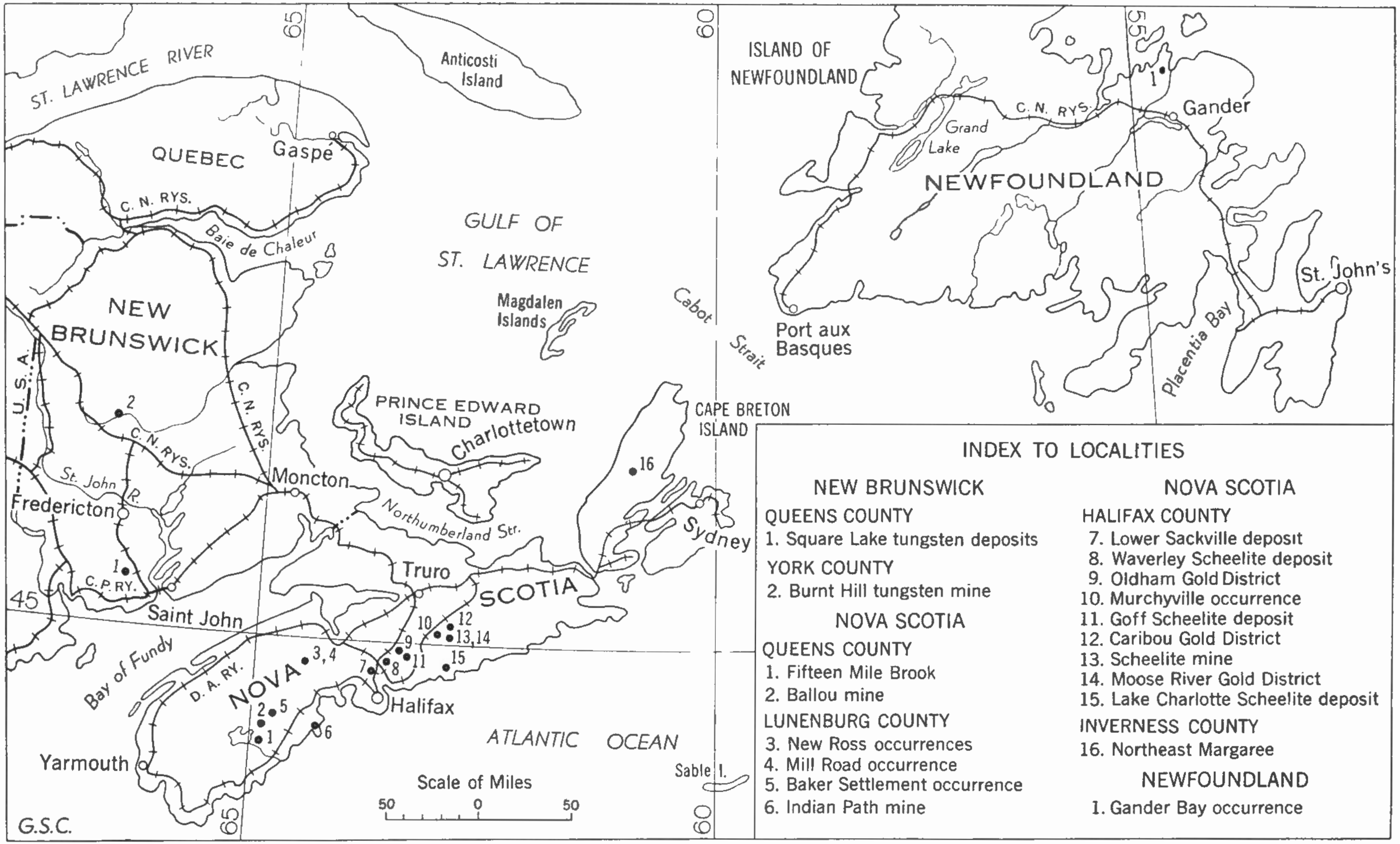


Figure 27. Index map showing location of tungsten deposits in New Brunswick, Nova Scotia, and Newfoundland. For explanation *see* page 191.

The property is underlain by thick, massive beds of grey argillite and quartzite of Silurian age, and, in the northwest part, Devonian granite. The beds strike from north 70 degrees east to south 75 degrees east, and dip 45 to 85 degrees north. The argillite and quartzite over wide areas are altered to hornfels. They are cut by basic dykes, dykes of aplite and by greisenized granite. Some of the greisen contains wolframite, molybdenite, and cassiterite, and, according to Brock, grades into quartz veins.

Small quartz veins are found in the granite and along the bedding planes of the sedimentary rocks. The important veins, however, occupy fissures that are parallel with prominent joints that traverse both granite and sedimentary rocks (*see* Figure 28). These joints are vertical and strike north 15 degrees west to north 5 degrees east. The fissure veins, therefore, strike about at right angles to the beds in which they are found. The wall-rocks are silicified and sericitized, particularly about the larger veins.

At least thirty fissure veins are known and these vary in width from a fraction of an inch to 6 feet, and some are more than 100 feet long. They are composed mainly of quartz, with some pyrrhotite, chalcopyrite, pyrite, fluorite, and chalcocite. Wolframite is fairly abundant locally and forms individual crystals or clusters of crystals up to 2 inches or more across. Cassiterite is widespread but not abundant and occurs in the greisen, and rarely in drusy cavities in granite and sedimentary rocks. Topaz is abundant in the fissure veins and common in the greisen. Most is white, though yellow crystals of gem quality have been found. Molybdenite is sparsely disseminated in both veins and greisen.

The workings of 1916-17 follow the main vein, which is at most points over 1 foot wide and locally swells to as much as 9 feet. It has been explored laterally on the 50- and 150-foot levels and during this development a few other veins were encountered. On the surface, the main lead or branch leads were traced at intervals by float and outcrop for over 2,000 feet. In 1916, 200 tons of ore was milled, which yielded 2,940 pounds of tungsten concentrate. There was further production in 1917, but this is not recorded.

Tests on combined samples from the property were made by the Bureau of Mines, Ottawa, in 1942. The composite sample for these tests consisted of quartz containing wolframite, molybdenite, and iron sulphides. It weighed 124 pounds and assayed 7.12 per cent WO_3 and probably represented selected material. This was crushed, screened and concentrated by a jig and Wilfley table. The concentrate assayed as follows:

	Per cent
Tungsten trioxide (WO_3)	68.50
Tin (Sn)	0.59
Iron (Fe)	11.59
Manganese (Mn)	6.52
Molybdenum (Mo)	0.24
Phosphorus (P)	0.009
Sulphur (S)	1.20

The molybdenum and sulphur content probably could be reduced by flotation, to give a product below the limits specified for these elements.

Nova Scotia

Queens County

Fifteen Mile Brook (1)

References: Faribault, 1911, p. 253; 1912, pp. 338, 339; 1913, p. 378. Messervey, 1931, p. 17.

A scheelite-bearing vein occurs at Fifteen Mile Brook, 15 miles northwest of Liverpool and 2 miles from Middlefield. The discovery was made in 1911 by E. R. Faribault of the Geological Survey following the discovery of abundant scheelite-bearing float in the vicinity.

The rocks are quartzite and slate of the Gold-bearing series, of pre-Devonian age. They dip steeply north and at lower angles to the east and south, thus forming an anticlinal dome. The vein is exposed in a pit 690 feet east of the Liverpool-Brookfield road. The dimensions and grade of the vein are not reported, however Faribault suggested that scheelite would probably occur "in ore-shoots formed at the intersection of the fissure vein with the interbedded veins and (would) pitch to the west at a low angle; while in the interbedded veins the ore-shoots (would) more probably pitch westward like the rolls and anticline".

Ballou Mine (2)

References: Faribault, 1907; 1909, p. 157; 1910*a*, p. 233. Malcolm, 1912, pp. 177-180, 286.

Ballou mine is on the northeast shore of Ponhook Lake, in the Malaga gold district. It began operations in 1888 under the management of the Malaga Mining Company. The property is underlain by quartzite and slate of the Goldenville formation, of pre-Devonian age, that form open, asymmetrical folds with gentle plunges and eastward trend. Several auriferous veins are known that lie in slate beds between layers of quartzite. In one of these, the Rabbit lead, Faribault found an interesting quartz vein that contained pyrite, arsenopyrite and light, smoky grey scheelite. No additional scheelite has been reported on the property, and a sample of mill concentrates collected by T. L. Walker in 1909 failed to show even a trace of tungsten.

Lunenburg County

New Ross Occurrences (3)

References: Faribault, 1908, pp. 81-83. Walker, 1909, pp. 30, 31. Malcolm, 1912, pp. 284-286.

The initial discovery of tin and tungsten minerals near New Ross was made in 1906 by Charles Keddy at a point 3 miles west of New Ross. Subsequent development proved several occurrences in that locality and at New Ross.

The region is underlain by light grey muscovite-biotite granite of Devonian age containing pegmatitic segregations composed of coarse feldspar, smoky quartz, and mica, with small amounts of cassiterite, monazite, columbite, durangite, amblygonite, lepidolite, fluorite, apatite, tourmaline, pyrolusite, manganite, hematite, magnetite, siderite, bismuthinite, galena, chalcopyrite, pyrite, wolframite, scheelite, and hübnerite. Walker also noted the presence of tungsten ochre or impure tungstite in a small vein. No commercial production has been reported from the deposits.

Mill Road Occurrence (4)

References: Faribault, 1909, p. 154; 1911, p. 253; 1912, p. 339. Walker, 1909, p. 52. Davison, 1930.

The discovery of tin and tungsten deposits near New Ross encouraged prospecting for these minerals, and in 1908, Ernst Turner opened a vein in granite near Mill Road, about 4 miles north of New Ross. The deposit is in grey muscovite-biotite granite of Devonian age, near the contact with quartzite and slate of the older Goldenville formation.

The vein is about 2 feet wide and is exposed for 250 feet on the strike. Two shafts, 55 and 25 feet deep, respectively, were sunk on this vein of quartz, red feldspar, white mica, serpentine, and purple fluorite. The metallic minerals present are cassiterite, chalcopyrite, stannite, sphalerite, molybdenite, arsenopyrite, wolframite, scheelite, and tungstite.

Assays of samples are reported as from 10 to 30 per cent tin and 8 per cent copper. Development proved the vein to be irregular in outline and to pinch out horizontally and at depth.

Baker Settlement Occurrence (5)

Reference: Faribault, 1912, p. 339.

Baker Settlement is 12 miles west of Bridgewater and half a mile north of Huey Lake. Bedrock is bluish grey siliceous slate of the Halifax formation, forming an anticline and syncline that plunge gently eastward. On the south limb of the anticline, eight quartz veins, 2 to 18 inches wide and dipping 35 degrees south, occupy fissures parallel with the strata. In 1911 parts of two of the veins were stripped. Along the walls of these veins, pockets and thin veinlets of scheelite occur with massive arsenopyrite.

Indian Path Mine (6)

References: Dept. of Mines, N.S., Ann. Repts., 1926, p. 87; 1927, p. 96; 1928, p. 87; 1931, pp. 126, 127; 1932, pp. 105, 106; 1933, p. 88; 1934, p. 131; 1935, pp. 111, 112, 155; 1937, p. 159; 1938, pp. 168, 169; 1939, p. 96; 1941, pp. 130-139; 1942, pp. 40-42. Goranson 1932, p. 41. Bureau of Mines, 1932*b*. Flynn, 1943.

Indian Path mine is near the Atlantic coast, about 6 miles by road south of Lunenburg. The property was staked and prospected for gold previous to 1926. In that year scheelite-bearing veins were discovered, and opened by trenches, shafts, and a little drifting. The property was optioned in 1939 by Siscoe Gold Mines, Limited, who carried out some diamond drilling. In

1941, the property was taken over by Guysborough Gold Mines, Limited, a subsidiary of Ventures, Limited, and further underground development was done. In 1942 Tungsten Mines Limited, explored the deposit but discontinued this work within a few months.

The property is underlain by slate of the Halifax formation, the upper division of the Gold-bearing series, of pre-Devonian age. The veins occur near the crest of the Indian Path anticline and strike east and dip steeply north, roughly parallel with the bedding.

The veins first explored were small, but they were grouped in a broad zone several hundred feet long. In 1928, larger veins were found; these were explored by four shafts and several hundred feet of drifts, the lowest level being at 230 feet. In 1942, a 20-stamp mill of 70 tons per day capacity was in operation.

Several of the quartz veins are up to 2 feet wide and in them scheelite is erratically distributed as irregular, honey coloured clots and patches in the milky quartz. A test shipment of 430 pounds of ore was made to the Bureau of Mines, Ottawa, in 1932. It assayed 3.95 per cent WO_3 and 0.01 ounce of gold a ton. The ore was crushed and classified, the product being treated on a Wilfley table. A concentrate of 48.7 per cent WO_3 was obtained, with a recovery of nearly 90 per cent. The product was high in sulphur and arsenic and subsequent tests proved that by roasting and magnetic separation the deleterious elements could be reduced, and a product of 68.9 per cent WO_3 made.

In 1942, "several thousand tons of low grade ore was concentrated and shipped to Ottawa for final treatment"[1].

Halifax County

Lower Sackville Deposit (7)

References: Piers, 1923. Dept. of Mines, N.S., Ann. Rept., 1937, p. 160.

The Lower Sackville scheelite deposit was discovered in 1921 by F. W. Dixon, and in 1937 was owned by F. R. Hyland of Halifax. It is on the Craig farm on the east side of Cobequid road, about one-half mile south of Lower Sackville, and 2 miles north of Bedford.

The property is underlain by thick beds of quartzite of the Goldenville formation, the lower part of the Gold-bearing series. These strata strike north 70 degrees east, dip 25 degrees south, and are on the south limb of the Waverley anticline.

The deposit is exposed by a trench 40 feet long and 6 to 10 feet deep, and consists of a lenticular vein of quartz up to 9 inches wide, containing a little arsenopyrite. Buff coloured scheelite and a little tungstite occurred as aggregates of large crystals. The deposit was examined by V. L. Eardley-Wilmot of the Bureau of Mines, Ottawa, in 1941, and he saw only a few pieces of scheelite-bearing quartz.

---

[1] Bureau of Statistics, Annual Report on the Mineral Production of Canada, 1942, p. 200.

Waverley Scheelite Deposit (8)

References: Walker, 1909, p. 51. Malcolm, 1912, p. 291. Camsell, 1917, p. 251. Dept. of Mines, N.S., Ann. Repts., 1925, p. 87; 1927, p. 96; 1939, p. 97; 1942, p. 44. Wilson, 1927, pp. 78, 79. Messervey, 1931, pp. 22-24, 26-28.

The Waverley scheelite deposit is about a mile north-northwest of the Waverley gold mine, and 1½ miles north of Waverley station. It was discovered in 1908 by A. L. McCallum.

Little development was done until 1917, when the vein was opened by two shafts and a number of trenches. The vein averaged 2 inches in width for a length of 300 feet and from 4 tons of vein matter about 500 pounds of hand-cobbed material assayed 37.5 per cent WO_3. This was shipped to the Munition Resources Commission, Ottawa.

In 1925, the vein was trenched for 200 feet on strike and to a depth of 16 feet. In 1939 the shafts were unwatered and a little scheelite ore was recovered. No further production has been reported, though in 1942 Lake Thomas Syndicate acquired the property.

The rocks are slate and arkose of the Gold-bearing series, which strike approximately east and dip 75 degrees north. The attitude of the vein conforms with that of the strata. The quartz vein is about 8 inches wide and has been traced for a length of 330 feet. Scheelite occurs in aggregates and zones up to 2 inches wide and several inches long, scattered throughout the quartz. The scheelite is yellowish brown to reddish brown. The present workings and dump expose only a little scheelite.

Oldham Gold District (9)

Reference: Piers, 1923, p. 40.

Gold was discovered in the Oldham district in 1861. According to Piers, scheelite was discovered by C. V. Brennan, about 1914, in a vein cutting the Dunbrack vein of the Oldham Mining Company. No further reports concerning this occurrence have been published.

In 1941, scheelite was reported in the Fish vein of the Dunbrack mine operated by Avon Gold Mines, Limited. The property was visited by V. L. Eardley-Wilmot and he reported a small pile of scheelite ore collected from the picking belt. An examination of the Fish vein and one or two others indicated they contain only a little scheelite. The waste dumps and mill tailing dumps were examined and a sample of tails obtained from the clean-up of the stamp mill assayed 0.20 per cent WO_3. The known quantity of this material is small.

Murchyville Occurrence (10)

Reference: Dept. of Mines, N.S., Ann. Rept., 1941, p. 45.

"The prospect of Mr. George Wilson (at Murchyville, 5 miles east of Middle Musquodoboit) is situated on the top of a ridge, and is in the Halifax slate formation near the Wyse Corner syncline. The slates are black, crinkly, and highly cleaved. Occasional bands of harder spotted slate and slaty quartzite were observed. Ten interbedded quartz veins were seen, ranging in thickness from ½ inch to 15 inches. These veins show some corrugations and a tendency to lens.

"In a small 1-inch cross vein in trench 'A' scheelite was observed, and one sample obtained from the dump indicated that at least one small interbedded vein contains scheelite."

Goff Scheelite Deposit (11)

References: Dept. of Mines, N.S., Ann. Rept., 1939, p. 96. Douglas, 1940.

The Goff scheelite deposit is near Goff, and north of Elmsdale. It was discovered in 1918, but no active development took place until 1931 when R. E. Kirkpatrick and others mined a little scheelite ore. Intermittent activity continued until 1940. In all, about 3 tons of concentrate assaying about 72 per cent WO_3 was recovered.

The rocks are quartzite and slate of the Goldenville formation. The beds strike south 75 degrees west and dip 70 to 85 degrees north, and lie on the north limb of the Waverley anticline. Some small faults occur on the west side of the property.

Six quartz veins have been uncovered by trenching and all parallel the beds. These veins are up to 6 inches wide but locally in drag-folds they are 18 inches wide. They are from 20 to 80 feet long. All are of quartz, with arsenopyrite and some scheelite.

The property was examined by V. L. Eardley-Wilmot in 1941, and by then most of the scheelite-bearing part of the vein had been mined.

Caribou Gold District (12)

References: Faribault, 1909, pp. 157, 158. Walker, 1909, p. 28.

In 1908, F. H. Mason found traces of scheelite in the mill tailings of Caribou mine. In the same year, T. L. Walker collected a sample of these tailings that assayed 0.22 per cent WO_3.

Scheelite Mine (13)

References: Faribault, 1909, pp. 155-157; 1910*a*, pp. 228-234; 1910*b*; 1919, p. 4. Walker, 1909, pp. 25-28. Hayward, 1910. Dept. of Mines, N.S., Ann. Repts., 1910, pp. 161-164; 1911, p. 207; 1912, p. 174; 1913, p. 152; 1914, p. 168; 1942, pp. 43, 44. Hills, 1912*a*, 1912*b*, Malcolm, 1912, pp. 286-291. Camsell, 1917, pp. 249, 250. Messervey, 1931, pp. 13-26. Douglas, 1940*b*. Cameron, 1946.

Scheelite mine is on Stillwater Brook, about 2 miles west of the village of Moose River Gold Mines. It was discovered in 1908 by systematic prospecting, after scheelite and tungstite had been found in a quartz boulder. The discovery was made by J. A. Reynolds, W. S. Currie and A. L. McCallum. Early development work consisted of extensive trenching, the sinking of several shafts, and several hundred feet of drifting and crosscutting. A mill was installed, and the initial shipment of 14 tons of scheelite concentrate containing 72 per cent WO_3 was made in 1912. Production was maintained sporadically until March, 1919.

In 1942, the property was acquired by the Nova Scotia Department of Mines from Mr. Lawlor of Shubenacadie. A. E. Cameron was put in charge of rehabilitating the mine, and H. C. Cooke and G. V. Douglas undertook a geological examination. Before full production was attained, however, the project was abandoned in view of the improved situation with regard to the supply of tungsten.

The property is underlain by altered grey quartzite, with thin intercalations of slate, of the Goldenville formation, outcropping along the apex of a prominent anticline that passes through the Moose River gold district. Several subsidiary folds occur upon the limbs of this anticline. A few small faults displace both the strata and the veins.

There are at least two, and possibly three, scheelite-bearing veins in the mine. They vary in thickness from 1 inch to 8 inches and are parallel with the strata. They are therefore repeated several times, both on the surface and in the underground workings. Quartz comprises most of the vein matter, with small amounts of dolomite, arsenopyrite, sericite, feldspar, tourmaline, and scheelite. The scheelite is concentrated where the veins are widest at the crest of anticlines and in the troughs of synclines. The main vein was traced underground for 1,500 feet, but contained scheelite for only 950 feet of this length.

Cooke concluded that most of the scheelite ore that had been blocked out had been removed, and he estimated that about 200 tons, averaging about 10 per cent WO_3 remained to be mined. Cameron estimated that of this about 45 tons was subsequently mined and this averaged 5.06 per cent WO_3.

Moose River Gold District (14)

References: Faribault, 1909, p. 157; 1911, p. 62. Walker, 1909, pp. 27, 28. Malcolm, 1912, p. 289. Camsell, 1917, p. 251. Hurst, 1927, pp. 138-140. Messervey, 1931, pp. 22, 26.

Small amounts of scheelite have been reported in the veins of four mines, from east to west, Moose River, Tonguay, Kaulback and Higgins or Davidson.

In the Moose River gold mine, lenticular masses of scheelite the size of a hen's egg occur in auriferous veins containing ferruginous calcite, pyrite, and arsenopyrite. No production of scheelite has been attained, but Walker found that a sample of concentrates from the Moose River mill collected in 1908 assayed 0.52 per cent WO_3.

A vein encountered in the Robinson or No. 3 crosscut of the Tonguay mine, which is adjacent to the Moose River mine, was reported to carry scheelite.

In the Kaulback vertical shaft some pieces of scheelite were observed in 1912, and in 1916 an examination of the mine by Camsell confirmed this occurrence. According to him, a vein in a crosscut on the 150-foot level contained two lenses of scheelite and arsenopyrite, each about 6 inches wide and 2 to 3 feet long.

The Higgins or Davidson mine was examined by V. L. Eardley-Wilmot of the Bureau of Mines in 1941. In his unpublished report he stated that numerous pieces of vein quartz containing scheelite were observed on the dump, and he estimated that a ton or more of ore containing 5 per cent or more of WO_3 might be hand-picked. The workings were filled with water so that the vein could not be examined underground.

Lake Charlotte Scheelite Deposit (15)

Reference: Douglas, 1940*c*.

Lake Charlotte gold-scheelite deposits are situated on both the east and the west sides of Lake Charlotte, about 32 miles east and a little north of Halifax. Leases of several square miles were obtained in 1934 by R. A. Logan, and subsequently acquired by Prasac Limited, who carried out exploration of several veins. In 1939, the property was leased by Guysborough Gold Mines, a subsidiary of Ventures, who continued exploration and erected a 5-stamp pilot mill of 10-ton capacity. Some scheeelite was produced.

The rocks are quartzite and slate of the Goldenville formation, intruded by Devonian granite that forms an elongated batholith lying south of the property. The sedimentary rocks are on the south limb of an anticline overturned to the south. These rocks therefore strike roughly east and dip steeply north, but are overturned as shown by the drag-fold pattern. There are a number of small faults with displacements up to 4 feet, and some of them are occupied by dykes of aplite and pegmatite.

On the east side of the lake three veins have been exposed by trenches. All parallel the bedding. One, No. 13, is near the shore, is 18 inches wide, and has been traced for 100 feet. Quartz comprises most of the vein matter; a little arsenopyrite is present, and scheelite is disseminated throughout the vein and in fractures adjacent to it. The second vein, No. 2, is also about 18 inches wide, and is exposed intermittently for more than 600 feet. In addition to arsenopyrite and scheelite, pyrrhotite and molybdenite are reported. A shaft was sunk by Guysborough Gold Mines to a depth of 70 feet and drifting was carried out 100 feet west and 140 feet east. V. L. Eardley-Wilmot of the Bureau of Mines in an unpublished report stated that the vein in this drift, examined in 1951, is narrow and grades were low across mining width. The third vein, the "scheelite" vein, is near the No. 2 vein and is parallel with it. It is only 1½ to 2 inches wide and 100 feet long, but contains a relatively high percentage of scheelite.

On the west side of the lake three veins have been explored by trenches, shafts and drifts. That nearest the shore is No. 32 vein, which was explored by an adit driven west, primarily in a search for gold. In 1941 the face was advanced 20 feet, so that it was then 410 feet from the portal. Very little scheelite was seen in the vein except at the face.

At 147 feet from the portal crosscuts extend 50 feet south and 131 feet north. In the south crosscut a vein ½ inch wide contains a little scheelite and in the north crosscut, several small veins and a zone of silicified dark quartzite several feet wide contained disseminated scheelite. Within this zone a band about 6 inches wide contained a relatively high percentage of scheelite. According to Eardley-Wilmot, this was followed west for 5 feet and in this distance the band reduced in width to 3 or 4 inches. A selected sample of 300 pounds, sent to Ottawa in November, 1939, assayed 4.6 per cent WO_3, but contained sulphur, arsenic and phosphorus, thus requiring special treatment.

Another crosscut was driven 50 feet south from the face of the adit. This intersected two quartz veins, each of which was drifted on westerly for about 50 feet, but little scheelite is present in them.

No. 4 vein is regarded by Douglas as the most important one west of the lake and lies at a point about one-half mile west of No. 32 vein. No. 4 vein averages 12 inches in width, but varies from less than an inch to 18 inches, and is about 150 feet long. It strikes roughly east and dips 30 degrees north. It has been explored by an incline shaft sunk on the vein to a depth of 25 feet, from which some drifting was done. In the east 18 feet of the drift, the vein contains abundant scheelite. The vein matter is largely quartz, with arsenopyrite, pyrite, galena, gold, and scheelite.

No. 5 vein is about 800 feet north of No. 4. It strikes about east and dips 70 degrees north. It is 1½ to 2 inches wide and about 200 feet long. This vein contains gold but little or no scheelite.

Inverness County

Northeast Margaree Occurrence (16)

References: Gilpin, 1899. Faribault, 1909, p. 157. Walker, 1909, pp. 22-24. Dept. of Mines, N.S., Ann. Rept., 1942, pp. 39, 40.

In the spring of 1899, on Murphy Brook, at Emerald near Northeast Margaree, a 1½-ton quartz boulder containing hübnerite was found. This boulder was broken up and from it about half a ton of tungsten ore was obtained. According to Walker, this assayed 66.32 per cent WO_3, 6.25 per cent SiO_2, 12.02 per cent Mn, and 0.12 per cent Fe. The hübnerite occurred as clusters of crystals in milky quartz, with a little chalcopyrite and hydrous mica.

The boulder lay on a lenticular vein of similar quartz, about 3 feet wide. This vein cuts gneissic granite of presumably Precambrian age. Slates outcrop nearby. A shaft was sunk on this vein and drifts were run both directions on the strike of the vein, but the vein pinched out and no others were encountered.

Newfoundland

Gander Bay Occurrence (1)

In 1952, T. O. H. Patrick of the Geological Survey, while engaged in geological mapping, discovered a large quartz vein containing scheelite and tungstite. The following account is abridged from his unpublished report.

The vein is a short distance inland from Charles Cove, at a point 3½ miles north of the government wharf at Victoria Cove on the west side of Gander Bay. The mining concession is owned by Newfoundland and Labrador Corporation Limited. The rocks are quartzite and slate of the upper part of the Farewell group of Ordovician or Silurian age, intruded by a stock of granodiorite that is probably Devonian. The sedimentary rocks form an anticline about the core of the stock. To the east, slate and phyllite of the Indian Islands group, which is younger than the Farewell group, but older than the granite, occupy the centre of a syncline.

The vein strikes north-northwest and from its outcrop on the shore has been traced northward intermittently for more than three quarters of a mile. The southern exposures are in quartzite and slate, and the northern in granodiorite. The vein is at no point very far from the contact from which it diverges in strike at a slight angle. The vein is from 2 to 15 feet wide, being widest near its northern exposure. The vein matter is milky quartz, dark grey quartz, and white, greasy quartz. No sulphides have been reported.

Scheelite has been found at three localities along the vein. At the first near the north end of the vein, the scheelite is in a zone about 1½ to 2 feet wide along the south side of a 4-foot-wide branch from the main vein. Scheelite is present in patches for about 40 feet along the branch vein. Some of the scheelite there has been altered to tungstite. A grab sample assayed 2.81 per cent WO_3, with *nil* Au, Mo, and Pb. A concentrate made from this material assayed 69.61 per cent WO_3, and *nil* Mo.

The second locality is also in granodiorite near the contact with slate and about midway between the north and south exposures of the vein. There a zone 4 feet wide near the west side of the vein contains scheelite. At the third locality half-way between the edge of the granodiorite stock and the shore of Charles Cove, scheelite was observed in loose blocks of the vein that are nearly in place.

Patrick stated this vein has not been thoroughly prospected and suggested that this and other large veins occurring in the vicinity warrant investigation as a possible source ot scheelite ore.

CHAPTER IV

TUNGSTEN DEPOSITS IN OTHER COUNTRIES

Tungsten minerals are widely distributed throughout the world, and deposits of them occur in many countries. In this chapter, the more important of such occurrences will be described briefly.

EUROPE

BRITISH ISLES

The tin mines of Cornwall have been worked intermittently for more than 2,000 years. Although the close association of wolframite lodes and the presence of wolframite in some of the tin veins had been known for a long time, little production of tungsten had been attained prior to World War I. Since then, tungsten concentrates have been produced, particularly in times of emergency.

The veins containing tin and tungsten occur in Devonian slates, locally called killas, and in Hercynian (Devonian) granites that intrude them (Lindgren, 1933; Kear, 1952). Adjacent to the veins, metasomatic alteration of the host rocks is intense, the slates being abundantly tourmalinized and the granites greisenized. The greisen consists chiefly of granular quartz, muscovite and zinnwaldite, and topaz, the last forming aggregates through the partly altered feldspars. This metasomatic alteration apparently followed early fractures and preceded the emplacement of the veins.

The veins occur near the contact between slate and granite, and some of them grade into pegmatite. Zoning of the veins is marked, in order of decreasing temperature, by the presence of tungsten, tin, copper, zinc, and lead. The tungsten-bearing veins are of quartz, and in addition to wolframite, may contain cassiterite, scheelite, tourmaline, zinnwaldite, arsenopyrite, topaz, fluorite, bismuthinite, wavellite, copper, and cuprite. Sulphides, and tourmaline, that are so abundant in the wall-rocks, are seldom present in the veins.

PORTUGAL

The largest tungsten deposits in Europe are in Portugal, and most of these are in Trasos-Montes, in the northeast part of the country. The largest mine is the Panasquiera, but the Ribeira and Borralha are also important producers.

Panasquiera mine (Bloot and DeWolf, 1953) is owned by Beralt Tin and Wolfram Limited, a British corporation. The deposit is in late Precambrian schist intruded by granite, which is locally greisenized particularly in the apophyses. The veins are numerous, and occur entirely in the schists, though some at depth enter a zone of greisenization. They are lenticular, from a few metres to 100 m. or more long, and up to 20 m. wide. Some are barren, but many contain wolframite, with cassiterite, rutile, and sulphides and arsenides. Gangue minerals are quartz, tourmaline, mica, siderite, and apatite. Production of tungsten concentrates has been stimulated by a contract with the United States Government, signed in 1952, calling for 1,000 short tons of tungsten concentrate, and an additional 2,500 long tons over a 5-year period. The product is a high-grade wolframite concentrate, containing very little tin and arsenic.

Borralha tungsten mine, in Serra das Alturas, is owned and operated by a French company. The veins are in schists of Precambrian age, believed to be older than those at the Panasquiera mine. The veins also are hypothermal and related to Hercynian granites.

Wolframite placers derived from the lode deposits are widespread, and have been worked extensively in the past.

SPAIN

Spain has for many years ranked second to Portugal in tungsten production in Europe. The high price of tungsten concentrates on the world markets in 1951 so stimulated production in Spain that at the beginning of the following year two hundred and twenty-three mines were operating. Most of these were small operations worked by hand labour.

The largest producer in Spain is Silleda mine in the province of Pontevedra in the northwestern part of the country. Tungsten mines occur also in the provinces of LaCoruna, Orense, Leon, Salamanca, and Badojoz, along a belt of Hercynian orogeny extending from northwest Spain through northeast Portugal to the Guadalquiver graben in the south.

ASIA

BURMA

Prior to 1939, Burma ranked second to China in the production of tungsten, but since then has dropped behind the United States, Bolivia, the Republic of Korea, and Australia. Much of Burman production was formerly derived from placer and eluvial deposits, but a greater proportion now comes from lode deposits.

Extensive tungsten and tin deposits occur at Mawchi, Bawlake state, in eastern Burma, about 200 km. northeast of Rangoon, and in the Tavoy district of southern Burma. At Mawchi, (Dunn, 1938a; Hobson, 1940) the geology is comparatively simple. The Mawchi series, of late Precambrian or early Palæozoic age, consisting of slates, fine sandstones, grits, and limestones, has been gently folded with a northeasterly trend, and intruded by biotite granite. The granite was extensively tourmalinized, in part prior to the emplacement of the veins. The veins occur both in the granite and in the clastic members of the Mawchi series; almost without exception they die out in contact with the limestone. Twenty-seven veins have been worked. They strike north-northeast and dip almost vertically. The veins are 3½ to 5 feet wide, and up to several hundred feet long. Quartz is the main gangue mineral, with calcite, tourmaline, muscovite, chlorite, fluorite, beryl, garnet, zoisite, orthoclase, and kaolin. The ore minerals are cassiterite, wolframite, and scheelite, with pyrite, arsenopyrite, chalcopyrite, galena, and a little molybdenite, sphalerite, tungstite, and other minerals.

Dunn (1938a) states that wolframite was the first ore mineral to form, and was succeeded by cassiterite, which partly replaced the early wolframite, after which simultaneous deposition took place. Hobson (1940) suggested that if the later stages of mineralization had not been checked by the limestone dams, the wolframite might have been entirely replaced and carried upward so that only cassiterite would have remained in the veins. In support of his hypothesis, he points out that the proportion of tin to tungsten increases at depth.

The largest mine in the Tavoy district is at Hermyingyi (Dunn, 1938b). The rocks consist of argillite, agglomerate, quartzite and minor limestone and conglomerate presumably of the Precambrian Mergui series. These rocks trend north-northwest and dip steeply, and they are intruded by granite. At Hermyingyi about sixty veins have been worked. In general they strike north-northeast and dip easterly, and are 500 to 1,100 feet long and from 10 inches to 5 feet wide. The veins pass from greisenized granite upward into the sedimentary rocks, and are sharply defined, with a thin selvage of mica along their borders.

The veins are of quartz, with fluorite and muscovite, and in one vein, topaz occurs along one wall. Ore minerals are wolframite and cassiterite, with sulphides, native bismuth, and a few supergene minerals. The veins differ from those at Mawchi by the absence of tourmaline, scheelite, arsenopyrite, and calcite, although the last three minerals occur sparingly in tungsten-bearing veins in other parts of Tavoy.

THAILAND

Li and Wang (1947, p. 60) pointed out that "it is remarkable that Thailand, although belonging to the same geological structural unit as Lower Burma and the Malay peninsula, is so far comparatively poor in tungsten deposits". Previous to 1941, tungsten production was indeed very small, but about that year deposits were discovered in the northwestern states by lumbermen, and under the stimulus of war demand, production rose to 1,579 long tons of concentrates containing about 65 per cent WO_3. In recent years, Thailand tungsten production has often exceeded that of Burma.

The tungsten deposits in northwestern Thailand (Brown *et al.*, 1953) are all within two or three kilometres of the Burmese border, and are about 100 km. southeast of Mawchi. They are fissure veins, stockworks, and pegmatites carrying cassiterite and wolframite. These cut both a series of slates, phyllites, and marbles, and the granite that intrudes them. The largest veins are in the Mae Sariang district where they occur near granite contacts. These veins form two distinct systems, one striking north 25 degrees east and the other striking north

65 degrees east; all dip steeply. The veins of the latter are the more productive; they are as much as 1.25 m. wide and 460 m. long, and appear to occupy tension fractures along an anticlinal axis. The main ore mineral is wolframite, but some scheelite is present. Arsenopyrite is quite abundant in these veins, with some pyrite, chalcopyrite and molybdenite. Cassiterite is rare there, but is fairly abundant in many other tungsten-bearing deposits in this part of the country, where it is also found in placers.

In southern Thailand tin is more abundant than tungsten, and has been produced for many years. Some wolframite-bearing veins and pegmatites occur here, and at Chenkit mines both wolframite and scheelite occur in skarn with cassiterite, although only the latter has been produced. At Chon mine, tin ore occurs in a pegmatite in schist on the flank of a large granite stock. Minor amounts of pyrite, chalcopyrite, fluorite, scheelite, powellite and topaz are associated with the tin ore. Most of the tungsten production of this part of the country is derived from numerous quartz fissure veins near granite contacts in Rong Lec district. There both wolframite and cassiterite are mined from veins 60 cm. to 1.5 m. wide and up to a kilometre long, but with workable lengths of from 50 to 400 metres.

MALAYA

Malaya has for many years been the world's greatest producer of tin, and from 1933 to 1936 inclusive ranked third in the production of tungsten. Both wolframite and scheelite ores occur in Malaya. Wolframite is found in the tin ore localities of Kedah and Trengganu, and scheelite is found in limestone in several places in Perak and Selangor.

In Kedah and Trengganu, most of the wolframite occurs with cassiterite in placer deposits. Because wolframite is more friable and less resistant than cassiterite, the ratio of tungsten to tin in the placers is less than it would be in the primary deposits from which it is derived. However, there the covering of soil and vegetation is abnormally thick, and the search for lodes is severely handicapped. A few wolframite veins in schist, close to granite, have been found.

The largest tungsten mine in Pelak, the Kramat Pulai, was worked out in 1939. There the scheelite ore occurred in replacement bodies, consisting largely of fluorite, in crystalline limestone underlying schist, which formed an impervious roof. The deposit occupied the crest of an anticline, and extended down 100 feet to granite.

CHINA

China not only is the greatest producer of tungsten concentrates in the world, but, according to Li and Wang (1947, p. 106) possesses more than 80 per cent of the tungsten ore reserves of the world. These deposits are in the Nanling region, a broad, mountainous area about 1,500 miles long, extending across southern China. It includes parts of Yunnan, Kwangsi, Kwangtung, Hunan, Kiangsi and Fukien provinces. The largest and most numerous tungsten deposits are in southern Kiangsi, which contributes about 70 per cent of Chinese production.

Kiangsi Province

In southern Kiangsi province (Hsü and Ting, 1943) the rocks consist of a basement complex of metamorphosed pre-Devonian argillites and quartzites. These are succeeded unconformably by Devonian to Lower Jurassic strata that have been folded into broad anticlinoria and synclinoria that trend east to northeast, and are intruded by batholiths and related stocks of the Nanling granite, of Upper Jurassic age. These rocks are in turn overlain by Cretaceous and Tertiary strata.

The tungsten-bearing veins of southern Kiangsi as a general rule occur near granite contacts, most of them being in granite, a large number in the intruded rocks, and only a few being in both. However, the greater production is derived from veins in sedimentary rocks. Placers contribute only a small percentage of the production. The veins are fissure fillings of quartz with wolframite, and contain a host of other minerals that are characterized in pegmatite deposits by orthoclase, tourmaline, zinnwaldite, muscovite, topaz, molybdenite, and a little cassiterite and beryl, and in hypothermal veins by fluorite, sulphides, sericite, and a little bismuthinite, bismuth, and scheelite.

Wolframite is the important ore mineral. It forms tabular crystals from 3 to 9 cm. long or clusters of crystals almost all of which are black. Wolframite crystallized later than tourmaline and zinnwaldite, and earlier than quartz, orthoclase, scheelite, and all sulphides but molybdenite. Zoning is indicated by the fact that bismuth minerals occupy higher levels and molybdenite lower levels in the veins than wolframite. Greisenization of granite wall-rock extends up to 2 m. from the veins.

Descriptions of Some Important Deposits

Tachishan. The rocks in this mining district are phyllite, sandstone, argillite, and quartzite of Ordo-Silurian age, intruded by diorite dykes. Granite is exposed 3 miles north of the deposit. The veins occupy joints approximately at right angles, both sets of which transect the bedding. The veins consist of quartz with wolframite and zinnwaldite, and a little tourmaline, cassiterite, and sulphides. Twenty such veins are known; they are from 0.1 to 1.0 m. wide, up to 650 m. long, and 260 to 300 m. deep. This district is one of the leading producers of tungsten concentrate in China.

Kweimeishan. The rocks are mainly dark grey quartzite of Cambro-Ordovician age intruded by granite. Within them is a sheeted zone, 200 to 500 m. wide by 1,500 m. long in which thirty parallel lenticular veins, striking north 20 degrees west and dipping steeply eastward, occur. The veins are worked from the surface to a depth of 90 m. and show no decrease in grade over that distance.

Sihuashan. This deposit is on the southern part of a granite stock 3 to 4 miles in diameter, on the periphery of which are three additional similar deposits. At Sihuashan, two hundred veins, striking east to north 70 degrees east and dipping steeply north, and from 10 cm. to 2 m. wide occur within an area 1,200 by 2,000 m. The quartz veins contain wolframite, orthoclase, muscovite, and a little cassiterite, beryl, topaz, fluorite, and sulphides. Nearly all occur in granite, and end abruptly against the granite-phyllite contact, near which the richest ore is found. The grade generally decreases at depth. Sihuashan is the largest tungsten producer in China, and the Tayu district in which it occurs may be the richest tungsten district in the world.

Hungshuichai. This district, which is rather inaccessible, is underlain by metamorphosed pre-Devonian argillites and quartzites that are complexly folded and faulted, and invaded by granite. Within the granite is a shear zone 20 to 80 m. wide and 650 m. long of greisen containing short, lenticular quartz veins arranged *en échelon*. Cassiterite occurs throughout the veins and greisen, but wolframite is confined mainly to the veins, which contain also orthoclase, mica, fluorite, scheelite and sulphides. The zone has been mined by open pit to a depth of 30 m. Hungshuichai is the largest producer of tin concentrate in China, and produces substantial quantities of tungsten concentrate.

Shangping. This deposit is in phyllite and sandstone of Ordo-Silurian age invaded by small bodies of granite. The beds strike north-northwest and dip steeply eastward, and are traversed by numerous small, discontinuous, parallel veins, of which fifty exceed 10 cm. in width. These veins occupy tension joints striking east to east-northeast and dipping steeply. The veins are of quartz, with orthoclase, zinnwaldite and wolframite, and traces of topaz, fluorite, cassiterite, pyrite, and chalcopyrite. They occur in a sheeted zone 150 by 900 m. The ore averages 1.5 to 2 per cent wolframite.

Pankushan. A zone 250 by 1,100 m. in Devonian sandstone and shale contains twenty-one veins from 0.2 to 3.5 m. wide. The nearest granite is 12 miles distant. The sandstone strikes northwest and dips from 15 to 60 degrees southwest, and the veins strike north 70 to 80 degrees west and dip 80 degrees south. Some of the larger veins have been traced for 1,100 m. along the strike. They have been mined by shafts to a depth of 40 m.

The quartz veins contain wolframite and bismuthinite, with pyrite, scheelite, zinnwaldite, chlorite, sericite, chalcopyrite, and sphalerite. Bismuth is produced as a by-product.

Siaolung. The deposit at Siaolung is in pre-Devonian phyllite, schist and quartzite. No granite is known within several miles of the deposit. Twenty-two veins, of which seven are 0.5 to 1 m. wide occur in a zone 300 by 500 m. The veins have been worked over a vertical distance of 180 m., with no change in grade.

Kwangtung Province

Kwangtung Province is second to Kiangsi in importance. Four principal districts have been described by Li and Wang (1947, pp. 49-50).

Weng Yuan. "The Weng Yuan tungsten and bismuth mines are located 25 miles northwest of the city of the same name. An igneous rock, mostly granite, is intruded between Devonian sandstone and shale, and is exposed over an area of 21 miles long and 14 miles wide. The quartz vein, carrying bismuth and tungsten, cuts the granite and extends over a distance of about 7 miles. There are four parallel branches of this vein, which are respectively 200, 400 and 500 feet apart. The first branch has been extensively mined and is from eight inches to one foot wide. The proportion of tungsten to bismuth is roughly 8 to 1."

Yo Chang. "The tungsten and bismuth mines are located at Feng-men-wa, 9 miles north of Yo Chang City. Granite is intruded into the Permian sandstone and shale. In the granite four parallel quartz veins have been found which are 20, 30 and 32 feet apart, respectively. The longest has an extension of about $1\frac{1}{4}$ miles. The veins strike N 63° W and dip 82° southwesterly. The first and second veins are a foot, the third is four inches, and the fourth nine inches wide."

En Ping. "At Po Chi Shan there are found in granite two parallel veins, which are about 10 feet apart striking E-W and dipping 70°S. They have a thickness of about 6 to 7 inches."

Pao An. "At Ju Heng, two quartz veins 3 feet apart and 4 inches and 6 inches thick, respectively, are found cutting a purple-reddish sandy shale, probably of the Triassic age. Besides the wolframite, a small quantity of native bismuth is mined from the veins."

Hunan Province

"Topographically and geologically the southeastern part of Hunan, in which most of the important deposits of this province are found, is a part of the Nanling region.

"The Tzehsing deposit (Yao-kang district) is the most important one in Hunan. The geology of this region is characterized by two prominent series of sedimentary rocks: Devonian quartzose sandstone and Carboniferous limestone and coal series, which were intruded by a huge mass of granite. Associated with the wolframite mineral are arsenopyrite, iron pyrite, chalcopyrite, malachite, galenite, zincblende, and a small amount of bismuthinite.

"The quartz veins which carry wolframite are of two types, those occurring in the granite itself and those occurring in the quartzose sandstone near the contact with the granite mass. The veins generally strike NW-SE and dip 60°. The thickness of the workable veins ranges from 0.2 to 2 metres."

JAPAN

During the years immediately preceding, and during World War II, the Japanese government subsidized tungsten production (Dickerman 1945; Klepper, 1947a). Six fairly large mines, and a number of small, low grade deposits contributed up to 900 metric tons of tungsten concentrates per year. After

1944, however, production fell off greatly, and it is doubtful that more than a very little tungsten will be produced in Japan. The greater part of the production came from low grade scheelite ores in skarn, although wolframite-bearing veins were also mined.

REPUBLIC OF SOUTH KOREA

The largest deposits of tungsten ore in the Korean peninsula are in the southern and central parts (i.e. within South Korea) (Klepper, 1947a, 1947b), and of these, the most productive are in the provinces of Kogen, North Chusei and Kangwon. The ores consist of both wolframite-bearing veins and scheelite-bearing contact metamorphic deposits, and placers derived from these.

The most important tungsten deposit in South Korea, and one of the largest in the world, is the Sangdong, Kangwon province, which has been described by Klepper (1947b). The deposit was discovered in 1940, and up to 1947 had produced 14,000 tons of concentrate containing 7,523 tons of WO_3 from 850,000 tons of ore. The reserves in 1947 were calculated at 2,280,000 tons of measured and indicated ore averaging 1.7 per cent WO_3, and 1 million tons of probable ore averaging 1.3 per cent WO_3.

The orebodies occur within lenticular silicified beds in the Cambrian Myobong formation, which consists of mudstone, siltstone, shale, and marl, and their metamorphic equivalents. This formation overlies a thick bed of quartzite that rests unconformably on Precambrian schist, and the beds form a part of the gently dipping south limb of a broad syncline. Only minor faults, most of which are normal, have disrupted the strata. The nearest outcrop of intrusive rock is a granite porphyry that intrudes these beds 7 km. to the southeast.

More than 90 per cent of the ore occurs within a single bed, averaging 4.5 m. in thickness, and 1,500 m. long. Within this bed are barren rocks of two types: hornfels and porphyroblastic garnetite. The ore-bearing rock is largely composed of quartz, with biotite, fluorite, apatite, sulphides (mainly pyrrhotite), and scheelite. The scheelite was emplaced during metasomatic alteration of the sedimentary rocks. The source of the metal-bearing fluids is presumed to be deep seated, for igneous rocks are absent in the vicinity of the mine.

NORTHERN KOREA

Information regarding the tungsten mines of Northern Korea is sparse, but there appears to be four mines in the country, three of them in the southern part. The deposits are largely quartz veins containing wolframite, with cassiterite, pyrite, chalcopyrite, arsenopyrite, molybdenite, fluorite, and calcite. The tungsten production of Northern Korea in 1952 was estimated to be 1,200 metric tons containing 60 per cent WO_3, or about one-third that of Southern Korea.

U.S.S.R.

The tungsten production of U.S.S.R. is not known, but is believed to be small in comparison to the enormous size of the country. One is handicapped in placing the localities of the deposits by the profusion of similar and identical names in different parts of the country, and by variations in spelling. There appears to be both wolframite-bearing veins and scheelite-bearing contact metamorphic deposits in the vicinity of Dzhizak in southern U.S.S.R., north of Afghanistan. In the eastern Urals, at least a dozen wolframite-bearing veins occur between Magnetogorsk and Sverdlovsk.

The principal tungsten-bearing metallogenic province, however, forms a broad belt extending from the Trans-Baykal region, north of Mongolia, eastward to Chukotskiy Peninsula near Bering Strait. Within this belt, there occur both wolframite- and cassiterite-bearing veins, and scheelite-bearing skarns. These deposits are found mainly in Palæozoic sedimentary rocks intruded by Mesozoic granites.

AUSTRALASIA

AUSTRALIA

Production of tungsten concentrates in Australia began late in the nineteenth century, and that country has assumed some importance in this industry during the years 1904 to 1919 and from 1938 to the present. The greatest source has been from the states of Queensland, Tasmania, and New South Wales, and Northern Territory (Fisher and Ball, 1949). Small amounts have been shipped from Western Australia, Victoria, and South Australia.

Northern Territory

Northern Territory has produced only wolframite concentrates, about three fourths of which comes from the Hatches Creek and Wauchope fields, which are 290 and 260 miles, respectively, north of the end of the railway at Alice Springs. At Hatches Creek the rocks are shale, quartzite, sandstone, and basic igneous rocks, presumably of Precambrian age, and all are intruded by granite. There are several wolframite-bearing quartz veins, some of which are parallel or subparallel with the bedding which strikes east-northeast, the others, trending north-northeast to north-northwest, cross the bedding. They are up to 5 feet wide and up to 500 feet long, but the lodes rarely exceed 350 feet in length.

In the Wauchope field (Sullivan, 1952) the rocks are shale, sandstone, and quartzite that are gently folded. Quartz reefs in the shale are up to 3 feet wide and 800 feet long, and dip 8 to 18 degrees east-southeast. They are worked as far as 400 feet down the dip. Ore shoots within the veins are 13 to 18 inches wide and up to 300 feet long.

Queensland

Queensland was until recent years the leading producer of tungsten concentrates in Australia. Most of this production was in the form of wolframite concentrates, but a large amount of wolframite-bismuth concentrate and a little scheelite concentrate were also shipped.

Most of the production comes from the Chillagoe-Herberton district, in which the principal centres are Wolfram Camp, Mount Carbine, and Bamford.

Wolfram Camp is in the periphery of a granite body 4 miles wide and 20 miles long, which intrudes slate and porphyry. The granite is locally greisenized, and within the greisen are quartz pipes 5 to 6 feet in diameter and from 50 to 600 feet long. Two hundred and fifty productive pipes occur. They contain a host of minerals, the important ore minerals being wolframite, scheelite, cassiterite, bismuthinite, bismuthite, native bismuth, and molybdenite.

At Bamford (Blanchard, 1947) similar wolframite-molybdenite-native bismuth-bearing pipes occur in granite. Here greisenization is less widespread than at Wolfram Camp and that present is largely confined to the vicinity of joint planes. Only sixty-nine such pipes are productive in this field.

At Mount Carbine the orebodies occur in pegmatite dykes and quartz veins that cross the schistosity of silicified slates and schists that form large roof pendants in a granite batholith. The dykes and veins occur along the crests of anticlines within the roof pendants, and form twelve overlapping and slightly radiating groups. The deposits are 6 inches to 2 feet wide, and contain ferritungstite(?), cassiterite, pyrite, and a little scheelite and molybdenite.

New South Wales

New South Wales was formerly a substantial producer of tungsten concentrates, but in recent years production has been comparatively small. The two major centres are Mole Tableland and Hillgrove. At Mole Tableland, near Torrington, the deposits occur within a huge roof pendant of Permian sediments. Disseminated wolframite and bismuthinite occur in dykes of greisen, and wolframite is especially concentrated in zones of abundant quartz veins and veinlets. Some wolframite is present also in quartz reefs within granite.

At Hillgrove, scheelite-bearing veins are present in gold reefs in granite and, to a lesser extent, in slate. These veins are 1½ to 6 inches wide, and the ore shoots within them are commonly short, although, as in the Damifino mine, some scheelite extends to a depth of 1,500 feet. The gangue is quartz, and a little stibnite is also present.

Tasmania

In recent years, Tasmania has led the other states of Australia in tungsten production. The major deposits are at King Island, and in the Avoca district (Fisher and Ball, 1949). In this district there are two large mines, Storey's Creek and Aberfoyle, which are 2 miles apart. The rocks at both these mines are Cambro-Ordovician slate and quartzite, which, at the Aberfoyle, is intruded by granite and dykes of greisen. Wolframite and cassiterite occur in quartz veins, and, at the Aberfoyle, also in greisen. Wolframite is the more abundant mineral at Storey's Creek, but at the Aberfoyle, cassiterite is more abundant. Small amounts of scheelite, bismuth minerals, sulphides, fluorite, and beryl occur in the veins.

At Grassy, on King Island, the scheelite deposit is one of the largest in the world. During the years 1946 to 1948 inclusive, the production of scheelite concentrate was about 630 long tons annually, or more than half the entire production of Australia. Ore reserves at October 31, 1948, were quoted as nearly three million tons of proved and probable ore, with an average grade of about 0.64 per cent WO_3.

The rocks are hornfels, intruded by aplite dykes probably related to a body of granite to the south. The most favourable host rocks for ore are garnet hornfels and garnet-pyroxene hornfels. Scheelite, associated with quartz, is disseminated throughout large parts of the favourable beds. The tungsten-bearing zone is at least 1,400 feet long and from 150 to 222 feet thick. Faults with horizontal displacements up to 90 feet intersect the beds and the ore.

NEW ZEALAND

New Zealand is not a large producer of tungsten concentrates, and all the production is in the form of scheelite. Some gold-bearing veins in Otago province at Glenorchy and at Macrae's Flat contain scheelite. At Glenorchy the veins are rich in scheelite and low in gold, the reverse being the case at Macrae's Flat. The rocks at Glenorchy are chlorite schists, formed by low grade regional metamorphism of probably Palæozoic greywacke. No granite is exposed in the region, but a subjacent batholith has been proposed by Reed (1945) as the source of scheelite-bearing solutions that formed the quartz veins that occupy fissures and the massive quartz lodes occupying a broad fracture zone that extends for nearly a mile along the strike. In addition to scheelite and gold, pyrite and arsenopyrite are present.

In the Macrae's Flat area, the lodes occur along a belt of mineralized rock from ½ mile to 2 miles wide, and 16 miles long, and form quartz reefs in which gold, scheelite, pyrite, arsenic, sulphur, and rhodonite are reported.

AFRICA

The major part of African production of tungsten concentrates is derived from Belgian Congo, Southern Rhodesia, and the Union of South Africa. In recent years, scheelite-bearing contact metamorphic deposits have been discovered in Algeria and French Morocco, and a significant amount may be produced from these deposits in future years.

BELGIAN CONGO

Production of tungsten concentrates in the Belgian Congo, which began in 1939, has in recent years been among the greatest in Africa. Most of the production has been obtained from tin-bearing alluvial and residual deposits at Kalulu, Kailo, Kima, Rinkwavu, and Utu Iseke tin areas, and the M.G.L. South concession.

The M.G.L. South concession is described by Wéry (1948), who studied some of the deposits from which the placers were apparently derived. There a number of pegmatite dykes and hydrothermal veins are grouped about granite bodies that intrude schist and gneiss. Zoning of the deposits is apparent; niobo-tantalates occur in pegmatites in the granite, and these minerals are succeeded in the deposits away from the granite by tin, tungsten, and gold. There is some overlap between the columbite, cassiterite, and wolframite, such that two or more may appear together in the same vein.

SOUTHERN RHODESIA

The tungsten ores of the Southern Rhodesia are almost entirely scheelite; wolframite is found at only two localities (Milton, 1943). Most of the ore occurs in quartz veins, although pegmatite dykes and contact metamorphic deposits yield some scheelite. The quartz veins are generally of the white "buck reef" type, and some contain gold, but where the gold is relatively abundant, scheelite is not common and forms only small crystals. The veins are for the most part found in schist and granite near the contacts, and in addition to scheelite and a little wolframite, fluorite, tourmaline, topaz, and galena are usually present.

UNION OF SOUTH AFRICA

Tungsten ores are widespread in South Africa (Joubert, 1941), those in the tin-fields of Transvaal having been known for a long time. More recently, deposits in the region south of Orange River have been explored. There the ancient terrain consists of Precambrian granites that have intruded a highly metamorphosed basement complex. Grouped about one of the youngest of these granites are pegmatites and quartz veins that contain ferberite as the predominant ore mineral.

The largest mine in the district is the Nababeep Near West tungsten mine, which has been described by Söhnge (1950). The more important deposits are confined to a band of hornfels and schist 400 feet thick that dips 40 degrees north at the surface, flattening to 10 degrees at depth. Within this, the main orebody consists of a series of parallel reefs, forming an ore shoot 1,000 feet long and 150 to 350 feet down the dip. The quartz veins contain tabular crystals of ferberite up to 2 inches long in lenticular clusters, fringed by a little scheelite. Some molybdenite, bismuthinite, pyrite and chalcopyrite, with garnet, apatite, sillimanite, zircon, and sericite are present.

NIGERIA

Wolframite is found in Nigeria in lode deposits from which the important tin placers were derived. It occurs also in eluvial and alluvial deposits near the source, but is much less abundant than tin in these placers owing to its rapid decomposition under tropical weathering. The main tungsten areas are at Kalato, Lireui, Rishi Hills, Daga Allah, Comber, and Kwandonkaya. The deposits comprise mainly veins and stockworks in both older Archæan granite and gneiss and in younger Archæan granite. Nearly all are within half a mile of the contacts of the younger granite. The veins are as much as 8 feet wide, but generally are much narrower, and contain quartz, wolframite, cassiterite, stannite, bismuth, sulphides, beryl, and fluorite.

EGYPT

Tin-tungsten lodes in eastern Egypt are described by Amin (1947). In this field greenstone and diabasic basalt are invaded by white granite and pink pegmatitic granite; the lodes are associated with the latter. Tin-tungsten veins occur in three mines: Abu Dabbab, Nabih, and Igla. The deposits are fissure-fillings of quartz, with wolframite and cassiterite, yellow mica, topaz, tourmaline, albite, and fluorite.

SOUTH AMERICA

Much tungsten has been produced from South America, particularly from Bolivia which has been one of the leading producers of tin and tungsten in the world. Argentina, Peru, and, in recent years, Brazil have contributed large quantities of tungsten concentrate.

ARGENTINA

The peak production of 1,923 tons of tungsten concentrate in 1942 was derived from fifty to sixty mines, but since that time production has decreased greatly, increasing again to 600 tons in 1952. Most of the deposits are of the hypothermal vein type, but some, occurring in the provinces of San Luis and Córdcba are of contact metamorphic origin. The veins are of milky quartz, and are 5 cm. to 3 m. wide. They are fissure fillings, and contain groups of tabular wolframite crystals, rosettes of muscovite, pyrite, and commonly chalcopyrite, bismuthinite, sphalerite, galena, and molybdenite. Cassiterite occurs only in the veins of the northern parts of the province. The gangue minerals, in addition to quartz and muscovite, are apatite, beryl, fluorite, tourmaline, and calcite, and, in some veins, feldspars and topaz. Although the veins are characteristic of high temperature and pressure conditions, cavities do occur in them.

The largest mine is the Aguila-Cóndores, a few kilometres west of Concaran, San Luis (Knox, 1945*a*). There a number of veins, of which four are important, strike east, at right angles to the trend of the schists that enclose them. They have been explored along the strike for 1,800 m. A second system of smaller veins that intersect the first at depth occurs to the south. In both systems of veins, the ore minerals are erratically distributed.

Other deposits, described by Smith and González (1947), are the Cerro Morro in San Luis province, the Josefina in Mendoza province, and the San Antonio in Catamarca.

The rocks at Cerro Morro are schist and gneiss with intercalations of epidote-actinolite rock derived from limestone, and the scheelite ore occurs in this rock. No igneous intrusive rocks occur in the vicinity of the mine, but the intense metamorphism suggests the presence of a batholith at depth. Scheelite occurs both as disseminated crystals in the epidote-actinolite rock, and in micaceous quartz veins that cut it. The veins are too narrow to be mined except where disseminated ore also occurs. The orebodies have assay walls and average about 0.8 per cent WO_3. The largest orebody is 30 by 20 m. and 0.5 m. thick.

At the Josefina mine, wolframite-bearing quartz veins occur in schist and gneiss, about 1 km. from the contact of a large granite body. The structure is fairly simple. The rocks are traversed by two large faults and a number of smaller ones. Six major wolframite-bearing quartz veins are mined. These contain a little scheelite, muscovite, fluorite, and sulphides.

At the San Antonio mine the wolframite ore also occurs in quartz veins, but there the host rock is granite. Near the veins, which occur near the contact of the granite with schist, the granite is greisenized. The mineralogy of the veins is simple; no sulphides are present. The grade of the ore is high, and the concentrates contain no objectionable impurities. Fifty veins are known, and the mine is probably the largest producer of tungsten concentrates in Argentina.

BRAZIL

Wolframite associated with cassiterite has been known for many years in Brazil, and a small quantity of tungsten has been exported. In 1942, extensive scheelite deposits were found in northeastern Brazil (Johnston and de Vasconcellos, 1945), in the states of Paraíba and Rio Grande do Norte. Up to 1944, sixty localities had been discovered.

The rocks in this region are a crystalline complex of Precambrian age, comprising limestone, marble, quartzite and schist intruded by granite and pegmatite. With only one exception, the scheelite orebodies occur in or near calcareous beds intercalated with mica schist. The calcareous beds have been recrystallized or altered to skarn or amphibolite. The development of epidote, garnet and quartz, and to a lesser extent, vesuvianite, wollastonite, hornblende, scapolite, and scheelite has taken place in these rocks. Some deposits are overlain by alluvium in which scheelite has been concentrated. Scheelite and bismutite concentrates have been obtained from both residual and alluvial material.

Brief Descriptions of Some of the Deposits

Quixaba. This mine is about 12 miles northwest of Sta. Luzia, Paraíba. Scheelite occurs in marble beds that have been replaced by epidote, garnet, and scapolite for a distance to 2 km. along the strike. It occurs, associated with quartz, pyrite, and graphite, mainly where the band is thinner. The average grade is estimated to be about 0.1 per cent WO_3, but selective mining might yield ore of about 0.5 per cent WO_3.

Quixeré. Quixeré mine is 15 km. east of São João do Sabugí, Rio Grande do Norte. There, a steeply dipping bed of epidotized and silicified amphibolite, interbedded with granitized schist, contains scheelite which appears to be most abundant in or near relicts of marble. The beds are cut by a number of small pegmatite dykes. The amphibolite bed has been traced for about 500 m. and the average scheelite content is less than 0.5 per cent.

Bonito. This mine is on the west side of Rio Piranhas, about 27 km. north of São Miguel da Jucurutú, Rio Grande do Norte. Thin beds of epidotized amphibolite, intercalated with sandy schist and marble, strike northward and dip steeply west. The members of this series on the west are probably faulted against a body of fine-grained granite. The amphibolite is cut by quartz veins that introduced at least a part of the scheelite, along with bismutite, pyrite, and molybdenite. Much of the production is from residual material overlying the ore zone.

Bara Verde and Barro Vermelho. These adjacent mines are about 12 km. south of Currais Novos, Rio Grande do Norte. A bed of marble 25 to 150 m. wide, flanked by schist, strikes north and dips 40 to 85 degrees west. A large granite body occurs 1 km. west of the mines and much of the schist on this side is granitized. At places almost all the marble has been altered to skarn, consisting of epidote, garnet, vesuvianite and some hornblende, and scheelite has been introduced into the skarn.

Bodó. Bodó mine, 18 km. west of Cerro Corá, Rio Grande do Norte, is one of the largest tungsten deposits in the country. The bands of limestone, largely altered to silicified skarn, are interbedded with schist. The beds dip south away from sill-like bodies of granite. Scheelite is widely distributed in the altered limestone.

Cafuca. This mine is 54 km. northwest of Cerro Corá. Schist, with interbedded limestone, forms a northerly trending anticline that is truncated on the northeast by granite. The limestone beds are up to 5 m. thick and have been altered to an epidote-quartz rock. Within altered limestone, crystals and masses of scheelite up to 3 kilograms occur.

BOLIVIA

Tungsten deposits occur throughout the Bolivian tin belt (Ahlfeld, 1941) which forms an arc 75 to 150 km. wide and more than 800 km. long from the Peruvian border north of Lake Titicaca to the Argentine border. The richest deposits occur in the central part of the belt. Sedimentary and volcanic rocks, of Palæozoic to Tertiary age, are intruded in the northwest part of the arc by stocks of granite and diorite, perhaps representative of a great cryptobatholith. A wide variety of metallic deposits are known of which those of tin and tungsten are the most widespread. Zoning of the deposits is apparent, with wolframite occurring nearer the centre of the inferred cryptobatholith than tin, although there is overlapping of these types. Bolivia is one of the major producers of tungsten concentrates in the world.

The Chicote deposit (Ahlfeld, 1945), 65 km. north-northeast of Oruro is one of the largest tungsten deposits in the country. The ore is in Devonian sandstone and shale that have been metamorphosed to silicified hornfels over an area of about 4 square km. Within this area seventy-two wolframite-bearing veins and veinlets occur throughout a vertical range of 1,300 m. Some of the larger veins, and a stockwork of about forty of the smaller ones, contain mineable ore shoots. In the quartz veins, wolframite forms clusters of crystals, associated with pyrite, arsenopyrite, and pyrrhotite. Within recent geological time, huge bodies of the vein zone have slid into the valley to form a talus containing workable wolframite ore.

Another major mine is the Chojlla, near Yanacachi, department of La Paz (Bellows, 1947). It produces tungsten and tin in the proportion of 60 per cent tungstic oxide to 40 per cent tin. The orebodies occur in quartz veins in shale that has been invaded by granite. The veins contain wolframite, cassiterite, white mica, tourmaline, sulphides, and some siderite.

PERU

Tungsten deposits occur in two regions of Peru (Knox, 1945b), the southern one being the northwestern end of the Bolivian tin belt and of lesser importance than the northwestern region, east of the coastal city of Trujillo. The former contains hypothermal tin-tungsten veins, and the latter, occupying an area of about 4 to 45 miles, contains epithermal veins. These veins occur in Jurassic schist, slate, phyllite, and quartzite, and in late Tertiary granite that intrudes the sedimentary rocks. The quartz veins are usually in groups and some veins are more than 2 feet wide. All veins contain wolframite, pyrite, sphalerite, tetrahedrite, enargite, and galena, and in some veins arsenopyrite, marcasite, realgar, and cinnabar also are present. The larger veins are too low grade in tungsten and the smaller veins are too widely spaced to support large-scale mining and milling. Consequently production is not great and is derived entirely from primitive mining and milling methods.

NORTH AMERICA

CUBA

Tungsten deposits occur in the southwest part of Isla de Pinos, which is about 60 miles south of the main island of Cuba (Page and McAllister, 1944). The rocks are schist and quartzite, probably of Jurassic age, that are invaded by diorite and pegmatite. The metamorphic rocks appear to be on the east flank of an anticline, and are isoclinally folded and faulted. During the later stages of the complex geological history, quartz-ferberite veins were emplaced, and later fractured and brecciated. Tourmaline, ferberite, quartz, arsenides, and sulphides were then introduced into the veins and the nearby brecciated rocks. A little scheelite was formed by alteration of ferberite.

The deposits of economic importance occur within an area 2,800 by 6,000 feet, though tungsten occurs beyond this area. In 1941, it was estimated that the probable ore reserve was 55,000 tons containing 750 tons of WO_3. It was anticipated that further exploration would reveal additional veins.

UNITED STATES

Tungsten concentrates have been produced in fourteen States, but in only five of these has the production been important. These are, in order of importance, California, Nevada, Colorado, Idaho, and North Carolina.

California

The production of tungsten concentrates in California up to 1942 (Jenkins, 1942) was derived from three major orpducers (over 1,000 tons of concentrate of 60 per cent WO_3), seven intermediate producers (100 to 1,000 tons), and more than a hundred minor producers (less than 10 tons).

The most productive area is in the Bishop district, Inyo county, which includes the Pine Creek and Tungsten Hills areas. At Pine Creek (Lemmon, 1941c) the Pine Creek and Tungstar mines are the principal properties. The area lies within the eastern edge of the Sierra Nevada, which is composed mainly of granitic rocks intrusive into quartzite, schist, and marble. The marble has, in certain zones, been altered to skarn (tactite), composed of red-brown garnet and dark green diopside-hedenbergite, with fluorite, apatite, and titanite. Fracturing of the skarn was followed by the introduction of feldspar-vesuvianite rock and lenses of quartz containing scheelite. Subsequently, pyrite, chalcopyrite, and molybdenite, and finally veinlets of epidote and prehnite and lenses of calcite were introduced.

The orebodies of Pine Creek mine (McKinley, Holmes, and Sausa, 1951) are irregular and lie along a north-striking zone in skarn near the granite contact. They have fairly sharp borders, rather than assay walls. Scheelite is the main ore mineral, but there is sufficient molybdian scheelite to require chemical treatment of part of the flotation products of milling, from which a by-product of molybdenum is obtained.

The Tungsten Hills area (Lemmon, 1941a; Bateman, Erickson, and Proctor, 1950), in the foothills to the east of Pine Creek, contains several mines of importance. The major producer is El Diablo Mining Company which operates the Little Sister, Jackrabbit, and Lucky Strike mines. A large output is derived also from the Aeroplane mine of Tungsten City Milling Company, and the

Round Valley mine. All these mines occur in septa of quartzite, hornfels, marble, and skarn within granite or quartz diorite. Scheelite occurs in skarn which is usually formed by selective replacement of certain marble beds, the adjoining marble being little affected.

A few miles southeast of Tungsten Hills is the Rossi mine, another fairly important producer. The scheelite ore occurs in a band of skarn 400 feet long and 150 feet wide adjacent to granite.

Twenty miles north of Bishop, in Mono county, is the Black Rock tungsten mine (Lemmon, 1941b). The rocks in the area about the mine form an anticline with a core of limestone and skarn and limbs of overlying schist, intruded by granite. The ore is scheelite, occurring in skarn composed of garnet, amphibole, diopside, calcite, epidote, and quartz, with sulphides, chlorite, and probably nontronite. The grade is about 1 per cent WO_3.

The Atolia district of San Bernardino and Kern counties (Lemmon and Dorr, 1940) has produced more tungsten concentrates than the Bishop district, but reserves of ore are now comparatively small. More than 95 per cent of the production has been derived from properties of Atolia Mining Company, which began production in 1906. The country rock is quartz monzonite, probably of late Jurassic age, in which a series of roughly parallel, branching veins, probably of Miocene age, occur. The veins are perhaps related to late Miocene volcanic rocks. The most productive zone is more than 2 miles long. The ore shoots are from a few inches to 17 feet wide, and some have been mined to a depth of more than 1,000 feet.

The quartz veins contain scheelite, with carbonates, and a little pyrite, stibnite, and cinnabar. The average grade of ore from 1906 to 1940 is reported as more than 4 per cent WO_3.

In addition to lode deposits, there are extensive placer deposits in the district, known as the "Spud Patch" because of the large masses of scheelite that have been recovered from it. A little gold also occurs in the placers. Production of scheelite from these deposits has been comparatively small owing to difficulties of concentration, and the erratic distribution of the scheelite. It has been estimated that 28 million cubic yards of gravel contain at least 2,800 tons of WO_3.

Two other tungsten mines of importance are the Hayward, near Darwin, Inyo county, and the Tungstore, near Posey, Tulare county. Both these properties produce scheelite from skarn deposits.

Nevada

The tungsten deposits of Nevada are in two belts, an eastern belt extending into Utah, and a western belt extending into California. The latter is the more important and includes the Mill City, Osgood Range, Oreana, Ragged Top, and Silver Dyke districts.

Mill City district is the most productive (Kerr, 1934). The scheelite orebodies occur in skarn formed by the selective replacement of limestone beds near a body of granodiorite. The skarn, composed of garnet and quartz, with epidote and scheelite and small amounts of other minerals, does not extend more than 2,000 feet from the granite contact. The average grade of ore exceeds 1 per cent WO_3.

The deposits of Osgood Range, Ragged Top and Silver Dyke (Kerr, 1936) are similar to those of Mill City district and the ore also occurs in skarn close to granodiorite or quartz monzonite. The Osgood Range deposits came into production in 1942, and by July, 1945 had produced 133,000 units of WO_3 from 250,000 tons of ore. At that time, reserves of measured and indicated ore were estimated at more than 500,000 tons containing between 0.5 and 0.6 per cent WO_3.

The orebodies at Oreana (Kerr, 1938) occur in pegmatite dykes that traverse limestone and meta-diorite. The dykes are confined to a narrow zone about 2,000 feet long. Scheelite is erratically distributed in the dykes and forms coarse crystals associated with feldspar, beryl, phlogopite, and a number of less abundant minerals such as apatite, rutile, titanite, and fluorite.

Colorado

More than 95 per cent of the production of tungsten concentrates in Colorado is derived from the tungsten deposits of Boulder county (Lovering, 1940; Lovering and Tweto, 1953). This district, which is 2 to 4 miles wide and 10 miles long contains more than fifty deposits and is the most productive in the United States. It lies at the northeast end of a zone of smaller deposits extending to Silverton.

The belt is underlain mainly by granite of the Boulder batholith, of Precambrian age, that intrudes a series of schists and gneisses. All these rocks are transected by faults of Laramide age that form brecciated fracture zones and shear zones. Subsequent movement produced three sets of fissures which are now occupied by the tungsten-bearing veins. These quartz veins are from 6 inches to 3 feet wide, and contain irregular ore shoots a few of which extend to a depth of 500 feet from the surface. Ferberite is the only ore mineral, and is associated with a host of minerals, of which the most significant are hematite, dickite, marcasite, siderite, pyrite, sphalerite, tetrahedrite, adularia, beidellite, scheelite, and calcite. The tenor of the ore shoots ranges from 1 to 20 per cent WO_3. No change in the average grade of the ore at depth has been noted.

Idaho

The two principal tungsten mines of Idaho are Yellow Pine mine, Valley county, and Ima mine, Lehmi county. Yellow Pine (Bradley, Mecia, and Baker, 1943) was worked for many years for gold and antimony, and it was not until early 1941 that scheelite was discovered. The tungsten ores were soon brought into production. The orebody is in quartz monzonite, and is in the shape of a V, with the western side terminated against a lamprophyre dyke and the eastern side against a fault. Early mineralization resulted in the introduction of arsenopyrite, pyrite, and gold, followed by scheelite and stibnite. The main orebody contains 3 to 4 per cent WO_3, 5 per cent Sb, and 0.08 ounce a ton gold.

Ima mine (Kerr, 1946), in Blue Wing area, is in Beltian quartzites, intruded by granite that is exposed in the lower workings of the mine. The veins strike north 20 to 40 degrees west and dip 60 degrees west, roughly parallel with the axial plane of a local warp. Ore shoots extend for 1,200 feet along the main vein, and have been mined 250 feet vertically. The west vein is smaller, and the ore shoots less continuous. The average grade of mill heads is 0.55 per cent WO_3. The only ore mineral is hübnerite, but fluorite, orthoclase, rhodochrosite, sulphides, and scheelite are also present in the quartz veins.

North Carolina

The only tungsten deposit of importance in this state, and indeed in all the eastern states is near Henderson, Vance county (Munds, Ewoldt, and Cohen, 1944). The area is underlain by schist, intruded by a granite batholith probably of Carboniferous age. Quartz veins from a few inches to 20 feet wide cut both schist and granite but are near the contact. The principal ore mineral is hübnerite, with which is associated rhodochrosite, fluorite, chalcopyrite, sphalerite, galena, pyrite, tetrahedrite, and scheelite. A large quantity of ore, containing from 0.5 to 1.5 per cent WO_3 was blocked out by bulldozing and drilling completed by the U.S. Bureau of Mines.

CHAPTER V

STATISTICS OF PRODUCTION

Canada has contributed only a very small amount of the total tungsten production of the world, and indeed in any single year has never contributed more than 2 per cent of the total annual production of the world. China, which began shipments of tungsten ore in 1915, in a few years became the leading producer; in the period 1913 to 1937, she contributed 37 per cent of the world production, more than double that of her nearest competitor, Burma.

TABLE I [a]

World Production of Tungsten Concentrate by Countries, 1948-1952, in Metric Tons of Concentrate containing 60 per cent WO_3

Country	1948	1949	1950	1951	1952
North America:					
Canada	791	191	215	15	923
Mexico	133	65	67	325	443
United States (shipments)	3,659	2,508	4,373	5,693	6,905
Total North America	4,583	2,764	4,655	6,033	8,271
South America:					
Argentina	33	30[b]	20[b]	100	600
Bolivia (exports)	2,485	2,543	2,461	2,718	3,707
Brazil (exports)	1,144	575	759	1,422	1,800[b]
Peru	353	455	516	655	630
Total South America	4,015	3,600[b]	3,760[b]	4,895	6,700[b]
Europe:					
Finland	4	49	20	8	47
France	567	792	442	765	1,000[b]
Italy	4	3	2	6	5
Portugal	2,944	2,700	2,500	4,680	4,900
Spain	876	888	850	2,553	2,400
Sweden	317	468	362	450[b]	380[b]
U.S.S.R.[b]	5,000	6,000	7,500	7,500	(c)
United Kingdom	46	81	76	61	55
Total Europe[b]	9,800	11,000	11,800	16,000	8,800
Asia:					
Burma	1,824	740	930	1,647	1,260
China	12,200	9,000[b]	12,000[b]	15,800	20,000[b]
Hong Kong				23	104
India			2	15	
Japan	9	20	64	86	239
Korea:					
Korea, Republic of	1,245	1,448	2,000	1,269	3,500
North Korea	1,000	1,000	1,000[b]	1,200[b]	1,200[b]
Malaya, Federation of	87	69	27	54	79
Thailand[b]	800	1,100	1,200	1,350	1,600
Total Asia[b]	17,200	13,400	17,000	21,400	28,000

83281—16½

TABLE I [a] *Conc.*

Country	1948	1949	1950	1951	1952
Africa:					
Algeria				17	75
Belgian Congo	236	276	164	330	500[b]
Egypt	15			7	21
French Morocco	1		7	38	13
Nigeria	4	5	5	23	23
Southern Rhodesia	80	26	64	231	420
South-West Africa	13	6	4	33	118
Tanganyika (exports)	1	42	15	15	14
Uganda (exports)	115	180	218	167	109
Union of South Africa	151	416	96	188	263
Total Africa	616	951	573	1,049	1,600
Australasia:					
Australia	1,234	1,371	1,235	1,892	2,000[b]
New Zealand	28	28	24	35	35[b]
Total Oceania	1,262	1,399	1,259	1,927	2,035[b]
Grand Total[b]	37,500	33,100	39,000	51,300	55,400[d]

[a]From Minerals Yearbook, 1952, U.S. Bureau of Mines.
[b]Estimate.
[c]Data not available.
[d]Excluding U.S.S.R.

From the data in Table I, it can be seen that, with the possible exception of the U.S.S.R., the United States in recent years has ranked second to China in the production of tungsten. Details of the distribution of this production, as recorded in the United States Bureau of Mines, Minerals Yearbook, 1952, are of considerable interest, and are presented in the following table:

TABLE II

Tungsten Ore and Concentrates Shipped from Mines in the United States, by States, in Short Tons of 60 per cent WO_3 [a]

State	Shipments, 1952		Total Shipments, 1900-52	
	Quantity	Per cent of total	Quantity	Per cent of total
Alaska	8	0.11	208	0.14
Arizona	71	0.93	3,996	2.76
California	2,980	39.15	45,416	31.42
Colorado	625	8.21	26,213	18.13
Connecticut			11	0.01
Idaho	333	4.38	16,292	11.27
Missouri			37	0.02
Montana			546	0.38
Nevada	2,329	30.60	42,377	29.31
New Mexico			103	0.07
North Carolina	1,254	16.48	6,473	4.48
Oregon	4	0.05	8	0.01
South Dakota	(b)	(c)	1,296	0.90
Texas			1	(c)
Utah	3	0.04	242	0.17
Washington	4	0.05	1,339	0.93
Total	7,611	100.00	144,558	100.00

(a) Shipments are credited to the State where final concentrates were produced.
(b) Less than 1 ton. (c) Less than 0.01 per cent.

TABLE III

Production and Value of Tungsten Ores and Concentrates in Canada, 1910 to 1952[a]

Year	Nova Scotia		New Brunswick		Quebec		Ontario		Manitoba		British Columbia		Northwest Territories		Yukon Territory		Canada		
	pounds	dollars	pounds	dollars	pounds	dollars	pounds	dollars	pounds	dollars	pounds	dollars	pounds	dollars	pounds	dollars	Crude pounds	WO_3 content pounds	dollars
1910	150,000[b]	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	150,000[b]		
1911	150,000[b]	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	150,000[b]		
1912	28,000[b]	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	28,000	20,160	
1913	20,000[b]	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	20,000[b]		
1916	...	...	5,000[c]	...	...	...	...	...	...	...	...	...	...	...	1,100[d]+	...	6,100+		
1917	101,000[b]	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	101,000[e]	403[e]	234
1918	240,000[b]	...	22,000	...	...	...	...	...	177[f]	42[f]	...	...	...	...	2,000[g]+	...	264,177[h]+	19,946[h]	11,700[h]
1939	...	...	...	...	...	...	...	...	...	...	8,825[i]	4,917	...	...	...	...	8,825		4,917
1940	8,586	5,226	...	...	...	...	1,064	690	...	...	2,352	1,387	...	...	...	...	12,002	...	7,303
1941	...	...	...	...	989	627	3,830	2,432	...	...	34,495	21,453	41,972	13,220	1,560	980	82,846	42,356	38,712
1942	4,300	3,967	...	...	2,981	2,612	162,185	145,241	1,399	1,300	250,930	228,590	98,218	23,725	968	840	520,981	321,847	406,275
1943	19,374	18,564	...	...	5,401	5,369	494,405	356,478	16	16	976,622	692,260	720	729	12,083	10,122	1,508,621	817,763	1,083,538
1944	...	...	...	...	...	...	63,152	5,212	...	...	818,000	236,788	...	...	5,593	3,780	886,745	283,253	245,780
1945	...	...	...	...	...	...	787	714	...	...	366	331	...	...	...	...	1,153	792	1,045
1947	...	...	...	...	...	...	...	...	...	...	668,000	680,792	...	...	...	...	668,000	496,023	680,792
1948	...	...	...	...	...	...	...	...	...	...	1,409,207	1,046,160	...	...	...	...	1,409,297	1,046,160	1,046,160
1949	...	...	...	...	...	...	...	...	...	...	334,000	252,380	...	...	...	...	334,000	252,380	252,380
1950	...	...	...	...	...	...	...	...	...	...	1,886,000[j]	160,343	...	...	...	...	1,886,000[j]	284,078	160,343
1951	...	...	...	...	...	...	...	...	...	...	...	...	...	...	4,145	7,098	4,145	2,833	7,098
1952	...	...	...	...	...	...	50,734[k]	164,886	...	...	1,434,641[k]	4,307,879	7,736[k]	15,472	...	...	3,670,686	1,493,111	4,488,237

[a] Compiled from publications of the Dominion Bureau of Statistics except where noted.
[b] Pamphlet No. 29, Nova Scotia Dept. of Mines—WO_3 content and value unknown.
[c] Dept. of Crown Lands, New Brunswick, Ann. Rept., 1916, p. 22.
[d] Geol. Surv., Canada, Sum. Rept., 1916, p. 27. Does not include "several hundred pounds" shipped from Canadian Creek (*Idem*, p. 30).
[e] Dominion Bureau of Statistics reports 580 lb. containing 69.41 per cent WO_3, valued at $234.
[f] Manitoba Dept. of Mines, Ann. Rept., 1928, p. 22.
[g] Geol. Surv., Canada, Sum. Rept., 1918, Pt. B, p. 11. "This spring (1918) over a ton of high grade concentrates were shipped . . . .".
[h] Dominion Bureau of Statistics reports 27,000 lb. containing 73.8 per cent WO_3, valued at $11,700.
[i] Probably includes 4,000 lb. of concentrates produced in 1937.
[j] Includes export of considerable low-grade material to United States.
[k] WO_3 content; weight of crude concentrates not recorded.

Records of tungsten production in Canada previous to 1919 are obscure, and there is marked confliction between the records of the Dominion Bureau of Statistics and those contained in other publications. In the table above, all known information regarding tungsten production is presented. Prior to 1946, the actual weights of tungsten ores and concentrates produced were recorded, but from that year only the calculated weight of WO_3 in these ores and concentrates has been given, in accordance with the modern practice of standardization. This dual standard, however, coupled with the probably inaccurate figures of the earlier years, makes comparison of productions for different provinces and different years difficult.

From the preceding table, it is apparent that most of the tungsten production of Canada has been from British Columbia. Ontario, Northwest Territories, Yukon Territory and the Maritime Provinces have made appreciable contributions.

An estimate of the tungsten reserves of the world has been given by Li and Wang (1947, pp. 105, 106). While such estimates may be grossly inaccurate they provide a rough idea of future sources of tungsten. Their figures are presented below.

TABLE IV

Tungsten Resources of the World, in Short Tons containing 60 per cent WO_3

China	2,057,000
United States	80,000
Burma	80,000
Brazil	45,000
Bolivia	40,000
Korea	25,000
Australia	22,000
Portugal	20,000
Russia	15,000
Malay States	5,000
Indo China	5,000
Spain	5,000
Argentina	5,000
Canada	3,000
Great Britain	2,000
Southern Rhodesia	2,000
Peru	2,000
New Zealand	1,000
Thailand	1,000
France	1,000
South Africa	1,000
Japan	1,000
Other Countries	6,000
Total	2,424,000

According to these figures, China is presumed to possess more than 80 per cent of the tungsten resources of the world. If Chinese production did not reach the world markets, the tungsten reserves of the remainder of the world could supply those markets for only 10 years, based on the consumption of tungsten in 1952.

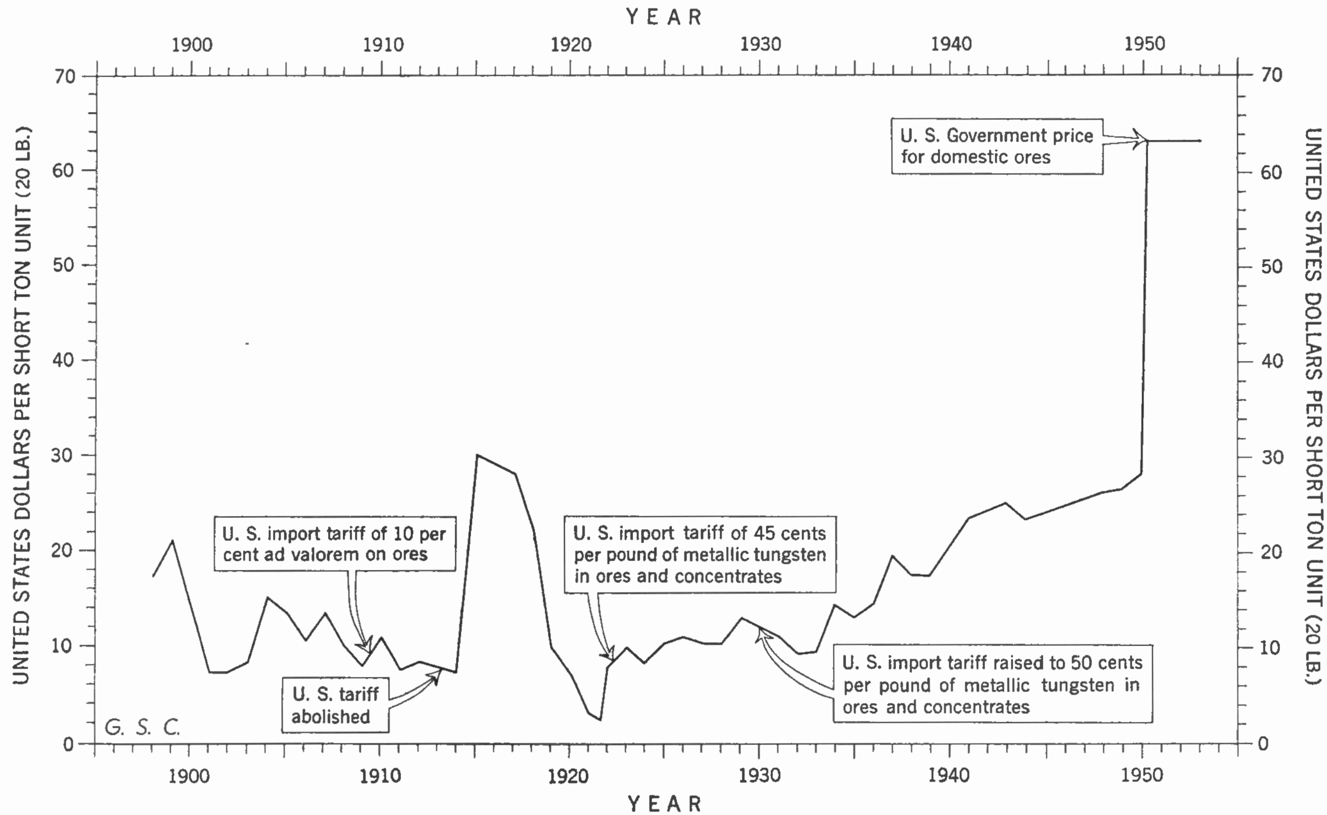


Figure 29. Graph showing yearly average prices of tungsten concentrates for period 1898 to 1953, inclusive. (*After* Stevenson (1943, p. 27) with additional information from *Minerals Yearbook*, U.S. Bureau of Mines, and *Engineering and Mining Journal*.)

Tungsten ores are usually marketed as concentrates, or as high grade cobbed ore, in which the content of tungsten oxide (WO_3) is at least 60 per cent. Prices are quoted for different types of tungsten ores, such as those of scheelite and wolframite, in dollars per short ton unit of 20 pounds in Canada and the United States, and in shillings per long ton unit of 22.4 pounds in the British Commonwealth of Nations, other than Canada. The prices are subject to certain penalties dependant upon the grade of the concentrates and certain limited impurities.

Figure 29 shows graphically the yearly average price of tungsten concentrates for the period 1898 to 1953, inclusive, f.o.b. New York, in U.S. dollars per short ton unit (20 pounds). Because most of the Canadian production is absorbed by the United States markets, these prices are of most interest to Canadian producers.

On May 10, 1951, the United States Government agreed to purchase domestic tungsten concentrates at a price of $63.00 per unit, for a period of five years. In the same year, the price of foreign ores rose from the equivalent of about $50.00 per unit to $78.00 per unit. A subsequent decline in price of foreign ores continued through 1952, and levelled off at $23.00 to $28.00 per unit in 1953. Since the passage of the Smoot-Hartley Tariff Act in 1930, there has been an import duty on raw material of 50 cents per pound of metallic tungsten, or $7.931 per short ton unit of ore or concentrates.

Specifications and penalties for impurities in ores and concentrates of tungsten purchased by the Administrator of General Services, United States Government are presented in the following tables.

TABLE V

Percentage of WO_3 Required in Tungsten Ores and Concentrates

	Ferberite	Hübnerite	Wolframite	Scheelite
Standard	60	60	65	60
Minimum	55	55	60	55

TABLE VI

Maximum Percentage Allowances of Elements Without Penalty

	Ferberite	Hübnerite	Wolframite	Scheelite
Tin (Sn)	0.20	0.25	1.50	0.10
Copper (Cu)	0.10	0.10	0.05	0.05
Arsenic (As)	0.15	0.10	0.25	0.10
Antimony (Sb)	0.10	0.10	0.10	0.10
Bismuth (Bi)	1.00	1.00	1.00	0.25
Molybdenum (Mo)	0.50	0.50	0.40	2.75
Phosphorus (P)	0.07	0.05	0.05	0.05
Sulphur (S)	0.50	0.50	0.50	0.50
Manganese (Mn)	1.00	(a)	(a)	1.00
Lead (Pb)	0.20	0.20	0.20	0.10
Zinc (Zn)	0.10	0.10	0.10	0.10

(a) Not specified.

"The minimum base price shall be subject to the following adjustments:

"(1) For each short ton unit of delivered tungsten trioxide (WO_3) the sum of twenty cents ($0.20) shall be deducted from the base price for each one per cent of tungsten trioxide (WO_3) below the standard requirements . . .

"(2) For each short ton unit of delivered tungsten trioxide (WO_3), a reduction of twenty-five cents ($0.25) shall be made for each of the following increments in excess of the maximum allowances (*see* Table VI), as to each of the following elements:

	Per cent
Copper (Cu)	0.01
Phosphorus (P)	0.01
Arsenic (As)	0.10
Bismuth (Bi)	0.50
Molybdenum (Mo)	0.10
Tin (Sn)	0.10
Sulphur (S)	0.10
Antimony (Sb)	0.10
Manganese (Mn)	1.00
Lead (Pb)	0.10
Zinc (Zn)	0.10"

Up to and including 1953, the only consumer of tungsten concentrates in Canada was Atlas Steel Corporation who added high grade scheelite concentrates directly to the bath of molten steel. Tungsten steel is thus produced, the calcium entering the slag. The specifications for such material are the same as those for scheelite concentrates listed in Tables V and VI, except that the minimum WO_3 content is 70 per cent, and the maximum molybdenum content is 0.10 per cent, and arsenic, antimony and tin combined must not exceed 0.25 per cent.

BIBLIOGRAPHY

Ahlfeld, F.

1941: Zoning in the Bolivian Tin Belt; *Econ. Geol.,* vol. 36, No. 6, pp. 569-588.

1945: The Chicote Tungsten Deposit, Bolivia; *Econ. Geol.,* vol. 40, No. 6, pp. 394-407.

Alcock, F. J.

1920: The Reed-Wekusko Map-area, Northern Manitoba; Geol. Surv., Canada, Mem. 119.

1930: Zinc and Lead Deposits of Canada; Geol. Surv., Canada, Econ. Geol. Ser. No. 8.

Allen, C. C., and Folinsbee, R. E.

1944: Scheelite Veins Related to Porphyry Intrusives, Hollinger Mine; *Econ. Geol.,* vol. 39, No. 5, pp. 340-348.

Ames, H. G.

1948: Perron Mine; Structural Geology of Canadian Ore Deposits; *Can. Inst. Mining Met.,* Jubilee Volume, pp. 893-898.

Amin, M. S.

1947: A Tin-Tungsten Deposit in Egypt; *Econ. Geol.,* vol. 42, No. 7, pp. 637-671.

Armstrong, J. E.

1941: Wekusko, Manitoba; Geol. Surv., Canada, Map 665A.

1949: Fort St. James Map-area, Cassiar and Coast Districts, British Columbia; Geol. Surv., Canada, Mem. 252.

Auger, P. E.

1947a: Siscoe Mine Map-area; Que. Dept. Mines, Geol. Rept. 17.

1947b: Desvaux Lake Area; Que. Dept. Mines, Geol. Rept. 27.

Ball, C. W.

1954: The Emerald, Feeney and Dodger Tungsten Ore-Bodies, Salmo, British Columbia, Canada; *Econ. Geol.,* vol. 49, No. 6, pp. 625-638.

Bateman, J. D.

1939: Geology and Gold Deposits of the Uchi-Slate Lakes Area; Ont. Dept. Mines, Ann. Rept., vol. 48, Pt. VIII, pp. 1-43.

1943: Scheelite near Falcon Lake, Manitoba; *Precambrian,* vol. 16, No. 8, pp. 4-7, 13.

Bateman, P.C., Erickson, M. P., and Proctor, P. D.

1950: Geology and Tungsten Deposits of the Tungsten Hills, Inyo County, California; *Calif. J. Mines Geol.,* vol. 46, No. 1, pp. 23-42.

Bell, A. M.

1951: Geology of Ore Occurrences of the Property of Gaspe Copper Mines; *Trans. Can. Inst. Mining Met.,* vol. 54, pp. 240-245.

Bell, L. V.

1937: Mining Properties and Development in the Rouyn-Bell River District during 1936; Que. Bur. Mines, Prelim. Rept., No. 116.

Bellows, G. D.

1947: Chojlla Mine Unusual in Geological Features; *Eng. Mining J.,* vol. 148, No. 9, pp. 68-70.

Blanchard, R.

1947: Some Pipe Deposits of Eastern Australia; *Econ. Geol.,* vol. 42, No. 3, pp. 265-304.

Bloot, C., and DeWolf, L. C. M.

1953: Geological Features of the Panasqueira Tin-Tungsten Ore Occurrences; Soc. Geol. de Portugal, Bol., vol. XI, fasc. I.

Bostock, H. S.

1930: Geology and Ore Deposits of Nickel Plate Mountain, Hedley, British Columbia; Geol. Surv., Canada, Sum. Rept. 1929, Pt. A, pp. 198-252.

1939: Mining Industry of Yukon, 1938; Geol. Surv., Canada, Mem. 220, pp. 8, 14.

1940: Hedley, British Columbia; Geol. Surv., Canada, Map 568A.

1941a: Olalla Area, British Columbia; Geol. Surv., Canada, Map 628A.

1941b: Mining Industry of Yukon, 1939 and 1940; Geol. Surv., Canada, Mem. 234, pp. 27-33.

1941c: Results of Investigation of the Tungsten Deposits in Yukon; Geol. Surv., Canada, Unpub. Rept.

1948: Preliminary map, McQuesten, Yukon Territory; Geol. Surv., Canada, Paper 48-25.

1952: Geology of Northwest Shakwak Valley, Yukon Territory; Geol. Surv., Canada, Mem. 267, p. 42.

Bradley, J. D., Mecia, J. A., and Baker, R. E.
1943: The Unique Yellow Pine Mine; *Eng. Mining J.,* vol. 144, No. 4, pp. 60-66.

Brock, R. W.
1904: The Lardeau Mining District, B.C.; Geol. Surv., Canada, Sum. Rept., 1903, pp. 42-81.
1912: Tin and Topaz in New Brunswick; Geol. Surv., Canada, Sum. Rept., 1911, pp. 13-15.

Brown, G. F., *et al*
1953: Geologic Reconnaissance of the Mineral Deposits of Thailand; Thai. Royal Dept. Mines, Geol. Surv., Mem. 1, pp. 96-133.

Brown, I. C.
1950: Fort Resolution, Northwest Territories; Geol. Surv., Canada, Paper 50-28, p. 7.

Bruce, E. L.
1919: Gold-Quartz Veins and Scheelite Deposits in Southeastern Manitoba; Geol. Surv., Canada, Sum. Rept., 1918, Pt. D, pp. 14, 15.
1935: Little Long Lac Gold Area; Ont. Dept. Mines, Ann. Rept., vol. 44, Pt. III.
1948: Cline Lake Mine; Structural Geology of Canadian Ore Deposits; *Can. Inst. Mining Met.,* Jubilee Volume, pp. 433-435.

Bruder, C.
1941: Mining Tungsten, Gold, and Copper at Outpost Islands; *Precambrian,* vol. 14, No. 2, February, 1941, pp. 2-5.
1942: Canada has a Tungsten Producer in Northwest Territories; *Eng. Mining J.,* May, 1942, pp. 47-49.

Buffam, B. S. W.
1942: Report on International Tungsten Mines, Limited, Great Slave Lake, N.W.T.; unpublished report submitted to the Metals Controller, September 2, 1942.
1948: Aunor Mine; Structural Geology of Canadian Ore Deposits; *Can. Inst. Mining Met.,* Jubilee Volume, pp. 507-515.

Buffam, B. S. W., and Allen, R. B.
1948: Chesterville Mine; Structural Geology of Canadian Ore Deposits; *Can. Inst. Mining Met.,* Jubilee Volume, pp. 662-671.

Burrows, A. G.
1912: The Porcupine Gold Area; Ont. Dept. Mines, Ann. Rept., vol. 21, pp. 205-249.
1924: The Porcupine Gold Area; Ont. Dept. Mines, Ann. Rept., vol. 33, Pt. II, pp. 1-84.

Bureau of Mines
1932a: The Concentration of a Lead-zinc-silver Ore from the Regal Silver Mines, Limited, B.C.; Pub. No. 724, Rept. No. 366.
1932b: Concentration of Scheelite Ore from Indian Path Mines, Lunenburg, Nova Scotia; Pub. No. 736, Rept. No. 431.
1935: Investigations in Ore Dressing and Metallurgy, July to December, 1935; Pub. No. 771, pp. 224, 225.
1938a: Gold-Copper Ore from the Slave Lake Gold Mines, Limited, Great Slave Lake, N.W.T.; Investigations in Ore Dressing and Metallurgy, January to June, 1937; Investig. No. 713, pp. 75-84.
1938b: Silver-lead-tungsten Ore from the Royal Silver Property, B.C.; Ore Dressing and Metallurgical Investig. No. 756.
1938c: Experimental Tests on a sample of Gold Ore from the Slave Lake Mine on Outpost Island, Great Slave Lake, N.W.T.; Ore Dressing and Metallurgical Laboratories, October 24, 1938; Unpub. Sum. Rept.
1940: Amalgamation and Concentration of a Gold-Copper-Tungsten Ore from the Slave Lake Gold Mines, Limited, Great Slave Lake, N.W.T.; Report of the Ore Dressing and Metallurgical Laboratories, Investig. No. 923, November 26, 1940.
1941: Concentration of Scheelite from the Ore of the A. M. Mining Syndicate, Gilmour Lake, Beaulieu River Area, Northwest Territories; Rept. of the Ore Dressing and Metallurgical Laboratories, Investig. No. 1004, April 30, 1941.
1942a: Concentration of Cobbed Scheelite Ore from the Gilmour Lake Area, Northwest Territories; Report of the Ore Dressing and Metallurgical Laboratories, Investig. No. 1147, January 21, 1942.
1942b: Tests on Ferberite Concentrate from Canadian Creek, Yukon; Report of the Ore Dressing and Metallurgical Laboratories, Investig. No. 1182.

1942c: Batch and Pilot-Plant Tests on the Flotation Concentration of Scheelite Ore from the Little Long Lac Gold Mines Limited; Report of the Ore Dressing and Metallurgical Laboratories, Investig. No. 1247.

1942d: Flotation Tests on Scheelite Ore from the Leitch Gold Mines, Limited, Beardmore, Ontario; Report of the Ore Dressing and Metallurgical Laboratories, Investig. No. 1250.

1942e: Deister Table Concentrate from the Sand River Mine of the Magnet Consolidated Mines Limited, Beardmore Area, Thunder Bay District; Report of the Ore Dressing and Metallurgical Laboratories, Investig. No. 1282.

1942f: Recovery of Scheelite from the Mill Tailing from International Tungstens, Limited, Outpost Island, Northwest Territories; Report of the Ore Dressing and Metallurgical Laboratories, Investig. No. 1283, August 13, 1942.

1942g: Concentration of Wolframite from Burnt Hill Brook, New Brunswick; Report of the Ore Dressing and Metallurgical Laboratories, Investig. No. 1311.

1943a: Gravity Concentration of Scheelite Ore from the Negus Mine, Yellowknife, Northwest Territories; Report of the Ore Dressing and Metallurgical Laboratories, Investig. No. 1379, April 1, 1943.

1943b: Concentration Tests on a Tin Ore from the Snowflake Property of Regal Silver Mines, Limited, Albert Canyon, B.C.; Investig. No. 1404.

Cairnes, C. E.

1921: Coquihalla Area, British Columbia; Geol. Surv., Canada, Sum. Rept., 1920, Pt. A, pp. 23-43.

1923: Geological Explorations in Yale and Similkameen Mining Divisions, Southwestern British Columbia; Geol. Surv., Canada, Sum. Rept., 1922, Pt. A, pp. 88-126.

1932: Mineral Resources of Northern Okanagan Valley, B.C.; Geol. Surv., Canada, Sum. Rept., 1931, Pt. A, pp. 66-109.

1933: Some Mineral Occurrences in the Vicinity of Cranbrook, B.C.; Geol. Surv., Canada, Sum. Rept., 1932, Pt. AII, pp. 74-105.

1935: Descriptions of Properties, Slocan Mining Camp, British Columbia; Geol. Surv., Canada, Mem. 184.

1937: Geology and Mineral Deposits of Bridge River Mining Camp, British Columbia; Geol. Surv., Canada, Mem. 213.

1943: Geology and Mineral Deposits of Tyaughton Lake Map-area, British Columbia; Geol. Surv., Canada, Paper 43-15.

1944: Hope Area, British Columbia; Geol. Surv., Canada, Map 737A.

Cairnes, D. D.

1917a: Investigations and Mapping in Yukon Territory; Geol. Surv., Canada, Sum. Rept. 1916, pp. 12-33.

1917b: Investigations in New Brunswick and Nova Scotia; Geol. Surv., Canada, Sum. Rept., 1916, pp. 251-254.

Cameron, A. E.

1946: Tungsten Project, Moose River; Dept. Mines, N.S., Ann. Rept., 1945, pp. 114-134.

Camsell, C.

1910: Geology and Ore Deposits of Hedley Mining District, British Columbia; Geol. Surv., Canada, Mem. 2.

1917: Tungsten Deposits of New Brunswick and Nova Scotia; Geol. Surv., Canada, Sum. Rept., 1916, pp. 247-251.

Canadian Institute of Mining and Metallurgy

1948: Structural Geology of Canadian Ore Deposits, Jubilee Volume.

Christie, A. M.

1953: Goldfields-Martin Lake Map-area, Saskatchewan; Geol. Surv., Canada, Mem. 269.

Clegg, E. L. G.

1947: Notes on Tin and Wolfram in Burma and India; Records, Geol. Surv., India, vol. 76, No. 15, pp. 24-168.

Cleveland, C. E.

1937: Geology of Bralorne Mine; *The Miner*, vol. 10, No. 4, pp. 39-42.

1938: Bralorne and Pioneer Geology; *Trans. Can. Inst. Mining Met.*, vol. 41, pp. 12-27.

Cockfield, W. E.

1919: Mayo Area, Yukon; Geol. Surv., Canada, Sum. Rept., 1918, Pt. B, pp. 1-15.

Cockfield, W. E., and Lang, A. H.
1937: Geology and Mineral Developments of Cariboo District, British Columbia; *Can. Inst. Mining Met.,* vol. 40, pp. 462-474.

Cockfield, W. E., and Walker, J. F.
1933: Cadwallader Creek Gold Mining Area, Bridge River District, B.C.; Geol. Surv., Canada, Sum. Rept., 1932, Pt. A II, pp. 57-71.

Davis, N. F. G.
1937: The Barkerville Gold Belt on Island Mountain; Geol. Surv., Canada, Paper 37-15.

Davison, E. H.
1930: New Ross Tin Deposits, Lunenburg County, Nova Scotia; *Mining Mag.,* vol. 42, No. 1, pp. 20-33.

De Lury, J. S.
1918: Tungsten Ore Deposits near Falcon Lake, Manitoba; *Can. Mining J.,* 1918, pp. 186-188.
1944: West Hawk and Falcon Lakes Area; Man. Dept. Mines Natural Resources, Map 37-4.

Dept. of Lands and Mines, N.B., Ann. Repts., 1911-1942.

Dept. of Mines, N.S., Ann. Repts., 1910-1942.

Derry, D. R., Hopper, C. H., and McGowan, H. S.
1948: Matachewan Consolidated Mine; Structural Geology of Canadian Ore Deposits; *Can. Inst. Mining Met.,* Jubilee Volume.

Dickerman, N.
1945: Mineral Resources of Japan; Foreign Minerals Survey, U.S. Bur. Mines, vol. 2, No. 5, p. 43.

Dolmage, V.
1934: The Cariboo and Bridge River Goldfields, British Columbia; *Trans. Can. Inst. Mining Met.,* vol. 37, pp. 405-430.

Douglas, G. V.
1940a: Scheelite of Goff; Dept. Mines, N.S., Ann. Rept., 1939, Pt. 2, pp. 50-55.
1940b: Geology of Moose River Gold District; Dept. Mines, N.S., Ann. Rept., 1939, Pt. 2, pp. 28-33.
1940c: Geology of Lake Charlotte Gold Area; Dept. Mines, N.S., Ann. Rept., 1939, Pt. 2, pp. 56-73.

Dresser, J. A., and Denis, T. C.
1949: Geology of Quebec; Que. Dept. Mines, Geol. Rept. 20, vol. III.

Drysdale, C. W.
1915: Geology and Ore Deposits of Rossland, British Columbia; Geol. Surv., Canada, Mem. 77.
1917: Ymir Mining Camp, British Columbia; Geol. Surv., Canada, Mem. 94.

Dunbar, W. R.
1948: Structural Relations of the Porcupine Ore Deposits; Structural Geology of Canadian Ore Deposits; *Can. Inst. Mining Met.,* Jubilee Volume, pp. 442-456.

Dunn, J. A.
1938a: Tin-Tungsten Mineralization at Mawchi, Karenni States, Burma; Records, Geol. Surv., India, vol. 73, Pt. 2, pp. 209-235.
1938b: Tin-Tungsten Mineralization at Hermyingi, Tavoy District, Burma; Records, Geol. Surv., India, vol. 73, Pt. 2, pp. 238-245.

Dyer, W. S.
1935: Geology and Ore Deposits of the Matachewan-Kenogami Area; Ont. Dept. Mines, Ann. Rept., vol. 44, Pt. II, pp. 1-55.

Eardley-Wilmot, V. L.
1942: Tungsten: Canada and World Situation; *Trans. Can. Inst. Mining Met.,* vol. 45, pp. 437-454.

Faessler, C.
1939: Risborough-Marlow Area; Que. Dept. Mines, Geol. Rept., No. 3.

Faribault, E. R.
1907: Malaga Gold District; Geol. Surv., Canada, Map. No. 995.
1908: Lunenburg County, Nova Scotia; Geol. Surv., Canada, Sum. Rept., 1907, pp. 78-83.
1909: Southern Part of Kings and Eastern Part of Lunenburg Counties, N.S.; Geol. Surv., Canada, Sum. Rept., 1908, pp. 150-158.

1910a: Tungsten Deposit of Moose River, Nova Scotia; Geol. Surv., Canada, Sum. Rept., 1909, pp. 228-234.

1910b: Structure of the Tungsten Deposits of Moose River, N.S.; *J. Mining Soc., N.S.*, vol. 15, pp. 59-64.

1911: Goldbearing Series of Lahave Basin, Lunenburg County, Nova Scotia; Geol. Surv., Canada, Sum. Rept., 1910, pp. 248-255.

1912: Goldbearing Series of the Basin of Medway River, Nova Scotia; Geol. Surv., Canada, Sum. Rept., 1911, pp. 334-340.

1913: Greenfield and Liverpool Town Map-areas, Nova Scotia; Geol. Surv., Canada, Sum. Rept., 1912, pp. 372-378.

1919: Investigations in Western Nova Scotia; Geol. Surv., Canada, Sum. Rept., 1918, Pt. F, p. 4.

Fisher, N. H., and Ball, C. W.

1949: Tungsten; Bur. Mineral Resources, Geol. and Geophys., Australia, Sum. Rept., No. 16.

Flynn, A. E.

1943: Tungsten Investigations; Dept. Mines, N.S., Ann. Rept., 1942, pp. 119-154.

Folinsbee, R. E.

1947: Preliminary map, Lac de Gras, Northwest Territories; Geol. Surv., Canada, Paper 47-5.

Folinsbee, R. E., and Moore, J. C. G.

1950: Preliminary map, Matthews Lake, Northwest Territories; Geol. Surv., Canada, Paper 50-2.

Fortier, Y. O.

1947: Preliminary map, Ross Lake Map-area, Northwest Territories; Geol. Surv., Canada, Paper 47-16.

Furse, G. D.

1948: McIntyre Mine; Structural Geology of Canadian Ore Deposits; *Can. Inst. Mining Met.*, Jubilee Volume, pp. 482-496.

Gilpin, E.

1899: New Mineral Discoveries in Nova Scotia; *Trans. N. S. Inst. Sci.*, vol. X, 1898, p. 88.

Goranson, E. A.

1932: Mineral Deposits at New Ross, Indian Path, Middle River, and Meat Cove, N.S.; Geol. Surv., Canada, Sum. Rept., 1931, Pt. D, pp. 36-41.

Greenwood, R.

1943: Effect of Chemical Impurities on Scheelite Fluorescence; *Econ. Geol.*, vol. 38, No. 1, pp. 56-64.

Gunning, H. C.

1929: Geology and Mineral Deposits of Big Bend Map-area, B.C.; Geol. Surv., Canada, Sum. Rept., 1928, Pt. A, pp. 136-193.

1937: Cadillac Area, Quebec; Geol: Surv., Canada, Mem. 206.

1941: Bousquet-Joannès Area, Quebec; Geol. Surv., Canada, Mem. 231.

Gunning, H. C., and Ambrose, J. W.

1940: Malartic Area, Quebec; Geol. Surv., Canada, Mem. 222.

Hage, C. O.

1944: Geology of Gurney Gold Mine Area, Manitoba; *Precambrian,* vol. 17, No. 4, pp. 4-7, 25.

Hanson, G.

1926: Reconnaissance in Zymoetz River Area, Coast District, B. C.; Geol. Surv., Canada, Sum. Rept., 1925, Pt. A, pp. 100-119.

1935a: Portland Canal Area, British Columbia; Geol. Surv., Canada, Mem. 175.

1935b: Barkerville Gold Belt, Cariboo District, British Columbia; Geol. Surv., Canada, Mem. 181.

Harding, W. D.

1942: Geology of Kaladar and Kennebec Townships; Ont. Dept. Mines, Ann. Rept., vol. 51, Pt. IV, pp. 51-74.

Harrison, J. M.

1949: Geology and Mineral Deposits of File-Tramping Lakes Area, Manitoba; Geol. Surv., Canada, Mem. 250.

Hawley, J. E.
1939: The Association of Gold, Tungsten and Tin at Outpost Islands, Great Slave Lake; University of Toronto Studies, Geol. Ser. No. 42, pp. 53-67.

Hawley, J. E., and Hart, R. C.
1948: Preston East Dome Mine; Structural Geology of Canadian Ore Deposits, *Can. Inst. Mining Met.,* Jubilee Volume, pp. 528-538.

Hayward, A. A.
1910: Tungsten and the Moose River Scheelite Veins; *J. Mining Soc., N.S.,* vol. 15, pp. 65-78.

Hess, F. L.
1909: Note on a Wolframite deposit in Whetstone Mtns., Arizona; U.S. Geol. Surv., Bull. 380, pp. 164, 165.
1919: Tactite, the Product of Contact Metamorphism; *Am. J. Sci.,* 4th ser., vol. 48, pp. 377, 378.

Hess, F. L., and Larsen, E. S.
1921: Contact Metamorphic Tungsten Deposits of the United States; U.S. Geol. Surv., Bull. 725-D.

Hills, V. G.
1912a: The Scheelite Deposits of Nova Scotia; *Can. Mining J.,* October, 1912, pp. 679, 680.
1912b: Tungsten and the Scheelite Mines of Nova Scotia; *J. Mining Soc., N.S.,* vol. 17, pp. 55-59.

Hobson, G. V.
1940: The Development of the Mineral deposit at Mawchi as determined by its Geology and Genesis; *Trans. Min. Met. Inst., India,* vol. 36, Pt. I, pp. 35-70.

Hoffman, G. C.
1905: Chemistry and Mineralogy; Geol. Surv., Canada, Sum. Rept., 1904, pp. 337-340.

Hopkins, P. E.
1921: Ontario Gold Deposits; Ont. Dept. Mines, Ann. Rept., vol. 30, Pt. 2.

Hopper, C. H.
1942: Geology of the Matachewan Consolidated Mine, Northern Ontario; *Trans. Can. Inst. Mining Met.,* vol. 45, pp. 387-400.

Horwood, H. C.
1937: Geology of the Casammit Lake Area and the Argosy Mine; Ont. Dept. Mines, Ann. Rept., vol. 46, Pt. VII.
1940: Geology and Mineral Deposits of the Red Lake Area; Ont. Dept. Mines, Ann. Rept., vol. 49, Pt. II.

Hsü, K. C., and Ting, I.
1943: Geology and Tungsten Deposits of Southern Kiangsi; Geol. Surv., China, Mem., Ser. A, No. 17.

Hurst, M. E.
1925: Tungsten Deposits near Hazelton, B.C.; Geol. Surv., Canada, Sum. Rept., 1924, Pt. A, pp. 44-46.
1927: Arsenic-bearing Deposits in Canada; Geol. Surv., Canada, Econ. Geol. Ser., No. 4.
1935: Gold Deposits in the Vicinity of Red Lake; Ont. Dept. Mines, Ann. Rept., vol. 44, Pt. VI, pp. 1-52.

James, H. T.
1934: Features of Pioneer Geology; *The Miner,* vol. 7, No. 8, August, 1934.

Jenkins, O.
1942: Tabulation of Tungsten Deposits of California; *Calif. J. Mines Geol.,* St. Min. Rept. 38, Nos. 3, 4, pp. 303-358.

Johnston, W. A., and Uglow, W. L.
1926: Placer and Vein Gold Deposits of Barkerville, Cariboo District, British Columbia; Geol. Surv., Canada, Mem. 149.
1933: Placer and Vein Gold Deposits of Barkerville, Cariboo District, British Columbia; Geol. Surv., Canada, Sum. Rept., 1932, Pt. A I, pp. 1-75.

Johnston, W. D., Jr., and de Vasconcellos, F. M.
1945: Scheelite in Northeastern Brazil; *Econ. Geol.,* vol. 49, pp. 34-50.

Jolliffe, A. W.

1942a: Tungsten is Precious Metal, Eagerly Sought; *Northern Miner,* Ann. No. 1942 (June 25, 1942), pp. 26, 34, 36, 37.

1942b: Tungsten Ore, Slave Lake Gold Mines, Limited; Geol. Surv., Canada, Unpub. Rept., June, 1942.

1946: Prosperous Lake; Geol. Surv., Canada, Map 868A.

Jolliffe, A. W., and Folinsbee, R. E.

1941: Scheelite Deposits, Yellowknife-Beaulieu Region, Northwest Territories; Geol. Surv., Canada, unpub. manuscript, November, 1941.

1942: Grading Scheelite Deposits with an Ultra-violet Lamp; *Can. Inst. Min. Met.,* Bull. No. 358, February, 1942, pp. 91-98; and *Trans. Can. Inst. Mining Met.,* vol. 45, pp. 91-98.

Jones, O. A.

1943: The Tin, Tungsten, and Molybdenum Deposits of Australia; Univ. Queensland Papers, Dept. Geol., vol. II (new series), No. 9.

Jones, W. A.

1948: Hollinger Mine; Structural Geology of Canadian Ore Deposits; *Can. Inst. Mining Met.,* Jubilee Volume, pp. 464-481.

Joubert, G. K.

1941: Tungsten Ores in South Africa; Union S. Africa, Dept. Mines, Geol. Ser., Bull. No. 13.

Kear, D.

1952: Mineralization at Castle-on-Dinas Wolfram Mine, Cornwall; *Trans. Inst. Mining Met.,* vol. 61, pp. 129-140.

Keele, J.

1905: The Duncan Creek Mining District; Geol. Surv., Canada, Sum. Rept., 1904, pp. 18A-42A.

Kerr, F. A.

1927: Preliminary Report on Stikine River Area, B.C.; Geol. Surv., Canada, Sum. Rept., 1926, Pt. A, pp. 14-34.

1948: Lower Stikine and Western Iskut River Areas, British Columbia; Geol. Surv., Canada, Mem. 246.

Kerr, P. F.

1934: Geology of the Tungsten Deposits near Mill City, Nevada; Nev. Bur. Mines, Bull. 28.

1936: Tungsten Deposits at Silver Dyke, Nevada; Nev. Bur. Mines, Bull. 30.

1938: Tungsten Mineralization at Oreana, Nevada; *Econ. Geol.,* vol. 33, No. 4, pp. 390-427.

1946: Tungsten Mineralization in the United States; *Geol. Soc. Amer.,* Mem. 15.

Kindle, E. D.

1937a: Mineral Resources of Terrace Area, Coast District, British Columbia; Geol. Surv., Canada, Mem. 205.

1937b: Mineral Resources, Usk to Cedarvale, Terrace Area, Coast District, British Columbia; Geol. Surv., Canada, Mem. 212.

1940: Mineral Resources, Hazelton and Smithers Areas, Cassiar and Coast Districts, British Columbia; Geol. Surv., Canada, Mem. 223.

1942: Report on Tungsten-Bearing Veins at Tibbitt Lake, Northwest Territories; Geol. Surv., Canada, Unpub. Rept.

Klepper, M. R.

1947a: Tungsten in Japan and Korea; *Econ. Geol.,* vol. 42, pp. 421, 422 (abs.).

1947b: The Sangdong Tungsten Deposit, Southern Korea; *Econ. Geol.,* vol. 32, No. 5, pp. 465-477.

Knox, N. B.

1945a: Tungsten Deposits and Mining Conditions in Argentina; *Eng. Mining J.,* vol. 146, No. 6, pp. 90-93.

1945b: Tungsten Deposits of Peru; *Eng. Mining J.,* vol. 146, No. 8, pp. 95-98.

Laird, H. C.

1936: The Western Part of the Sturgeon River Area; Ont. Dept. Mines, Ann. Rept., vol. 45, Pt. II, pp. 60-117.

Lang, A. H.
1936: Keithley Creek Map-area, Cariboo District, British Columbia; Geol. Surv., Canada, Paper 36-15.
1938: Keithley Creek Map-area, Cariboo District, British Columbia; Geol. Surv., Canada, Paper 38-16.
1940: Keithley Creek; Geol. Surv., Canada, Map 562A.

Leech, G. B.
1952: St. Mary Lake, British Columbia; Geol. Surv., Canada, Paper 52-15.

Lemmon, D. M.
1941a: Tungsten Deposits in the Tungsten Hills, Inyo County, California; U.S. Geol. Surv., Bull. 922-Q.
1941b: Tungsten Deposits of the Benton Range, Mono County, California; U.S. Geol. Surv., Bull. 922-S, pp. 581-593.
1941c: Tungsten Deposits near Bishop, California; U.S. Geol. Surv., Bull. 931-E, pp. 79-104.

Lemmon, D. M., and Dorr, J. V. N., 2nd.
1940: Tungsten Deposits of the Atolia District, San Bernardino and Kern Counties, California; U.S. Geol. Surv., Bull. 922-H, pp. 205-245.

LeRoy, O. E.
1912: Geology of Nelson Map-area; Geol. Surv., Canada, Sum. Rept., 1911, pp. 139-157.

Li, K. C., and Wang, C. Y.
1947: Tungsten; *Am. Chem. Soc.*, Monograph No. 94, second edition.

Lindgren, W.
1933: Mineral Deposits; 4th Edition, McGraw-Hill Book Company, New York.

Little, J. D., Ball, C. W., Whishaw, Q. G., and Mylrea, F. H.
1953: The Lead-Zinc and Tungsten Properties of Canadian Exploration Limited, Salmo, B.C.; *Bull. Can. Inst. Mining Met.*, vol. 46, No. 496, pp. 468-476.

Little, H. W.
1950: Salmo Map-area, British Columbia; Geol. Surv., Canada, Paper 50-19.

Lord, C. S.
1941: Mineral Industry of the Northwest Territories; Geol. Surv., Canada, Mem. 230.
1944: Geological Reconnaissance along the Alaska Highway between Watson Lake and Teslin River, Yukon and British Columbia; Geol. Surv., Canada, Paper 44-25.
1951: Mineral Industry of District of Mackenzie, Northwest Territories; Geol. Surv., Canada, Mem. 261.

Lovering, T. S.
1940: Tungsten Deposits of Boulder County, Colorado; U.S. Geol. Surv., Bull. 922-F.

Lovering, T. S., and Tweto, O.
1953: Geology and Ore Deposits of the Boulder County Tungsten District, Colorado; U.S. Geol. Surv., Prof. Paper 245.

Mailhiot, A.
1919: Gold Deposits at Lake DeMontigny, Abitibi, P.Q.; Que. Dept. Col., Mines, and Fish., pp. 125-158.

Malcolm, W.
1912: Gold Fields of Nova Scotia; Geol. Surv., Canada, Mem. 20-E.

Manitoba Dept. Mines and Natural Res., Ann. Repts., 1928-1944.

Marshall, J. R.
1927: Lakelse Lake Map-area, Coast District, B.C.; Geol. Surv., Canada, Sum. Rept., 1926, Pt. A, pp. 35-44.

Matheson, A. F.
1948: Bankfield and Tombill Mines; Structural Geology of Canadian Ore Deposits; *Can. Inst. Mining Met.*, Jubilee Volume, pp. 401-406.

Matheson, A. F., and Douglas, J. H.
1948: Hard Rock Mine; Structural Geology of Canadian Ore Deposits; *Can. Inst. Mining Met.*, Jubilee Volume, pp. 406-413.

McKenzie, G. S.
1941: Halliwell Mine Map-area; Que. Dept. Mines, Geol. Rept., No. 7.

McKinley, H. L., Holmes, T. W., and Sausa, L. E.
1951: How U.S.V.'s Pine Creek Mine will increase Tungsten Output; *Eng. Mining J.*, vol. 152, No. 5, pp. 76-82.

Meen, V. B.
1942: Geology of the Grimsthorpe-Barrie Area; Ont. Dept. Mines, Ann. Rept., vol. 51, Pt. IV, pp. 1-50.

Messervey, J. P.
1931: Tungsten in Nova Scotia; N.S. Dept. Mines, Pamphlet No. 29.

Milton, H. C.
1943: Tungsten in Rhodesia; *S. African Mining Met. J.*, vol. 54, No. 2628, pp. 325-329.

Mines Branch
1918: Tungsten Ore from Burnt Hill Tungsten Mines, N.B.; Sum. Rept., 1917, No. 454, pp. 91-94.
1920a: Tests Nos. 90 and 104; Sum. Rept., 1918, pp. 135, 150, 151.
1920b: Tests Nos. 107, 112, 119, and 124; Sum. Rept., 1919, pp. 60, 61, 68, 76, 88, 89.

Minister of Mines, British Columbia, Ann. Repts., 1904-52.

Mulligan, R.
1952: Bonnington Map-area, British Columbia; Geol. Surv., Canada, Paper 52-13.

Munds, W. H., Ewoldt, H. B., and Cohen, C. J.
1944: A Tungsten Find in North Carolina; *Eng. Mining J.*, vol. 145, No. 8, pp. 80-81.

North, H. H., and Allen, C. C.
1948: Young-Davidson Mine; Structural Geology of Canadian Ore Deposits; *Can. Inst. Mining Met.*, Jubilee Volume, pp. 633-637.

O'Neill, J. J.
1919: Preliminary Report on the Economic Geology of the Hazelton District, British Columbia; Geol. Surv., Canada, Mem. 110.

Ont. Dept. Mines, Ann. Repts., Pt. I, vols. 45-55, 1936-1946.

Page, L. R., and McAllister, J. F.
1944: Tungsten Deposits of Isla de Pinos, Cuba; U.S. Geol. Surv., Bull. 435-D, pp. 177-246.

Palache, C., Berman, H., and Frondel, C.
1951: Dana's System of Mineralogy, Seventh Edition, vol. II, John Wiley and Sons, New York.

Piers, H.
1923: On a New Tungsten Deposit at Lower Sackville; *Proc. and Trans., Nova Scotian Inst. Sci.*, Vol. XVI, pp. 41-45.

Poitevin, E.
1933: The Occurrence of Wolframite, Molybdenite, and Other Minerals at Square Lake, Queens County, New Brunswick; Geol. Surv., Canada, Sum. Rept., 1932, Pt. D, pp. 56, 57.

Prest, V. K.
1942: Geology of the Port Hope Area; Ont. Dept. Mines, Ann. Rept., vol. 51, Pt. III, pp. 1-28.

Quebec Dept. Mines, Ann. Repts., 1934-35, 1942.

Reed, J. J.
1945: The Scheelite Deposits of Glenarchy, New Zealand; *Trans. Roy. Soc. New Zealand*, vol. 75, Pt. 3, pp. 371-393.

Reinecke, L.
1915: Ore Deposits of the Beaverdell Map-area; Geol. Surv., Canada, Mem. 79.
1920: Mineral Deposits between Lillooet and Prince George, British Columbia; Geol. Surv., Canada, Mem. 118.

Retty, J. A.
1931: Gaboury-Blondeau Townships Map-Area; Que. Dept. Mines, 1930-31, Pt. B, pp. 53-88.

Rice, H. M. A.
1941: Nelson Map-area, East Half, British Columbia; Geol. Surv., Canada, Mem. 228.
1946: Preliminary map, Salmon Arm, British Columbia; Geol. Surv., Canada, Paper 46-7.
1947: Geology and Mineral Deposits of the Princeton Map-area, British Columbia; Geol. Surv., Canada, Mem. 243.

Ridgway, J. E.
1948: Ollera Wolfram Field; *Queensland Govt. Mining J.*, vol. 49, No. 555, pp. 13, 14.

Ridland, G. C.
1941: Mineralogy of the Negus and Con Mines, Yellowknife, Northwest Territories Canada; *Econ. Geol.*, vol. 36, No. 1, pp. 45-70.

Ross, S. H., *et al*
1938: Mining Properties and Development Work in Abitibi and Chibougamau Regions during 1937; Que. Bur. Mines, Prel. Rept., No. 120.

Russell, G. A.
1948: Geology of the Wallace Lake Area, Manitoba; Man. Mines Branch, Prel. Rept. 47-1.

Satterly, J.
1941: Geology of the Dryden-Wabigoon Area; Ont. Dept. Mines, Ann. Rept., vol. 50, Pt. 2, pp. 58, 59.

Smith, E. S. C., and Parsons, W. H.
1938: Studies in Mineral Fluorescence; *Am. Mineralogist*, vol. 23, No. 8, pp. 513-521.

Smith, W. C., and Gonzáles, E. M.
1947: Tungsten Investigations in the Republic of Argentina, 1942-43; U.S. Geol. Surv., Bull. 954-A.

Söhnge, P. G.
1950: The Nababeep Near West Tungsten Mine, South Africa; *Am. Mineralogist*, vol. 35, Nos. 9, 10, pp. 931-940.

Springer, G. D.
1952: Geology of the Rennie-West Hawk Lake Area, Manitoba; Man. Dept. Mines and Natural Resources, Pub. 50-6.

Stevenson, J. S.
1941: Tungsten Deposits of British Columbia; British Columbia Dept. Mines, Bull. No. 10.
1943: Tungsten Deposits of British Columbia; British Columbia Dept. Mines, Bull. No. 10 (revised).

Stockwell, C. H.
1946: Flin Flon-Mandy Area, Manitoba and Saskatchewan; Geol. Surv., Canada, Paper 46-14.

Stoll, W. M.
1953: Tungsten Mining in Canada; *Western Miner*, vol. 26, No. 11, pp. 90-95.

Sullivan, C. J.
1952: Wauchope Wolfram Field, Northern Territory; Bur. Mineral Resources, Geol. and Geophys., Australia, Bull. No. 4.

Tanton, T. L.
1944: Scheelite Occurrences in Saskatchewan; Sask. Dept. Natural Resources, Ann. Rept., 1943, pp. 43, 44.

Taylor, R. B.
1948: Delrite Mine; Structural Geology of Canadian Ore Deposits; *Can. Inst. Mining Met.*, Jubilee Volume, pp. 504-507.

Thomas, L. O.
1944: Canadian Institute of Mining and Metallurgy; Bull. No. 385, pp. 203-227, May, 1944.

Thomson, J. E.
1933: Geology of the Manitou-Stormy Lakes Area; Ont. Dept. Mines, vol. 42, Pt. IV, pp. 1-40.
1935: Gold Deposits on the Lake of the Woods; Ont. Dept. Mines, vol. 44, Pt. IV, pp. 29-47.
1938: The Crow River and Uchi Lake Areas; Ont. Dept. Mines, Ann. Rept., vol. 47, Pt. III.
1941: Geology of McGarry and McVittie Townships, Larder Lake Area; Ont. Dept. Mines, Ann. Rept., vol. 50, Pt. VII, pp. 1-99.
1948: Omega Mine; Structural Geology of Canadian Ore Deposits; *Can. Inst. Mining Met.*, Jubilee Volume, pp. 658-662.

Thomson, J. E., and Griffis, A. T.
1941: Geology of Gauthier Township, East Kirkland Lake Area; Ont. Dept. Mines, Ann. Rept., vol. 50, Pt. VIII, pp. 1-26.

Todd, E. W.
1928: Kirkland Lake Gold Area; Ont. Dept. Mines, Ann. Rept., vol. 37, Pt. II, pp. 1-176.

Tremblay, L. P.
1950: Fiedmont Map-area, Abitibi County, Quebec; Geol. Surv., Canada, Mem. 253, pp. 78-87.

Uglow, W. L.
1923: Bedrocks and Quartz Veins of Barkerville Map-area, Cariboo District, B.C.; Geol. Surv., Canada, Sum. Rept., 1922, Pt. A, pp. 82-87.

U.S. Bureau Mines
1947: Foreign Minerals Survey; vol. 2, No. 6, pp. 76, 77.

Vermaas, F. H. S.
1952: South African scheelites an X-ray method for determining members of the scheelite-powellite series; *Am. Mineralogist,* vol. 37, Nos. 4, 10.

Walker, J. F.
1934: Geology and Mineral Deposits of Salmo Map-area, British Columbia; Geol. Surv., Canada, Mem. 172.

Walker, J. F., Bancroft, M. F., and Gunning, H. C.
1929: Lardeau Map-area, British Columbia; Geol. Surv., Canada, Mem. 161.

Walker, T. L.
1909: Tungsten Ores of Canada; Mines Branch, Bull. No. 25.
1911a: Recently Discovered Wolframite Deposits in New Brunswick; *Econ. Geol.,* vol. VI, No. 4, pp. 396-398.
1911b: Molybdenum Ores of Canada; Mines Branch, Rept. No. 93.

Walker, W. S.
1942: Tungsten Prospecting in the Gilmour Lake Area, and some Notes on the Ultra-violet Ray Method; *Can. Mining J.,* vol. 63, No. 3, pp. 145-149.

Wallace, R. C.
1925: Relationships in Mineral Deposits in Northwestern Manitoba; *Econ. Geol.,* vol 20, pp. 431-441.

Wang, C. Y.
1951: Tungsten; *Mining Eng.,* vol. 3, No. 10, pp. 853-856.

Warren, H. V., and Mathews, W. H.
1943: Some notes on a Gold-Tungsten Occurrence in the Bridge River District; *The Miner,* vol. 15, No. 5, pp. 31-34.

Warren, T. S.
1944: List of Fluorescent Minerals; *Mines Magazine,* vol. XXXIV, No. 7, pp. 342, 343, 363.

Wéry, A.
1948: Le Domaine minier de la Compagnie des Grands Lacs; *Soc. géol. Belg.,* Bull., vol. 57, pp. 40-75.

Wheeler, J. O.
1954: A Geological Reconnaissance of the Northern Selwyn Mountains Region, Yukon and Northwest Territories; Geol. Surv., Canada, Paper 53-7.

Wilson, H. S.
1948: Lamaque Mine; Structural Geology of Canadian Ore Deposits; *Can. Inst. Mining Met.,* Jubilee Volume, pp. 882-891.

Wilson, M. E.
1927: Mineral Deposits in Nova Scotia and New Brunswick; Geol. Surv., Canada, Sum. Rept., 1926, Pt. C, pp. 77-99.
1948: McWatters Mine; Structural Geology of Canadian Ore Deposits, *Can. Inst. Mining Met.,* Jubilee Volume, pp. 783-789.

Wright, J. F.

1931: Geology and Mineral Deposits of a Part of Northwest Manitoba; Geol. Surv., Canada, Sum. Rept., 1930, Pt. C, pp. 1-124.

1932: Geology and Mineral Deposits of a Part of Southeastern Manitoba; Geol. Surv., Canada, Mem. 169.

Wright, W. J.

1940a: Burnt Hill Tungsten Deposit, N.B.; N.B. Dept. Lands and Mines, Paper 40-2.

1940b: Tungsten and Molybdenite Deposits of Square Lake, Queens County, N.B.; N.B. Dept. Lands and Mines, Paper 40-3.

Young, G. A.

1918: Burnthill Brook Map-area, New Brunswick; Geol. Surv., Canada, Sum. Rept., 1917, Pt. F, pp. 1-15.

Following references added in press:

Cockfield, W. E.

1948: Geology and Mineral Deposits of Nicola Map-area, British Columbia; Geol. Surv., Canada, Mem. 249.

Pye, E. G.

1951: Geology of Errington Township, Little Long Lac Area; Ont. Dept. Mines, Ann. Rept., vol. 60, Pt. VI.

Stockwell, C. H.

1937: Gold Deposits of Herb Lake Area, Northern Manitoba; Geol. Surv., Canada, Mem. 208.

INDEX

PAGE

Aberfoyle 212
Abitibi county 179
Abu Dabbab mine 215
Ada claim 61
Addington Mines, Limited 178
Africa 213, 224
Aguila-Cóndores 215
Akokli Creek 119
Alger, G. 45
Alluvial (placer) deposits 7
Alpine mine 119
Amisk Lake 149
A. M. Mining Syndicate 135
Angus Creek 120
Apex mine 154
Arctic Circle Syndicate 133
Argentina 215, 223
Arizona Creek 17, 20
Arrow Tungsten Mines, Limited .. 115, 116
Arsenault, U. J. 138
Ashloo Gold Mines, Limited 78
Ashlu Creek 78
Asia 204, 223
Asselstine, W. J. 42
Atlin area 38, 39
  district 8
Atolia district 220
Aunor Gold Mines, Limited 170
Aunor mine 172
Australasia 211, 224
Australia 12, 211, 224
Avoca district 212
Avon Gold Mines, Limited 197
Baker Settlement occurrence 195
Ballanger, Mrs. 104
Ballanger's claims 104
Ballou mine 194
Bamford 212
Bankfield Consolidated Mines, Limited 165
Bara Verde 217
Barker, E. H. 24
Barro Vermelho 217
Bayonne Consolidated Mines, Limited 99
Bayonne Creek 119
Bayonne mine 119
Bear and Cub claims 42
Beardmore 164
Bear River 41
Beauchastel township 187
Beaucourt Gold Mines, Limited 185
Beaverdell 90
Belgian Congo 214, 224

PAGE

Bell, J. 45
Bennet (Bear) Creek 112
Ben Williams prospect 89
Beralt Tin and Wolfram, Limited .. 203
Besner, George 21
Bidgood Kirkland Gold Mines, Limited 174
Big Sheep Creek 98
Billy Goat group 89
Bishop district 219
Bitter Creek valley 40
Black Bull 43
Black claims 157
Black Diamond Tungsten Limited .. 39
Black Hills 9
Black Prince property 12, 54
Black Rock mine 220
Bleiler, E. 24
Blue Moon (Blue Eyes) group 99
Blue Moon property 9
Blythman, T. 58
Bodó 217
Bolivia 12, 217, 223
Bonito 217
Bornite Mountain 44
Borralha mine 204
Boulder county 12, 13, 221
Boulder Creek 17, 19, 38, 39
Bourlamaque township 185
Bralorne Mines, Limited 73, 93, 97
Brazil 10, 216, 223
Brennan, C. V. 197
Bridge River 12, 72
Bristol Mines, Limited 75
Bristol property 13
British Columbia 37
British Isles 203
Broulan Reef mine 173
BRX Consolidated Mines 74
Buffalo Ankerite 173
Bulldog mine 174
Bulldog Yellowknife Gold Mines, Limited 147
Bunker Hill group 100, 101
Burma 8, 9, 12, 204, 223
Burnt Hill tungsten 9, 12, 191
Cadillac township 182
Cadwalladar Creek 73, 74, 75
Cafuca 217
Calder, R. 68
California 219, 224
  Gulch 38
Cameron, Arthur 41
Campbell-Dome Creek group 159

PAGE

Canada 223
Canadian Creek 9, 16, 17, 18, 30
Canadian Exploration Limited 104, 105, 106
Canadian Malartic Gold Mines, Limited 183
Canadian Mining Company, Limited 61
Canadian Tungstens Limited 19
Cantin, Frank 24
Canyon Creek 17, 21
Cariboo area 38, 62
district 8, 12
Cariboo Gold quartz mine 68
Cariboo Hudson Gold Mines, Limited 70
Cariboo Scheelite group 71
Caribou gold district 198
Casino Creek 16, 17
Castnor (Cement) Creek 17, 30, 31, 32
Casummit Lake 161
CC group 142
Central Patricia Gold Mines, Limited 162
Cerro Morro 216
Chalco group 75
Chenkit mines 206
Chesterville Larder Lake Gold Mining Company Limited 176
Chicote deposit 218
Chillagoe-Herberton district 212
China 8, 9, 12, 206, 223
Chojlla 218
Chon mine 206
Chuchi Lake occurrence 60
Clabon Creek 92
Classification of tungsten deposits ... 7
Clear Creek 17, 19
Clear Creek Placers Company Limited 19
Clearwater Creek 117
Cline Lake Gold Mines, Limited .. 168
Clubine, L. R. 104
C.O.D. group 141
Cole Gold Mines, Limited 161
Collen, C. D. 88
Colonial Mines, Limited 181
Colorado 221, 224
Columbia Lead and Zinc Mines, Limited 92
Columbia Tungstens Company, Limited 62
Columbiere Mines, Limited 173
Comber 215
Commander (Major) property 98
Coniaurum mine 172, 173
Con and Rycon mines 121, 123
Consolation Lake 134
Consolidated Beaulieu Mines, Limited 138
Consolidated Central Cadillac Mines, Limited 182
Consolidated Mining and Smelting Company of Canada, Limited 38, 39, 52, 72, 93, 98, 99, 102, 115, 119, 121, 124, 125, 138, 140, 141, 154

PAGE

Consolidated Nicola Goldfields, Limited 86
Contact Metamorphic deposits 10, 11
Copper Chief claim 95
Cordillera mine 44
Cornwall 11, 203
Corp, E. 20
Corrigan property 157
Courageous Lake 145
Cournor Mining Company, Limited .. 186
Cranberry Portage 151
Cranbrook 119
Cuba 218
Cunningham Creek 68
Cunningham, S. 79
Currie, W. S. 198
Daga Allah 215
Dalquier township 179, 181
Dasserat township 187
Davis, S. A. 44
Dawson Mining Division 16, 30
Deer Horn Mines, Limited 59
Delnite Mines, Limited 170
De Santis mine 172
De Santis Porcupine Mines, Limited 170
Desperation Lake occurrences 142
DeStaffany, G. D. 134, 142
DeStaffany Tantalum Beryllium Mines, Limited 142
Devil's Elbow 40
Dick group 134
Dinorwik 159
Dion Lake occurrence 149
Disseminations of tungsten minerals in igneous rocks 8
Dixon, F. W. 196
Dodger deposit 105, 112
Dome Lake occurrences 131
Dome mine 172, 173
Dome Mines, Limited 163
Donhurd Prospecting Syndicate 174
Don (Scottie) group 87
Dot and Eva claims 135
Doubling Lake occurrences 142
Doyle, Murray 87
Drever, H. 141
Dryden-Red Lake property 158
Dublin Gulch 8, 9, 12, 17, 21, 22, 25, 26, 34, 35
Dubuisson township 184
Duggan, Howard 177
Duggan property 177
Dunbrack mine 197
Duncan River 96
Durham Red Lake 161
Eagle Creek 118
Eardley-Wilmot, V. L. 100, 103, 104, 112, 115, 116, 117, 158, 159, 169, 173, 174, 188, 196, 197, 198, 200, 201

PAGE

East Malartic Gold Mines, Limited .. 183
Eden, Oscar 61
Edwards Creek 17, 30, 36
Edwards Lake 154
Egypt 215, 224
Ek, C. 52
El Diablo Mining Company 219
Elite claim 90
Emerald deposit 105, 108
  mine 9, 11, 105
Emma and IXL claims 44
En Ping 209
Epithermal deposits 13
Epithermal veins 12
Erdahl and Pinchbeck group 96
Erdahl, R. E. 96
Esperanza 42
Estella Mines, Limited 120
Euphrates mine 118
Europe 203, 223
Falcon Lake 155, 157
Feeney deposit 105, 110
Fenlon claims 169
Ferberite 1
Fenlon, M. 169
Fiddler group 16, 17, 37
Fielding, C. A. 169
Fielding property 169
Fifteen Mile Brook 194
Fisher, Norman 38, 39
Fluorescence 4
Flynn, J. 42
Fort Francis Mining Division 157
Fort Hope 162
Fort St. James 60
Foster, Dave 142
Four Mile Mountain 59
Fournière township 183
Fox Pass occurrence 61
François Lake 138, 141
Friday Creek 60
Frontenac county 178, 189
Fyles, J. T. 106
Gaboury township 188
Gaffney claims 158
Gallo, Joe 97
Gander Bay occurrence 201
'garnetite' 10
Gaspé Copper Mines, Limited 190
Gaspé North county 190
Gem Creek 17, 20
Gilmour Lake 133, 134, 135, 137, 138
Gladstone Creek 16
Glenorchy 213
Glynne, H. 88
Goff scheelite deposit 198
Golconda 13
Gold Basin group 119
Gold Coin claim 71
Gold Eagle Gold Mines, Limited 160

PAGE

Gold Gossan group 85
Gold Hill Development Syndicate .. 151
Gold Rock Mines, Limited 158
Golden Eagle and T. S. group 118
Good Hope group 89
Goodman Creek 17, 29
Goodrock Gold Mines, Limited 130
Gordon Lake 130
Granby River 98
Grand Forks 98
Granite Creek 17
Granite group 79
Granite Mining Company 61
Granite-Poorman mine 118
Grassy, on King Island 213
Greathouse, A. 142
Gregg, T. 24, 25
Grotto group 45
Groundhog group 97
Gulches southeast of Lynx Creek ... 17
Gunterman, Henry 93
Gurney Gold Mines, Limited 152
Guysborough Gold Mines 200
Hagan, W. 43
Haggart Creek 17, 21
Haggart Mining Company 24, 28
Halifax county 196
Hall creek 117
Halliwell Gold Mines, Limited 187
Hallnor mine 173
Hard Rock Gold Mines, Limited 168
Hardscrabble Creek 38, 45, 62
  property 62
Harrison group 59
Hasaga Gold Mines, Limited 159
Hatches Creek 211
Haukendahl, Ed 115
Hayward mine 220
Hazelton-Telkwa 46
Hearne Channel 142
Hedley 88
Hedley, M. S. 100
Herb Lake 154
Herblet Lake 9
  deposits 154
Hermyingyi 205
Hewlett, C. G. 106
Hidden Lake 125
Higgins or Davidson mine 200
Higgins (Haegan) property 58
Highet Creek 17, 21
Hillgrove 212
Holland township 190
Hollinger Consolidated Gold Mines,
  Limited 171
Homer Yellowknife Mines, Limited .. 147
Hope-Princeton 79
Howey Gold Mines, Limited 160
Hübnerite 1

PAGE

Hudson Bay Mining and Smelting Company 149
Humblin claims 161
Hunan province 209
Hungshuichai 208
Hutt, J. 152
Hyland, F. R. 196
Hypogene deposits 8
Hypothermal veins 12

Idaho 221, 224
Igla mine 215
Ima mine 221, 222
Incomappleux River 93
Indian Path mine 195
International Nickel Company of Canada, Limited 169
Inverness county 201
Irwin, J. 134
Isla de Pinos 218
Island Mountain mine 67

Jack of Clubs Lake 67, 68
Jack Pot mine 115
Jameson, R. 79
Japan 209, 223
Jason Mines, Limited 98
Jellicoe Mines (1939), Limited 165
Jenson, Andrew 61
Joannès township 188
Johnson Creek 17, 20
Josefina 216
July group 138
Jumbo group 103
Jupiter group 88
Jutras, Arthur 189

Kailo 214
Kalato 215
Kalulu 214
Kaulback mine 199
Kayrand Mining and Development Company, Limited 179
Kedah 206
Kelowna Exploration Company 89
Keno-Ladue River 17, 36
Kenora Mining Division 158
Kenville Gold Mines, Limited 118
Kerr-Addison Gold Mines, Limited 175
Kettle River occurrence 91
Kiangsi 12
  province 207
Kima 214
King Island 10, 212, 213
Kirkland, A. 149
Kirkland Lake 174
Kirkpatrick, R. E. 198
Kitsalas Mountain 44
Kitsault River 42
Kleanza Mountain 43
Kluane 17, 30
Knob Hill occurrence 91
Knutson, Gottfrid 42

PAGE

Kootenay Belle mine 114
Kootenay Lake area 119
Korea 10
  North 210, 223
  Republic of 223
Kwandonkaya 215
Kwangtung Province 208
Kweimeishan 207

La Corne mine 181
La Corne township 181
Laguna Mines Limited 155
Laidlaw, M. H. 85
Lake Athabasca 147
Lake Charlotte scheelite deposit 200
Lake claims 156
Lake of the Woods 158
Lakes, Harold 105
Lamaque Gold Mines, Limited 185
Lang, H. 134
Lardeau 93
Larder Lake 175
Larder Lake Mining Division 173
La Reine township 179
Last Chance group 80
Laverlochère township 189
Lawlor, Mr. 199
Leader group (Wellington) 120
Ledge Creek 17, 29
Legate Creek 45
Leitch Gold Mines, Limited 164
Lennox and Addington county 178
Limestone Point 71
Limpid Creek 100
Lindquist Mountain 59
Lireui 215
Little Keen group 112
Little Long Lac area 165
Little Long Lac Gold Mines, Limited . 166
Little Pat, Badland, and Hogback .. 40
Locke, Victor F. 90, 91
Logan, R. A. 200
Lorntzsen, Egil H. 73
Lost Creek 102, 103, 105
Louise and Dot 41
Louvricourt and Pascalis townships .. 185
Louvricourt township 186
Low, Ernest 40
Lower Arrow Lake 97
Lower Sackville deposit 196
Lowhee Creek 38
Lowrie, R. 44
Lucille No. 1 (United Empire) 40
Lucky Boy group 93
Lucky group 135
Lucky Luke mine 44
Lundborg, Gunnar 73
Lunde, V. 24
Lundmark, R. 149, 150
Lunenburg county 194
Lynx Creek 17, 29

PAGE

McAvoy, J. 125
McCallum, A. L. 197, 198
McCulloch Creek 91
McDonald, C. S. 138
McDonald, W. L. 134
McIntyre mine 172
McIntyre Porcupine Mines, Limited . 172
McKay, T. 31
McKenzie Island 160
McKenzie Red Lake Gold Mines, Limited 160
McKim Creek 17
MacLeod-Cockshutt Gold Mines Limited 168
McMarmac Red Lake Gold Mines, Limited 161
McMaster, W. 87
Macrae's Flat 213
McWatters Gold Mines, Limited 187
Madsen Red Lake Gold Mines, Limited 159
Mae Sariang district 205
Magnet Consolidated Gold Mines, Limited 166
Malaga Mining Company 194
Malaya 12, 206, 223
Mammoth group 79, 117
Manitoba 147
Manitou Lakes 158
Manley Quebec Gold Mines, Limited . 179
Manolovici, M. P. 133
Man-Sask property 150
Marcotte, L. 79
Marlow township 189
Maroon Mountain 42
Mason, F. H. 198
Mason, J. D. 134
Mast, A. G. H. 151
Matachewan 176
Matachewan Consolidated Mines, Limited 176
Matheson, Don 87
Mawchi 8, 204
Mayo Mining Division 14, 16, 19, 30
May-Spiers 161
Meloy, J. 18, 19
Merritt 80
Mesothermal veins 12
Meteor group 96
Mexico 10
Meymacite 2
M.G.L. South concession 214
Michaud, A. 43
Michaud, J. A. 43
Michipicoten-Goudreau area 168
Middlecoff, E. 21
Mill City 220
Mill Road 12
occurrence 195
Milner, W. B. 80
Mine Hill scheelite deposits 189

PAGE

Minto Creek 17, 21
M. J. T. group 155
Mohawk mine 59
Mole Tableland 212
Molly B. 41
Molly group 102
Molybdenite Corporation of Canada, Limited 181
Molybdoscheelite 2
Montreal River Mining Division 176
Moodie, L. E. 44
Moody's property 149
Moore, E. I. 70
Moose group 142
Moose River gold district 199
Moose River mine 199
Morris Kirkland Gold Mines, Limited 174
Mosher Lake 149
Mosher, M. 150
Mount Carbine 212
Moyie River occurrence 119
M. T. group 125
Murchyville occurrence 197
Murphy Brook 201
Nababeep Near West 214
Nabih mine 215
Negus mine 124
Nelson 100
Netalzul Mountain 58
Nevada 220, 224
New Brunswick 190, 191, 192
Newfoundland 190, 192, 201
New Jason Mines, Limited 161
New Jersey Zinc Explorations Limited 115
New Ross 9
occurrences 194
New South Wales 212
New Zealand 213, 224
Nickel Plate Mountain 89
Nigeria 215, 224
Nighthawk group 88
Norma group 138
North America 218, 223
North Carolina 222, 224
North Coast 42
Northeast Margaree occurrence 201
Northern Territory 211
Northern Tungsten Limited 152
North Fraser River 61
Northwest Territories 121, 122
Nova Scotia 12, 190, 192, 194
Nugget Gulches 38
Oakey, A. D. 95
Oakey, Bert 93
O'Brien Gold Mines, Limited 182
Oldham gold district 197
Oldham Mining Company 197
Old Timer mine 117
Ole Bull and Orphan Boy 91
Olsen, Ole 39

PAGE

Omega Gold Mines, Limited 175
O'Neill-Thompson mine 188
Ontario 157
Orange River 214
Oreana 9, 221
Osgood Range 221
Outpost Islands 143

Pacific Gold and Uranium Mines, Limited 102
Pamour mine 173
Panasquiera mine 203
Pandora Cadillac Gold Mines, Limited 182
Pankushan 208
Pao An 209
Paraíba 216
Parent, Louis A. 56
Parsnip River 61
Pascalis Gold Mines, Limited 186
Pascalis township 186
Patricia Mining Division 162
Patty, Ernest 19
Paxton group 70
Pearson, A. G. 38
Pedlow claims 188
Pegmatite dykes 14
Pegmatites 9
Pelak 206
Peninsula Lake 127
Penny Creek 38, 70
Perron Gold Mines, Limited 186
Peru 218, 223
Peter Gulch Creek 38
Peterson, C. 52
Peterson, Fred 61
Phantom Lake 150
occurrences 149
Pickle Crow Gold Mines, Limited ... 162
Pickle Lake 162
Pigeon Lake 177
Pinchbeck, J. E. 96
Pine Creek mine 219
Pioneer Gold Mines of B.C., Limited 61, 74
P. M. W. group 156
Pontiac Creek 96
Porcupine Mining Division 170
Port Arthur Mining Division 164
Portland Canal 40, 42
Porto Rico Creek 117
mine 117
Portugal 12, 203, 223
Potter, George 24
Powellite 2
Prasca Limited 200
Pre-Cambrian Gold Mines, Limited .. 89
Prelude Lake 125
Preston East Dome mine 172
Preston East Dome Mines, Limited .. 173
Price, A. A. 79
Prices of tungsten concentrates 227

PAGE

Princess Royal Island 42
Properties 6
Property of Mosher, Lundmark and Ward 150
Prosperous Lake 125
Ptarmigan group (Annie Laurie claim) 43
Ptarmigan mine 125
Quartz veins 11, 12, 14
Quebec 178, 180
Queen mine 115
Queens county 191, 194
Queensland 212
Quixaba 217
Quixeré 217
Radiore Uranium Mines Limited ... 147
Ragged Top 221
Rainier (Silverado) 42
Rand group (Cariboo Thompson) .. 68
Ray Gulch 17, 29, 34
Ray, Harvey 34
Red Bluff Mountain 42
Red Gulch 38
Red Lake 159, 160
Red Lake Mining Division 159
Red Rose 12
mine 51
Reid, R. McD. 80
Reno mine 115
Republic of South Korea 210
Republic Tungsten Mines, Limited .. 173
Revelstoke 91
Rex mine 155
Reynolds, J. A. 198
Rich Lake Patricia Syndicate 162
Ridge property 45
Rinkwavu 214
Rio Grande do Norte 216
Riordan Mountain 89
Rishi Hills 215
Rocher Déboulé Mine 46
Rocher Déboulé Mountain 46, 48, 51, 54, 56
Rodin Creek 17, 29
Roop Creek 17, 30, 36
Ross Lake 9, 132
Rossi mine 220
Rossland 98
Rouyn township 187
Royal Canadian and Nevada group .. 118
Rozen, W. 118
Rudolph Creek 17, 21
Rugged Red Lake 161
Rutherford, C. 99
Ruth group 132, 140

St. Elmo, St. Elmo Consolidated, and Cliff Claims 99
St. Mary River occurrence 120
Sabbath (Swede) Creek 17, 20
Salmita Consolidated Mines, Limited 145

PAGE

Salmo district 11
Salmo River 118
Sam, Mathew 60
San Antonio 216
Sand River Gold Mining Company, Limited 164
Sandybeach Lake property 159
Sangdong 210
San Juan River 120
Santa Rosa group 98
Sapples, J. 112
Sargent, Mrs. B. 54
Saskatchewan 147
Sault Ste. Marie Mining Division 168
Scheelam Mines, Limited 159
Scheelite 2
  Creek 9, 17, 20, 30
  mine 198
Schist Lake 150
Schmidt, Oscar A. 85
Scranton Consolidated Mining Company, Limited 96
Seaholm, H. 24
Secret Creek 17, 29
Seely, R. W. 44
Sesekinika 173
Shangping 208
Shawkey Gold Mining Company, Limited 184
Sheep Creek 105, 112, 114, 115
Siaolung 208
Sigma Mines (Quebec), Limited 185
Sihuashan 207
Silleda mine 204
Silver Cup 60
Silver Dyke 221
Silver group 61
Siscoe Gold Mines, Limited 184
Sitkum Creek 119
Skarn 10, 11
Skate Creek 17, 29
Skogland, O. L. 56, 58
Slocan 96
Snowflake and Regal Silver (Woolsey) groups 92
Snow Lake 152
Snowshoe Creek 17, 29
Snowshoe Plateau 70, 71
South America 215, 223
Southern Rhodesia 214, 224
Southern Vancouver Island 120
Spain 204, 223
Spencer, George 189
Spencer-Jutras property 189
Spotted Horse claim 117
Springer Creek 96
"Spud Patch" 220
Squamish 78
Square Lake 9
  tungsten deposits 191

PAGE

Star gold mine 178
Statistics of production 223
Stellite 6
Stevens Gulch 38
Stewart Creek 115
Stewart, E. J. 125
Stewart property 115
Stikine area 40
Stillwater Brook 198
Stolzite 2
Storey's Creek 212
Storm group 130, 134
Stump Lake 86, 87
Sudbury area 169
Sudbury Mining Division 169
Sullivan Consolidated Mines, Limited 184
Swakum Mountain 80
Swanson, R. 24

Tachishan 207
'tactite' 10
T. A. group 138
Talmora Longlac Gold Mines, Limited 166
Tambeau, C. 88
Tasmania 212
Taylor, Fred 24
Ted group 125
Telkwa River 58
Temiscamingue county 187
Terrace-Usk 42
Thailand 205, 223
Thompson, George 150
Thompson, Hawley 150
Thompson, W. 68
Thompson-Lundmark mine 132
Thompson's property 150
Thor Gold Mines, Limited 155
Thornhill Mountain 43
Tibbitt Lake 127, 128, 129
  occurrences 126
Tidsbury, A. D. 141
Tillen, C. H. 93
Tombill Gold Mines, Limited 165
Tommy Creek 75
Tonapah 13
Tonguay mine 199
Trengganu 206
Tungold Mines Limited 154
Tungstar Mines 219
Tungsten 1, 6
  carbide 6
  minerals 1, 2, 3
Tungsten of British Columbia, Limited 40
Tungsten City Milling Company 219
Tungsten Corporation of Canada, Limited 142, 143
Tungsten Developers 134
Tungsten Hills 219
Tungsten King group 73, 104
Tungsten Queen property 13
Tungsten Queen (Phillips' Tungsten) 72

	Page
Tungstite	2
Tungstore mine	220
Turner, Ernst	195
Turner, J. S.	125
Turner, T.	43
Tyaughton Creek	72, 73
Tyranite Mines, Limited	177
Tzehsing deposit	209
Uchi Gold Mines, Limited	161
Uchi Lake	161
Union of South Africa	214, 224
United Kingdom	223
United States	219
United Victory group	93
Upper Canada Mines, Limited	174
Upstream Gold Mines, Limited	187
U.S.S.R.	211
Uses	6
Usk Mining Company	44
Utu Iseke	214
Vaughan-Rhys, T. J.	52
Velvet mine	98
Venango mine	118
Vernon	89
Victoria mine	169
Victory claim (Westbank)	120
Victory-Trout Lakes occurrences	132
Victory Tungsten Limited	112
V Mineral claim	38
Wadd Placer Company	24
Walker, S.	133
Wallace Lake	155
Waneta Gold Mines Limited	100
Ward, H.	150
Wauchope	211

	Page
Waverley Scheelite deposit	197
Wells, Fred	70
Wendigo Gold Mines, Limited	158
Weng Yuan	208
Western Tungsten Copper Mines Limited	46, 52
West Hawk Lake	157
Whetstone Mountains	8
Whishaw, Q. G.	105
White Bluffs group	43
White Elephant group	89
Whitehorse Mining Division	30
Whitewater group	58
Williams, Ben	89
Wilson, George	197
Wilson, J.	58
Windle, J.	68
Winter, J. J.	31
WO_3 group	135
Wolfram	1
Wolfram Camp	212
Wolframite	1
Wow No. 1 claim	154
Wyoming property	98
X-L group	142
Yellowknife	121
Bay	124
Yellow Pine mine	221
Yo Chang	209
York county	191
Young-Davidson Mines, Limited	177
Yuba Consolidated Gold Fields	19
Yukon Territory	14
Zona May group	45

INDEX OF CANADIAN TUNGSTEN-BEARING MINERALS

Ferberite 1, 7, 11, 12, 14, 16, 18, 19, 24, 53-55, 57, 121, 144, 195
Hübnerite 1, 7, 11, 190, 195, 201
Meymacite 2, 190
Powellite 2, 5, 60, 113, 114
Scheelite 1, 2, 4-12, 14-17, 19-38, 40-45, 49-51, 53-62, 65-81, 84, 85, 87-91, 93-142, 145-191, 194-202
Stolzite 2, 120
Tungstite 2, 114, 115, 116, 190, 195, 196, 201
Wolframite 1, 7, 9, 11, 12, 14, 16, 18, 22, 34, 37, 39, 40, 54, 114, 190, 191, 193, 195