A REGIONAL INVESTIGATION OF SCHEELITE OCCURRENCES IN THE MEGUMA GROUP OF NOVA SCOTIA

by

BRIAN E. FISHER

A thesis submitted to the Department of Geology
in conformity with the requirements for the
Degree of Bachelor of Science (Honours)

DALHOUSIE UNIVERSITY
HALIFAX, NOVA SCOTIA, CANADA

MARCH 2, 1984

DALHOUSIE UNIVERSITY
Department of Geology
Halifax, N.S. Canada B3H 3J5 Telephone (902) 424-2358 Telex: 019-21863

DALHOUSIE UNIVERSITY, DEPARTMENT OF GEOLOGY

B.Sc. HONOURS THESIS

Author: Brian E. Fisher

Title: "A Regional Investigation of Scheelite Occurrences in the Meguma Group of Nova Scotia."

Signature of author

Date: April 25, 1984

Distribution License

DalSpace requires agreement to this non-exclusive distribution license before your item can appear on DalSpace.

NON-EXCLUSIVE DISTRIBUTION LICENSE

You (the author(s) or copyright owner) grant to Dalhousie University the non-exclusive right to reproduce and distribute your submission worldwide in any medium.

You agree that Dalhousie University may, without changing the content, reformat the submission for the purpose of preservation.

You also agree that Dalhousie University may keep more than one copy of this submission for purposes of security, back-up and preservation.

You agree that the submission is your original work, and that you have the right to grant the rights contained in this license. You also agree that your submission does not, to the best of your knowledge, infringe upon anyone's copyright.

If the submission contains material for which you do not hold copyright, you agree that you have obtained the unrestricted permission of the copyright owner to grant Dalhousie University the rights required by this license, and that such third-party owned material is clearly identified and acknowledged within the text or content of the submission.

If the submission is based upon work that has been sponsored or supported by an agency or organization other than Dalhousie University, you assert that you have fulfilled any right of review or other obligations required by such contract or agreement.

Dalhousie University will clearly identify your name(s) as the author(s) or owner(s) of the submission, and will not make any alteration to the content of the files that you have submitted.

If you have questions regarding this license please contact the repository manager at dalspace@dal.ca.

Grant the distribution license by signing and dating below.

Name of signatory | Date

TABLE OF CONTENTS

ABSTRACT

The scheelite deposits of the Meguma Group of Nova Scotia are found within interbedded veins in the slates and quartzites of the lower Halifax and upper Goldenville Formations. The veins are found at the edge of or within slate beds and are parallel to the bedding. They range in thickness from 1-60 cm and contain predominantly quartz carbonate and arsenopyrite with traces of gold. The ore is found in rolls or pinches near the crest or on the limbs of large broad anticlines, some of which can be traced along strike for 150 km and have wavelengths of up to 15 km.

Five of the six producing scheelite deposits are found along the trend of a single upheaval, the Moose River - Waverly - Indian Path Anticlines, and account for 95% of tungsten production. Ninety percent of the tungsten comes from deposits where there is a sandstone:shale ratio close to 1.0:1.0. This area consists of roughly 15% of the thickness Meguma Group centering near the base of the Halifax Formation and the top of the Goldenville Formation.

It appears that the veins formed during the early stages of deformation and greenschist metamorphism in the Meguma. Horizontal fractures appeared within or next to slate beds which opened up allowing the metamorphic fluids to flow in from adjacent greywacke and quartzite beds. The first minerals to precipitate were scheelite and carbonates followed later by quartz, arsenopyrite, pyrite and rutile. The scheelite occurrences are restricted to the greenscist facies in

both the chlorite and biotite zones.

The veins typically have open-space-filling textures with both the scheelite and carbonate on or near the wall. The sediments near the veins are predominantly quartz, chlorite, muscovite, arsenopyrite with minor amounts of plagioclase. The host rocks appear to be enriched in tungsten and contain large arsenopyrite crystals in pressure shadows, porphyroblastic biotite and chlorite, and "moth-eaten" or patchy like rutile.

CHAPTER 1

GENERAL STATEMENT

The purpose of this thesis is to summarize information about the scheelite occurrences found in the rocks of the Meguma Group of Nova Scotia, and examine possible controls for the localization of tungsten in quartz-arsenopyrite-carbonate (gold) veins in the Meguma Zone.

INTRODUCTION

Tungsten in the mineral form scheelite is found in numerous localities south of the Glooscap fault in Nova Scotia. Most commonly scheelite can be found in quartz veins which are conformable with and parallel to the the bedding planes of the Halifax and Goldenville Formations. Less commonly it can be found associated with pegmatites and granites of Devonian-Carboniferous age. Figure 1 lists most of the scheelite occurrences in Nova Scotia and some general information about them.

PREVIOUS WORK

The first major geological study on the mineral occurrences in the Meguma was by E.J. Faribault, who mapped the entire area between 1889 and 1939. His work was compiled by W. Malcolm in 1912 under the title, 'Gold Fields of Nova Scotia,' which was later revised and republished by Malcolm and the Geologic Survey of Canada under the same title in 1929. Although Faribault's work mostly concerned the gold fields, he also investigated the scheelite occurrences.

The vast majority of the information available on the scheelite occurrences can be found by searching the assessment files of the Nova Scotia Department of Mines and Energy (NSDM). Although many are not authored, the information is invaluable in locating and researching information. Also invaluable in the research are various annual reports of the NSDM, especially: Messervey, 1930; Douglas, 1939; Cameron, 1941; Charlick, 1941; and Flynn, 1942, all of which provide much information on individual sites.

In more recent years (since the early 1940's) very little work has been done on the scheelite occurrences. Several papers and articles during this time should be considered regarding these deposits. They include: Little, 1959; Miller, 1974; Nance, 1977; Miller, Graves and Zentilli, 1976; Shaw, 1983. Little's (1959) paper, 'Tungsten Deposits of Canada,' summarized the findings at most of the occurrences in Nova Scotia.

PURPOSE, METHODS AND SCOPE

The purpose of this thesis was to better understand the geological factors that may control the concentration of tungsten in the most important localities known to have produced scheelite in Nova Scotia.

Several of the larger scheelite deposits in the Meguma were visited, samples were collected from outcrop and dump piles, and occurrences where maps are not available were mapped. Seven sites were visited, (fig. 2) which include the most prominent occurrences as follows: 1) The mine site commonly known as Scheelite Mine, will be referred to as Stillwater Brook so as not to confuse it with other scheelite occurrences; 2) The Waverly scheelite occurrence which will be referred to here as Fall River to distinguish it from the Waverly gold mine; 3) Indian Path; 4) Goff; 5) Lake Charlotte; 6) Lower Sackville; and 7) Murchyville.

A literature search was combined with the information found in the field and summary written of each of the seven occurrences. A visit to many of the smaller occurrences and to gold districts where scheelite is reported is outside the scope of the thesis due to time limitations and financial considerations. General information on these occurrences were obtained obtained from the literature.

The purpose of this thesis involves an examination of several aspects of the mineral deposits and an attempt to find a common factor between them:

1) are they found in the same lithologic unit, stratigraphic level, or in rock units with similar sand:shale ratio?

2) the first question concerns any geological structures where the occurrences are found.

3) what is the mineralogy of the veins?

4) are the metamorphic effects in the areas of the deposits similar?

5) is there any relation between the deposits and the granite in the area?

6) is there any relationship between the scheelite bearing veins and the gold bearing veins?

7) are the host sedimentary rocks enriched in tungsten?

8) what is the best model to explain the formation of these veins?

The scope of the thesis here is not to investigate each of these in greatest depth but rather each in general, in an attempt to find a factor that may give a clue to the formation of these deposits which may later be studied in greater depth.

FIELD AND LAB WORK

The field work for this thesis included visiting the seven scheelite occurrences that were chosen. Mapping was conducted at those sites where there previously were no maps and the outcrops and diggings at the mine could be located. Samples were collected for later use from outcrops, veins if they could be found, and from dump heaps. This approach required the use of an ultraviolet lamp in the field. A total of seventeen days were spent in the field at the various scheelite occurrences as follows: Goff - three; Fall River - five; Lower Sackville - two; Stillwater Brook - two; Indian Path - one; Lake Charlotte - two; and Murchyville - two. Time was also spent at several of the local gold mines looking for traces of scheelite in the dump rock and collecting samples for comparative work if desired. Six gold mines were visited, a couple while in the vicinity of the scheelite properties, including Moose River and Tangier while the others: Lake Catcha; Waverly; Montague; and Oldham were visited over a two day period.

Samples for x-ray diffraction; electron microprobe; slabbing; thin-polished sections; oxygen isotopes; tungsten analysis and rare earths were collected from all sites. A total of 215 samples were collected from the scheelite occurrences and 63 from the gold mines. Of the 278 samples, chips were taken from 50, powdered and run through x-ray diffraction by the author. Thin-polished sections were made from 22 which were later described under both transmitted and reflected light. Of these 12 had electron microprobe analysis performed by the author. Fifty more samples were slabbed and along with the 22 cut for thin-polished sections, all were examined for mineralogy and paragenesis. Twenty-two samples of slate and quartzite were sent away for tungsten analysis, while seven chips of carbonates were sent for oxygen isotopes.

Field work also included a search through the assessment files, mineral occurrence reports and various maps at the NSDM library, which took approximatly 10-12 days. Other lab work included taking various pictures and slides of the thin-polished sections and slabs.

The remaining work included research in the Dalhousie Science Library for reference material on other scheelite occurrences and the drafting of the various tables, maps, graphs, and sections contained in this thesis.

FIG.1

NAME	COUNTY	N.T.S. MAP	LATITUDE	LONGITUDE	FORMATION	CHARACTER	STATUS	LBS OF WO_3
MURCHYVILLE	HALIFAX	11E/3	45°00'00"	63°05'36"	HALIFAX FM.	INTERBEDDED QUARTZ VEINS	W OCCURRENCE	200
STILLWATER BROOK (SCHEELITE MINE)	HALIFAX	11D/15	45°01'	63°03'	Goldenville	INTERBEDDED QUARTZ VEINS	W MINE	87,045
LOWER SACKVILLE	HALIFAX	11D/13	44°45'35"	63°37'53"	GOLDENVILLE	INTERBEDDED QUARTZ VEINS	W MINE (ABANDONED)	6,000
GOFF	HALIFAX	11D/14	44°53'	63°28'30"	GOLDENVILLE	INTERBEDDED QUARTZ VEINS	W MINE (ABANDONED)	6,000
FALL RIVER (WAVERLY)	HALIFAX	11D/13	44°47'35"	63°37'	GOLDENVILLE	INTERBEDDED QUARTZ VEINS	W MINE ABANDONED	8,750
LAKE CHARLOTTE	HALIFAX	11D/15	44°52'	62°59'	GOLDENVILLE	INTERBEDDED QUARTZ VEINS	W MINE ABANDONED	4,000
INDIAN PATH	LUNENBURG	21A/8	44°19'45"	64°20'30"	HALIFAX	INTERBEDDED QUARTZ VEINS	W MINE ABANDONED	29,296
LAZY HEAD	GUYSBOROUGH	11F/6	45°20'58"	61°04'25"	GOLDENVILLE	SPESSARTINE-QUARTZ CHLORITE HORIZON	PROSPECT	14,400 EST. SHAW (1983)
15 MILE BROOK	QUEENS	21A/6	44°13'	64°53'	GOLDENVILLE	INTERBEDDED QUARTZ VEINS	PROSPECT	TR

Harmony Mills	QUEENS	21A/6	44°23'40"	65°04'30"	HALIFAX fm.	INTERBEDDED QUARTZ VEINS	PROSPECT	TR
BAKER SETTLEMENT	LUNENBURG	21A/7	44°24'	64°43'40"	HALIFAX fm.	INTERBEDDED QUARTZ VEINS	PROSPECT	TR
BALLOU MINE	QUEENS	21A/7	44°22'	64°55'	Goldenville fm	INTERBEDDED QUARTZ VEINS	Au MINE (ABANDONED)	TR
CARIBOU	HALIFAX	11E/2	45°03'	62°58'	HALIFAX fm	INTERBEDDED QUARTZ VEINS	Au MINE	TR
OLDHAM	HALIFAX	11D/14	44°55'	63°28'	Goldenville fm	INTERBEDDED QUARTZ VEINS	Au MINE	TR
New Ross	LUNENBURG	21A/10	44°43'	64°33'	GRANITE	PEGMATITE	OCCURRENCE	TR
Mill Road	LUNENBURG	21A/16	44°48'	64°24'	GRANITE	PEGMATITE	PROSPECT	TR
MURPHY BROOK	INVERNESS	11K/6	45°15'	61°03'	GRANITE	GRANITE	PROSPECT	TR.
GOLDSBORO	GUYSBOROUGH	11F/5	45°11'	61°39'	Goldenville fm.	INTERBEDDED QUARTZ VEINS	Au MINE (ABANDONED)	TR

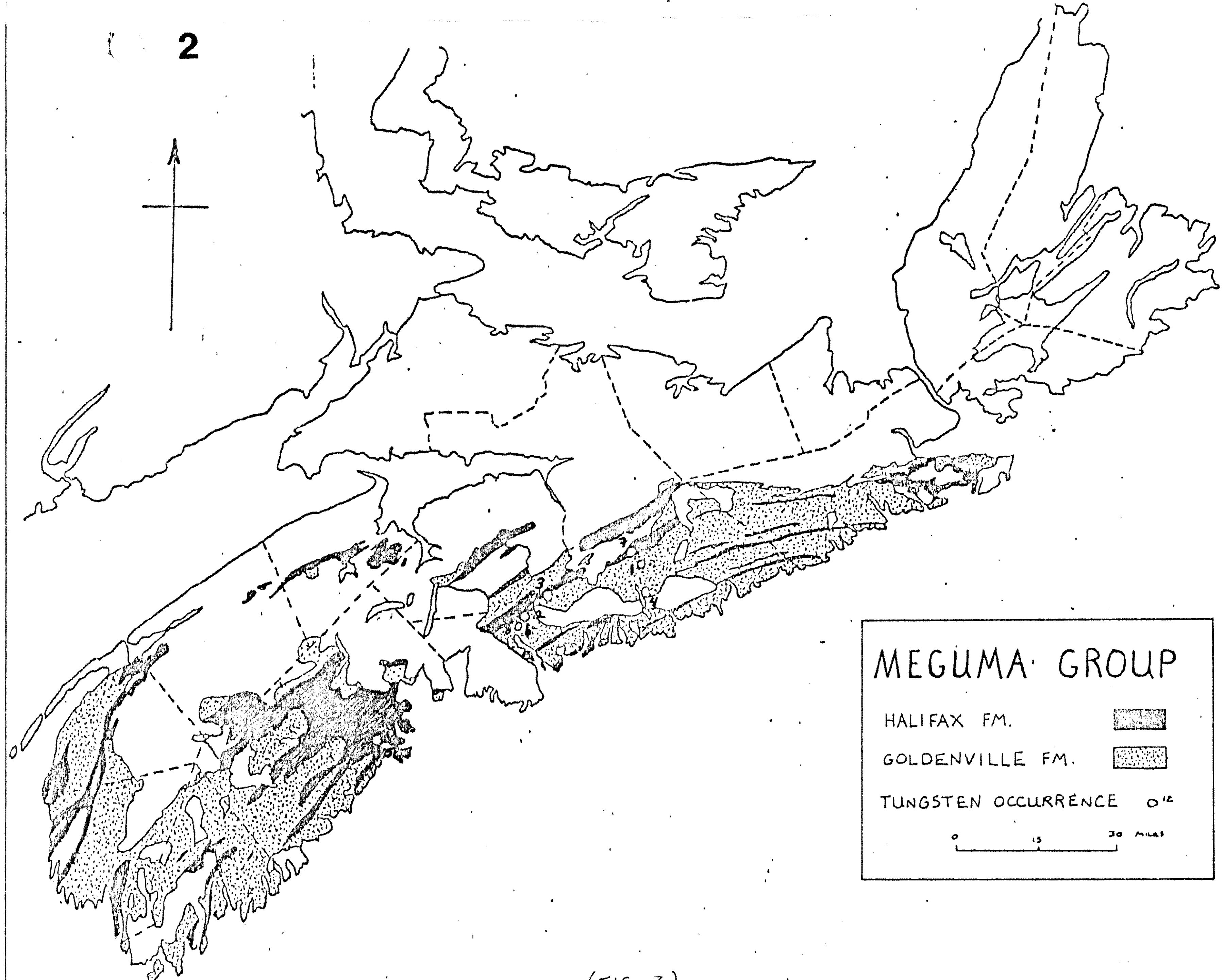
COCHRAN HILL (CROW'S NEST)	GUYSBOROUGH	11E/1	45°15'	62°04'	GOLDENVILLE Fm	INTERBEDDED QUARTZ VEINS	Au MINE	TR
FOREST HILL	GUYSBOROUGH	11E/5	45°18'	61°46'	GOLDENVILLE Fm.	INTERBEDDED QUARTZ VEINS	AU MINE	TR
GOLDENVILLE (SHERBROOK)	GUYSBOROUGH	11E/1	45°07'30"	62°01'	GOLDENVILLE Fm.	INTERBEDDED QUARTZ VEINS	AU MINE	TR
MOLEGA (MALAGA)	QUEENS	21K/7	44°20'	64°54'	GOLDENVILLE Fm.	INTERBEDDED QUARTZ VEINS	AU MINE (ABANDONED)	TR
WESTFIELD	QUEENS	21A/6	44°25'	64°02'	HALIFAX Fm.	INTERBEDDED QUARTZ VEINS	AU MINE (ABANDONED)	TR
WAVERLY	HALIFAX	11D/13	44°47'	63°36'	GOLDENVILLE Fm.	INTERBEDDED QUARTZ VEINS	AU MINE (ABANDONED)	TR
MONTAGUE	HALIFAX	11D/12	44°42'58"	63°31'	GOLDENVILLE Fm.	INTERBEDDED QUARTZ VEINS	AU MINE (ABANDONED)	TR
MOOSE RIVER	HALIFAX	11D/15	44°58'45"	62°57'	GOLDENVILLE Fm.	INTERBEDDED QUARTZ VEINS	Au MINE (ABANDONED)	TR.
LAKE CHARLOTTE (WEST)	HALIFAX	11D/15	44°52'	62°59'	GOLDENVILLE Fm	INTERBEDDED QUARTZ VEINS	Au MINE ABANDONED	TR
MOOSELAND	HALIFAX	11D/15	44°56'25"	62°40'15"	GOLDENVILLE Fm.	INTERBEDDED QUARTZ VEINS	Au MINE (ABANDONED)	TR

FIG. 2

Scheelite Localities:

1. Stillwater Brook
2. Fall River
3. Goff
4. Lake Charlotte
5. Indian Path
6. Lower Sackville
7. Murchyville.

2



(FIG. 3)

REVISED FROM MILLER '74

CHAPTER 2

TUNGSTEN

GENERAL INFORMATION

Tungsten was first discovered and isolated from its ore minerals, scheelite and wolframite, in the 1780's (Stevens, 1975). The element Tungsten, whose chemical symbol is W, is one of the so-called "less abundant elements". Cronan (1980) reports its crustal abundance to be 0.00015 in weight percent. The word Tungsten comes from the Swedish and means heavy stone. The term was first used by A.F. Cronstedt in 1755, and referred to the heavy minerals of tungsten (Little, 1959). In 1781 C.W. Scheele found that the mineral now known as scheelite was composed of calcium and a peculiar acid, and two years later, J.J. and F. de Elhuyar isolated the element from wolframite (Little, 1959). Since this time the element has become known as tungsten in the english-speaking world, but in other areas, especially Germany, it has been called wolfram. Since this time both terms have become commonly accepted.

With an atomic number of 74, tungsten is found in group VI (chromium group) in the periodic table. The properties of tungsten include: brilliant white; highest melting point (3401° C) and boiling point (5900o C) of any metal; low volatility; high specific gravity (19.3); relatively chemically inert, but readily forms alloys; it has the greatest tensile strength of all metals (590,000 pounds per square inch); elastic and ductile properties allow wire to retain its rigity at very high temperatures; forms alloys with many metals and with carbon, imparting to these increased hardness, durability and resistance to corrosion and heat.

MINERALOGY

There are four tungsten minerals which are of major importance, this includes both ferberite, an iron tungstate $FeWO_4$, in which atomic substitution of Fe by Mn up to 20% may occur and hubnerite a manganese tungstate, $MnWO_4$, where Fe may substitute for up to 20% of Mn. Wolframite $(Fe,Mn)WO_4$ is a solid solution series between the two.

Scheelite, $CaWO_4$, is the fourth major tungsten mineral and also the only one that is reported to occur in the seven sites to be examined. Scheelite forms a partial isomorphous series with Powellite, $CaMoWO_4$, in which MoO3 of up to 24% by weight, but rarely more than 2 or 3 percent, may replace WO_3. This mineral is referred to as molybdoscheelite and it is not reported in these occurrences.

Calcium tungstate (scheelite) contains 80.6% tungsten trioxide (WO_4) and 19.4% lime (CaO). Its colour varies from white, yellow, green to brown and is commonly noted in Nova Scotia as honey-coloured. It has a hardness of 4.5-5.0; specific gravity 5.9-6.1; vitreous to adamantine luster; cleavage along (101); extremely brittle; a member of the tetragonal crystal system; and flouresces bright bluish white in short wave ultraviolet radiation (Hurlbut and Klein, 1971). Scheelite is hard to recognize in hand specimen without an ultraviolet lamp, (fig. 3) especially if it is finely distributed in the rock and its high specific gravity cannot be noticed. This is especially true since it does not have a distinctive metallic luster. Care must be taken during exploration that it is not ove looked.

GEOCHEMISTRY

Very little appears to be known about the geochemistry of tungsten, preesent data is scarce and contradictory (Jeffery, 1958; Miller, 1974). A search at the Dalhousie Science Library for 100 references produced only one on the geochemistry of tungsten. Wolf (1976) noted the low metamorphic mobility of scheelite, while Higgins (1980) stated that fluid inclusion evidence indicated that CO_2-rich fluids are involved in the transport of tungsten at high temperatures and pressures, most likely by carbonate/bicarbonate complexes.

USES

The first significant use of tungsten, to make high-speed tungsten-manganese steel (Stevens, 1975) was developed in the middle of the 19th century. This accounted for most of the tungsten used before 1900. Stevens (1975) reported that the major uses of tungsten by 1974 could be divided into four categories: in alloys, chiefly alloy steel, 15%; in carbides (cemented or cast), 68%; as a pure or substantially pure metal, 15%; and in various chemical compounds and other forms, 2%. It has become an imporant strategic metal in our time due to its use in weapons.

ECONOMICS

Tungsten trioxide, WO_3, is the part of scheelite that is of interest when mining. To be profitable, scheelite must contain at least 65% WO_3 (Law-West, 1981). Of the seven scheelite sites studied, five have reported values in the literature for WO_3 percentage: Stillwater 72%; Lower Sackville 77%; Goff 72%; Fall River 71%; and Indian Path 65%; while there are no available values for either Lake Charlotte or Murchyville. The current price is $U.S. 71-75 per tonne unit WO_3 (Northern Miner, January 12, 1984). In 1975 estimated world resources were estimated at 11,400 million pounds with 54% of in

China, and Canada with the second highest total of 10%. The large production capacities coming on stream in Canada and other countries combined with increased tungsten scrap recycling could result in an unbalanced market where supply is greater than demand, therefore forcing prices down. The situation thus does not appear bright for the tungsten industry in the near future.

TYPE OF TUNGSTEN DEPOSITS

The following is a brief summary of the various types of tungsten deposits as described by Little in 1959.

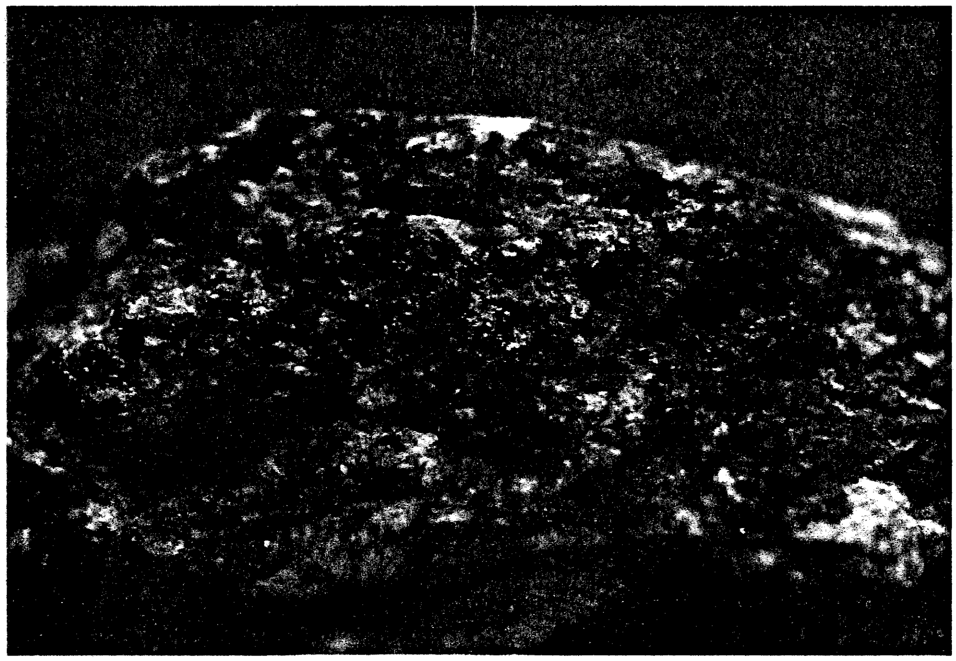
Primary deposits, believed to have formed from ascending waters or by segregation from a magma, are said to be genetically related to acidic igneous bodies. These include: disseminations in igneous rocks; pegmatites; contact metamorphic; hot spring; and quartz veins of the hypothermal, mesothermal and epithermal type. Secondary types of tungsten deposits formed by mechanical processes of concentration include both alluvial and eluvial placers which account for only a small percentage of production.

The type of tungsten deposits found in the Meguma Group do not appear to fit into any of Little's classical types. This is discussed later in the paper.

FIG. 3

58-19 SCHEELITE IN A HAND SPECIMENT CAN BE SEEM TO FLUORESCE BRIGHT WHITE UNDER ULTRAVIOLET LIGHT. IN 3A THE SCHEELITE FAILS TO 'GRAB' YOUR ATTENTION AND COULD EASILY BE MISSED. THE BROWN MATERIAL IS WEATHERED CARBONATE.

3a



1 cm

3b

CHAPTER 3

MEGUMA GROUP

STRATIGRAPHY

The Meguma Group makes up approximately 30% of mainland Nova Scotia and lies south of the Glooscap fault (fig. 1). Faribault (in Malcolm, 1912; 1929) referred to the Meguma as the "Goldbearing Series" and mapped it in its entirety between 1886 and 1939 on a scale of one inch to one mile (see appendix B for photocopies of some of his maps). It is a thick succession of greywacke, sandstone, siltstone and slate that was deposited in a deep-marine eugeoclinal setting (Schenk, 1975).

The Meguma Group is overlain by the more fossiliferous White Rock, Kentville and Torbrook Formations which consist mostly of quartz arenites, mixed quartzites, siltstones, shales, and black shales. The presence of the fossil Dictyonema flabelliforme in the uppermost Halifax Formation places the minimum age of the Meguma at Early Ordovician. Since fossils through the rest of the Meguma are rare or nondiagnostic, the age of the group is believed to be Cambro-Ordovician (Graves and Zentilli, 1981). The base of the Meguma is not known to outcrop and as yet has not been drilled. This creates problems in determining the age of the group and its thickness. The Meguma Group is estimated to be at least 10 km thick and possibly exceeds 14 km (Schenk, 1978). The Halifax Formation ranges in thickness from 500 m to 4400 m while the greatest thicknesses recorded in the Goldenville Formation were 5600 m.

The Halifax Formation consists chiefly of slates of various textures and colours, siltstone, minor sandstone with both distal and non-turbidite characteristics (Harris and Schenk, 1975), and a very small amount of limestone (Malcolm, 1912). The "limestone" is reported to outcrop out at two localities: Southeast Passage and Preston Road; in the same horizon at the base of the Halifax.

The Goldenville Formation consists chiefly of a quartzite varying from grey to blue grey to dark grey in colour with mica, pyrite, and arsenopyrite commonly associated; and slate units of various colours and composions which consist of 3% of the formation (Malcolm, 1912). Taylor and Schiller (1966) noted small amounts of argillite, siltstone, and slate interbedded in the upper part of the formation. The Goldenville is believed to be predominantly sandy turbidites. Graves and Zentilli (1981) referred to the Meguma as predominantly a quartz-rich greywacke and noted that the interbedded slates increased in thickness and number towards the top of the formation. Intercalations of up to 1 km in thickness of Halifax within Goldenville lithologies are levee, overbank, and interchannel facies of either deep sea fans or the upperslope (Harris and Schenk, 1975). Schenk (1970) places the boundary between the Halifax and Goldenville where there is a sandstone to shale ratio of one.

STRUCTURE

Fyson (1966) noted that the Halifax and the Goldenville Formations have the same deformational history. The most prominent megastructures are the folds, up to 150 km in length, with wavelengths of up to 15 km. A regional cleavage parallels the folds. The axes of these folds trend northeast in southern Nova Scotia, curving to east-northeast, and finally to east toward Chedabucto Bay (Fyson, 1966; Graves and Zentilli, 1981). Most folds are upright or have axial planes inclined no more than 20 degrees from the vertical, with no overall preference for the dip of the axial planes. The folds plunge gently except for a few localities where they plunge more that 40 degrees either northeast or southwest (Fyson, 1966). Fold limbs dip 50o-90o with the southern limb being predominantly steep and commonly overturned (Henderson, 1983). Fyson (1966, p.933) describes the folding differences in the two formations as follows: "In the Halifax folds are more similar than concentric in shape as the layers thicken in the hinge areas and the folds remain constant with depth. However interbedded siltstones retain their thickness and form concentric parallel folds. The Goldenville with massive quartzitic layers appears to have dominant concentric folding. The slate beds are found by Faribault (in Malcolm, 1912) to thicken in the hinge areas due to drag folding."

Later stress produced minor kink-folds divided by Fyson (1966) into F2 and F3 types. He noted that these folds deformed both the bedding and the axial-plane cleavage and therefore interpeted them as younger than the main F1 folds. These small cross-folds or kink-folds do not occur in all outcrops but do predominate in the Halifax Formation.

Most of the gold districts in the Meguma are located on or near the crests of anticlines where there has been a doming of the strata. The crest in these areas usually plunge at low angles to the east and west.

Faribault (in Malcolm, 1912) describes two types of faults in the Meguma: local faults, those found within individual gold districts which do not continue for great distances along strike or at depth; and "cross-country faults". These are NW-trending and offset the folds with horizontal displacements of up to 6 km. Graves and Zentilli (1981) stated that faults and fractures are related to F2 and F3 folding events.

Taylor and Schiller (1966) found that the only common primary structure in these rocks is bedding, but that cleavage is commonly so closely spaced that it destroys or masks the bedding. They also report other structures including graded bedding, scour and fill, crossbedding, and ripple marks. Schenk (1970) also noted sole marks; crescentic current - ripples; cross, parallel, contorted, and convolute stratification; fully - developed Bouma sequences; flaser structures; ball and pillow structures; clastic dikes; concretions; tracks; flutes and grooves. Waldron (1982) further noted: load casts;

pseudonodules; small sand volcanoes; dish, pipe and sheet structures in the Goldenville Formation.

GRANITES

The Meguma Group has been intruded by large granitic bodies of Middle Devonian age (Clark and Halliday, 1980; Reynolds <u>et al</u>., 1981) throughout Nova Scotia. These rocks are primarily granodiorites and adamellites (monzogranites) which are genetically related (Smith, 1979). Graves and Zentilli (1981) reported that the intrusions cut all the lower Palezoic rocks of the Meguma zone, truncate the large scale folds and their contact aureoles overprint the regional metamorphic minerals.

METAMORPHISM

Regional metamorphism is prominent throughout the entire Meguma while contact metamorphism is found associated with the granitic intrusions overprinting the regional metamorphism. Taylor and Schiller (1966) found that most rocks in the Meguma could be placed in one or the other category while only a few cannot be placed with certainty. They also noted that both types of metamorphism resulted in recrystallization accompanied by the orientation of newly formed minerals in several places. The bulk composition of most rocks appears to have changed little. Retrograde metamorphism has occurred only on a small scale (Taylor and Schiller, 1966).

Of the regionally metamorphosed areas, the greenschist facies appears to cover by far the largest part of the Meguma. It can be subdivided into three subfacies:

1) quartz - albite - muscovite - chlorite subfacies;

2) quartz - albite - epidote - biotite subfacies;

2) quartz - albite - epidote - almandine subfacies;

These can be subdivided further into twelve individual mineral assemblages (Taylor and Schiller, 1966).

All seven of the scheelite occurrences studied are reported to be in either the biotite or chlorite subfacies (Keppie and Muecke, 1979). Cullen (1983) recognized that two mineral assemblages are found in the chlorite zone (fig. 4):

1) quartz - albite - muscovite - chlorite - ankerite (+/- calcite, sphene, rutile);

2) quartz - albite - muscovite - chlorite - ankerite - graphite (+/- calcite, sphene, rutile).

He found the biotite zone to contain three assemblages:

1) quartz - albite - oligoclase - biotite - muscovite - chlorite - epidote - calcite (sphene - ilmenite);

2) quartz - albite - oligoclase - biotite - muscovite - chlorite - calcite - graphite (sphene - ilmenite - epidote);

3) quartz - cacite - albite - oligoclase - garnet - chlorite -

muscovite - biotite (sphene - ilmenite - epidote).

Both the chlorite and biotite were found as small flakes aligned along cleavage and as large (0.5 mm) porphyroblastic grains. In the chlorite zone calcite could be found in late veinlets and rutile locally in biotite zones near late alterations. Cullen further noted the following reaction to be the basis for the biotite isograd in his area:

$$KAl_3Si_3O_{10}(OH)_2 + 3SiO_2 + 8CaMg(CO_3)_2 + 4H_2O \longrightarrow$$

(muscovite) (quartz) (dolomite)

$$8CaCO_3 + KMg_3AlSi_3O_{10}(OH)_2 + Ca_2Al_2Si_3O_{12}(OH) + 8CO_2$$

(calcite) (biotite) (epidote)

Turner and Verhoogen (1960) noted temperatures from 300-500°C and P (H_2O) from 3000-8000 bars during greenschist metamorphism. Cullen (1983) noted the following physical conditions in the chlorite zone: P= 3000 bars (approx.); T< 430°C; X_{CO2}= 0.05-0.13; X_{H2O}= 0.95-0.87; while the conditions in the biotite zone were P= 3000 bars (approx.), T= 400-470°C, X_{CO2}= 0.08-0.13, X_{H2O}= 0.92-0.87. He found the conditions of contact metamorphism to be P_{H2O}= 1000-3000 bars and T= 550-700°C.

The almandine-amphibolite facies is known only in the southern and western parts of the province as well as at the most easterly edge of the Meguma Group (Keppie and Muecke, 1979). Eight different mineral assemblages are represented in this facies (Taylor and Schiller, 1966).

Contact metamorphism overprints the regional metamorphism and produces aureoles which range from 0.5-2.4 km away from the granite (Taylor and Schillor, 1966). The rock from the aureoles are characteristic of the hornblende-hornfels facies and consist predominantly of quartz, muscovite,and biotite; occasionally in differing areas one may find one or more of: cordierite; plagioclase; andalusite; and sillimanite (Taylor and Schiller, 1966). The mineral assemblages are consistent with temperatures of 500-700°C and water pressures from 1000 to 3000 bars.

QUARTZ VEINS

Numerous quartz veins are found throughout the Meguma Group although the majority appear to be located in slates of the upper part of the Goldenville Formation. The vast majority of the literature on the veins concerns those that are auriferous. The following summary on the quartz veins will come primarily from descriptions of these veins.

The mineralogy of the quartz veins has been summarized by Malcolm (1912; 1929; and Newhouse, 1936). Quartz is the most prominent mineral with calcite (magnesian and ferruginous) and sulphides in subordinate amounts. Among the metallic minerals arsenopyrite and pyrite are the most common but galena, chalcopyrite, sphalerite, and pyrrhotite also occur. Several other minerals are rarely reported to occur in more than one district: molybdenite; stibnite; garnet; zircon; black rutile; mica; and chlorite. Rarely arsenopyrite or pyrite may form the complete vein filling. The gold occurs not only free and visible but also bound up in the sulphides. Commonly silver can be recovered from the gold.

Faribault (in Malcolm, 1912; 1929) noted that not all of the quartz was equally auriferous. He found that the coarsely crystalline white quartz contained little if any gold while the best prospect was the laminated veins of "oily" quartz carrying sulphides. The gold-bearing veins occur in parallel groups on limbs or at crests of F1 anticlines and are commonly found concordantly within or at either margin of a slate bed (Graves and Zentilli, 1981). The majority of the auriferous veins occur where there is a doming of the anticline although a few are found on the plunging parts of anticlines such as those at Upper Seal Harbour (Malcolm, 1912; 1929). A vein can vary between a few millimeters and a few meters in thickness and several can occupy one slate unit (Graves and Zentilli, 1981).

Mining operations have shown that underlying the veins exposed at the surface are other parallel interbedded veins of a similar type. Many interstratified veins exhibit a folded or corrugated structure and the slate beds adjacent to the corrugated veins show a sympathetic folding which extends from a few to 6 m from the vein and gradually dies out (Malcolm, 1912; 1929). When part of a vein becomes enlarged or takes on some peculiarity of form, structure, or mineral content, or when one of the corrugations becomes enlarged so as to have an individuality of its own, this portion of the vein is called a roll, (Malcolm, 1912; 1929). A roll is frequently richer than other parts of the vein. Faribault (in Malcolm, 1912; 1929) noted that veins commonly attain their maxinium thickness on the apex of the fold and become thinner as they extend downward on the limbs. He also notes that the interbedded veins are continuous and may have been traced over 300 m in length with little variation in thickness.

Faribault (in Malcolm, 1912; 1929) also noted several other types of vein which are described as follows. Cross or fissure veins cut across the strata for a considerable distance and in some districts form the principal gold deposit. These veins commonly contain inclusions of country rock, thicken only where they intersect interstratified veins and have the same mineral content. Angulars are veins which pass into the foot-wall and hanging-wall from the main veins. The point from which an angular passes from the main vein into the hanging-wall is usually higher than that from which it passes into the foot-wall. Interbedded veins are found to be very rich in gold at intersections with the angulars. Their mineral content is similar to the main lead but the quartz is fine, more granular, and free of laminations. Bull veins may cross the strata or lie in a stratification plane. They are white coarsely crystalline quartz with no laminations, few metallic minerals, and are not auriferous.

Graves and Zentilli (1981) noted that the vein minerals typically have open-space-filling textures. Commonly carbonate makes up 10 to 20 percent of the vein by volume at the walls and strained quartz is the dominant vein mineral in the center of the vein. There is up to 5 percent arsenopyrite and much more locally in the veins in sharp contact with lesser amounts of pyrite and pyrrhotite. Arsenopyrite is found throughout the vein, but generally occurs with carbonate at the walls. Arsenopyrite, as well as other vein minerals, is also common in the wall rock and has been deformed, resulting in the crystal being shattered, following crystallization. Gold distribution generally, but not exclusively, follows that of arsenopyrite and carbonate.

O'Brien (1982) in his structural classification of the quartz veins noted two groups of veins that can be distinguished in the field easily. The first is an early array commonly transected by steep cleavage and a late array injected along joints or faults. He notes that the early array is in part auriferous, having been emplaced before and during several structurally dated episodes of metamorphism, and appear to be unrelated to the granites and pegmatites. Furthermore, some folded veins are deformed along with bedding, while others fold independently of this surface. The late array of veins is injected along joints, fault gouges and kink planes.

Haynes (1982) in his work in the Isaac's Harbour-Goldboro-Seal Harbour area revealed the existence of at least eleven different quartz vein polytypes. Of these he notes gold in three types: stratiform; stratabound; and ac-joint infillings. Following are his names for the other types of quartz veins: step veins; side veins; discordant lenses; concordant lenses; radial veins; vertical veins; quartz tension gashes; and late quartz veins.

The origin of these veins has been much disputed over the years. Several of these theories will be described later in the section on genesis.

SCHEELITE OCCURRENCES

Three different types of scheelite mineralization can be distinguished in the Meguma Zone of Nova Scotia (fig. 1): the New Ross; Lazy Head; and Moose River types (Shaw, 1983). Figure 2 indicates the location of the 7 sites to be examined.

The New Ross type of deposit is known to occur in only three localities. These deposits are characterized by a scheelite, wolframite, tungstenite, cassiterite, bismuthenite and base metal sulphide assemblage (Smith, 1983). The ore minerals are found in quartz, plagioclase, microcline, muscovite, fluorite, +/- apatite, +/- tourmaline, +/- manganese oxide veins and greisen zones. The mineralized zones occur in, muscovite, +/- biotite granite of Devonian-Carboniferous age (Charest, 1978). Miller (1974) reported that scheelite can be found in pegmatites that are traceable to these same granites.

Shaw (1983) reported that the Lazy Head deposit is the only occurrence of this type known in Nova Scotia. Scheelite, sphalerite, chalcopyrite, pyrite and pyrrhotite occur in 2 to 5 cm wide veins of quartz, microcline, chlorite, and apatite. The veins have filled post-tectonic and post-intrusive extension joints that are restricted to a 1.5 m wide, spessartine-quartz-chlorite horizon at the top of the Goldenville Formation.

Of the 29 reported occurrences of scheelite in Nova Scotia 25 are of the Moose River type. These appear to occur throughout the entire Meguma within the biotite and chlorite zones. Scheelite in these types of deposits is found in the folded quartz-carbonate veins with arsenopyrite and rutile, subparallel to the bedding of the metapelites of the Ordovician Meguma Group (Miller et al., 1975). Graves (1976) further reported that this type of mineralized vein bears many of the characteristics of the gold-bearing quartz veins in the Meguma Zone.

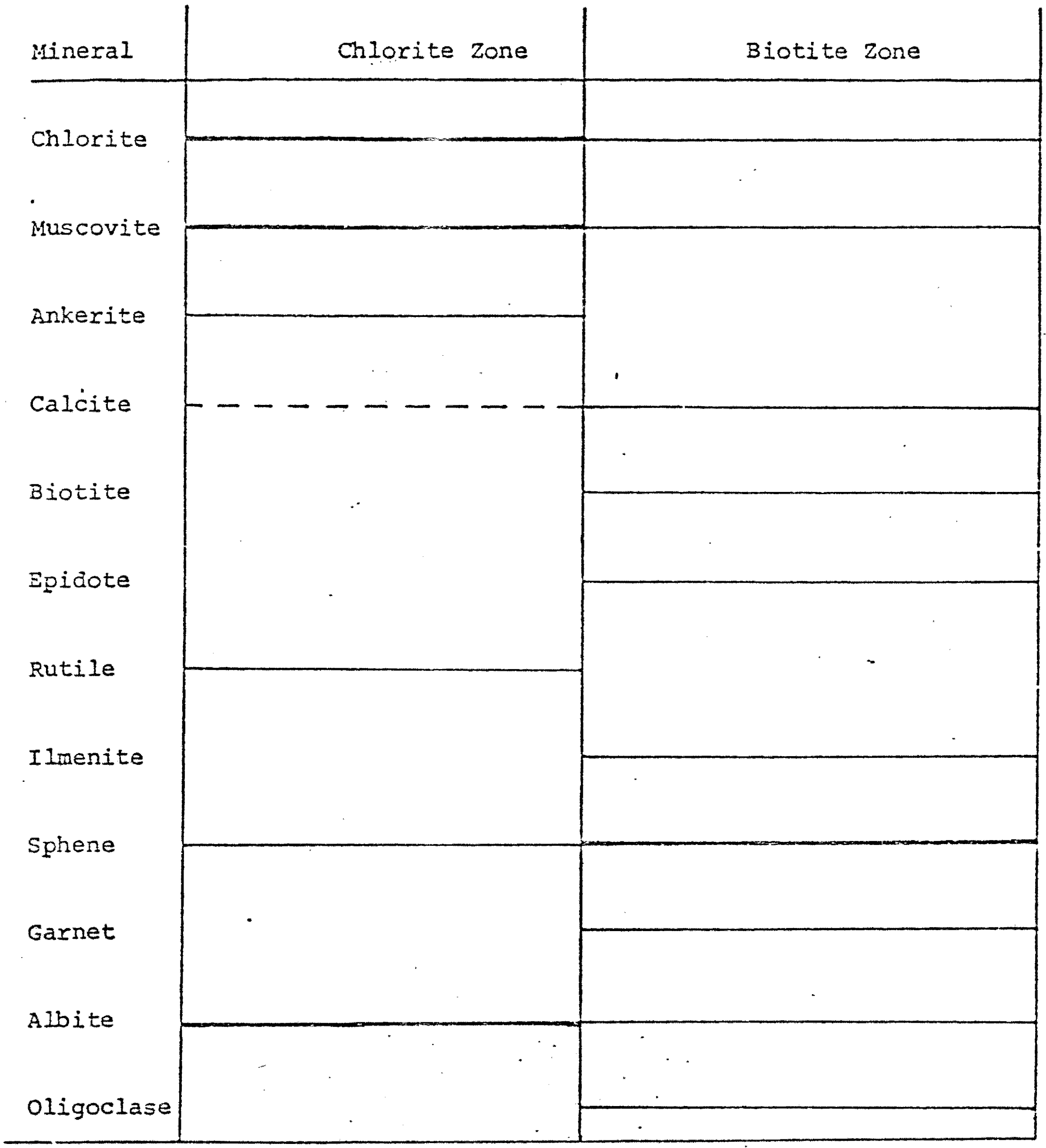
Fifteen of the scheelite occurrences are in fact reportedly found in the quartz veins within one of the gold producing districts. Here though, the scheelite is predominantly reported in only trace amounts. The other 10 reported scheelite occurrences have reported only trace amounts of gold, Indian Path being the only exception where 50 ounces of gold were recovered. There are no mines which are reported to have recovered both scheelite and gold. Figure 5 plots ounces of gold against pounds of W03 for several of the reported scheelite occurrences and several of the gold-producing areas. Virtually all the data points fall along either one of the axes of the graph, indicating a very definite separation of the two. Little (1959) found that scheelite is widespread in gold-bearing veins, though it is usually most abundant where the gold content is low. Newhouse (1936) reported that the gold-bearing series in the Meguma has negligible, if any, gold values reported from them. Boyle (1979) noted that some gold belts are notable for their scheelite whereas others have little or none of the mineral. He further stated that, "some shoots in gold-quartz veins enriched in scheelite tend to be relatively low grade in gold", and notes the Meguma as one such area.

FIG. 4

Mineralogical differences between chlorite zone and biotite zone metawackes and metapelites.

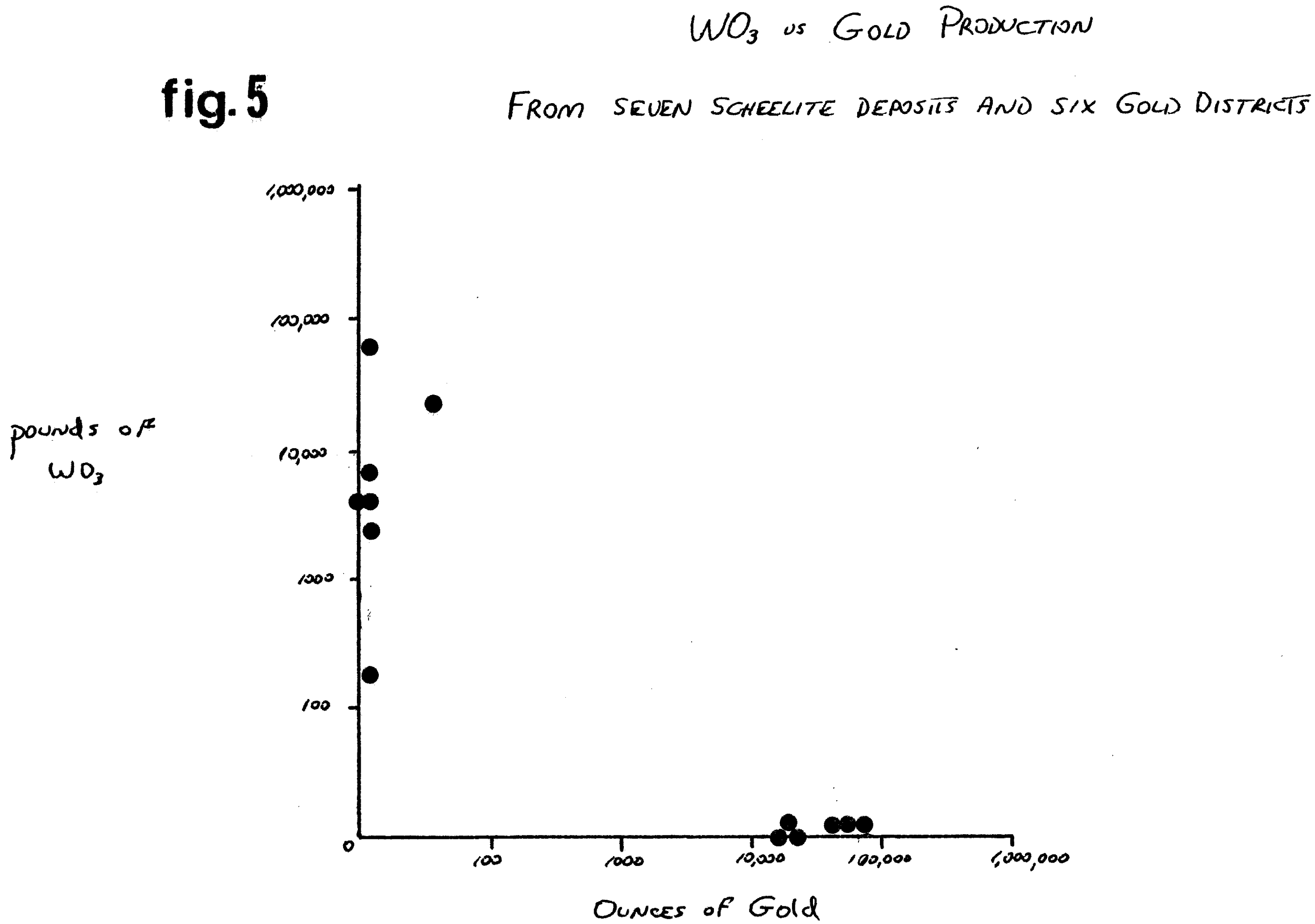
▬ = more abundant relative to alternate zone.

--- = less abundant relative to alternate zone.



From:
Cullen, 1983

fig. 5


WO3 vs GOLD PRODUCTION
FROM SEVEN SCHEELITE DEPOSITS AND SIX GOLD DISTRICTS
pounds of WO3
1,000,000
100,000
10,000
1000
100
0
100
1000
10,000
100,000
1,000,000
Ounces of Gold

CHAPTER 4

STILLWATER BROOK

LOCATION AND ACCESS

The Stillwater Brook scheelite mine is located in the northeastern part of Halifax county at latidude 45° 01' and longitude 63° 03' on topographic map 11D/15 (appendix A, map 1). It is found on the western edge of the Moose River gold district 3.2 km west of the village of Moose River village on Stillwater Brook.

The area can be accessed from the east along good secondary roads off highway 224, 8 km northeast of Middle Musquodoboit or from the south through Mooseland by taking the turn off to the north at Tangier on highway 7.

GEOGRAPHY

The area consists of low rolling hills. There are two brooks in the vicinity of the mine, Stillwater Brook and Little Brook, which drain to the south. Swamps cover a large area lying to the north and south of the property.

Some of the land has been cultivated while the vast majority is heavily forested with softwood trees. Logging operations are active in the area and farming is carried out to a minor degree.

PREVIOUS WORK

The first note of scheelite in the area came from a trapper who found a heavy white stone in the late 1800's in the area. The stone eventually made its way to California where it was found to be scheelite (Malcolm, 1912; 1929).

In 1908 John Reynolds and W.S. Currie found scheelite float in Little Brook. Further prospecting in the area revealed scheelite _in situ_, after trenching across the beds (Malcolm, 1912; 1929). The adit near Little Brook was his first work on the area. From 1908 to 1911 mine shafts were sunk and considerable drifting was done (fig. 6). In 1911 Scheelite Mines took over the area and worked on it intermittently until 1919. A total of 15 shafts were sunk, 7 on the east side of Stillwater Brook, 8 on the west side (Douglas, 1939) and thousands of feet of drifts and crosscuts were made from them (NSDM). The shafts were sunk to varying depths of up to 37 m. During this time it is reported that approximately 45 tons of concentrate at 72% WO3 was removed. No work occurred again until 1942.

In 1942 work began again on the site, but after a long incline was sunk and 200 m of drifting done, nothing new was found. After dewatering the shafts and drifts in 1942, examinations by G.V. Douglas indicated that there was several tons of scheelite available by high grading the previous drifts (Miller, 1974). Salvage operations began in early 1943 and continued until all possible scheelite was brought to the surface (NSDM) later in the year. Work on the property then ceased.

Further exploration was undertaken from 1969-74 by E. Martin, who carried out extensive trenching, and exposed a number of the veins in the area. He produced an estimated 1500-2000 pounds of scheelite by high-grading the dumps (Miller, 1974). In 1977 TFM Mineral Resources Ltd. claimed the property and hired D. Nance as consultant to evaluate it. He recommended that there was not sufficient scheelite to warrant further work on the property (Nance, 1977).

During operations at the mine it is reported that 3 scheelite bearing veins were discovered ranging in thickness from 2.5-20 cm (Little, 1959).

It is reported that a little scheelite occurs in some of the leads at the Moose River gold mines 3.2 km to the east. The principal showings are on the Kaulback and Cameron properties (NSDM). No production is reported from these showings.

THESIS WORK

One day was spent in the area looking over the mine site. Several old trenches that had collapsed along with a couple of shafts were located. Outcrop in the area is very scarce except for some which is found along Stillwater Brook.

The majority of the time was spent at the site of what appears to have been a crusher (fig. 7a). It is found on the main road through the property next to Stillwater Brook (fig. 7b). The area appears to have been a dump pile for the crusher and there is abundant broken rock scattered throughout the area. A lot of this rock contains scheelite in the quartz veins which often is nearly massive, filling the whole vein. At the Brook interbedded slates and quartzites crop out but contain no veins. Meanwhile scheelite can be found in the rocks on the stream bed. A total of 45 samples was collected from the area most of them coming from this location. More than half of these samples contain scheelite.

Nance (1977) stated that numerous veins are exposed. However, the author found no outcrops of these.

STRATIGRAPHY

The host rocks of the Stillwater Brook deposit are located in a low horizon of the Goldenville Formation (Douglas, 1941). The scheelite-bearing veins in the area are interbedded and conformable with the bedding of the host rock. The veins range in thickness from

2.5-20 cm (Little, 1959) and are found within slate beds (Malcolm, 1912; 1929; Douglas, 1941) in the series.

Faribault (in Malcolm, 1912; 1929) believes that the host quartzites show some minor metamorphic changes since they are somewhat schistose. He describes the interbedded slates to be graphitic with black specks throughout giving evidence of incipient recrystallization and the formation of a knotted phyllite. Adjacent to the vein they carry much white scaly mica and well-formed arsenopyrite. Nance (1977) referred to them as dark gray greywackes and slates. The author noted grey greywackes, quartzites, and slates. The slates were described as: grey to green in colour; waxy to semiphyllitic in appearance; abundant white micas in fractures; well formed arsenopyrite crystals in both the quartz and country rock; and locally long, thin, black rutiles were found predominantly in the quartz but also in the slate.

Thicknesses of these beds could not be measured. A search through the literature did not find any mention of either absolute or relative thickness of the beds. No drill holes have been put down in the area. The only way found to measure the beds and obtain sandstone:shale ratios was to measure them on two generalized transverse sections prepared by Faribault in 1911 (in Malcolm, 1912). The blown up versions included here in the back (see also fig. 8) were measured. The cross section through No. 4 to the north of the anticlinal axis gave a ratio of 2.1:1.0 and to the south 2.0:1.0. The section through the crosscut west of shaft No. 14 gave a ratio of 1.0:1.1 both north and south of the axis. This is not what might be expected in the lower levels of the Goldenville Formation.

Measurements made from Faribault's cross sections through the map area placed the mine site 5200 m below the base of the Halifax Formation. The author notes that these measurements may not be accurate since at the scale that the cross sections were drawn the apparent thicknesses of the slate beds may not be the true thickness. In the area near the crest of these folds there is reported drag folding in the slates. If this is the case here then at this scale the slates would give a greater apparent thickness and a lower sandstone:shale ratio than expected.

The nearest granites to the area are located 16 km to the south.

STRUCTURE

Two kilometers east of the scheelite property the Beaver Dam and Fifteen-Mile Stream Anticlines converge near the Moose River gold mine and form the Moose River Anticline which runs through the Stillwater Brook mine (appendix B, map 1). The Moose River Anticline is reported as being very broad and plunging gently SW. Superimposed upon the anticline at the Stillwater property are three anticlines and two synclines which trend roughly east-west and plunge 12° to 17° west (Miller, 1974). The axes of the northern and southern anticlines lie approximately 200 m apart (Messervey, 1930). Figure 6 is from Douglas's work in 1939.

The bedding in the area is generally east-west and dips at varying degrees from 50° to 90° , north and south. Cleavage is near vertical throughout the area (Nance, 1977).

Douglas (1939) indicated a left hand (14 m displacement) horizontal fault west of Stillwater Brook striking 045°. He also noted two small right hand ones in the brook striking 160° and dipping steeply west with a displacement of 45 cm. He also suggested a longitudinal fault paralelling the axis of the major anticline. He could not determine its dip or displacement. After further mapping in the area in 1941 Douglas determined that all three were left hand faults (Douglas, 1941). Both Faribault (in Malcolm, 1912) and Messervey (1930) noted that the major fault in the area west of the brook had a displacement of between 25 and 57 m. Little (1959) noted that the faults cut both strata and veins.

Quartz veins in the area vary in thickness from 1 to 60 cm and are found within the slate beds which are interbedded with the quartzites. The major scheelite-bearing veins are reported to average 2.5-10 cm across. Scheelite is found on the limbs of the anticlines but not on the apex of all the folds (Malcolm, 1912). Veins are generally uniform in width but some enlargements and rolls are common (Malcolm, 1912; Messervey, 1930; Douglas, 1941) and tungsten values generally increase in these areas. The rolls plunge westward and parallel the plunge of the fold. In the larger veins the scheelite occurs between the wallrock and the vein; in the smaller ones (which average 10 cm in width and in which most of the scheelite is found) it occurs as lenses (Douglas, 1939). A remarkable feature of the

Stillwater Brook deposit, as opposed to most deposits of tungsten ore, is their continuity in form and consistency in tungsten content (Malcolm, 1912).

MINERALOGY

Quartz is by far the most abundant mineral in the vein and appears to be of two types (Miller, 1974): 1) transparent, glassy and dark in colour; 2) milky with a greasy luster. In the veins it is found to be highly strained and Miller (1974) and the author noted strained quartz grains in the sedimentary rocks to have undulose extinction in thin section. The quartz veins are locally fractured and occasionally scarce muscovite can be found along these. Other mineral phases in the veins are: scheelite; ankerite; dolomite; arsenopyrite; calcite; rutile; muscovite; and minor amounts of pyrite. Traces of gold, silver and platinum are noted by the NSDM.

Scheelite is noted by Miller (1974) to occur in three forms in the veins: crystals 2.5-7.5 cm in length; coarse granular masses; and lenticular "kidneys". The scheelite is often veined by quartz (figures 9 and 10a) and usually found on or near the walls. Miller (1974) noted that the veins of quartz may be found in contact with the walls.

Ankerite is believed to be the most common carbonate mineral found in the veins. It is usually found along the walls of the vein and is almost always associated with scheelite although the opposite is not necessarily true. The ankerite is also commonly veined by the quartz (figures 10b and 11). Although it was not recognized in hand specimen or in thin section the existence of dolomite was proven by probe analysis (appendix C1). Faribault (in Malcolm, 1912) found dolomite in the veins but it has not been reported in the literature since that time. How much of the alleged ankerite is actually dolomite has not been determined. The minerals found to be dolomite were probed originally with the belief that they were ankerite.

Arsenopyrite was noted by Miller (1974) to occur as massive bodies varying in shape. The author noted it as individual well-formed grains in the host rock (fig. 11b) and along the quartz vein edge of a carbonate covering along the slate wall. Miller further noted that small blebs of a yellow sulphide surrounded some arsenopyrite crystals. The author also noted in thin section arsenopyrite accompanying quartz in veinlets into the ankerite. Some micas also appeared to be associated with these veinlets.

Rutile can be seen in hand specimen as long thin black needles (fig. 12a) in the veins and in the country rock. Originally noted as tourmaline by most authors including Malcolm (1912) and Newhouse (1936) they were probed by Miller (1974) and the author and found in fact to be rutile (appendix C1). It must be noted here that these large (up to 1 cm) crystals may not necessarily be of the same generation as the small (0.1 mm) "moth eaten" rutiles that are noted in the sedimentary rocks (fig. 12b, proven by probe analysis) here and elsewhere.

Calcite was also noted in the vein and proved by XRD.

The slate host rocks are well cleaved and consist primarily of chlorite (0.1-0.2 mm) aligned along the cleavage planes and and small (0.1 mm) quartz grains. Plagioclase was also noted and proven to be albite by XRD. In the slate 2-3 mm long pods of quartz and chlorite crystals are orientated along cleavage and often contain well-formed arsenopyrite crystals 2-3 cm long. The arsenopyrite commonly appears corroded in the center and appears tarnished in these areas. Rutile as small "moth eaten" blebs is found throughout the sediments.

Miller (1974) found that the time relationships of the minerals appeared to be contradictory and therefore proposed that each phase had more than one period of introduction as follows: 1)Crystallization of scheelite, along with glassy quartz, carbonate, rutile, and arsenopyrite; 2) main introduction of scheelite-carbonate, quartz and arsenopyrite; 3) arsenopyrite and carbonate; 4) milky quartz, rutile and sericite. The author's work found general agreement with Miller in that scheelite and ankerite (or dolomite) were early precipitates which were followed by quartz, arsenopyrite, and rutile in turn followed by muscovite along the fractures (fig. 13).

Douglas (1939)

FI . 6A

FOR BLOWEN UP VERSIONS 6A AND 6B SEE POCKET IN BACK.

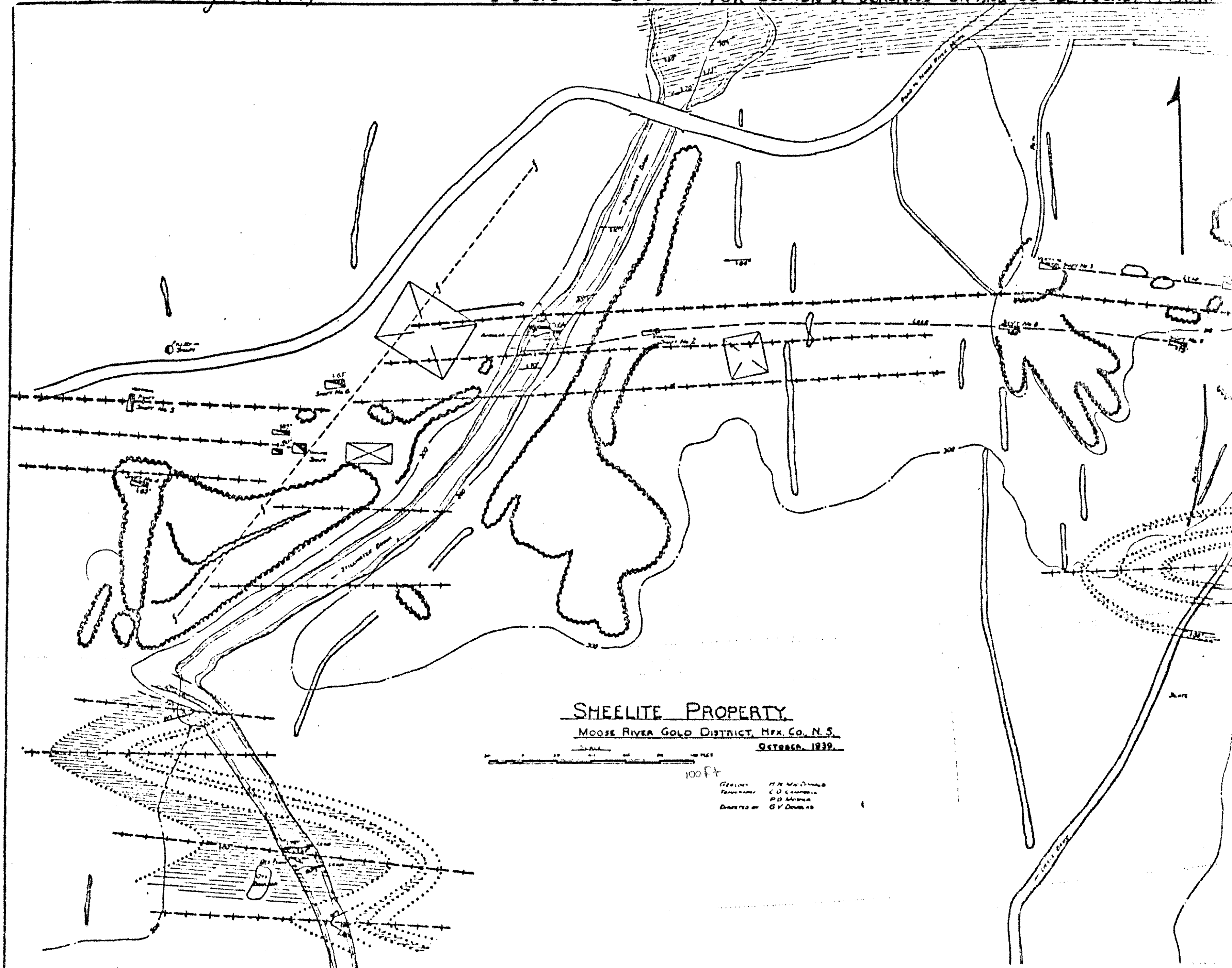
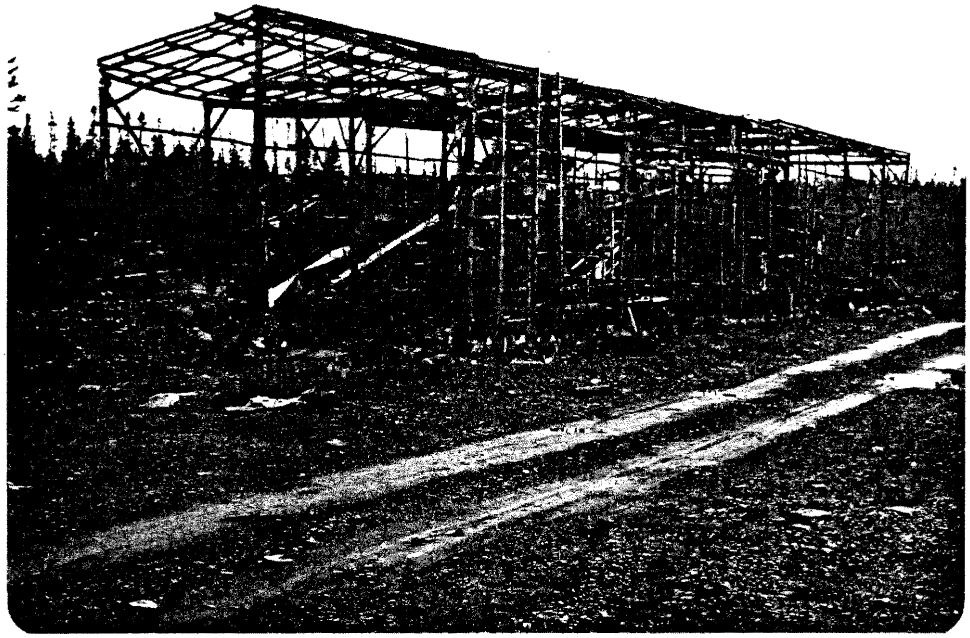


FIG. 7

A) THE CRUSHER AT THE STILLWATER BROOK MINE. WORK HAS OCCURRED IN THE AREA RECENTLY.

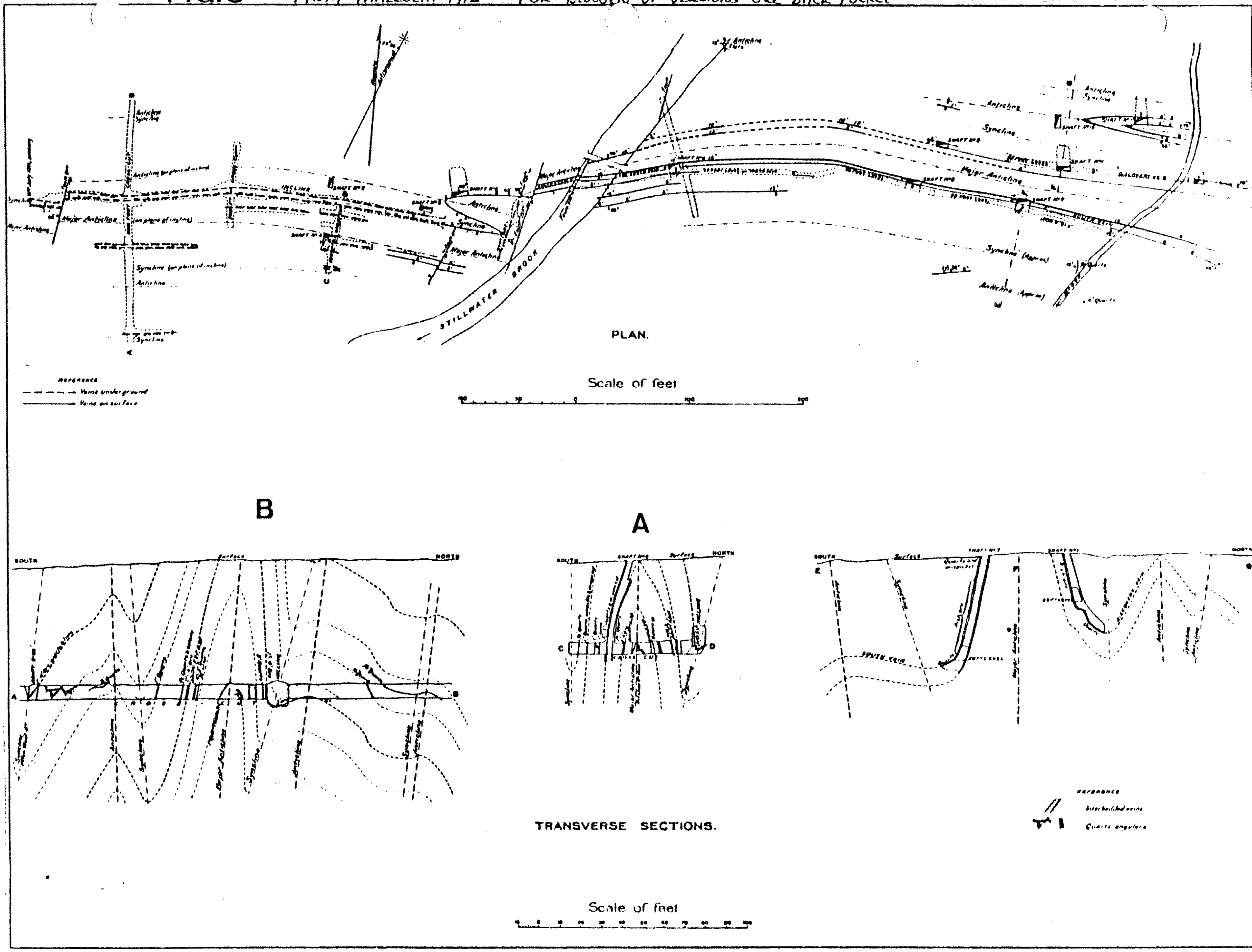
B) STILLWATER BROOK WITH DUMP PILES FROM THE MINE IN THE BACKGROUND. THE CRUSHER IN 7A IS JUST OUT OF SITE TO THE RIGHT. THIS AREA INCLUDING THE STREAM CONTAINS ABUNDANT SCHEELITE.

7a



7b

FIG. 8 FROM MALCOLM 1912 FOR BLOWN UP VERSIONS SEE BACK POCKET



To accompany Memoir No. 20

Fig. 20—THE TUNGSTEN DEPOSIT

SCHEELITE, HALIFAX COUNTY, N.S.

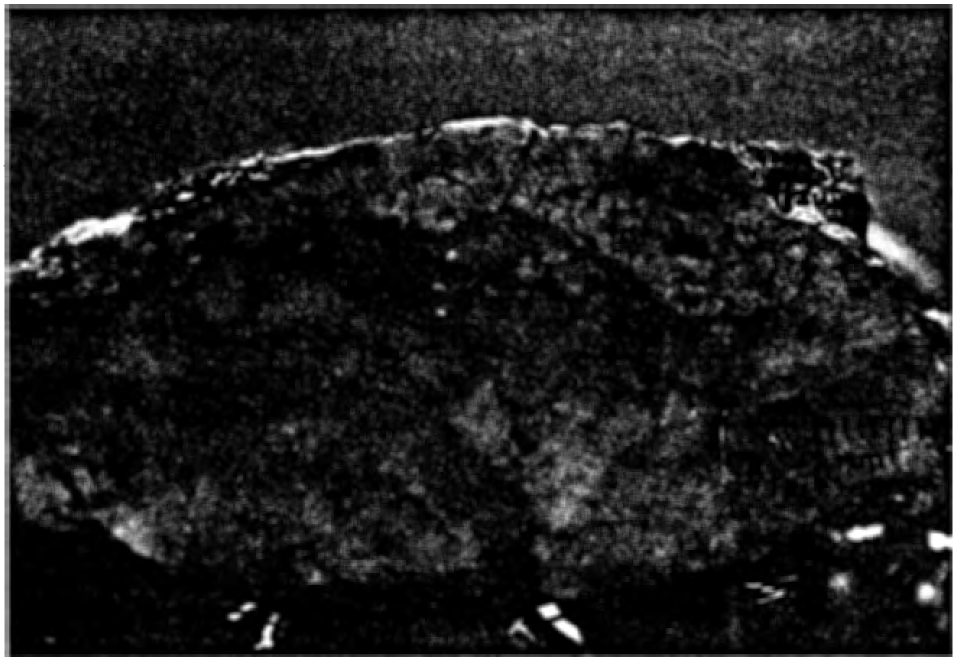
Geologically surveyed in 1911 by E.R.Faribault

FIG. 9

58-17 A) SCHEELITE ALONG THE UPPER EDGE OF THE SLAB IS SEEN WITH ABUNDANT QUARTZ VEINING. THE WHITE GRAIN ON THE LOWER EDGE IS ANKERITE.

B) UNDER ULTRAVIOLET LIGHT, THE SCHEELITE FLUORCES BRIGHT WHITE. QUARTZ CAN BE SEEN VEINING THE SCHEELITE.

9a



9b

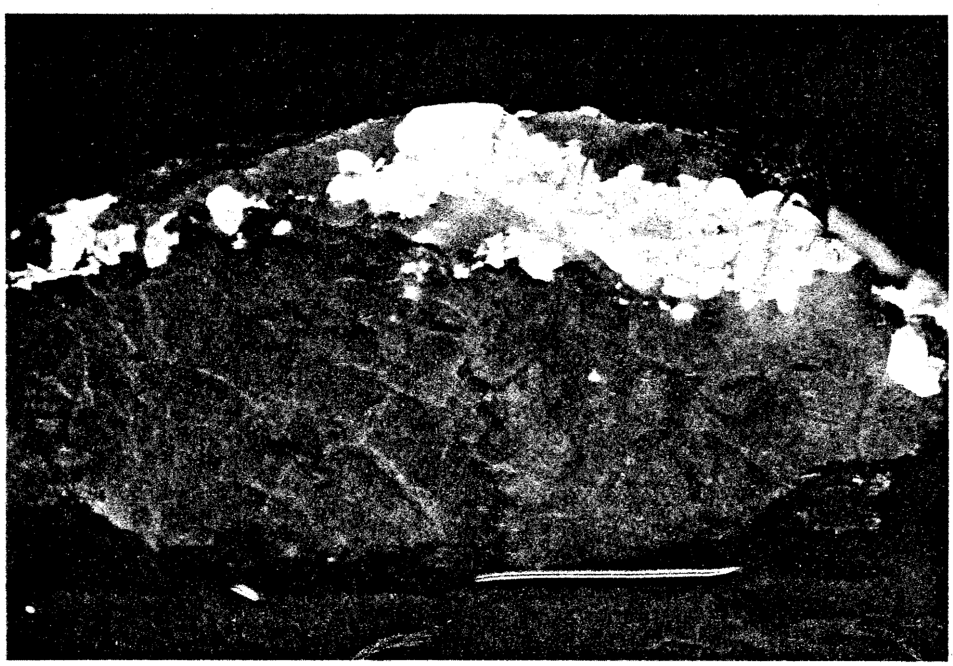
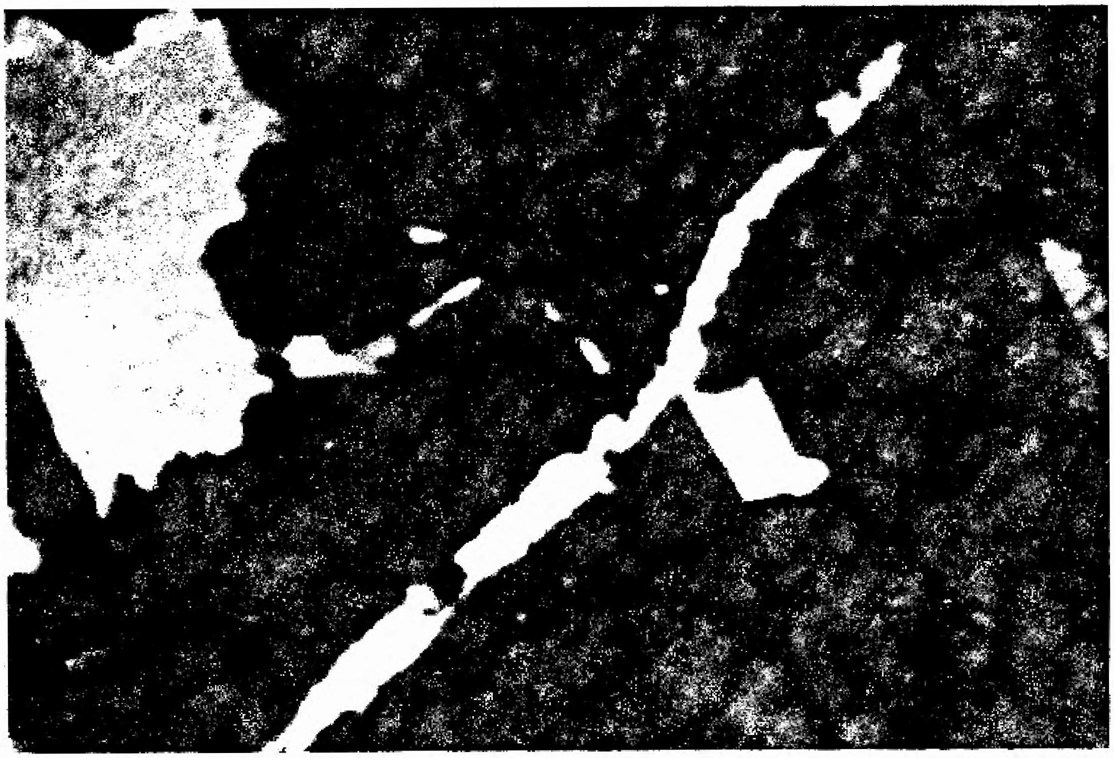


FIG. 10

SB-1 A) UNDER CROSSED NICOLS SCHEELITE IS VEINED BY QUARTZ. THE HIGH BIREFRINGENCE COLOURS ARE DUE TO THE SLIDE BEING EXTREMELY THICK AS A RESULT OF POLISHING.

B) ANKERITE (BUFF COLOUR) VEINED BY QUARTZ.

10a



1mm

10b

1mm

FIG. 11

SB-25 A) AN ANKERITE GRAIN FRAGMENTED by QUARTZ EMPLACEMENT. Good EVIDENCE FOR A LATE QUARTZ EMPLACEMENT.

SB-5 B) THE WHITE GRAINS IN THE QUARTZ ARE ANKERITE, found predominently IN THE LEFT side of THE VEIN. IS veined by WHITE-LIGHT GREY QUARTZ. THE CRYSTALS ALONG THE upper Edge ARE ARSENOPYRITE, AND THE SMALL yellow GRAINS IN THE SLATE ARE PYRITE.

11a

0.1mm

11b

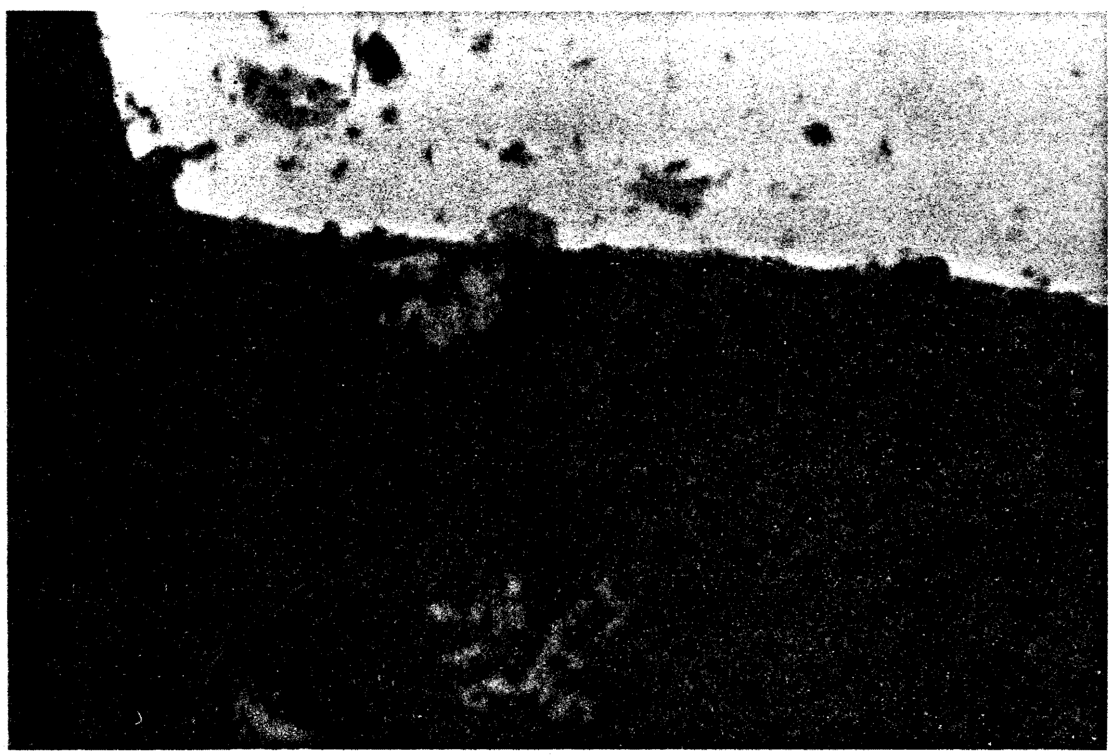
FIG. 12

SB-1 A) THE WHITE-YELLOW MINERAL IS SCHEELITE THAT IS VEINED BY QUARTZ. THE SMALL DARK SPOTS IN THE QUARTZ ARE BLACK RUTILES. ONE LARGE ONE (CUT LENGTH WISE) CAN BE SEEN WITHIN THE SCHEELITE NEAR THE UPPER LEFT OF THE SLAB.

SB-35 B) THE GREY OPAQUE MINERAL IS "MOTH-EATEN" RUTILE. THE LARGE WHITE GRAIN IS ARSENOPYRITE.

12a

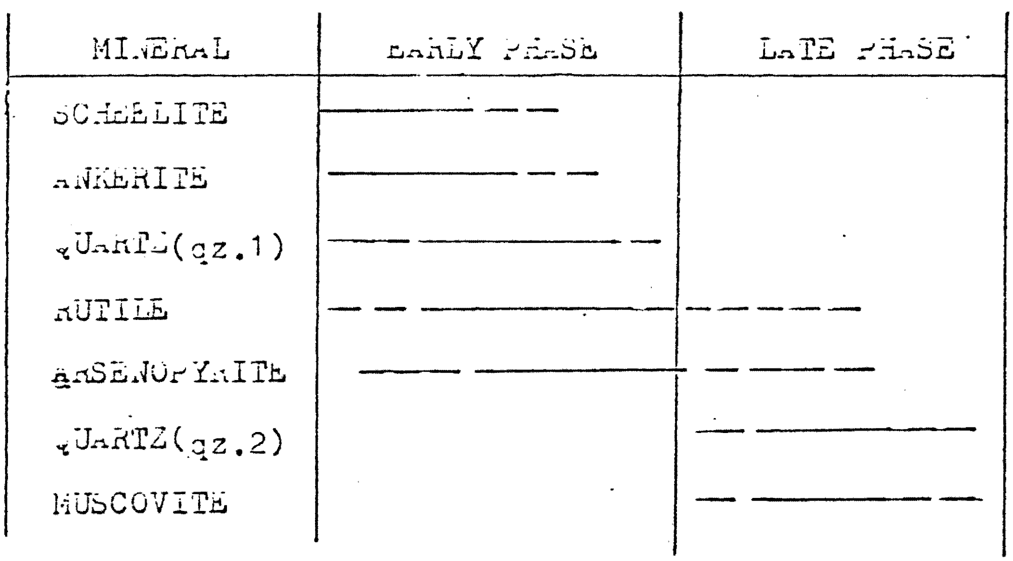
12b



0.1mm

FIG.13

Figure III-6. Paragenesis of the mineralized veins at the Moose River scheelite mine.



From Shaw (1983)

CHAPTER 5

FALL RIVER

LOCATION AND ACCESS

The Fall River scheelite mine is located approximately 1.5 km north of the Waverly gold mine and the community of Waverly (appendix A, map 2). It is found at latitude 44°47'35" and longitude 63°37' on topographic map 11D/13. The NSDM occurrence report has it wrongly located about 1 km south of this location. The mine site can be accessed by foot from Bicentennial Drive near Lake Thomas where the old Cobequid Road intersects the highway. Although the road is drivable and the mine site can be reached by car from Fall River, the Cobequid Road cannot be accessed by car from the highway due to the construction that took place. From the highway one travels north along the old road for 200 m then turns west, where the mine is 200 m into the woods, along the crest of a ridge about 15 m above the height of the road.

GEOGRAPHY

The deposit is located on a ridge that rises 15-20 m above the surrounding land to the east. Along the side of the ridge there is abundant outcrop. The remaining area consists predominantly of low rolling hills as the land slopes down to Lakes Perry and Thomas.

The area is mostly softwood trees with some birch and small scrub throughout. The land at one time appears to have been logged over and there seems to be some minor cutting (likely a private woodlot) going on in the vicinity today. There are no streams near the mine site. During operations water had to be pumped in from Lake Thomas. The ridge appears to be close to the boundary of the Lake Thomas and Perry Lake watersheds.

PREVIOUS WORK

During 1911-12 the first work was begun on a single interbedded quartz vein which averaged 5 cm in width with a strike of 070°. The work consisted of 100 m of trenching along strike and digging two shafts 10 and 14 m deep. By 1917, 750 pounds of WO_3 assayed at 70.9% were reported to have been removed. In 1925 one trench was extended for 70 m to a depth of 15 m where the vein averaged 20 cm in width. In 1939-40 trenching was extended for 370 m. One shaft was deepened to 25 m and a 20 m drift was dug at the 20 m level. Unfortunately there are no production figures available since

1917.

Faribault (in Malcolm, 1929) reported that to the south another quartz vein containing scheelite occurs which has not been carefully examined, nor have other veins in the area.

THESIS WORK

The Fall River deposit was not located until the third day in the field searching for it. This was due to its wrong location on the occurrence reports of the NSDM. Three additional days were spent in the area mapping the site (fig. 14), measuring beds and searching for scheelite.

This occurrence has the best exposure of all occurrences visited. Outcrop is abundant enough along the ridge, especially at the eastern edge, to give a good cross section through the strata. Although some of the trenching is filled in there are still some good exposures of the vein in some of the trenches and near the shafts. The shafts themselves are filled with water and cannot be examined.

There was no visible scheelite in the exposed veins, but it could be found through the dump piles in the area. Samples of 61 rocks were taken, mostly of dump rock, with some of it from the exposed vein, and the rest from slate and quartzite outcrops.

GEOLOGY

STRATIGRAPHY

The quartz vein is found lying conformably within the interbedded slates and quartzites of the Goldenville Formation. The author noted that the vein is found within a slate bed that averages 30 cm in width (fig. 15). The NSDM reported that it is usually found on the hanging wall within this bed but at other times can be found at other places in the bed.

The slate beds in the area range in thickness from 5-87 cm and the quartzite beds from 10-213 cm. Sandstone:shale ratios are measured for the beds stratigraphically above the vein, 2.3:1.0, and for those below it, 5.7:1.0. The overall average for the area is, 3.6:1.0. Figure 16 is a cross section drawn of the beds measured in this area. Faribault's maps and cross sections (1886-1939) were interpreted by the author who found that the Fall River deposit lay 2100 m below the base of the Halifax Formation.

The author noted the slates and quartzites to be dark-light gray in colour and contain both arsenopyrite and biotite. Both the NSDM and Little (1959) reported the host rocks to be slates and arkoses.

The nearest granite to this deposit is found 3.2 km to the north.

STRUCTURE

The Fall River mine site is located on the northern limb of the Waverly Anticline. Bedding in the area was measured between 059° and 075°, averaging 065°, and dipped from 75°-90° to the north. The strike of the cleavage is the same as for the bedding but it dips from 65°-90° south. Some of the beds consist of very fine well-developed laminae that have good cross-bedding and give a younging direction to the south, indicating that these beds were overturned. This would agree with Faribault who mapped overturned beds on the east side of Lake Thomas.

One quartz vein ranging in thickness from 1.5-20 cm and averaging 5 cm, is found interbedded in the slates and quartzites (NSDM). One part of the quartz vein was measured in the field at 23 cm in width. Various reports of the NSDM, Messervey (1930), and Little (1959) report that the scheelite occurs in "chutes" or zones that pinch out westward. They claimed that the rest of the vein is usually barren but may contain specks of scheelite. These zones are usually found along the wall and are 5.0-7.5 cm thick and 7.5-10 cm long, containing solid scheelite. True rolls as such are not mentioned in the literature.

MINERALOGY

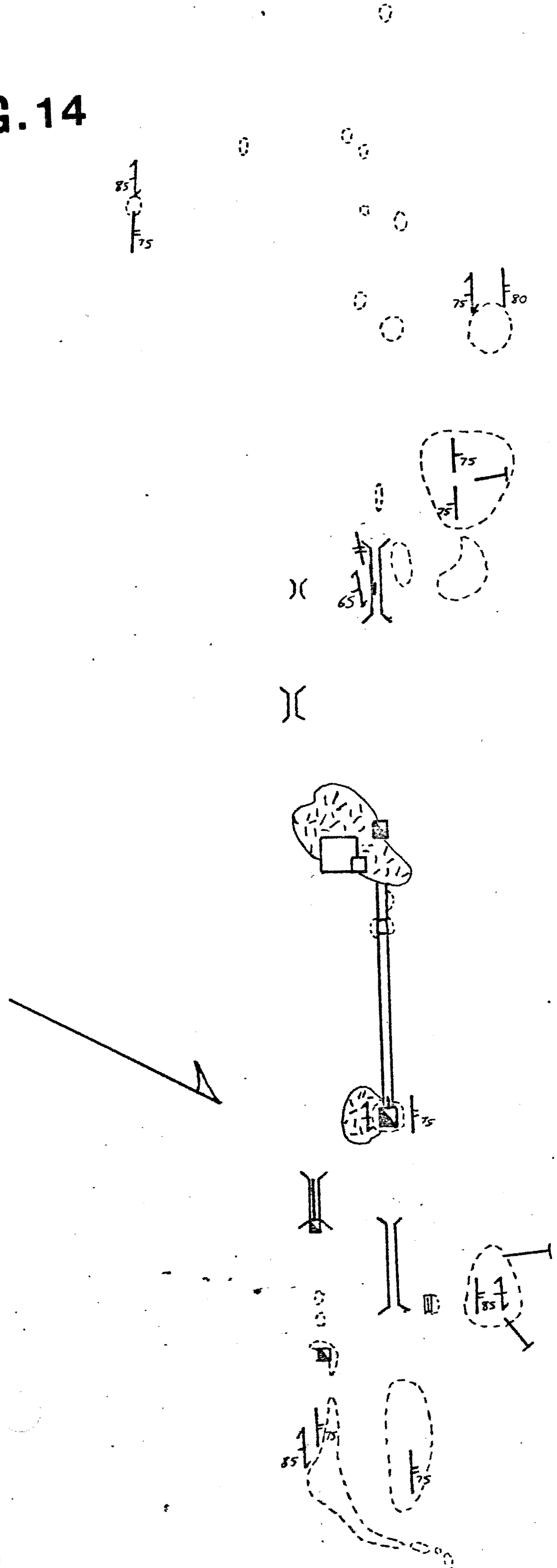
Scheelite is reported to be associated with arsenopyrite and galena in the ore shoots (NSDM; Messervey, 1930). The author found scheelite only in the dump rock where it is was found within the quartz vein associated with slate chips (fig. 17). Neither arsenopyrite or galena were noted in the vein material but arsenopyrite is abundant in the host rocks. The quartz veins have abundant carbonates occurring mostly along the walls and also in fractures. X-ray diffraction techniques proved these to be ankerite and calcite.

Polished-thin sections of the quartzite showed abundant 0.1-0.5 mm quartz grains with a minor amount of plagioclase. Cleavage is poor but does have some chlorite developed along it. Scarce muscovite can also be seen. Small (0.1 mm) "moth-eaten" rutiles were also common. The slate consists mostly of very fine-grained micas, occasional quartz grains, some randomly orientated biotite, rutile, and arsenopyrite. The quartz veins have slate along the edge associated with large (up to 2 mm) euhedral arsenopyrites, usually in pressure shadows, and large (up to 2mm) euhedral biotites. There are also carbonates, commonly veined by quartz, and chlorite. X-ray diffraction indicated that the chlorite is clinochlore.

In hand specimen a green banded structure was evident in many of the rocks. The bands are composed of chlorite (0.5 mm) and small (0.1 mm) "moth-eaten" rutiles. All the quartz in the veins was highly strained.

The NSDM reported gold assayed at 0.04 oz per ton and traces of platinum in the gold. Faribault (in Malcolm, 1912; 1929) and Messervey (1930) reported that the veins do not contain any gold.

FIG. 14



FALL RIVER

Key

Vein	
Bedding, Tops unknown (Inclined, Verticle)	
Cleavage (Inclined, Vertical)	
Joint (Inclined, Vertical)	
Trench	
Open cut	
Rock Dump	
Outcrop	
Shaft	
Building	
Stream	

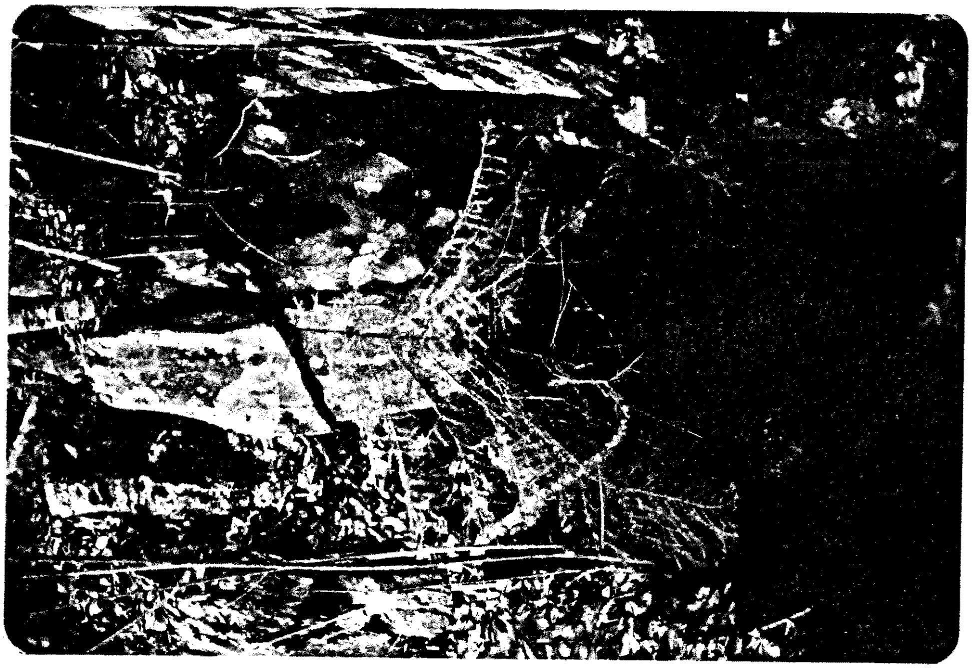
Scale 1:1000

0 20 METERS

FIG. 15

TWO SHAFTS AT FALL RIVER. THE FAR WALL IN EACH PICTURE CONTAINS A 10 cm QUARTZ VEIN CONFORMABLE WITH THE SLATE AND QUARTZITE. ALTHOUGH NOT OBVIOUS AT THIS DISTANCE BOTHS VEINS ARE WITHIN A SLATE bed.

15a



15 b

0 2 4 Feet

FIG. 16

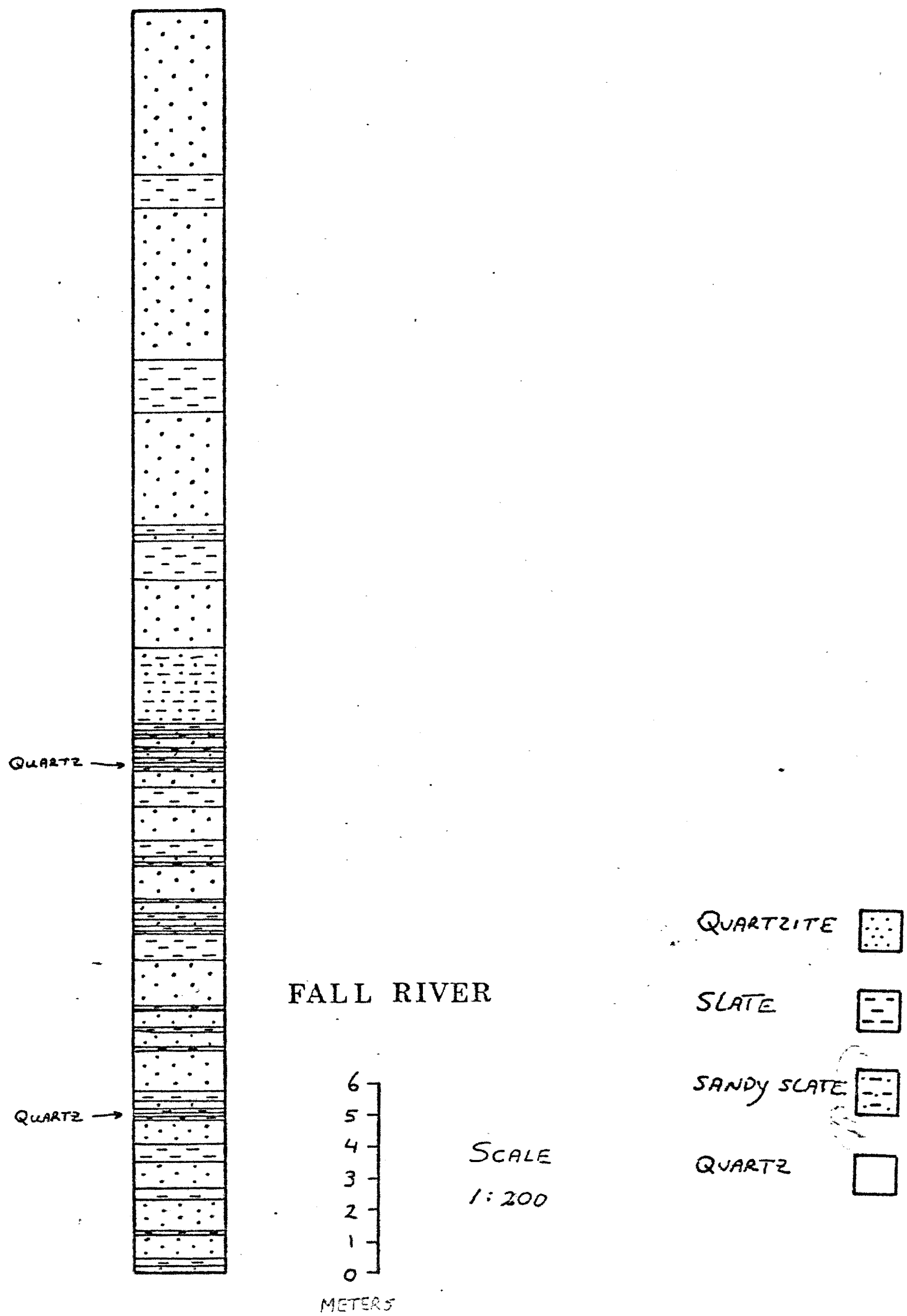
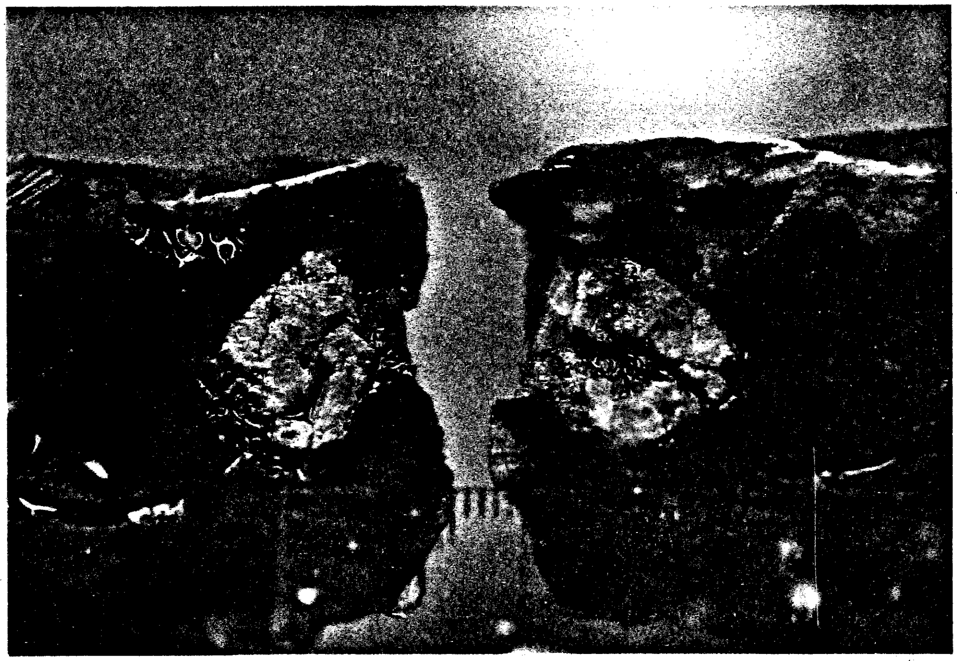

QUARTZ
QUARTZ
FALL RIVER
6
5
4
3
2
1
0
METERS
SCALE
1:200
QUARTZITE
SLATE
SANDY SLATE
QUARTZ

FIG. 17

FR-25 A) Single well-formed scheelite crystal within slate that is found in the body of the quartz vein.

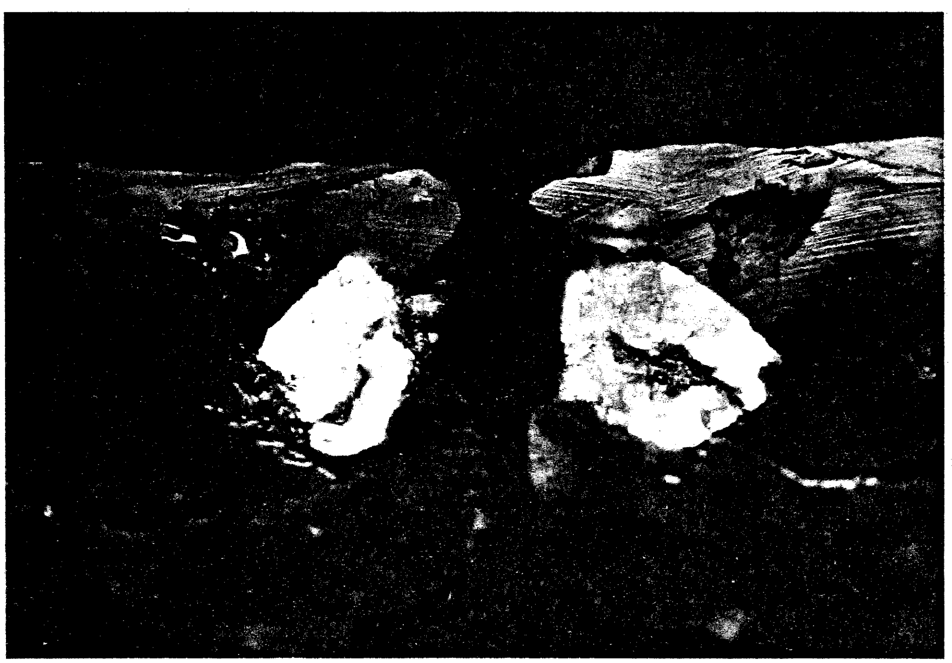
B) Under ultraviolet light, note the quartz veining the scheelite.

17 a



1 cm

17 b



CHAPTER 6

GOFF

LOCATION AND ACCESS

The Goff scheelite mine is located in the central northern part of Halifax county, approximately 3.2 km NE up the old Guysborough Road from Goff and approximately 1.5 km SE down an old woods road adjacent to the radio tower, at latitude 63°25'30" and longitude 44°53' on topographic map 11D/14 (appendix A, map 3). This old woods road, no longer suitable for driving, can be followed to a swamp by an old cabin where it appears to end. On the other side of the swampy area, which is about 50 m across, a small path can be found. This is followed for about 300 m and the mine site is about 30 m off the path to the east.

GEOGRAPHY

The maximum difference in elevation in the area of the mine site is reported to be 7 m. The topography varies between areas of slightly higher elevation, usually associated with outcrop, which are surrounded by boggy or swampy areas. It would appear that this is the area on Faribault's map (appendix B, map 3) called Caribou Bog. The mine site is located on one of the outcrops in a higer relief area. The vegetation on and surrounding the outcrops is mostly large fir trees while that in the boggy areas is knee-to waist-high shrub. One small-slow moving stream runs in SSW. There was no apparent use for this land except for the mining activites.

PREVIOUS WORK

The Goff deposit was first discovered in 1918 by Joseph Cope, who with some friends soon after opened the first trench (Little, 1959). Very little work was done until Mr. Cope took Ralph Kirkpatrick to the property in 1931. Work continued intermittently until 1942 during which time stripping and trenching uncovered 6 veins containing scheelite. Total production during this time was 3000 pounds of scheelite which assayed at 72% WO_3.

Since 1942 very little work has been done on the property, apart from a little work conducted in the mid 1950's, including a report by Hopkins Exploration Consultants. Nothing came of this and no work has been reported since.

THESIS WORK

The Goff deposit was mapped (fig. 18) over a two day period during which time 26 samples were collected from the quartz veins, outcrop and the dump piles. The trenches have exposed the quartz veins quite well but unfortunately no scheelite was found exposed except for that in the dumps. In one area of the trenches there appeared to be a shaft (although none are reported in the literature), but it was full of water and nothing could be seen. There seemed to be some recent prospecting in the area indicated by fresh hammering and some digging in the trenches, but again this is not noted in recent files of the NSDM.

GEOLOGY

STRATIGRAPHY

The prospect is located in the quartzites and slates of the Goldenville Formation. At the mine site the slate and quartzite beds are well interbedded with the slate beds being much thinner than the quartzite. In fact all the quartz veins noted were within the slate beds or between the slate and the quartite. Douglas (1939) noted that the slate beds ranged in thickness from 15 cm to 180 cm and always contained at least one quartz vein. The author found the slate beds to be from 3 to 240 cm thick and did not note quartz in all of them. The quartzite beds were from 30 to 500 cm thick.

The sandstone:shale ratio in the area measured from the outcrops averaged 1.8:1.0 while over smaller areas it ranged from 1.4:1.0 through to 2.3:1.0. Faribault (from various maps and cross sections) mapped the area at this deposit as being 3650 m below the base of the Halifax formation. The nearest granite to this deposit is found 4.8 km to the south.

The slates are light green to grey in colour, well cleaved, and show abundant small (approximately 1 mm) prismatic crystals of arsenopyrite throughout the rock. The quartzites are light grey, massive, with arsenopyrite disseminated throughout.

STRUCTURE

The Goff deposit is found on the north limb of the Waverly Anticline about midway between the axis of the Waverly Anticline to the north and the Wyses Corner Syncline to the south. The anticlinal axis is located 1700 m to the south of the prospect (Douglas, 1939). According to Douglas (1939) the beds strike approximately 096° and dip from 70°-85° N, while the cleavage strikes 075° and dips 70°-80° to the south. The author although agreeing with the cleavage directions found that the beds had a strike of 070° and dipped from 70°-90° to the south. Bedding and cleavage were both easily distinguished in the slates and from the slate-quartzite relationship.

Drag folding was recognized by the author in one outcrop of slate next to a quartz vein, and was noted also in the literature (Douglas, 1939; Little, 1959; NSDM). Drag folds are parallel to the bedding and plunge 25° to the east, defining the direction and plunge of the ore shoots. Six quartz veins have been uncovered by trenching, all of which parallel the bedding for 6 to 24 m and average 15 cm in width, but locally in drag folds are up to 18 inches wide (Douglas, 1939). The NSDM noted that the scheelite is found mainly in two positions in the veins: 1) where the vein begins to narrow down; and 2) on the quartz rolls in shoots, following the inclination of the dragfolds. They further noted that most of the scheelite occurs in these pockets, which average 15 cm in length by 10 cm in width.

Douglas (1939) reported faulting in the western end of the property with a displacement in the order of 70 m, where the ground in the west has moved northerly relative to the ground in the east.

MINERALOGY

Scheelite is reported to occur mostly in pockets or rolls of quartz asociated with arsenopyrite, pyrite and bog manganese (NSDM). In the field the author was able to find only disseminated scheelite in the dump rocks and pockets of large (up to 3 cm) arsenopyrite crystals associated with a minor amount of pyrite. X-ray diffraction confirmed the presence of these minerals and calcite.

Thin-polished sections show a good cleavage through the slate with abundant fine micas and quartz orientated along it. Large muscovite and chlorite crystals (0.5-1 mm) occur randomly throughout the section, commonly occurring perpendicular to the cleavage. A minor amount of plagioclase was also noted. Large (up to 1 mm) fractured arsenopyrite crystals in pressure shadows and small "moth-eaten" rutiles are also common (fig. 19). One large (1 cm) crystal of scheelite was found in the center of a quartz vein with abundant quartz veining the mineral. A crystal of what is interpreted to be ankerite veined by quartz was also found in the center of the quartz mass.

FIG. 18

GOFF

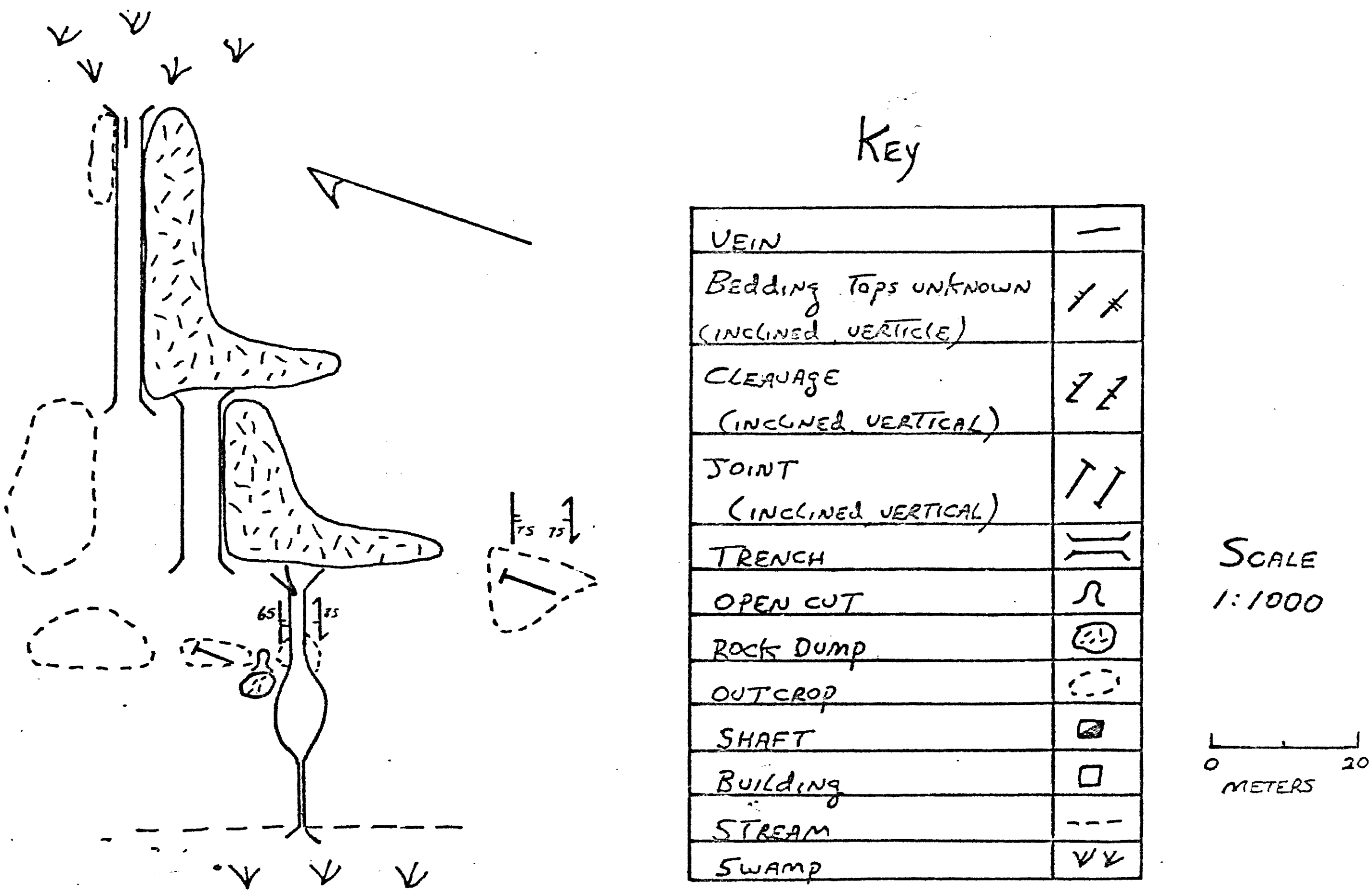
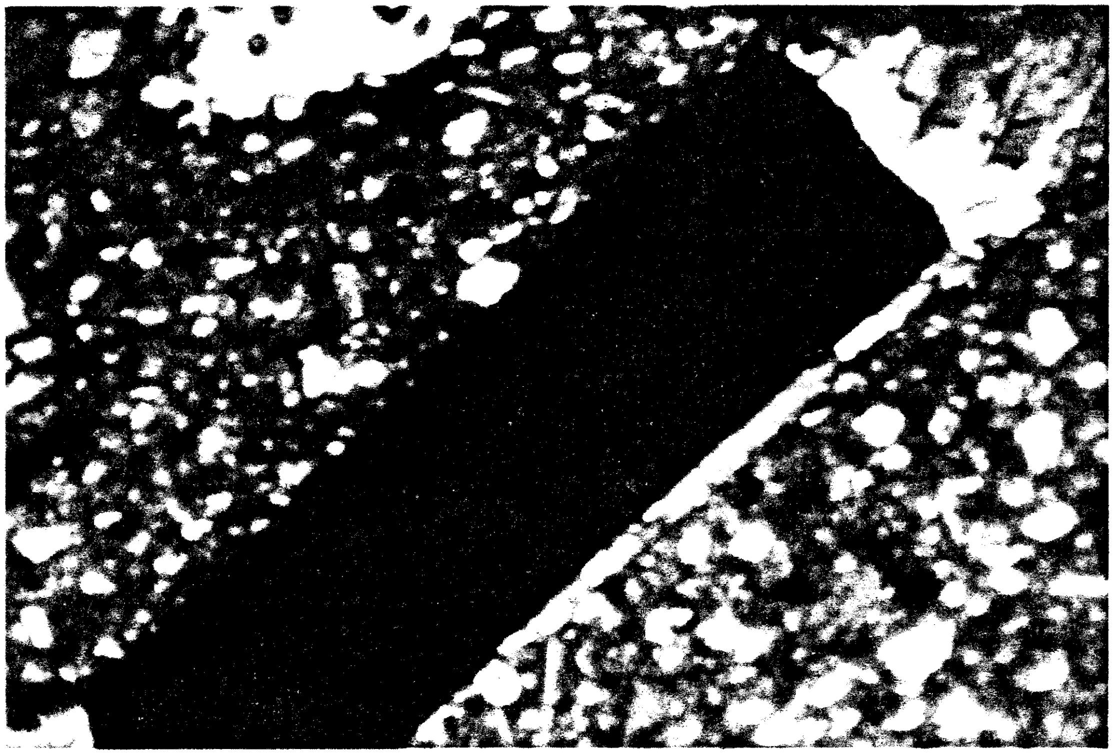

75
75
65
75
Key
Vein
Bedding Tops unknown (inclined, verticle)
Cleavage (inclined, vertical)
Joint (inclined, vertical)
Trench
Open cut
Rock Dump
Outcrop
Shaft
Building
Stream
Swamp
Scale 1:1000
0
20
Meters

FIG. 19

GF-1A A) LARGE well-FORMED ARSENOPYRITE IN A PRESSURE SHADOW. THE GREENISH-YELLOW MATERIAL IN THE GROUNDMASS IS CHLORITE AS IS THE LARGE GREEN MINERALS IN THE PRESSURE SHADOW. THE SMALL OPAQUES ARE RUTILE.

GF-1A B) THE BUFF-G OPAQUE MINERAL IS "MOTH-EATEN" RUTILE. THE LARGE WHITE CRYSTAL IN THE LOWER RIGHT IS A FRACTURED ARSENOPYRITE. NOTE THE RUTILE ON THE EDGE OF THE ARSENOPYRITE, A COMMON RELATIONSHIP AT GOFF.

19a



1 mm

19b

0.1 mm

CHAPTER 7

LAKE CHARLOTTE

LOCATION AND ACCESS

The Lake Charlotte scheelite property is in Halifax County located on the east side of Lake Charlotte, approximately halfway up the lake. It can be found on topographic map 11D/15 at latitude 44o 52' and longitude 62o 59', within 300 m of the lake near a point jutting into it (appendix A map 4). The area is fairly easily acessible by car by turning north off the eastern shore highway (Highway No. 7) at Tangier and driving north to Mooseland, and driving east along very good new dirt logging roads for 20 km, to where the road comes within 1 km of the lake. Unfortunately no roads go down to the mine or the lake and it is therefore hard to judge where you are along the lake since there are no good maps with these roads. The property may also be reached by boat from Upper Lakeville on the southwestern side of the lake. The site may be reached by car from the north through Murchyville but personal experience has shown four-wheel drive to be a necessity.

The trench in the northern part of the property can be found only 7 m from the lake, while the other trenching is found 200 m to the SW on the side of the hill and 130 m from the lake.

GEOGRAPHY

The scheelite property is on the side of a large hill which slopes down to the lake. The vertical drop is about 100 m over the area of the occurrence. A small point of land juts out into the lake which is a small hill itself on the slope of the larger hill. Two small streams run down into the lake in the vicinity of the mine, one running northwest around the small hill and the other, Ash Brook, south west around it. There is a larger seasonal stream in the eastern and southern areas of the property.

Vegetation in the area is mostly large softwood trees with a few hardwoods. The general area had been cleared and put under cultivation in the 1870s and the area became wooded since (Douglas and MacQuarrie, 1939). Today logging operations are quite extensive in the general area but not in the direct vicinty of the mine site itself.

PREVIOUS WORK

The Lake Charlotte scheelite prospect is located on the east side of the lake. On the west side scheelite has been reported from a couple of veins, but only one small vein reported any significant amount and it was traced for less then 2 m (Douglas and Macquarrie, 1939). The west side of the lake has been mined for gold and the east side for scheelite.

The scheelite property was first leased in 1934 to R.A. Logan who passed it on to Prospector's Associated Activities Ltd. in the same year. Work began on the prospect in 1934 and continued until 1939. During this time three veins were exposed by trenching (fig. 20). The first (trench No. 13) is near the shore, 45 cm wide and has been traced for 33 m. Scheelite is disseminated throughout the vein. The second vein (No. 2) is also 45 cm wide and is exposed intermittently up the hill for 200 m. Grades are reported to be relatively low in this vein. The third vein, near the No.2, is reportedly only 3-4.5 cm wide for 33 m and contains considerable scheelite (NSDM; Douglas and Macquarrie, 1930; Little, 1959). A shaft was sunk into the No. 2 vein to a depth of 25 m and drifting was carried out 33 m west and 46 m east.

In 1939 a mill was constructed and reportedly produced for a time (Little, 1959). Aside from 2 tons of ore taken as a mill test there are no production results for the mine.

More prospecting was carried out in 1940-41 amd limited work in 1947. Since this time no work has been reported.

THESIS WORK

Part of first day in the area was spent searching for the mine. The major problem finding the site was that the NSDM occurrence reports had the site located approximatley 1 km ENE of its actual location. A second day was also spent in the area examining the site.

The No.13 vein on the shore was well exposed for its full length and outcrops were visible near the trench (fig. 21). The dump rock near the lake and in the trench contained abundant visible disseminated scheelite. In fact scheelite was located in place throughout the vein. It was at this time that the batteries in the portable ultraviolet lamp died.

The trenches and the shafts of the No. 2 vein were easily found but unfortunately the majority of the trenches were filled in and little could be seen. The dump pile near the shaft was huge, over 10 m in height and contained abundant samples of quartz. Unfortunately no scheelite was noted in this area at all, but without the lamp they would be hard to locate.

A total of 23 samples were collected from the outcrop, including the veins, and the dump rock.

GEOLOGY

STRATIGRAPHY

The rocks here are interbedded slates and quartzites of the Goldenville Formation within which the quartz veins lie conformably. The author found that the veins were within a thin slate bed amongst thicker quartzite beds.

Although outcrop was found near vein No. 13 most of it was found along strike and therefore did not represent a very thick section, only about 2 m. Along vein No. 2 the host rock visible was only centimeters thick. A thorough literature search was conducted to see if any mention is made of drill holes in the area or of bedding thicknesses but none was. Therefore no measurements on the sandstone:shale ratio could be made. Faribault's maps and cross sections (1886-1939) were interpreted as placing the location of the occurrence 1125 m below the base of the Halifax Formation.

Douglas and MacQuarrie (1939) noted that the host slates and quartzites were contact metamorphosed to "ironstone", and described them as silicified and mineralized with magnetite. Assays indicated iron content as high as 10%. The author found the rocks to be dark in colour, very friable and slighly heavier than would be expected. Disseminated scheelite and arsenopyrite may or may not account for this. The quartz was noted as appearing granular and massive while many of the samples were smokey in colour. Douglas and MacQuarrie (1939) noted that the effects of the granite were not noted more than 35 m from the contact. The author noted the effects of it throughout the No. 13 vein and to a lesser extent in No. 2.

The granite outcrops less than 1 km south of the property, but may be closer subsurface. Pegmatite and aplite dykes have been mapped in several areas of the property (Douglas and MacQuarrie, 1939) and were found in the dump piles of the No.2 vein by the author. Douglas and MacQuarrie (1939) note that both the pegmatites and aplites can be seen cutting the quartz veins and therfore cannot be the source of the quartz. They suggest a separate earlier intrusion to explain the veins.

STRUCTURE

The scheelite property is located on the southern limb of the Mooseland-Gegogan Anticline (appendix B, map 4). The author noted that bedding and cleavage in the area strike 075° and the bedding dips at 40° to the north, while the cleavage dips 75° north. Douglas and MacQuarrie (1939) found the same general strikes, with the dip of the bedding varying from 45°-75° north and the cleavage from 35°-50° north. They also noted that the beds are overturned to the north while the NSDM and Little (1959) reported that the beds dipped steeply north and are overturned to the south. These conclusions were based on the pattern of the drag folds. Douglas and MacQuarrie report the anticlinal axis to be 2 km to the north plunging to the west (fig. 20).

All the veins in the area are reported to be concordant with the slates, and have an average thickness of 45 cm while the richest one (No. 3) is 5 cm. The main quartz veins are usually characterized by rolls or corrugations plunging at approximately 15° to the west (NSDM; Douglas and MacQuarrie, 1939) and the scheelite is reported to follow the narrow rather than the wide veins. Drag folding is reported throughout the area in the slate beds.

There are no major faults in the area but numerous small ones can be found on the exposed vein between veins Nos. 2 and 3. The greatest displacement noted is just over 1 m (NSDM; Douglas and MacQuarrie, 1939). Pegmatite and aplite dikes are exposed in the area cutting both the bedding and the veins. They normally strike NW with a fairly flat dip SW, often they are found along the small faults (NSDM; Douglas and MacQuarrie, 1939).

MINERALOGY

The quartz veins in the area seen by the author contained disseminated scheelite associated with arsenopyrite and patches of what appeared to be chlorite but had a minor reaction with HCl acid. The NSDM reported that scheelite has been found disseminated in the quartzites. There are also reports (NSDM; Douglas and MacQuarrie, 1939) that traces of gold, silver, molybdenum and pyrrhotite are associated with the scheelite. Thin-polished sections showed that the quartz in the vein is weakly strained and commonly fractured. Chlorite and rutile line some of these fractures. The disseminated scheelite in the veins is in direct association with calcite (confirmed by XRD). Slabs showed that the scheelite is veined by quartz (fig. 22). Large 1 cm biotite and muscovite crystals are found on the edges of some veins.

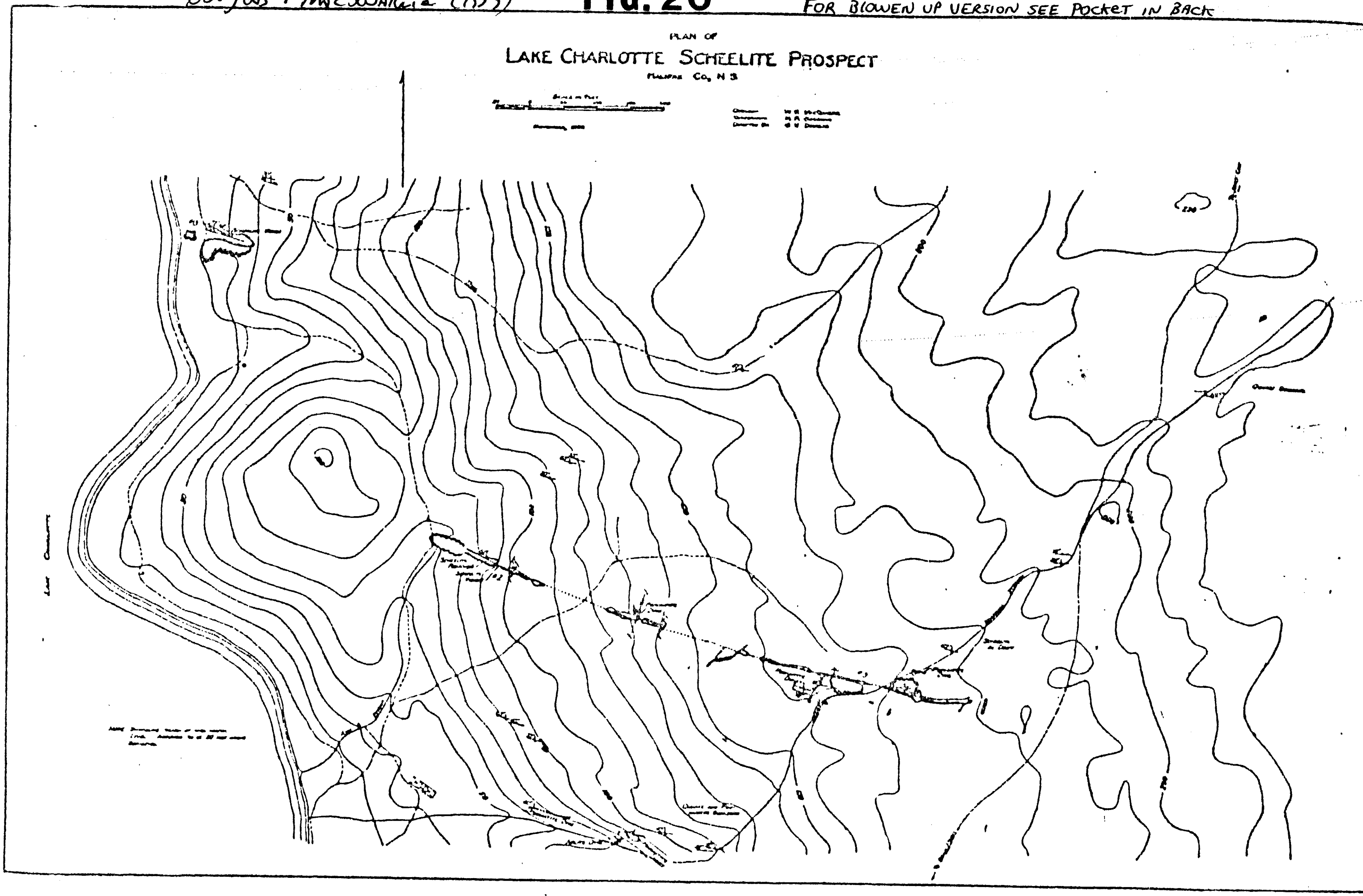
Thin sections of the quartzite indicate a very poor cleavage, along which quartz, biotite, muscovite and chlorite are oriented. Quartz grains (0.1-0.2 mm) made up about 50% of the groundmass while 20% was biotite and 10% chlorite. Large pods of quartz crystals up to 5 mm long contained subhedral to euhedral, 3-4 mm long, arsenopyrites. Small 0.1 "moth-eaten" rutiles were distributed throughout the groundmass. Douglas and MacQuarrie (1939) reported that thin sections made by them showed the quartzite to be even grained with considerable biotite and muscovite aligned along the cleavage, but noted that they are essentially quartz-rich rocks with minor sericitized and kaolinized plagioclase and orthoclase.

X-ray diffraction on several samples confirmed the existence of scheelite, calcite, clinochlore, muscovite, and albite.

Douglas + MacQuarrie (1939)

FIG. 20

FOR BLOWEN UP VERSION SEE POCKET IN BACK



MAP NO. 1

L, 2-4.

FIG. 10

A TRENCH ALONG VEIN NO. 13. THE ROCK SCATTERED ABOUT IS PREDOMINANTLY QUARTZ CONTAINING ABUNDANT SCHEELITE.

21

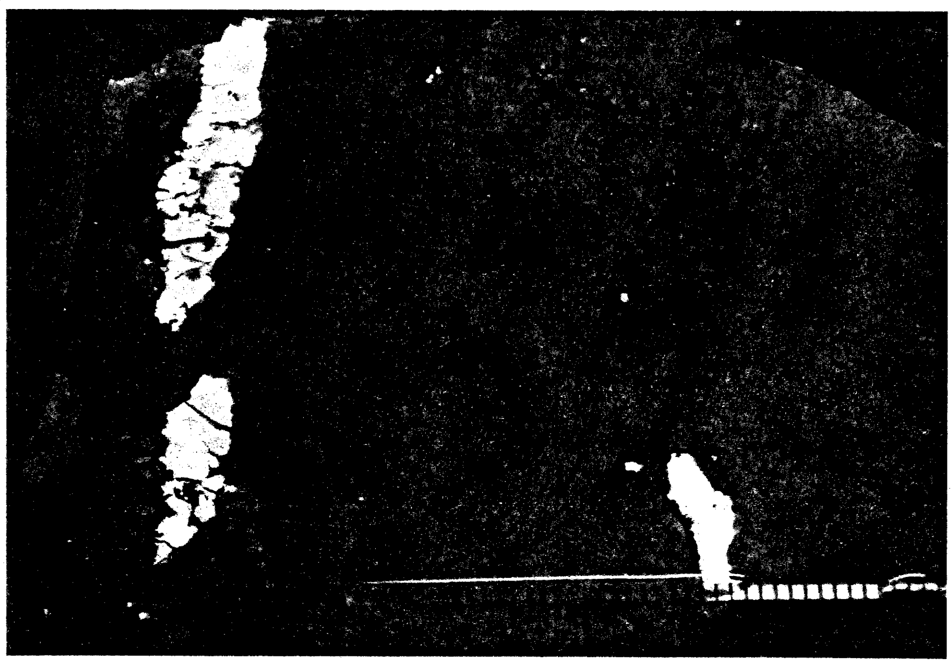
FIG. 22

LC-15 A) SCHEELITE VEINED BY QUARTZ ASSOCIATED WITH ARSENOPYRITE. GREEN MINERAL IS CHLORITE.

B) SCHEELITE FLUORESCING BRIGHT WHITE.

22 a

22 b



CHAPTER 8

INDIAN PATH

LOCATION AND ACCESS

The Indian Path scheelite mine is located in Lunenburg County and can be found on topographic map 21A/8 at latitude 44°19'45" and longitude 64°20'30" (appendix A, map 5). The property can be reached easily by car from Lunenburg by following highway 332 south from Lunenburg for approximately 8 km to where it forks. The right hand fork to the south is followed about 1 km to where it forks again. Turn again to the right and follow an old woods road approximately 0.5 km to where trenches can be seen by the road.

GEOGRAPHY

The land consists of gently rolling hills, except to the south where it drops off fairly steeply to a small salt-water inlet surrounded by a large swampy area. This is found on the southern side of the main road which continues through to the LaHave River. The drainage pattern in the area is towards the south.

The vegetation is mostly small scrub and very thickly wooded areas of young softwoods. The area appears to have been cut over at one time but has not seen any activity for a long time.

PREVIOUS WORK

Faribault (in Malcolm, 1929) reported that gold was discovered on the property in 1862, at which time trenching and a shaft 9 m deep were dug. He noted that 10-12 veins were discovered, some containing free gold. Between 1862 and 1896 work on the property was sporadic and a total production of 50 ounces was reported. He reported little work between that time and his paper. The NSDM noted in their occurrence report in March 1980 that although Faribault indicated gold production in the area, there are no known records of any such production.

Scheelite was discovered in 1926, and between 1927-31 work was sporadic. During this time three shafts were dug, one reported to a depth of 9 m. Drifting and crosscutting were carried on in all three with one drift noted at the 60 m level. Trenching was also carried out in the area and reported to total 300 m in length. In 1931, 7 diamond drill holes were reported.

In 1935 a new shaft was sunk 330 m to the west of the old workings and in 1937 work continued in the original area. In 1939-40, 18 drill holes totalling almost 2000 m and covering a length of 400 m along the anticlinal axis were drilled (NSDM; Charlick, 1941). In 1941 a new shaft, with 260 m of cross cutting, and 200 m of new drilling were done. Later in the year operations ceased due to high costs.

C.E. Richardson staked the area in 1979 and did some new trenching, but nothing has been reported on the outcome of this.

There is no mention in the literature of the number of veins found in the scheelite area although both Messervey (1930) and Little (1959) noted that there are several, some of which are 0.7-1.0 m wide. Production from the area is noted at 29,296 pounds of WO_3 making it the second largest reported tungsten producer in the history of the province.

Charlick (1941) noted that although Indian Path did not look like a profitable operation, in times of necessity a considerable amount of tungsten could be recovered from relatively shallow and inexpensive workings.

THESIS WORK

One day was spent in the area of the mine. Several old trenches were located but all had collapsed in the years since they were opened, or had been grown over and hidden in thick bush. Two new trenches that appeared to have been recently worked were also found. The veins were well exposed in these but unfortunately no scheelite was located in place or in the dump rock. Numerous small pits occur throughout the area but again there was no exposure in them.

A shaft was located next to the road but has been used in recent times by local residents as a garbage dump and thus it cannot be entered. There was a large dump pile next to the shaft which provided numerous samples of quartz and slate, but no scheelite was found despite a couple of hours searching the pile with the ultraviolet lamp.

The only outcrop in the area, aside from a couple of small ones on or near the road, was in the recently opened trenches. Whether these are extensions of old trenches or completely new ones is unknown, and they may never have contained scheelite. There were 32 samples taken from the area, a few from the trenches and the rest from the dump pile next to the shaft.

On the road approaching the trench in the north there are broken core boxes with the core lying on the ground. The core was examined for scheelite but none was found although the core did intersect several small quartz veins. A few samples were taken from here as well. The core would be impossibe to put back together but a study of it would indicate what lies below, but not where within the stratigraphic unit. It also raises the possibility that more of the core drill may still be in the area and was not located.

GEOLOGY

STRATIGRAPHY

Charlick (1941) reported that Indian Path is found within the Halifax Formation and consists of interbedded fine-grained slates and relatively coarse-grained graywackes lying in beds which vary in thickness from a few millimeters to a meter or more. The author noted the slates to be black, micaceous, and to contain abundant arsenopyrite and cubic pyrite.

The author was able to measure bed thicknesses only for a couple of meters, it was therefore impossible to measure accurate sandstone:shale ratios in the field. In the literature of the NSDM the core logs for two holes drilled in 1939 were located and measurements made from these descriptions which found the ratios to be 1.0:2.8 and 1.0:1.4, sandstone:shale. Faribault's maps and crossections (1886-1939) were examined by the author who found the site to lie approximately 500 m above the base of the Halifax formation.

The veins in the area are found in wide zones of slate. These veins are said to parallel the bedding planes and tend to pinch out as the edge of the slate zone is reached. Some veins were also found along slips and fractures (Charlick, 1941).

Granite crops out 24 km to the north.

STRUCTURE

The veins at Indian Path occur within 50 m (NSDM) of the crest of the Indian Path Anticline (appendix B, map 5), strike east and dip steeply to the north, roughly paralleling the bedding (Little, 1959). The anticline appears to be tightly folded with the axis dipping about 77° south and the whole structure plunging 50° to the east (Charlick, 1941). However the shape and plunge vary considerably along the strike of the axis. Faribault (in Malcolm, 1912; 1929) noted that the bedding in the area strikes at about 070° and dips 80° north on the northern limb and at a low angle on the southern limb. The author noted bedding at 080° dipping 70° north and the cleavage at 070° dipping 70° south.

The anticlinal axis appears to be tight with a tendency for the veins to pinch out. Away from the nose of the fold along strike of the veins there is a considerable widening of the veins and then they tend to pinch out within 50 m of the nose (Charlick, 1941). In almost every drift and crosscut where there was quartz, at least a little scheelite could be seen. The size of the scheelite segregations vary from specks to lumps of several pounds and the distrbution is very erratic (Charlick, 1941). Faribault (in Malcolm, 1912; 1929) noted in the gold areas that the one vein worked for gold contained rolls of scheelite, while the NSDM noted that the maximum widths and values of scheelite were found at minor flexures some distance from the axis.

Charlick (1941) noted that the more quartz found in a given area the more scheelite is likely to be observed.

Neither drag folding or faulting were reported in the literature, although Faribault's maps of the area place a fault, which cuts the anticline, just to the west of the mine area.

MINERALOGY

The quartz in the veins shows greasy luster, is milky in colour, and somewhat fractured; vugs in some places occur within the veins and are lined with small, milky white, terminated quartz crystals (Charlick, 1941). Samples collected from the site commonly show a banding through the quartz of what appears to be discontinuous shale partings. Faribault (in Malcolm, 1912; 1929) noted that the vein worked for gold was banded and well mineralized. He further reported that the veins on the apex of the fold were coarsely granular and did not look good for gold.

Of the samples collected from the site thin-polished sections were made from two samples. The quartz grains appear to be well-formed and very highly strained. The slate beds on either side of the quartz are composed primarily of clinochlore (from X-ray diffraction) and muscovite which lie along well-developed cleavage planes, and small (0.1-0.2 mm) grains of quartz. Also along the cleavage lie large (1 mm) arsenopyrites and a minor amount of pyrite. The arsenopyrite was usually found within quartz-rich pods believed to be pressure shadows. Small "moth-eaten" rutiles (average 0.1 mm) are distributed throughout the slate. Carbonates are noted along fractures in both hand specimens and thin sections. X-ray diffraction techniques determined both ankerite and calcite in the samples but it cannot distinguish if one or both are in the fractures.

Charlick (1941) undertook a study of both polished and thin sections to determine relative ages of the minerals. He found that scheelite was the first to crystallize in the vein since he found it veined by both quartz and pyrite. The second to crystallize was arsenopyrite and noted it being veined by pyrite. Quartz, pyrite and pyrrhotite formed together and seemed to follow each other throughout many sections. Lastly were small stringers of calcite found cutting the slate and quartz with no associated mineralization.

Faribault (in Malcolm, 1912; 1929) noted that galena could be found in some of the veins associated with the free gold. Charlick (1941) also noted the presence of a very minor amount of sphalerite and free gold associated with scheelite in one location. He further stated that in contrast to the gold districts only one age of quartz deposition appears to occur here.

CHAPTER 9

LOWER SACKVILLE

LOCATION AND ACCESS

The Lower Sackville or Hyland deposit is located 300 m east of the old Halifax-Windsor highway and 200 m north of the Cobequid Road within what is now the town of Sackville at latitude 44°45'35" and longitude 63°37'35" (appendix A, map 6). It is reported that the exposure can be found at the crest of a small hill near the height of land (NSDM). Neither the pit or shaft were located and it appears that it was filled in to allow for housing construction and a trailer park (fig. 23a).

GEOGRAPHY

The ridge where the deposit should be rises to a height of about 15-20 m. The land at the base of the ridge is fairly flat and a slow-moving stream up to 2 m wide (usually smaller) flows westerly through the area. Existing vegetation consists of softwood trees and thick alder groves along the stream in places. Most of the area now consists of residential housing and some stores.

PREVIOUS WORK

The Lower Sackville deposit was discovered in 1921 by F.W. Dixon, and in 1937 was owned by F.R. Hyland (Piers, 1932). In 1937 a trench 15 m long was dug to a depth of 3-5 m. Several tons of scheelite were reportedly removed from a 20 cm wide quartz vein. In 1942 a test shaft 50 m NE of the trench found a 23-cm-wide vein of scheelite; there are no reports as to how much if any was in place or removed. Six diamond drill holes were put down to a vertical depth of 50 m over a distance along strike of 130 m. A trench was later opened for 35 m to a depth of 10 m and scheelite was mined from a 1 m wide vein (NSDM). Again no figures for production are reported.

THESIS WORK

The literature indicates the location of the site very well (fig. 24). Questioning of residents to find the exact location of the mine were unsuccessful in finding anyone who had ever heard of the mine.

Several outcrops were located in the area including a 140 m section along Memory Lane. All the outcrop was interbedded slates and quartzites, and except for two, 2 cm wide quartz veins along Memory Lane no veins were seen. Seven samples were taken from the outcrops near the mine site.

GEOLOGY

STRATIGRAPHY

The occurrence is reported to be within the interbedded slates and quartzites of the Goldenville Formation. The slate beds range in thickness from 2.5-213 cm while the quartzite beds are 23-914 cm thick as measured by the author. It must be remembered that the beds measured are found throughout the area including the section along Memory Lane and therefore do not necessarily include the beds within the mine area.

The sandstone:shale ratio has been measured for this area in several ways. First the outcrops in the near vicinity of the mine area were measured. The result was a ratio of 5.7:1.0. Then the outcrop along Memory Lane, which likely lies stratigraphically above the occurrence was measured to have a ratio of 4.1:1.0. Then the drill core logs from three holes drilled by Boyles Brothers Limited in 1959

(NSDM) were examined and measured. These most likely, from literature descriptions (NSDM) lie within and below the occurrence, were found to have the following sandstone:shale ratios; 5.7:1.0; 5.8:1.0; and 8.1:1.0. It can therfore be noted that as would be expected as one goes down section the sandstone:shale ratio increases. The mine site likely lies in the area with a ratio of 4 to 5:1.0. Figure 25 is a cross section through the area.

From various maps and cross sections by Faribault (1889-1939) the author interpreted the area to be approximately 2650 m below the the base of the Halifax Formation. The nearest granite is reported to be 4.5 km to the north.

The slates in the area are dark gray to black in colour with 2-3 mm rust-coloured spots around pyrite (strained along a well developed cleavage) and are very calcareous.

STRUCTURE

The Lower Sackville deposit is found on the south limb of the Waverly Anticline (Piers, 1923) where the beds strike 070° and dip 25° south (appendix B, map 6). In the area of the deposit the present author noted that the beds strike from 060° to 070° and dip between 25° and 40° south. The cleavage strikes parallel the bedding and dips from 50° to 85° south.

Piers (1923) noted that the rocks in the trench were near the nose of the anticline. He further noted the quartz vein to average 23 cm in width but found reports where it is said to have widened to 45 cm. The NSDM in 1959 noted that the scheelite occurs in lenses or pods 30-120 cm long and 3 to 30 cm thick. Small drag folds were noted by the author in one outcrop but are not reported in the literature.

Some minor faulting is reported to the south (NSDM).

MINERALOGY

The NSDM and Piers (1923) both note the presence of arsenopyrite and marcasite in the quartz veins along with the scheelite. All six drill holes in 1959 reported scheelite shows in the quartz veins. Thin-polished section LS-1 of black slate show a very poor cleavage with abundant large (1 mm) porphyroblastic biotites throughout the sample along with numerous (1/10 mm) "moth-eaten" rutiles. Also noted were large (1 mm) well-formed twinned calcite crystals (fig. 23b, confirmed by XRD). Pyrite could be found strained along the cleavage planes. Sample LS-1 was taken from the nearest outcrop to the assumed location of the mine site.

CHAPTER 10

MURCHYVILLE

LOCATION AND ACCESS

The Murchyville tungsten occurrence is located in Halifax county 7 km east of Middle Musquodoboit at latitude 45°00'00" and longitude 63°05'56" on topographic map 11E3. The occurrence can be found on the top of a ridge (Little, 1959) approximately 500 m west of the road south from Brookvale (appendix A, map 7). A very rough logging road goes up the hill to the area of several pits and trenches. There are several other logging roads throughout the area as well.

GEOGRAPHY

The ridge rises 30 m above the road and at one time the area was covered in softwood trees, but now it has been logged over and only small brush is growing in the area of the trenches. A small stream, flowing north, and a swampy area is found between the base of the hill and the road to the east.

PREVIOUS WORK

The NSDM reported that in 1943 the property was owned by a John Reynolds and George Wilson. They prospected by opening a few pits and trenches, which they report did not appear to be of any economic value. About 200 pounds of rock containing approximately 0.5% WO_3 was recovered from the site as samples.

THESIS WORK

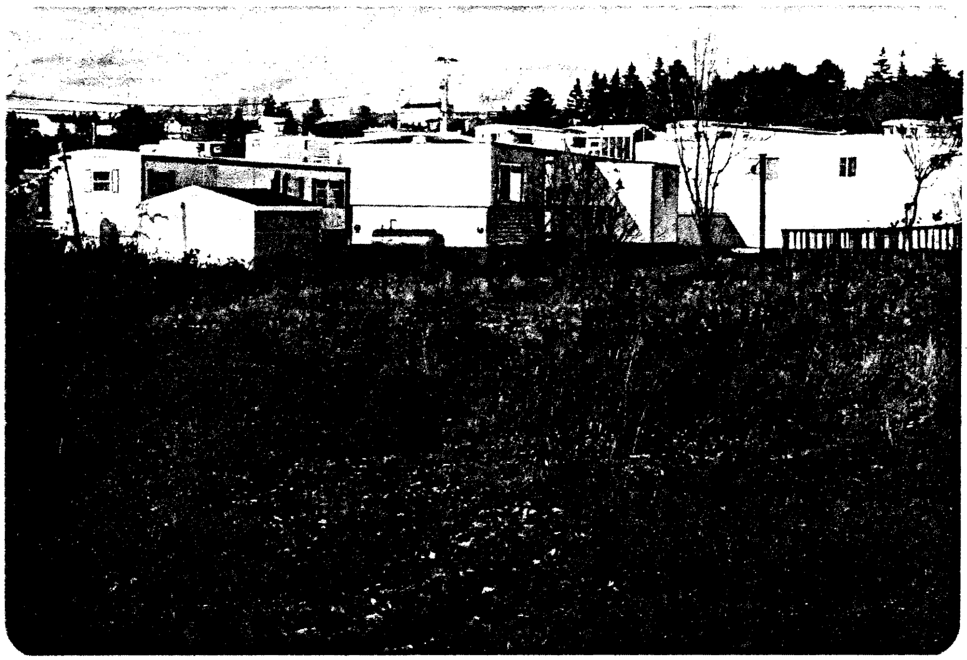
Attempts to locate the trenches or scheelite were unsuccessful in spite of help from local people. It seems that logging operations may have filled them in (fig. 26a). Seven samples were collected from outcrop seen in the area, all were black slate. Unfortunately no quartz veins were seen in the area.

FIG. 23

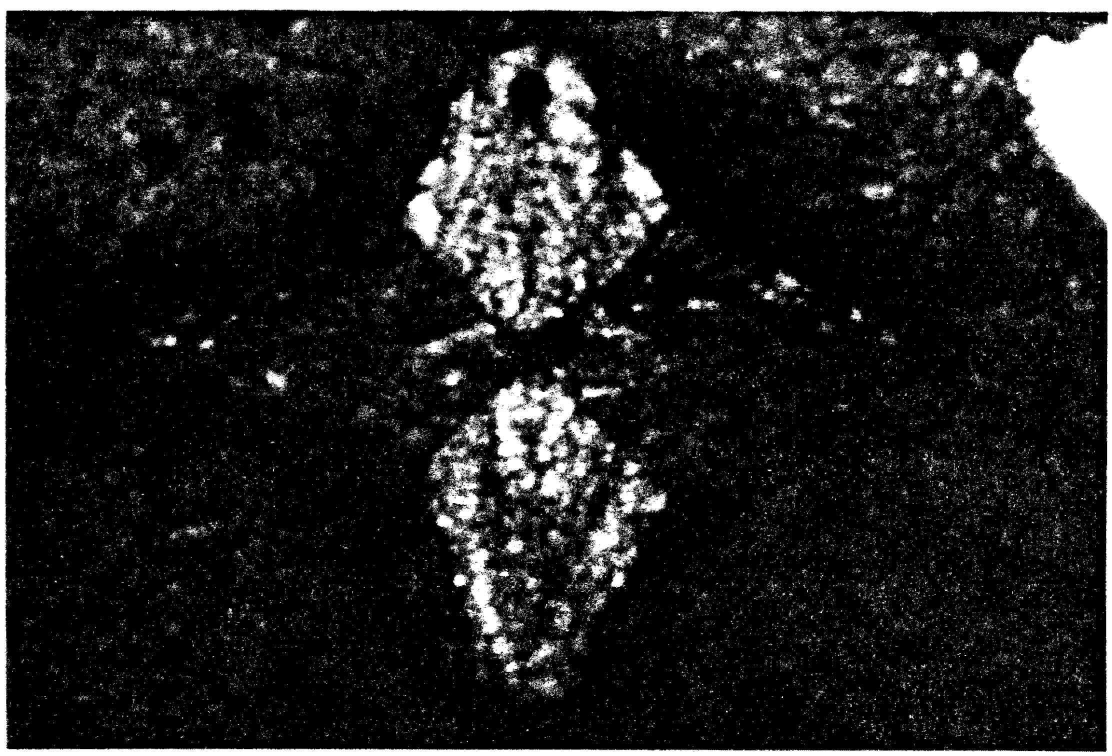
LS-1 A) THE FORMER SCHEELITE SITE AT LOWER SACKVILLE.

B) PORPHYROBLASTIC TWINNED CALCITE. BLACK SPOTS ARE RUTILE, BROWN ARE BIOTITE.

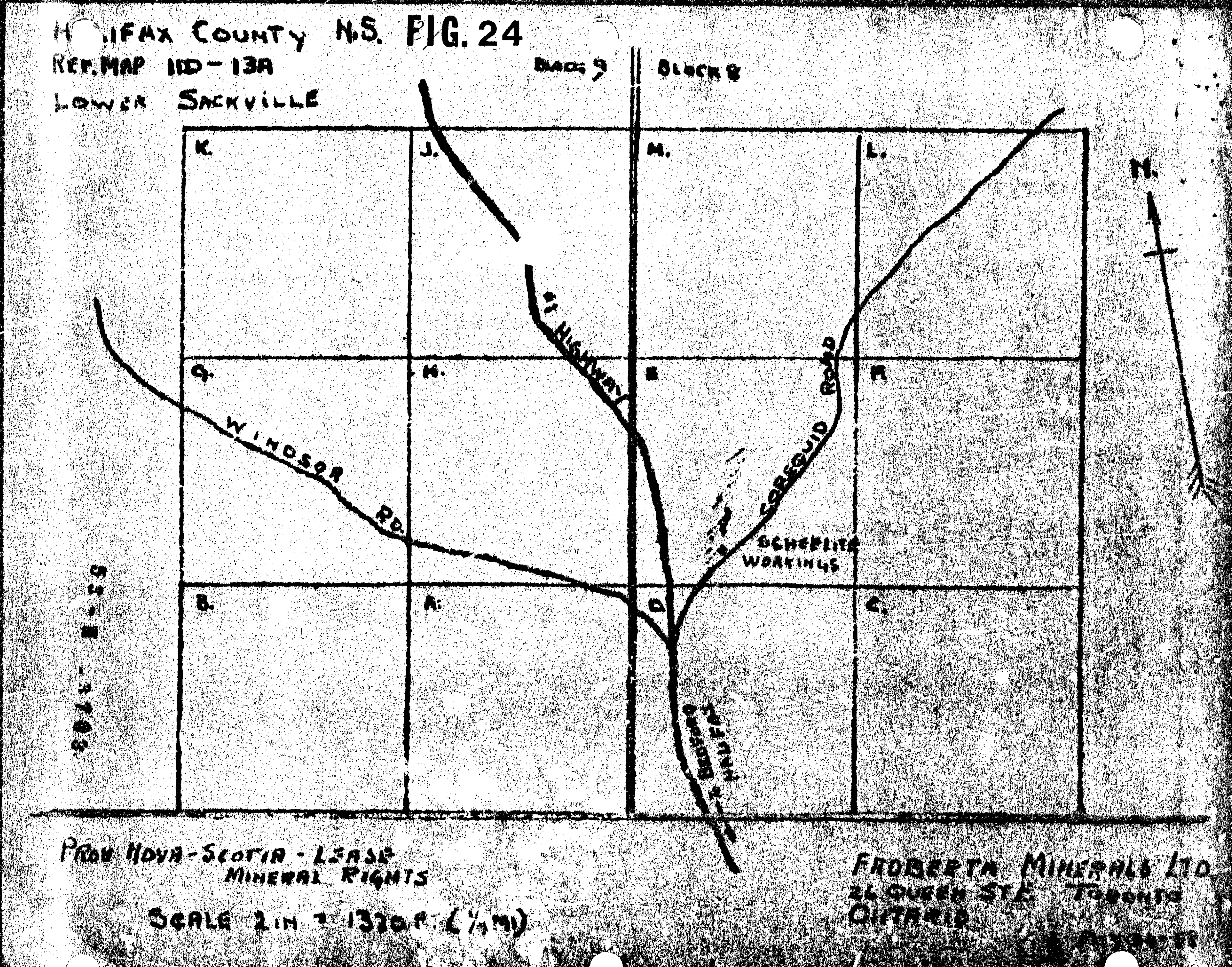
23 a



23 b



1mm



H IFAX COUNTY N.S.
REF. MAP 11D-13A
LOWER SACKVILLE
BLOCK 9
BLOCK 8
K.
J.
M.
L.
N.
G.
H.
E
F.
B.
A.
D
C.
#1 HIGHWAY
WINDSOR RD.
COBEQUID ROAD
SCHEELITE WORKINGS
PROV. NOVA-SCOTIA - LEASE MINERAL RIGHTS
SCALE 2 IN = 1320 F. (1/4 MI)
FROBERTA MINERALS LTD
22 QUEEN ST E. TORONTO
ONTARIO

FIG. 24

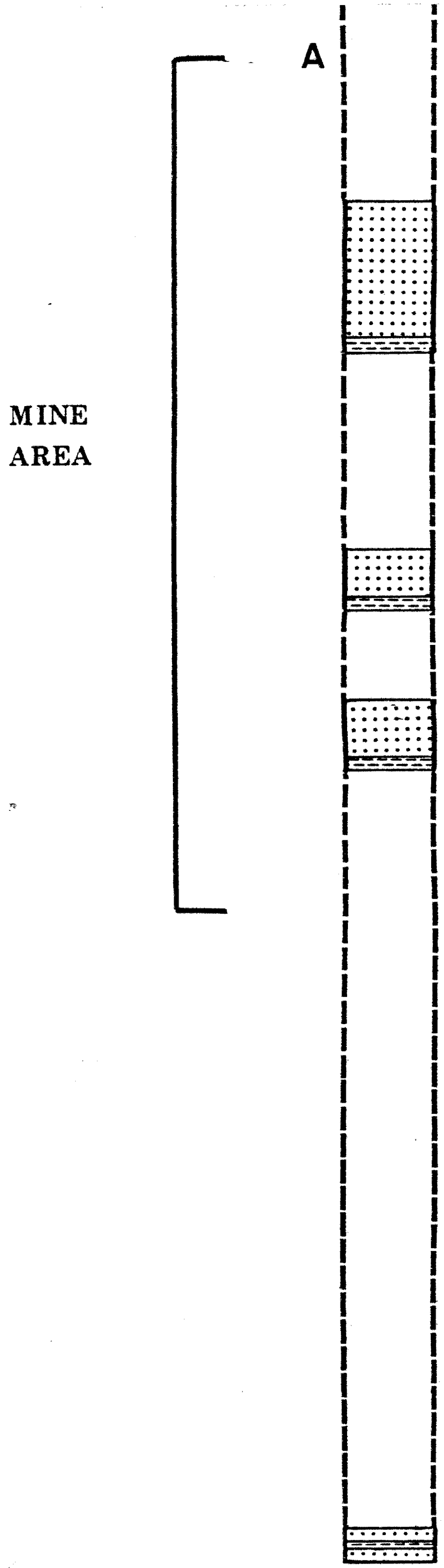
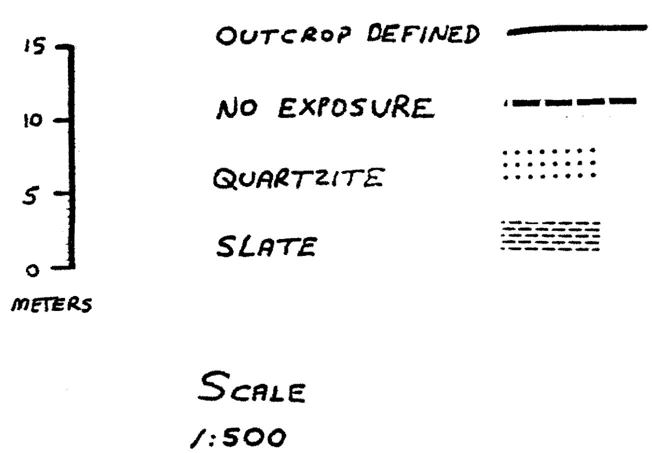
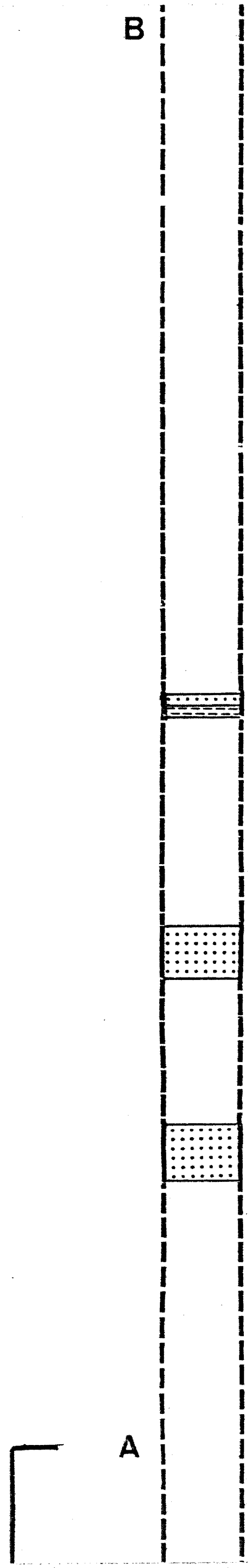


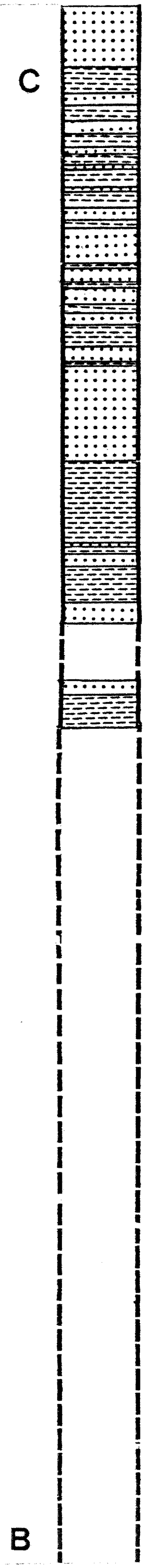
FIG. 25

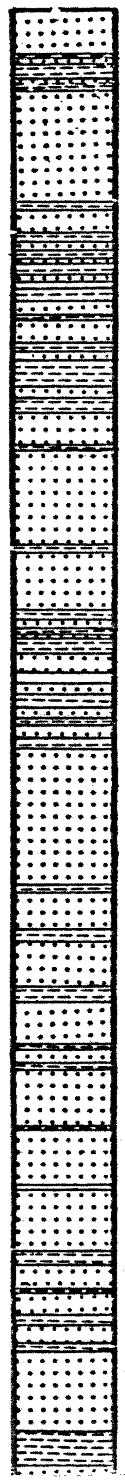
LOWER SACKVILLE



FOR FULL VERSION SEE POCKET IN BACK


B
A


C
B



C

GEOLOGY

STRATIGRAPHY

The Murchyville occurrence is located within the slate beds of the Halifax Formation (Little, 1959). Faribault places the stratigraphic position of the occurrence approximately 1300 m above the base of the Halifax Formation. While this author's measurements on the few outcrops in the area place the sandstone:shale ratio at about 1:9. The outcrops proved to be about 90% black slate with occasional thin greywacke beds. Little (1959) reported the slates to be black, crinkly, and highly cleaved with occasional bands of harder spotted and slaty quartzite.

STRUCTURE

Located on the north limb of the Wyse Corner Syncline (Little, 1959) cleavage and bedding in the area strike roughly at 072° and have a vertial dip. Only one rough map of the trenched area could be found (fig. 27) and it agrees roughly with this data.

Both Little (1959) and the NSDM occurrence reports note quartz veins which range in thickness from 1.5 cm to 37.5 cm, showing some corrugations and a tendency to lens.

MINERALOGY

It is reported by Little (1959) that only a small amount of scheelite was noted, along with arsenopyrite and traces of gold. Of the several samples collectd one thin-polished thin section (MV-1) contained abundant fine micas along well developed cleavage planes, large porphyroblastic chlorites (up to 5 mm) which appear unaffected by cleavage, quartz grains with undulose extinction, pyrite strained along the cleavage planes, large (10 mm) highly fractured arsenopyrite, and small (0.1 mm) "moth-eaten" textured rutile (fig. 26b).

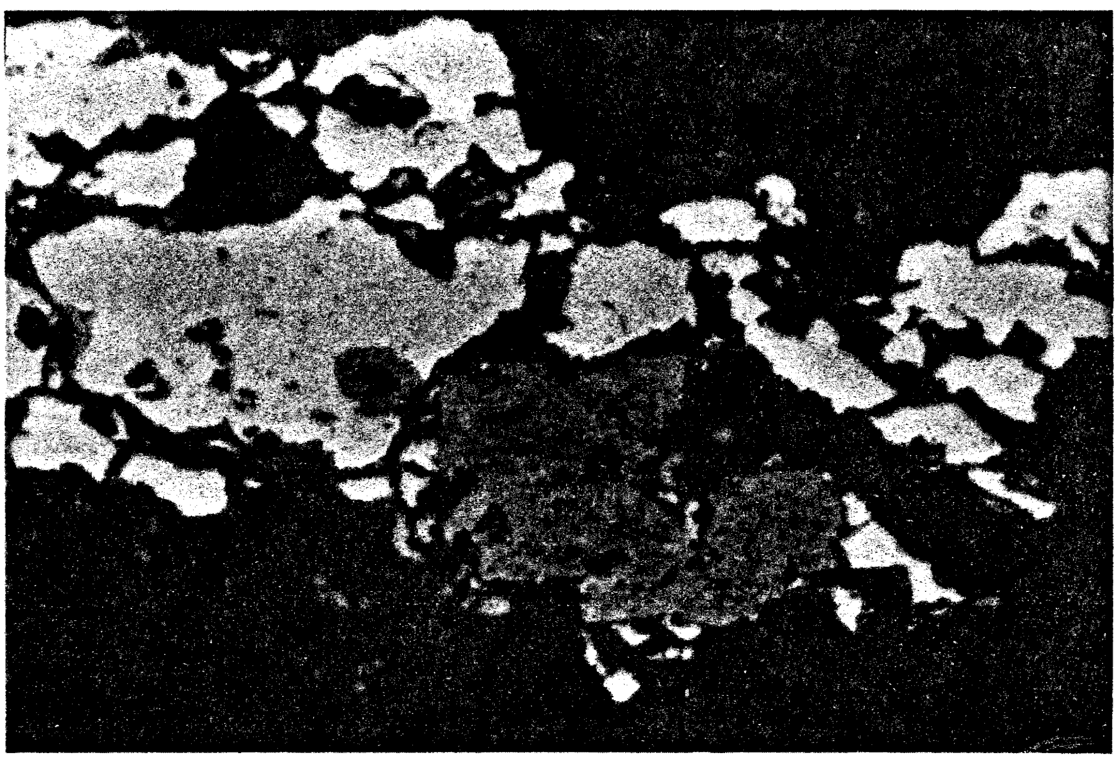
FIG. 26

A) Approximate site of occurrence at Murchyville.

mv-1 B) A large fractured arsenopyrite grain (white), pyrite is yellow.

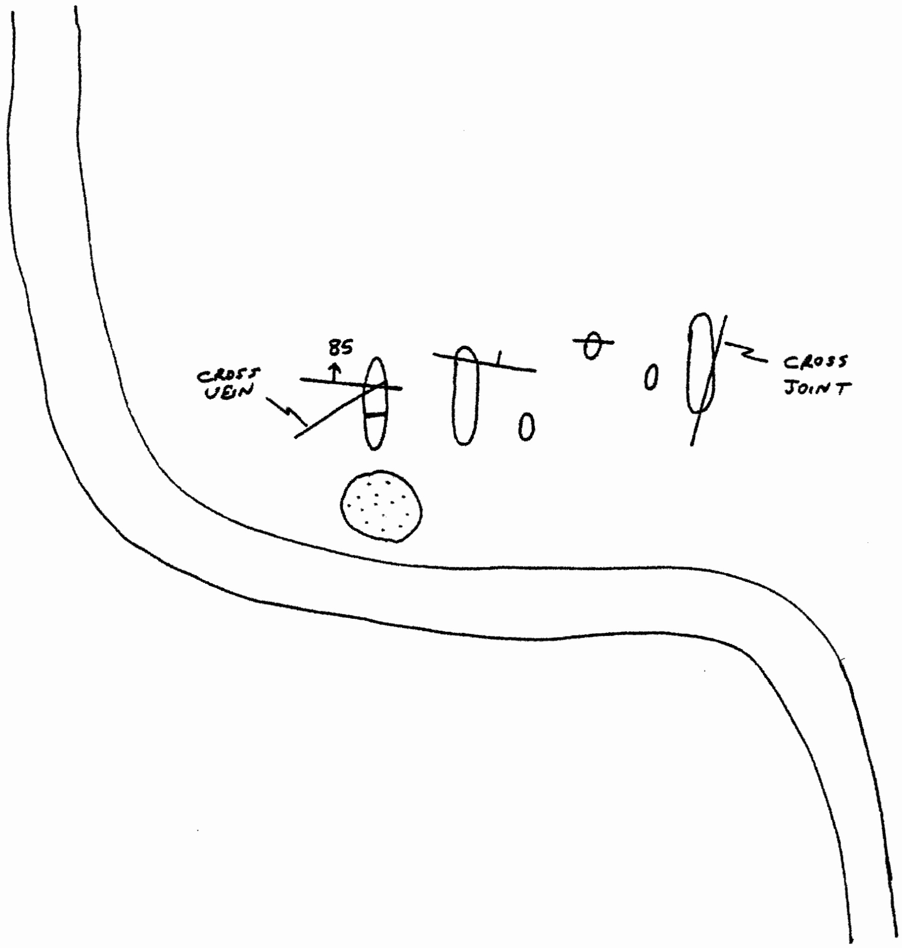
26 a

b



0.1 mm

FIG. 27



Rough map from NSDM, no other information given.

CHAPTER 11

DISCUSSION

STRATIGRAPHY

The stratigraphy of the deposits was looked at to determine if there may be a particular zone within the Meguma where the scheelite may be preferentially found. This was done by measuring the sandstone:shale ratios of any rocks: a) in the field where possible; b) from drill core where available; c) estimated from the literature for Lake Charlotte; and d) from published cross-sections at Stillwater Brook.

Although several occurrences seem to have ratios that fall in sandstone-rich sections (typical of the upper part of the Goldenville Formation; fig. 28) the deposits appear to be spread throughout a wide range of sandstone-shale ratios. In the Murchyville occurrence (which was not a producer) it is found that all the producing sites lie below the 1.0:3.0 sandstone:shale ratio level in the Halifax. This may indicate that the scheelite veins were not emplaced in rock dominated by slate. Five of the producing sites were found below the 1.0:1.0 ratio on the graph (which is taken as the boundary between the Halifax and Goldenville Formations; Schenk, 1970) which may mean that areas of thicker sand units are preferred sites for scheelite, although scheelite is not restricted to them.

The next step was to use cross-sections of the Meguma prepared by Faribault (1886-1939) for his maps of the Meguma and measure the location of the scheelite deposits relative to the base of the Halifax Formation, which is generally given on these sections. The measurments made on these cross-sections are assumed not to be accurate because: measurments were made from the vertical scale of the cross sections where the scale is approximately 1:63,000; lateral variation in the facies between the location of the deposit and the site of the section line; and extrapolations by Faribault in drawing in the folds. In any case the approximate positions located should be of some value.

Figure 29 plots the stratigraphic level (according to Faribault's maps) versus the district. The seven sites appear to be scattered throughout the Meguma, except that no deposits are found in the upper part of the Halifax Formation, more than 1300 m above the base.

The above results indicate that there appears to be a general preference for the lower 1500 m of the Halifax Formation and the upper 3000 m of the Goldenville Formation.

The sandstone:shale ratios were plotted against the datum levels relative to the base of the Halifax on figure 30. The general relationship expected would be a scattered trend from the upper left on the graph to the lower right. The result was a set of points that grouped between the sandstone:shale ratios of 1.0:2.2 and 3.0:1.0.

regardless of position in the strata. The only occurrences outside of these ratios were Lake Charlotte and Murchyville which was not a producer. This lends further weight to the theory that the veins favor, in general, a particular sandstone:shale ratio.

To determine if this was true for the amount of tungsten production the sandstone:shale ratio was plotted against the pounds of WO_3 production. The result can be seen in figure 31 where the vast majority of the scheelite comes from near the 1.0:1.0 ratio. For this to be significant we must assume that the production to date is represenative of the distribution of tungsten. The values used in figure 31 do not include Lazy Head (since there are no sandstone:shale ratios) but this deposit is believed to be in the Goldenville Formation just beloe the base of the Halifax Formation. This would likely give a ratio close to 1.0:1.0 and add in 14,000 lbs of WO_3. According to these figures 90% plus of the scheelite may very well be found within an area that consists of only 15% of the the Meguma. These results may therefore be very significant in the location of new deposits.

STRUCTURE

The regional deformation of the Acadian Orogeny produced north-easterly trending folds and axial plane slaty cleavage (Fyson, 1966). The scheelite veins in all the districts examined were found to be within or next to a slate bed concordant with the bedding in these folds. Scheelite mineralization is usually found near the crest of the folds or on the limbs. Scheelite in all districts is reported to be very erratic in distrbution throughout the veins. Scheelite-bearing veins range from less than 1 cm to 60 cm in thickness and appear to average about 10 cm. The scheelite is commonly found in rolls which are reported at all locations examined except Fall River, where the scheelite occurs where the veins narrow and pinch out. The scheelite at Goff and Lake Charlotte is reported also to follow the narrow veins in places and to fill them on occasion. It is also reportedly found as disseminated grains in the veins, usually along the walls. Charlick (1941) noted that areas high in quartz are also high in scheelite. While this may be true for most of the scheelite occurrences it does not appear to be true for Fall River, where the highest scheelite values are found where the veins narrow and pinch out.

Cleavage in the area is reported to cut the across the veins in most areas thus indicating that the veins formed prior to deformation, or at the latest early during the folding event.

There appears to be little doubt that the veins in which scheelite is found were produced at the same time and by the same means as that of the gold districts. Faribault (in Malcolm, 1912; 1929) noted that the veins at Stillwater Brook were similar to the auriferous veins. Newhouse (1936) found the scheelite veins to be mineralogically and structurally similar to the gold veins. The author noted that a major difference between the scheelite and gold veins, aside from the inverse relationship between the two minerals, appears to be that the gold districts are usually found associated with doming while the scheelite deposits are not.

Five of the scheelite occurrences examined can be found along the same general fold upheaval. Stillwater Brook is located on the Moose River Anticline which to the west becomes the Waverly Anticline. Goff, Fall River and Lower Sackville are found along this anticline. If the trend of the Waverly Anticline is traced to the west along strike across the granites and a couple of ocean inlets it appears to become the Indian Path Anticline, where the Indian Path deposit is found. These five deposits account for 95% of the tungsten production from the Meguma Group. The only other producing scheelite deposit is found 10 km to the south of the Moose River Anticline on the Mooseland-Gegogan Anticline. With 5 of the 6 scheelite producers located along this trend, the possibility is raised that there may be a tungsten-rich zone through this area. A feature such as a primary channel facies, basement structure, or a break in paleotopography may have concentrated sediments containing tungsten.

MINERALOGY

Figure 32 shows the reported minerals in each of the scheelite deposits and indicates the reference and if the present author confirmed their presence. Quartz is the main-vein filling mineral and is usually associated in these veins with scheelite, carbonates and arsenopyrite. The veins may or may not contain any of the other minerals listed in the table.

Two types of quartz were noted in the scheelite veins: one is glassy to vitreous, clear to slightly smokey, and may be coarse and crystalline; the other is white or milky, greasy or oily looking, and may contain some banding or lamination. The quartz is usually highly strained and may be fractured.

Scheelite is commonly found on or near the walls, if not actually filling the vein, usually asociated with carbonates. The scheelite is commonly fractured and veined by the quartz. Microprobe analysis of the scheelite by Miller (1974) and Shaw (1983) found that the scheelite of Stillwater Brook and Lazy Head were almost pure CaWO4 with little or no molybdenum.

Carbonate minerals from most of the districts are predominantly ankerite and calcite (XRD thesis work). Probe analysis of ankerites at Stillwater Brook shows some are actually dolomite. All three are usually found on or near the walls and commonly veined by quartz and in one case by arsenopyrite. Micro-faulting is not uncommon in some of the carbonates. Calcite can be seen in some cases filling fractures in the quartz. Probe analysis was done on 21 samples of carbonates (appendix C1). All the carbonates had minor amounts of MnO with the ankerites varying from 1.2-3.5%, dolomite 0.25-0.9 %, and the calcite 0.8-1.5%. Minor amount of V205 were found in all three carbonates. While doing the probe analysis an unknown peak appeared on the probe screen for virtually all of the carbonates. It eventually was determined most likely to be tungsten. Unfortunatly we were unable to perform analysis for this.

Arsenopyrite is found in all the veins that contain scheelite. It may occur as large (3 cm) crystals, large masses nearly filling the vein or as disseminated individual crystals. Arsenopyrite is also very common in the slates and quartzites. Here it usually occurs as large crystals 1-50 mm long in quartz pods which are referred to as pressure shadows and indicate that the arsenopyrite was formed prior to deformation. Many of these crystals are also highly fractured (cataclastic).

Rutile was found in all the polished sections of slates and quartzites. It occurs as small (0.1 mm) "moth-eaten" grains distributed randomly throughout the sandstones and shales with no preference for, or orientation along the cleavage planes. It may also be found as long (up to 1 cm) thin black needle like minerals predominently in the quartz veins and to a lesser extent in the wall rock at Stillwater Brook. The rutiles in three districts were probed and found to be 86-97% or more TiO2 and the remainder predominantly minor amounts of Na_2O_3, MgO, Al_2O_3, and SiO2 (appendix C1). Iron was absent from 7 of the analyses while present in 4 with a high of 1.75%.

Chlorite was found in 4 of the districts (confirmed by XRD) and identified as clinochlore in all cases. In thin section it is very abundant, usually along cleavage. It is found as relatively large porphyroblastic grains (0.5 - 1.0 mm) randomly distributed regardless of cleavage and associated with quartz in pressure shadows.

Biotites (up to 1 mm) were found in thin sections of slate and quartzite and 1 cm in a vein in the field. Large (0.5 - 1.0 mm) porphyroblastic biotite in the sediments was found randomly distributed and not aligned along the cleavage.

Gold is reported in trace amounts from some of the scheelite occurrences, but how it fits into the paragenesis of the scheelite veins has not been reported in the literature.

Although there is some question in the literature as to the exact order of precipitation of the vein minerals and the number of ages of quartz deposition there does appear to be general agreement that the scheelite and carbonates were the eariest minerals to form while arsenopyrite, pyrite and at least one period of quartz followed. Calcite and muscovite were found in the fractures as late minerals in some areas. The early deposition of scheelite is supported by Cameron (1942); Miller (1974); Miller, Graves and Zentilli (1976); and Shaw (1983).

Appendces C2, C3, and C4 contain microprobe analysis of carbonate, scheelite, and arsenopyrite respectively from Stillwater Brook (Shaw, 1983).

METAMORPHISM

The seven areas that were examined all were found to be within the greenschist facies of regional metamorphism. None of the thin sections examined revealed any contact metamorphism and only one (Lake Charlotte) was in close proximity to the granite. Faribault (in

Malcolm, 1912; 1929) believed that the Stillwater Brook area shows signs of contact metamorphism; this along with the presence of tourmaline lead him to believe that a large granite body underlay the area. Neither the author or Miller (1974) found direct evidence to support this conclusion.

Of the seven areas examined 3 (Murchyville, Stillwater Brook, and Indian Path) are in the chlorite zone, while the others (Lower Sackville, Goff, Fall River, and Lake Charlotte) are in the biotite zone.

In the chlorite zone small flakes of chlorite were found orientated along cleavage, and at Stillwater Brook and Murchyville as large (0.5 mm) porphyroblastic randomly orientated grains. Ankerite and calcite were both found at Stillwater Brook and Indian Path. The calcite containing specimens X-rayed were noted in hand specimen to contain small veinlets of a highly fluorescent mineral believed to be calcite which would explain its presence in the chlorite zone. Albite was identified by X-ray diffraction at Stillwater Brook. Muscovite was identified at Stillwater Brook both along fractures and in the groundmass.

Biotite was found as small flakes orientated parallel to cleavage at Fall River and Lake Charlotte while it was found as large randomly orientated porphyroblastic grains at Lower Sackville. Large 1 cm biotites were found along the walls of one vein at Fall River. Goff was placed in the biotite zone due to the lack of ankerite and presence of calcite, although biotite could not be identified. Calcite was found in all these locations and at Fall River one sample was identified as containing ankerite by X-ray diffraction and electron microprobe, and one ilmenite was found by probe analysis. This would seem to indicate that in this area the reaction to form biotite was not completed. Albite was identified at Lake Charlotte. Large muscovite grains were found at Goff orientated perpendicular to cleavage. It may well occur in the groundmass along cleavage in both chlorite and biotite zones but due to its small size its distribution among the more abundant chlorite was masked. Chlorite was found aligned along cleavage at Fall River and Lake Charlotte and occurs as randomly orientated porphyroblastic grains at Lower Sackville, Goff and Fall River.

According to Cullen (1983) rutile should be found in the chlorite but not the biotite zone. During the examinations of polished sections rutile was found as small (average 0.1 mm) "moth-eaten" or blebby patches throughout slates and quartzites examined for all sites. Probe analysis confirmed their presence at Stillwater Brook, Fall River and Indian Path (appendix C1). Cullen does note that rutile may be found in the host rock within the biotite zone adjacent to large (>1 mm) porphyroblastic biotites, which are found along the walls of 4-10 mm wide hydrothermal quartz-calcite veinlets. This does not appear to be the case in these areas since the rutile is found throughout the rocks. Ilmenite, which was noted at Fall River and is found in the rocks of the Meguma (Newhouse, 1936; MacEachern, 1983), under various hydrothermal conditions may oxidize to rutile (Ade-Hall, 1971), but such textures and oxidation effects do not occur here.

The mineral assemblages found in the scheelite areas appear to fit well into the biotite and chlorite zone mineral assemblages, except for the presence of the rutile in the biotite zone. The presence of rutile and explanations of its textures are not understood and are likely worthy of further study, especially to see if this rutile occurs near gold-producing areas as well.

GRANITE

The presence of numerous large granitic batholiths throughout the Meguma Group raises the possibility that the scheelite deposits may be genetically related to the granite. Newhouse (1936) undertook a study of the possible relationship between the granites and the gold properties. By plotting both the number of gold areas and their gold production against distance from the granite he came up with three zones from the granite where gold production appears to be affected:

1) in the 0-4 km range 30% of the gold districts were located but only 8% of the gold was produced;

2) in the 4-6.4 km range 15% of the areas were found but 57% of Nova Scotia's gold came from here;

3) from 6.4 km and farther 55% of the districts were located but only 35% of the gold found.

Newhouse took these results and the vein mineralogy, which he noted included the presence of tourmaline in many of these areas, to mean that a zonal mineralization of gold took place in the Meguma and that the veins were the result of solutions derived from granites at depth which acted as local heat centers.

The author decided to test the hypothesis of Newhouse on the scheelite occurrences. Scheelite areas and their respective production were plotted against distance from granite (fig. 33). To do this production figures had to be averaged in some cases, since figures vary between authors, assumed for others in relation to the discussions from the literature, and for Lazy Head were based upon Shaw's (1983) tonnage predictions. The result was that in the 0-4 km area 29% of the deposits were found and 17% of the scheelite produced. From 4-6.4 km 14% of the districts were located and 4% of the scheelite produced, and from 6.4 km on, 57% of the sites were found and produced 79% of the tungsten.

Thus there does not appear to be any noticeable relation to the granite. The majority of the tungsten is produced from where the majority of the deposits lie and the least tungsten production comes from where the least number of tungsten deposits are located.

Newhouse noted that the scheelite veins and the gold veins appear to be structurally and mineralogically the same and that all the scheelite areas contain tourmaline. He further claimed that although it did not appear that the scheelite was zoned as the gold, the presence of wolframite in the pegmatites near New Ross and Gold Brook was likely proof that the scheelite and gold came from the same magmatic source, but at different times.

The presence of tourmaline in these veins has since been refuted by Miller (1974) at Stillwater Brook, and by the author at

Stillwater Brook, Goff, and Indian Path. Electron microprobe analysis on the alleged tourmaline showed it to be rutile in all cases (appendix C1). Furthermore, the study of polished sections show that the rutile is present in all 7 deposits while tourmaline is totally absent.

Faribault (1899) stated that granite dykes and veins have been observed always to cut the quartz veins whenever they come in contact with them, the granite thus has no relation to the auriferous character of the veins, "and need not be referred to again". Douglas (1941) noted the pegmatites and aplite at the Lake Charlotte scheelite occurrence cutting both the strata and veins. Various other papers note the same for gold and/or scheelite veins (Graves, 1976; Miller, Graves and Zentilli, 1976; Graves and Zentilli, 1981; Haynes, 1982). The granites therefore appear to have no genetic relationship with the scheelite veins.

RELATIONSHIP WITH GOLD DISTRICTS

The scheelite veins in the Meguma and the quartz veins appear to be very much alike in structure and mineralogy. It is very likely then that both veins are actually formed by the same processes at the same time. Boyle (1976) suggested that some of the scheelite-rich veins appear to be younger than the gold veins. Newhouse (1936) stated that the scheelite veins transect the gold veins in the Malaga and

Oldham districts. No mention of this could be found in the literature.

The major differences between the two types of deposit are as follows: the exclusion of more than trace amounts of gold from the scheelite deposits and vice versa; gold districts are normally found associated with doming of the strata whereas the scheelite areas are not necessarily in domes; the presence of the "moth-eaten" rutile has not been confirmed in the gold areas; Graves (1976) noted that rutile was more abundant in the scheelite areas; Graves and Zentilli (1981) noted that the gold veins favored a general sandstone:shale ratio of 1.0:1.0, while this does not appear to be strictly true for the scheelite areas; carbonates tend to be more iron-rich where scheelite is present (Graves, 1976); scheelite appears to be an early mineral in the veins while gold is a late one.

Aside from the forementioned differences between the scheelite and gold districts, this thesis has not revealed any new information on the reason for the separation of the two.

TUNGSTEN ENRICHMENT IN SEDIMENTS

Tungsten in the sediments is suspected as the source for the scheelite. Douglas (1939) reported that at Lake Charlotte a 7.5 cm band of quartzite, which according to assay carries 1% WO_3, follows the strike and dip of the bedding. Meanwhile Little (1959) reported that at Lake Charlotte a zone of silicifed dark quartzite a couple of meters wide contained disseminated scheelite. A 15 cm wide band in this zone was assayed at 4.6% WO3. Shaw (1983) found that one sample of grey slate analysed for tungsten was enriched in it (appendix D1). At Fall River the author found a piece of quartzite that contained a small (<0.5 mm) speck that had a whitish flourescence under the ultraviolet lamp. The size of the particle did not allow confirmation of the mineral but it is believed to be scheelite.

In order to determine if the sediments are enriched in tungsten 22 samples, 13 slate and 9 quartzite, were sent away for analysis. The samples cover each of the 7 scheelite occurrences, and the results may be found in figure 34. Taylor (1964) reported the average crustal abundance of tungsten to be 1.5 ppm, with a basaltic average of 1 ppm and a granitic average of 2 ppm. Using these values as standarts we can note that most of the samples analysed are enriched in tungsten. Samples enrichmented by an order of magnitude can be found in all deposits except for Lower Sackville and Murchyville which were the only two that were not located exactly, even here though values of 2-3 ppm were found. The highest value was a slate (SB-7) at Stillwater Brook with a value of 92 ppm. Tungsten enrichment was found in both slates and quartzites. Only at Stillwater Brook, where it was predominent in shale, was one rock type enriched significantly relative to the other.

GENESIS

Numerous authors over time have suggested various methods for the genesis of the gold-quartz veins in the Meguma. Since the scheelite veins appear to be structurally and mineralogically the same as those carrying gold it is likely that one of the models for the formation of the gold veins may fit the scheelite-bearing veins. Several of these proposed models will be looked at to see if this may be true.

Malcolm (1912) summarized three different opinions as to the origin of the solutions by which the fissures were filled: 1) that the minerals were deposited from descending solutions; 2) that they were dissolved out of the country rock; 3) that they were deposited from ascending fluids. He further noted that little evidence has been offered in favor of the first, and the two most generally held are the second and third.

Faribault (1899) completely rebutted the claim that the veins were related to the granites. Still many held on to this theory until the 1970's. Earlier in this chapter in the section on relation to granites, the idea of this relationship was disscussed and it was concluded that no such relationship existed. It must be noted here that the usual evidence for ascending thermal solutions, which is wall rock alteration, is lacking around these veins (Graves, 1976; Graves and Zentilli, 1981).

Faribault (in Malcolm, 1929) suggested his own mechanism for the formation of the veins. "The veins were formed in the openings produced by the movements of the strata. During the folding of the interstratified beds of slate and quartzite or shale and sandstone, there was a certain amount of slipping of one bed over another. This slipping produced openings along the bedding planes, which were in general widest at the apex of the fold and decreased in width down the limb until at a depth of a few hundred feet they pinched out. During or subsequent to the formation of these openings, which took place within the less resistant beds, the vein filling was introduced by solutions." Graves (1976) disputed this theory by claiming that it did not satisfy the restraints placed upon it by the relative timing of events. He further claimed that if vein formation preceded folding, a mechanism dependant on folding cannot be invoked, and if vein formation accompanied incipient folding of a plastic deformation style, flexural slip would not be consistant with rock plasticity.

Graves (1976) and Graves and Zentilli (1981) have proposed another model based on hydraulic fracturing under greenschist conditions for the formation of the veins. They claim that studies have showed that the gold veins formed at the greenschist conditions of T= 430 +/- 60o C and P= 2.3 +/- 1.0 kilobars. There is no apparent hydrothermal alteration surrounding the veins and the vein minerals are essentially the same as those regional metamorphic minerals of the surrounding country rock. They further noted that the gold veins have open-space-filling textures (the carbonates are found essentially at the walls and the quartz in the center of the vein; while the arsenopyrite is found throughout it is generally with carbonate at the walls), thus implying vein formation and crystallization at relatively low pressures. This study into the scheelite veins does not find any evidence to contradict these ideas, and in fact seems to support it for the scheelite-bearing veins.

The Graves and Zentilli model is as follows. Greenschist-grade metamorphism involves a pervasive change in mineralogy with the production of water. The mechanical effect of this large amount of metamorphic pore fluid, as it makes its way out of the metamorphosing rock, can be considered graphically in terms of the Mohr diagram. Tension fractures will occur if the pore fluid pressure becomes sufficiently high to drive the stress circle against the failure envelope in the zone of tension. If the maximum effective stress is a tectonic one, the analysis predicts the formatiom of horizontal fractures. Such fractures could provide locations for precipitation of the veins as "flats" which were to be later folded by stress in the same orientation as that responsible for the fracture formation. To hold open these fractures a large nearby reservoir of high permeability would be needed to supply the fluids, but the best place for the formation of these fractures is in the finer grained or shaley areas. This problem appears to be solved since the vast majority of the veins are located at the edge of or within thin slate beds that are interbedded with much thicker and coarser quartzite and greywacke units. This would account for the majority of the gold and scheelite veins being found in the lower parts of the Halifax Formation and upper parts of the Goldenville Formations. As these fractures opened, pore fluids would flow in and the minerals would be precipitated primarily in response to a decrease in pressure. If the fluid contained significant amounts of carbonate at greenschist grades and temperatures, then the sequence of minerals precipated would be first carbonate, then quartz and Fe-As-S minerals. The nature of the fluid inclusions indicates a low salinity, CO_2 -rich fluid which should allow Ca as well as Si to be mobile along with all other gold vein components under greenschist-grade conditions. After precipitation the veins were competent layers in a package of rocks of varying ductility. Where they were mostly enclosed by less competent slate near the hinges of the folds, they were mechanically buckled, forming parasitic folds. On the fold limbs veins were locally boudinaged and rolls formed. There was no subsequent remobilization. The high gold values appear to be the result of an increased amount of vein material (i.e. rolls) in a given volume of rock and hence mechanically enhanced the grade.

This appears to be the best explanation to explain the formation of the veins since it accounts for timing, textures and paragenetic relationships. This result is supported by Miller, Graves and Zentilli (1976) and Shaw (1983) for the Stillwater Brook deposit.

Recently another theory has been put forward by Haynes (1982; 1983) suggesting another possible mechanism for the formation of the gold veins. Unfortunately the first major paper on the subject is not due to be published until mid-March 1984. His theory is as follows. The association of auriferous stratiform and stratabound veins with sericite - tourmaline - arsenopyrite wall rock alteration and K-Feldspar + muscovite-bearing step-vein "feeders" indicates that the gold was deposited from (or mobilized by) hot hydrothermal solutions. The "feeder-like" relationship of a cross-cutting step vein to a stratiform ribbon vein is suggestive of a submarine hydrothermal-vent system with attendant seafloor chemical sedimentation (stratiform veins), intrasediment sills (stratabound veins and some stratiform veins) and fault controlled feeders (step veins). He states that the veins exhibit crosslamination and columnar structures, similar to modern geyserites at Yellowstone, and are usually rich in carbonate. Haynes relates this theory to the gold, silver, mercury and stibnite mineralization but does not mention tungsten (Haynes, 1983). The wall rock alteration Haynes describes has not been observed by other authors and was not found in the examination of thin sections for this paper. Further discussion on this theory should be left until the first paper is published.

FIGURES 28, 29 and 30

○ - NON-PRODUCER

● - $<$ 10,000 Lbs. WO_3

● - 10,000 - 50,000 Lbs. WO_3

● - $>$ 50,000 Lbs. WO_3

SB - STILLWATER BROOK
GF - GOFF
FR - FALL RIVER
LC - LAKE CHARLOTTE
IP - INDIAN PATH
LS - LOWER SACKVILLE
MV - MURCHYVILLE

fig. 28

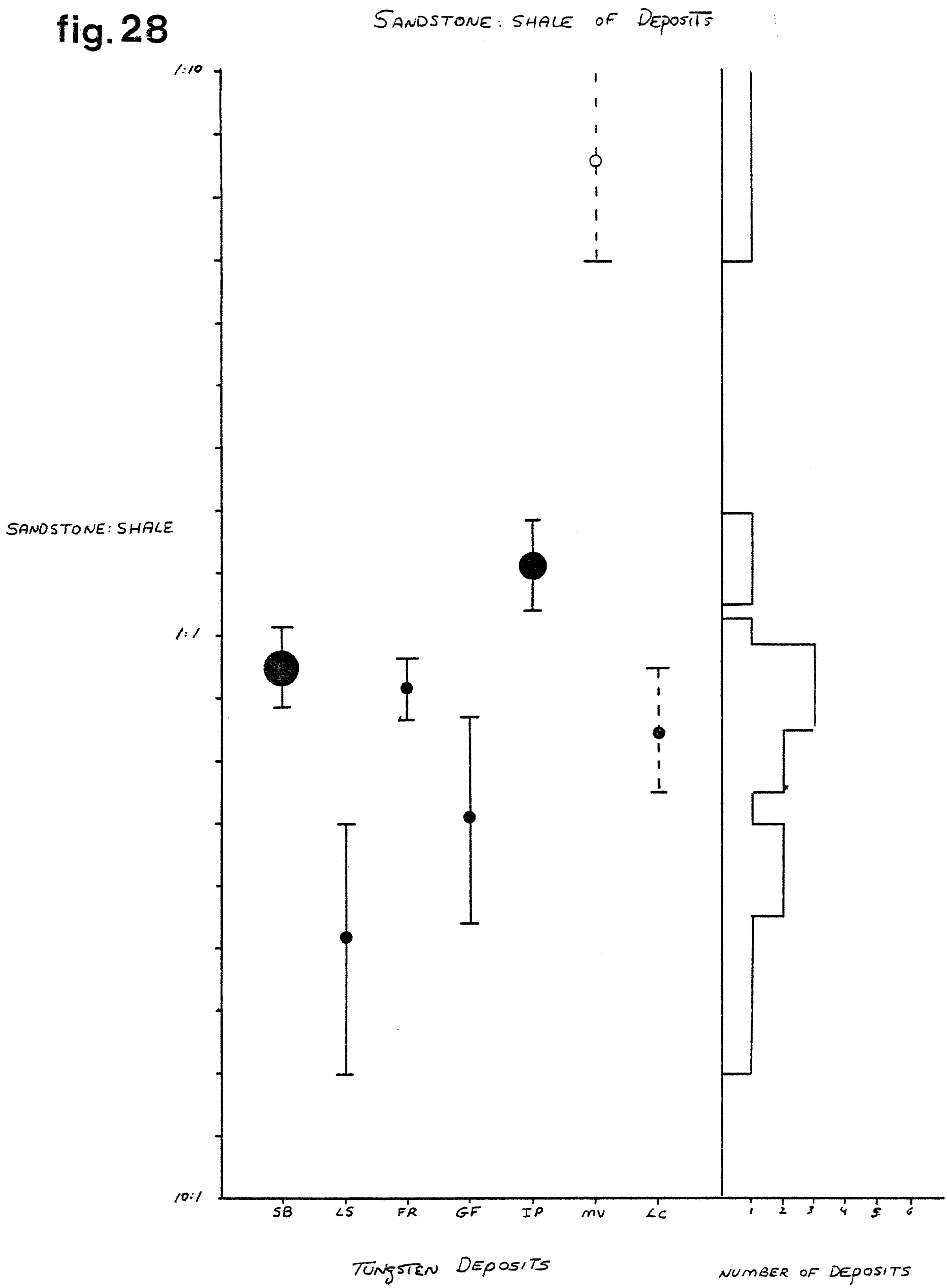
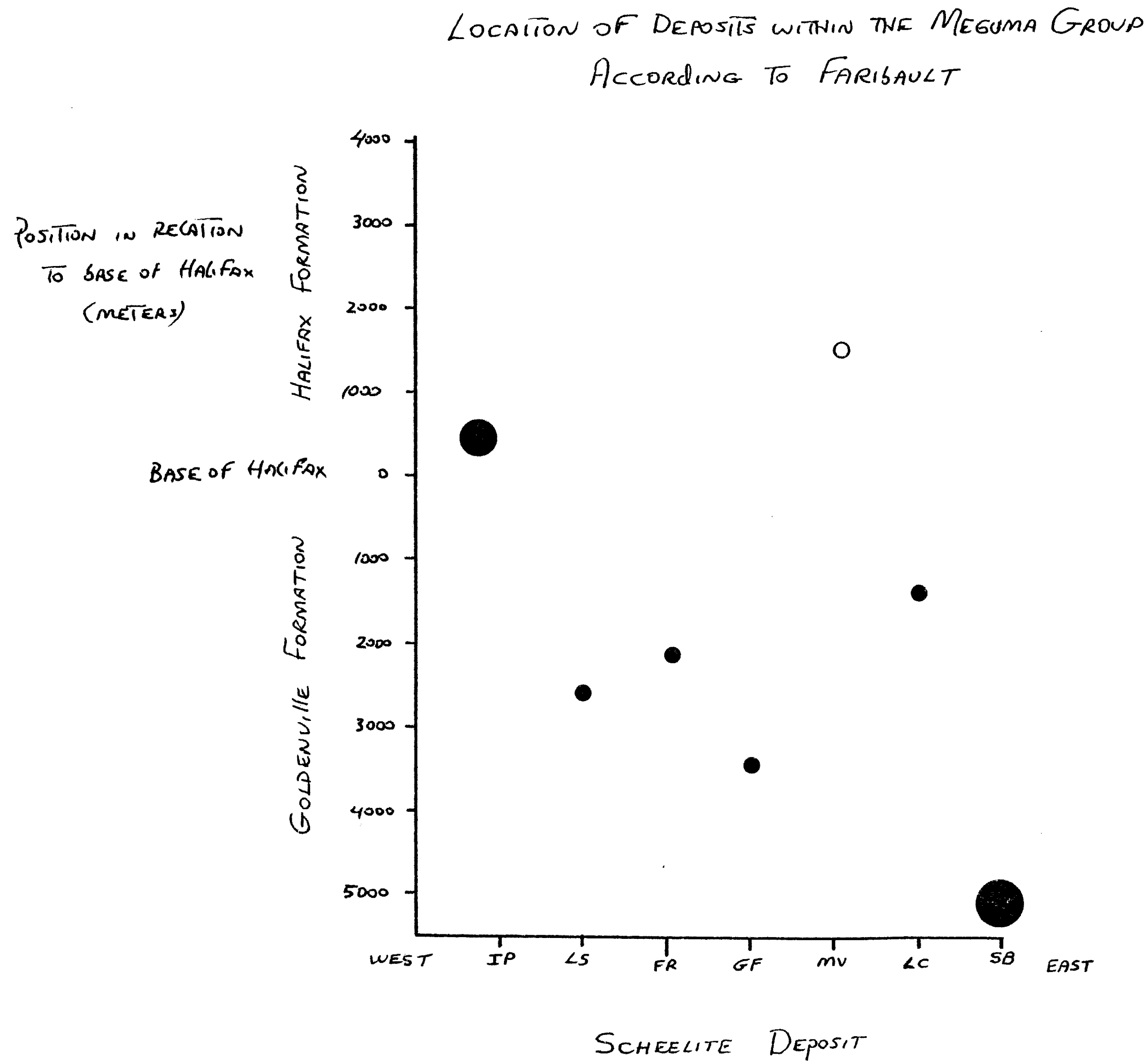
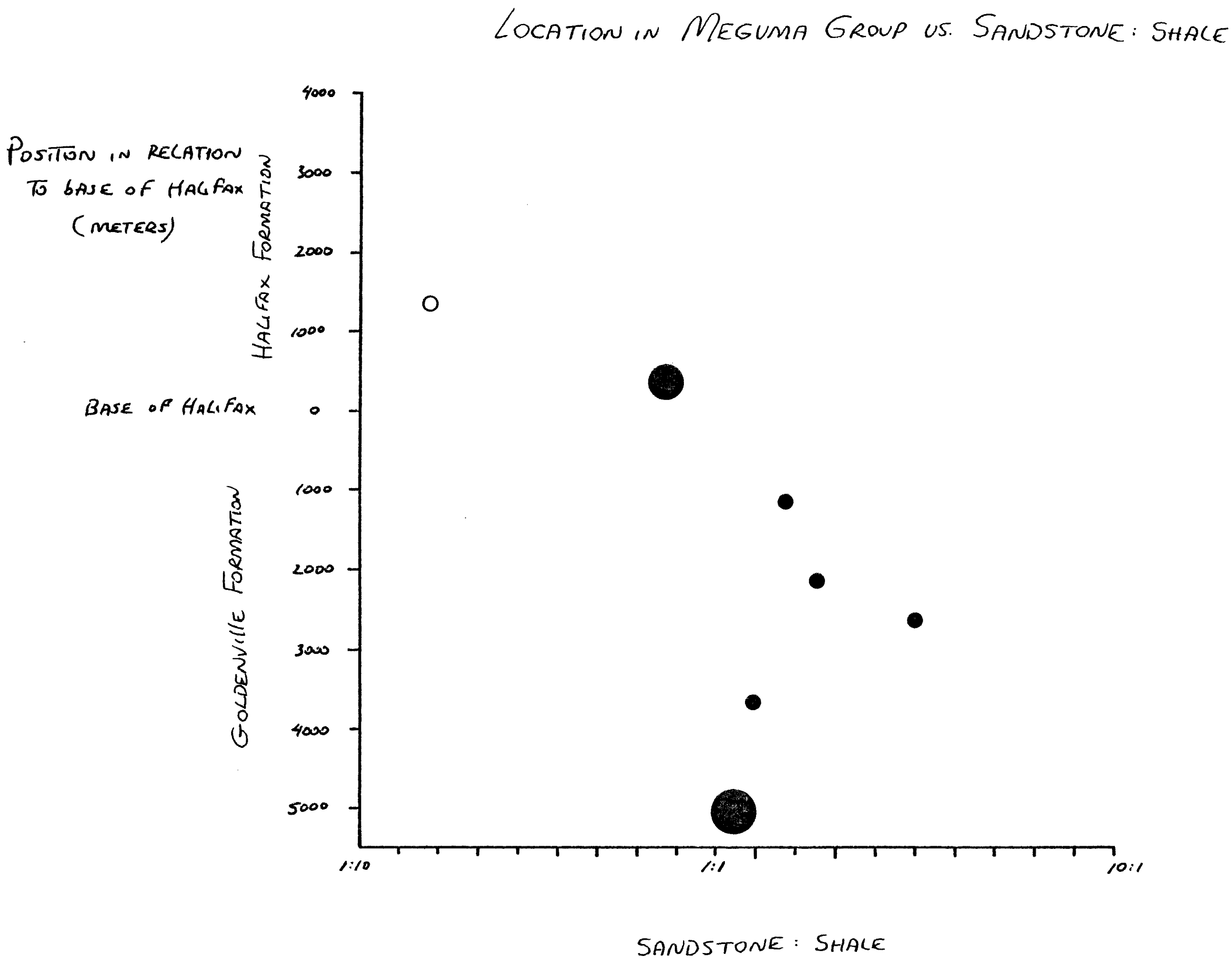

SANDSTONE : SHALE OF DEPOSITS
1:10
SANDSTONE: SHALE
1:1
10:1
SB
LS
FR
GF
IP
MV
LC
1
2
3
4
5
6
TUNGSTEN DEPOSITS
NUMBER OF DEPOSITS

fig. 29



LOCATION OF DEPOSITS WITHIN THE MEGUMA GROUP
ACCORDING TO FARIBAULT
POSITION IN RELATION TO BASE OF HALIFAX (METERS)
HALIFAX FORMATION
BASE OF HALIFAX
GOLDENVILLE FORMATION
4000
3000
2000
1000
0
1000
2000
3000
4000
5000
WEST
IP
LS
FR
GF
MV
LC
SB
EAST
SCHEELITE DEPOSIT

fig.30



LOCATION IN MEGUMA GROUP VS. SANDSTONE : SHALE
POSITION IN RELATION TO BASE OF HALIFAX (METERS)
HALIFAX FORMATION
BASE OF HALIFAX
GOLDENVILLE FORMATION
4000
3000
2000
1000
0
1000
2000
3000
4000
5000
1:10
1:1
10:1
SANDSTONE : SHALE

fig. 31 SANDSTONE : SHALE VS WO_3 PRODUCTION

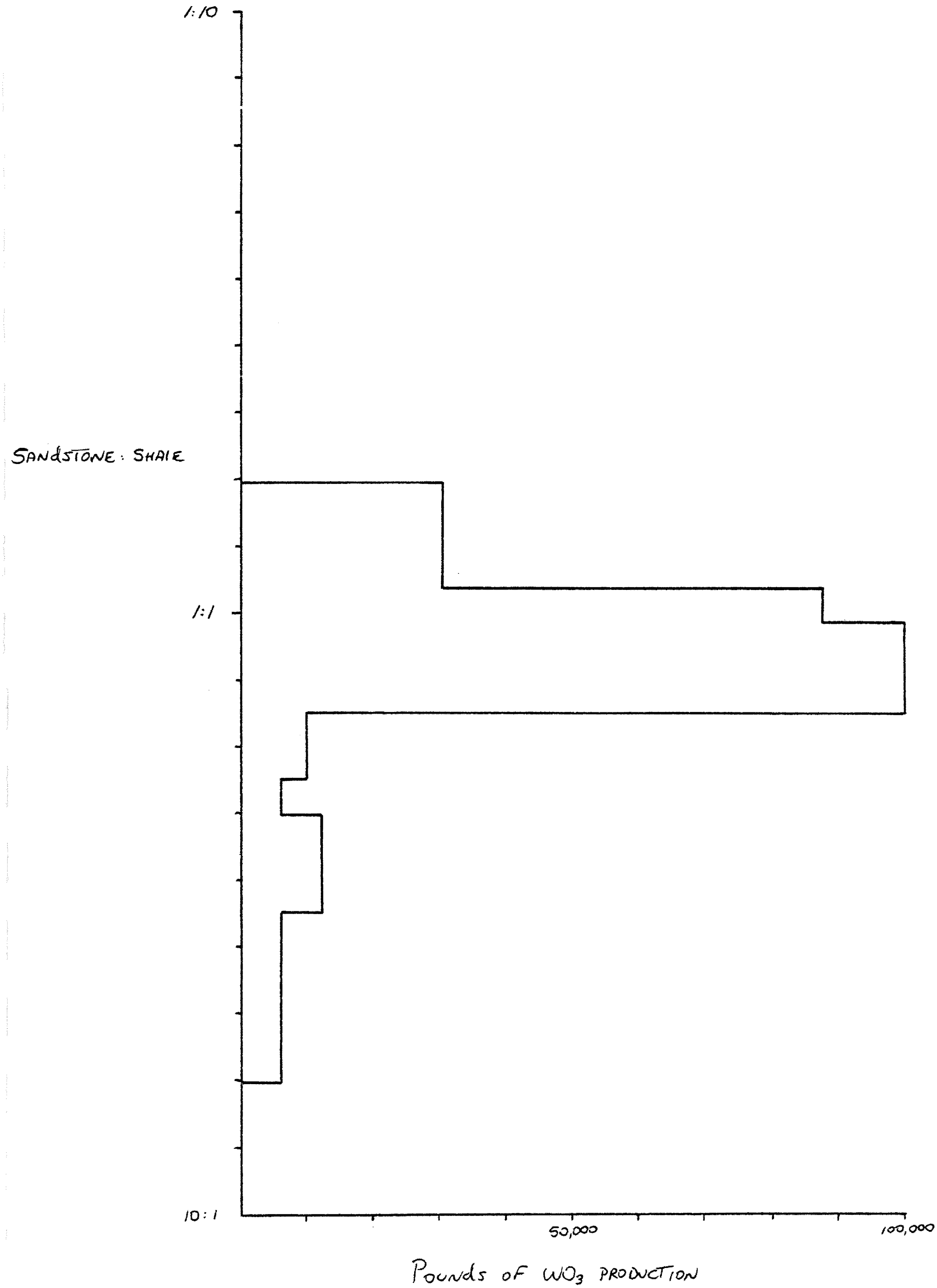


FIG. 32

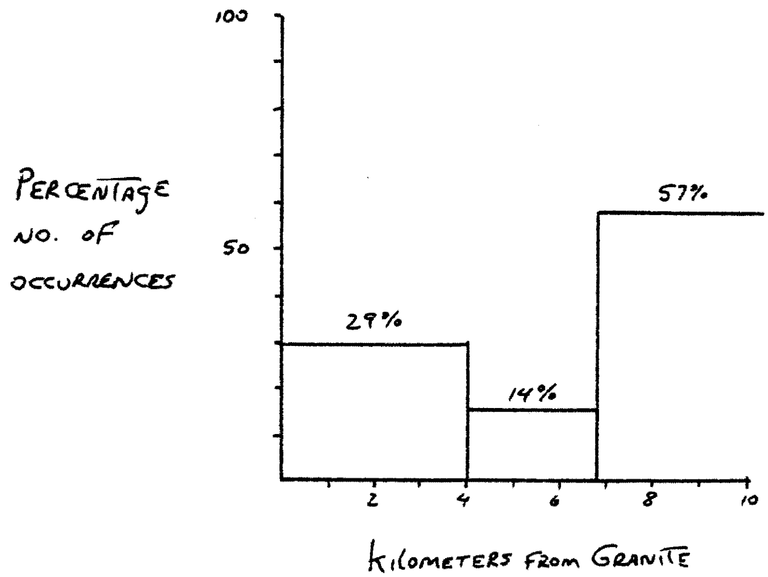
MINERAL OCCURRENCES
BY
DISTRICT

S = THIN-POLISHED SECTION (FISHER, 1984)
F = FIELD OBSERVATION (FISHER, 1984)
P = ELECTRON MICROPROBE (FISHER, 1984)
X = X-RAY DIFFRACTION (FISHER, 1984)
M = NSDM
1 = LITTLE (1959)
2 = MALCOLM (1912; 1929)
3 = DOUGLAS (1939) - MOOSE RIVER
4 = DOUGLAS (1939) - LAKE CHARLOTTE
6 = FLYNN (1942)

MINERAL OCCURRENCES

	STILLWATER BROOK			GOFF			FALL RIVER			LAKE CHARLOTTE			INDIAN PATH		LOWER SACKVILLE		MURCHYVILLE	
QUARTZ	S	F	X	X	F	S	X	F	M	X	M		X	2	S	F	S	
SCHEELITE	S	F	X	X	F	M	X	F	M	X	F	M	/	6	/	M	/	M
ANKERITE	S	P	X				X	P					X					
CALCITE	X			X			X	P		X	F		X	6	S	F		
RUTILE	S	F	P	S			P			S			P	S	S		S	
BIOTITE							S	F		F	S	4						
MUSCOVITE	F	X		S			X			X	4		F					
TOURMALINE	/	2																
ALBITE	X						S			X	4		F					
ARSENOPYRITE	S	F	X	X	S	M				F	4		F	6	/	M	M	S
PYRITE	X			X	F		F	M					/	S	F		S	
GOLD	M						M			M			/				M	
BOG MN				M														
CALCOPYRITE				M														
MARCASITE	M						M								M			
GALENA													/					
PLATINUM							M											
NICKEL																		
SILVER										M								
Molybdium										M	4							
PYRRHOTITE										4			6					
ORTHOCLASE										4								
SPHALERITE													6					
ILMENITE							P											
DOLOMITE	P	2																
SERICITE																		
GRAPHITE																		
CHLORITE	X	S		S	F		X	S		X	S		X	S	S	F	S	

fig. 33


PERCENTAGE
NO. OF
OCCURRENCES
100
50
29%
14%
57%
2
4
6
8
10
KILOMETERS FROM GRANITE

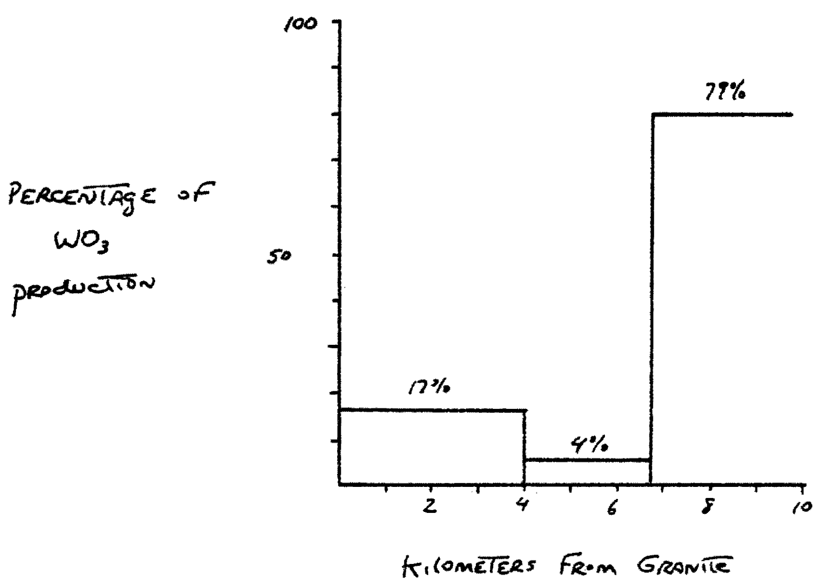

PERCENTAGE OF
WO_3
production
100
50
17%
4%
79%
2
4
6
8
10
KILOMETERS FROM GRANITE

FIG. 34

TUNGSTEN ANALYSIS

SHALE		QUARTZITE	
SAMPLE	W PPM	SAMPLE	PPM
FR-9	< 15	FR-1	4
FR-44	< 15	FR-2	< 15
GF-1A	< 15	GF-2A	7
GF-1B	6	GF-3	4
IP-9	22		
IP-13	22		
LC-14	12	LC-12	25
LC-21	15	LC-13	25
LS-1	3	LS-4	2
LS-6	2		
MV-1	2		
SB-7	92	SB-10	2
SB-35	< 50	SB-18	2

FR = FALL RIVER
GF = GOFF
IP = INDIAN PATH
LC = LAKE CHARLOTTE
LS = LOWER SACKVILLE
MV = MURCHYVILLE
SB = STILLWATER BROOK

CHAPTER 12

CONCLUSIONS AND RECOMMENDATIONS

1) The scheelite deposits are found at the edge of or within slate beds which are interbedded with quartzites and graywackes.

2) The veins are found conformable with and parallel to the bedding planes near the crest or on the limbs of large anticlines within the Meguma Group. Although the gold districts appear to be associated with doming of the anticlines, the scheelite occurrences are not. Further mapping in the vicinity of the deposits may find some doming, but to date none is known.

3) Approximately 90% of tungsten production within the Meguma Group comes from an area that consists of about 15% of the Meguma and appears to center around a sandstone:shale ratio of 1.0:1.0. It would appear to suggest that a particular zone or horizon within the Meguma favors the formation of scheelite deposits. This would meet the requirements of the Graves-Zentilli model for vein formation which implies the need for slate beds where fracturing will occur and thick permeable beds nearby to supply abundant fluids. This particular area of the Meguma would be a prime location for this type of interbedding.

4) The ore is found associated with the limbs and occasionally the crests of the folds in the Meguma. The ore is predominantly found on or near the wall rock in rolls or bulges in the veins, and to a lesser extent where the veins narrow and pinch out. Occasionally it may be found disseminated throughout the vein.

5) The veins contain predominantly quartz, carbonate, scheelite, arsenopyrite and minor amounts of rutile, pyrite, and traces of gold. There seems to be a varying opinion on the sequence of precipitation in the veins. In general the following seems to be true for their formation. The earliest forming minerals in the veins are the scheelite and carbonate, followed by quartz then arseopyrite, rutile and pyrite.

6) The deposits are found in the greenschist facies grade of regional metamorphism. The mineral assemblages found at the various sites appear to fall into one or the other of the mineral assemblages given by Cullen (1983) for the biotite and chlorite zones. The only difference is that "moth-eaten" rutiles are found throughout both zones and should only be in the chlorite zone. The reason for this is not understood and deserves further study. If rutile is not found in the rock near the gold occurrences then it may be a clue to the formation of the scheelite deposits.

7) There appears to be no genetic relationship between the granite and the scheelite occurrences .

8) The results of tungsten analysis performed on 22 samples shows the host rocks near the scheelite deposits to be enriched in tungsten with values ranging from 2-92 ppm, while the world crustal average is 1.5 ppm. This would agree with the literature which indicated that the host rocks were the source for the tungsten. Further work should be conducted to determine if the rock near the scheelite deposits are enriched relative to the gold districts and non-mineral producing areas of the Meguma Group.

9) The scheelite veins appear to satisfy the requirements of the Graves and Zentilli model for vein formation: hydraulic horizontal fracturing and pore fluid migration during conditions of greenschist regional metamorphism, vein precipitation, folding and formation of rolls.

10) No new insight was gained into the empirical separation of the gold and scheelite deposits.

11) While performing electron microprobe analysis on several carbonates a peak believed to be tungsten appeared on the probe screen. Unfortunately analysis of these samples for tungsten could not be performed at the time. Further work on this should be conducted in the future.

12) Five of the six past scheelite producing deposits were found

to occur near the crest of the same fold upheaval (Moose River Anticline - Waverly Anticline - Indian Path Anticline). This may indicate that a feature such as a primary channel facies, basement structure, or a break in paleotopography may have concentrated sediments containing tungsten.

13) The results of this thesis indicate the following as the most likely locations for future exploration for scheelite deposits within the Meguma Group. The primary location would be on or near the crest of an anticline, prefeably along the trend of the Moose River - Waverly - Indian Path Anticlines or to a lesser degree the Mooseland - Gegogan Anticline, in rocks where the sandstone:shale ratio lies between 2.5:1.0 and 1.0:2.5 preferably as close to 1.0:1.0 as possible. Scheelite may be found in rolls or pinches within quartz veins that are conformable with the bedding of the strata in the above areas. The presence of host rocks enriched in tungsten may indicate that quartz veins in an area mentioned above contain scheelite.

ACKNOWLEDGEMENTS

I would like to thank Dr. Marcos Zentilli for his enthusism, guidance, suggestions, criticisms and patience. Mrs. Ruth Fisher for the typing of the reference list. Dr. James Hall and the Center for Marine Geology for the use of their word processor. Charlie Walls and

John Robinson for their guidance in the use of the word processor.

REFERENCES

Ade-Hall, J.M., Palmer, H.C. and Hubbard, T.R., (1971) The Magnetic and Opaque Petrological Response of Basalts to Legional Hydrothermal Alteration. Geophys. J. Roy. Soc., 24, 137-174.

Boyle, R.W. (1979). The Geochemistry of Gold and its Deposits. Geological Survey of Canada, Bulletin 280, 584.

Cameron, A.E. (1941) Tungsten Project, Moose River, Nova Scotia Dept. of Mines, Annual Report on Mines, 114-134.

Cameron, L.E. (1942) Mineralogical Examination of Indian Path Tungsten Ore, Nova Scotia Dept. of Mines, Annual Report on Mines, 143 - 155.

Charlick, R., (1941) Tungsten Deposit Indian Path, Lunenburg Co., Nova Scotia Dept. of Mines, Annual Report on Mines, 130 - 140.

Charest, M.H., (1978) Petrology, Geochemistry and Mineralization of the New Ross, Lunenburg County, Nova Scotia. M.Sc. Thesis, Dalhousie University.

Clark, P.B., and Halliday, (1980) Strontium Isotope Geology of the South Mountain Batholith, Nova Scotia. Geochem et Cosmochem, Acta, 44, 1045-1058

Cronan, D.S. (1980) Under Water Minerals. Ocean Science Resources and Technology, an International Series, 362.

Cullen, J.D., (1983) Metamorphic Petrology and Geochemistry of the Goldenville Formation Metasediments, Yarmouth, Nova Scotia. Unpubl. M.Sc. Thesis, Dalhousie Univ., Halifax, Nova Scotia 130.

Douglas, G.V., (1939) Geology of Lake Charlotte Gold Area. Nova Scotia Dept. of Mines, Annual Report on Mines, Pt.2, 46-63.

Douglas, G.V. (1939). Geology of Moose River Gold District, Nova Scotia Dept. of Mines, Annual Report on Mines, pt.2, 18-26

Douglas, G.V., (1939) Scheelite at Goff, Nova Scotia Dept. of Mines, Annual Report on Mines, pt. 2, 40-45.

Faribault, E.R., (1886-1939) Annual Reports of the Geol. Surv. Can. and Numerous Maps and Plans of Gold Districts Published by the Geol. Surv. Can.

Faribault, E.R. (1899) The Gold Measures of Nova Scotia and Deep Mining, J. Can. Mining Inst., 11, 119-128

Flynn, A.E., 1942 Tungsten Investigations, Nova Scotia Dept. of Mines, Annual Report on Mines, 119-143

Fyson, W.F., (1966) Structures in the Lower Paleozoic Megums Group, Nova Scotia. Geological Society of America Bulletin, v. 77, 931-944.

Graves, M.C. (1976) The Formation of Gold-Bearing Quartz Veins in Nova Scotia: Hydralic Fracturing Under Conditions of Greenschist Regional Metamorphism During Early Stages of Deformation. Unpub. M.Sc. Thesis, Dalhousie Univ., Halifax, Nova Scotia, 119 p.

Graves, M.C. and Zentilli, M. (1982). A Review of the Geology of Gold in Nova Scotia; in Geology of Canadian Gold Deposits, ed. R.W. Hodder and W. Petruk, Canadian Institute of Mining and Metallurgy Special 24, 233-242.

Gretener, P.E., (1969) Fluid Pressure in Porous Media - Its Importance in Geology: A Review, Bulletin of Canadian Petroleum Geology, v. 17, No. 3, 255-295.

Harris, I.M., Schenk, P.E., (1975). The Meguma Group, Field Trip, Ancient Sediments of Nova Scotia, Eastern Section Society of Economic Paleontologists and Mineralogists, Ed. by I.M. Harris 17 - 38

Harrison, R.B., (1938) Thesis on Paragenesis of Minerals in Nova Scotia Gold Quartz Veins, Nova Scotia Dept. of Mines, Annual Report on Mines, 2, 5-12.

Haynes, S. (1982) Relation of Gold to Quartz-vein polytypes in Greenschist Faceo Turbidites, Meguma Group, Eastern Nova Scotia. Nova Scotia Dept. of Mines and Energy, Information Series No. 5, 44-45.

Haynes, S. (1983) Polygenetic Origin of Gold Deposits, Eastern Meguma Terrane, Nova Scotia Dept. of Mines and Energy, Information Series. No. 6, 69-72.

Henderson, J.R. (1983) Structural History of the Meguma Terrine in Nova Scotia from Sheet Harbour to Sherbrooke, Nova Scotia Dept. of Mines and Energy, Information Series. 6, 55p.

Higgins, N.C. (1980) Fluid Incwsion Evidence for the Transport of Tungsten by Carbonate Complexes in Hydrothermal Solutions. Canadian Journal of Earth Science. 17, 823-830.

Hosking, K.F.C. (1973) The Search for Tungsten Deposits. Bull. Geol. Soc. of Malaysia. 5, 66 p.

Hurlbut, Jr., and Klein, C., after Dana, J.D., (1971) Manual of Minerology. 19th. Ed., 531 p.

Jeffrey, P.G., (1958) The Geochemistry of Tungsten, with Special Reference to the Rocks of the Uganda Protectorate, Geochimica et Cosmochimia, Acta, 1959, 16, 278-295.

Keppie, J. (1976) Structural Model for the Saddle Reef and Associated Gold Veins in the Meguma Group, Nova Scotia. Nova Scotia Department of Mines, Paper 76-1, 28 p.

Keppie, J. and Mucke, G.K., (1979), Metamorphic Map of Nova Scotia, Nova Scotia Department of Mines and Energy.

Law-West, D.G., (1981) Tungsten, Energy Mines and Resources Canada, 44.1 - 44.7.

Little, H.W. (1959). Tungsten Deposits of Canada, Economic Geology Series, 17, 251 p.

MacEachern, I.J., (1983) The Distribution, Character and Composition of Gold in the Till at the Fifteen Mile Stream Gold District Halifax County, Nova Scotia. Unpubl. B.Sc. Honours Thesis Dalhousie University

Malcolm, W. (1912) Gold Fields of Nova Scotia. Geological Survey of Canada, Memoir 20-E, 331 p.

Malcolm, W., (1929) Gold Fields of Nova Scotia, Geological Survey of Canada, Memoir 385, 253 p.

Maucher, A., (1976) The Strata-Bound Cinnabar-Stignite-Scheelite Deposits, Handbook of Strata-bound and Strata Form Ore Deposits, v. 7, 477-503.

Messervey, J.P., (1930) Tungsten in Nova Scotia, Nova Scotia Dept. of Mines, Annual Report on Mines, pt. 1, 235-260.

Miller, C.K., (1974) Sheelite Mineralization in the Region of the Moose River Gold District, Halifax County, Nova Scotia. Unpubl. B.Sc. Honours Thesis, Dalhousie University, Halifax, Nova Scotia.

Miller, C.K., Graves, M.C., Zentilli, M., (1976) Sheelite Mineralization of South Eastern Nova Scotia, Geol. Surv. Can., Paper 76-1A, 68 p.

Nance, D., (1977). Report on the Stillwater Scheelite Property Moose River, Nova Scotia. Nova Scotia Department of Mines Assessment Report, 11D/15C 21-H-49(05).

Newhouse, W.H., (1936) A Zonal Gold Mineralization in Nova Scotia. Economic Geology, 31, 805-831.

NSDM. Nova Scotia Department of Mines, Various Assessment Files and Occurence Reports.

O'Brien, B.H., (1982) A Structural Classification of Quartz Veins in Greenschist Rocks of the Meguma Group, Nova Scotia Department of Mines and Energy, Information Series No. 5, 41-43.

Piers, H., (1926) On a New Tungsten Deposit at Lower Sackville, Halifax. Trans, Vol. 26, N.S. Inst. of Science, 1922-26, 39-45.

Reynolds, P.H., Zentilli, M., and Mucke, G.K., (1981) K-Ar and $^{40}Ar/^{39}Ar$ Geochemistry of Granitoid Rocks from Southern Nova Scotia: Its Bearing on the Geological Evolution of the Meguma Zone of the Appalachians, Canadian Journal of Earth Sciences, 18, 386-394.

Schenk, P.E., (1969) Regional Variation of the Flysch-like Meguma Group (lower paleotoic) of Nova Scotia, compared to Recent Sedimentation off the Scotia Shelf, Geological Association of Canada, Special Paper Number 7, 127 - 153.

Schenk, P.E., (1975) A Regional Synthesis, Field Trip in Ancient Sediments of Nova Scotia, Eastern Section Society of Economic Paleontologists and Mineralogists, ed. by I.M. Harris, 9-16.

Schenk, P.E. (1978). Synthesis of the Canadian Appalacians, G. S.C. paper 78-13, 111-136.

Shaw, W.G., (1982) A Geological Investigation of the Lazy Head and Moose River Tungsten Deposits, Meguma Zone, Central Nova Scotia; Unpubl. M. Sc. Thesis, Dalhousie University, Halifax, Nova Scotia.

Smith, T.L., (1979) The Geochemistry and Origin of the Devonian Granite Rocks of Southwest Nova Scotia. Summary, Bull. Geol. Soc. Annex., part 1, 90. 424-426.

Taylor, F.C., Schiller, E.A., (1966) Metamorphism of the Meguma Group of Nova Scotia. Canadian Journal of Earth Sciences, v. 3, 959 -974.

Taylor, S.R., (1964), Abundance of Chemical Elements in the Continental Crust: A New Table, Geochemia et Cosmochimica Acta, 28, 1273 - 1285.

Turner, F.J. and Verhodgen, J. (1960). Igneous and Metamorphic Petrology, McGraw - Hill Book Co., Inc., New York, Toronto, Lond. 508 p.

Waldron, J.W.F. (1982) Sedimentary Features of the Goldenville Formation, Sherbrook Area, Nova Scotia. Nova Scotia Dept. of Mines and Energy, Information Series. 5, 49-51.

APPENDIX A

NATIONAL TOPOGRAPHIC SURVEY

MAPS

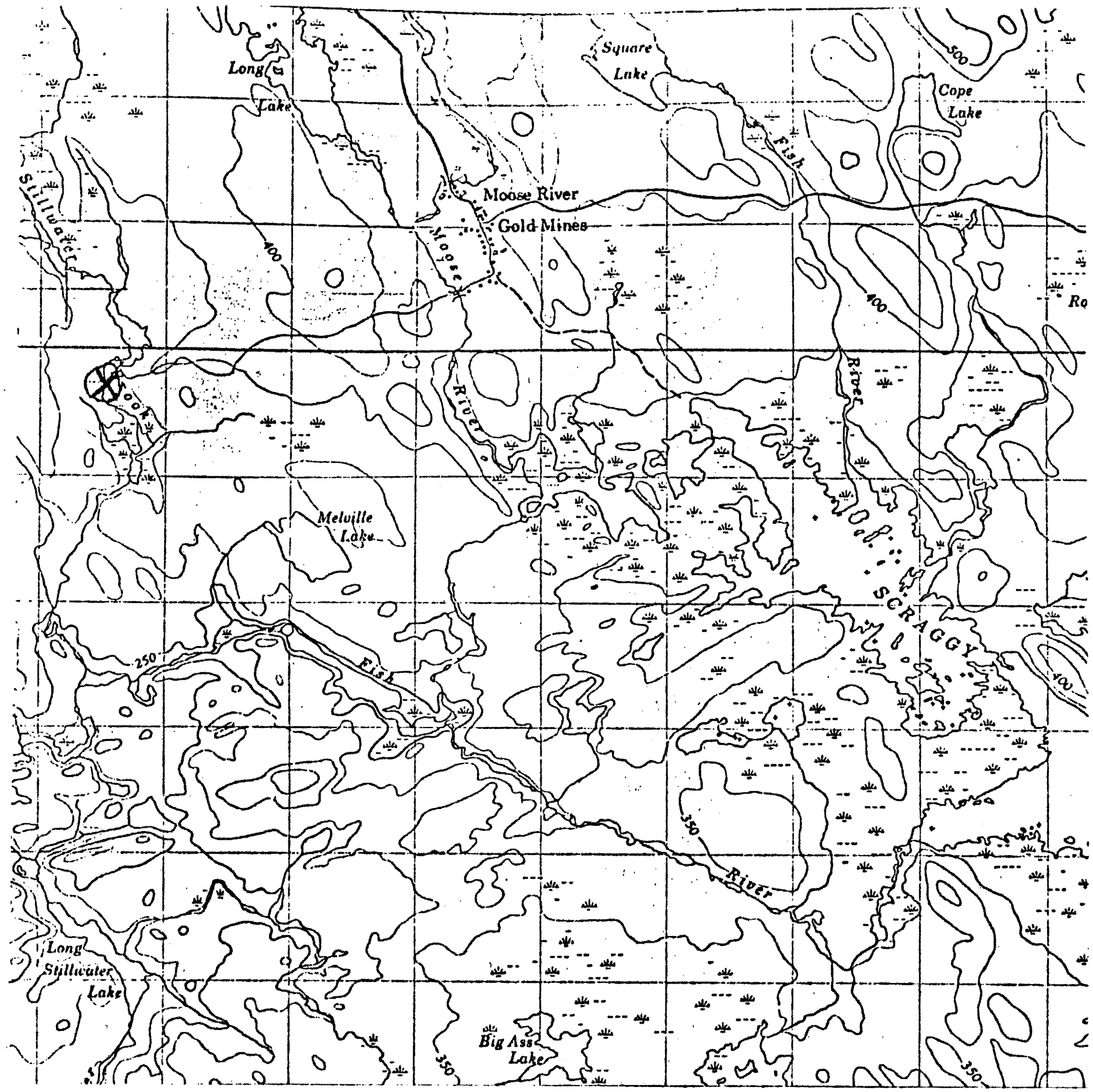
1) 11D/15 STILLWATER BROOK
2) 11 D/13 FALL RIVER
3) 11 D/14 GOFF
4) 11 D/15 LAKE CHARLOTTE
5) 21 A/8 INDIAN PATH
6) 11 D/13 LOWER SACKVILLE
7) 11E/3 MURCHYVILLE

All MAPS ARE 1:50,000

X = LOCATION OF DEPOSIT

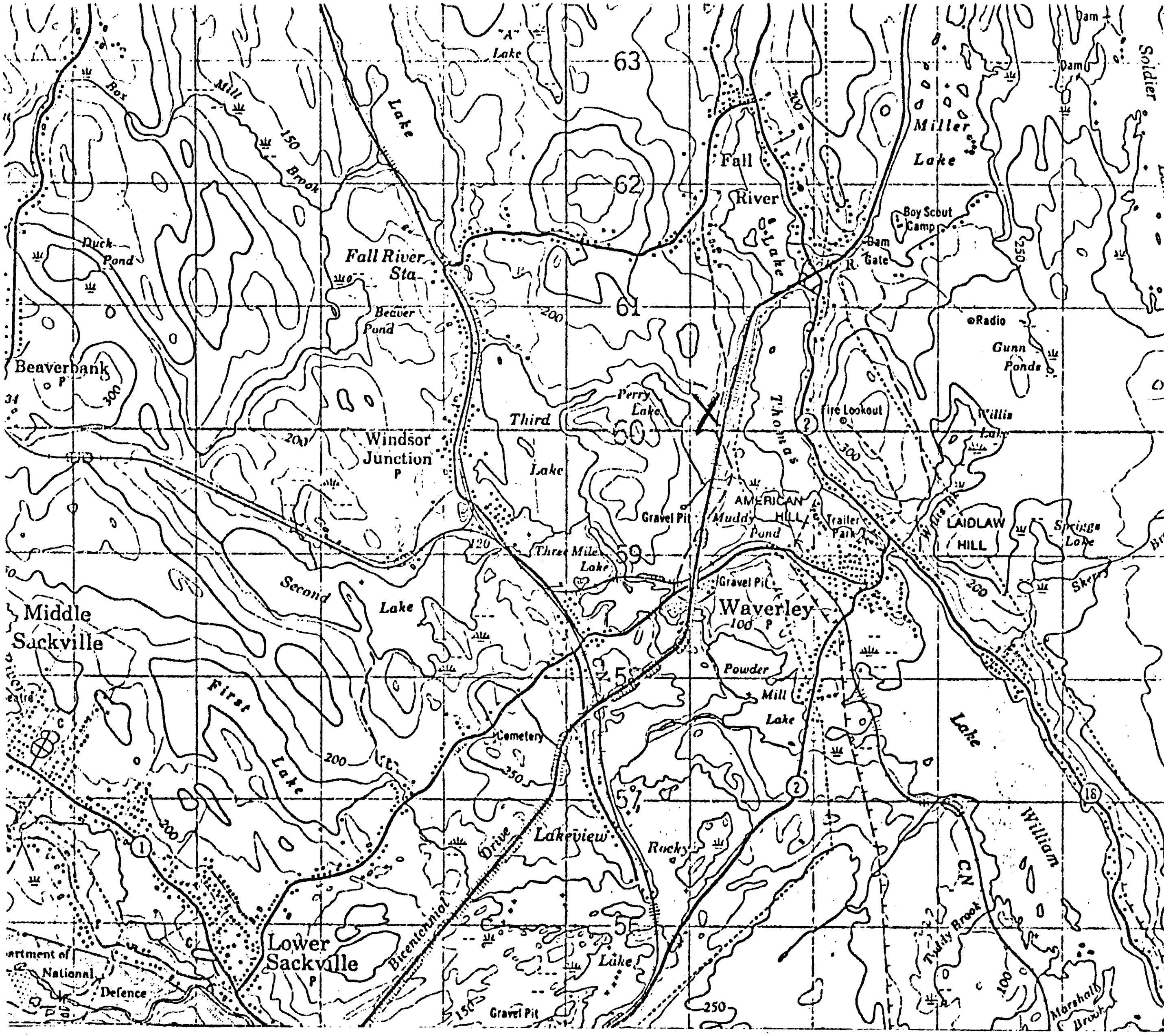
LOCATION MAP: Uncertainty approx. 50 METERS 1:50,000

1



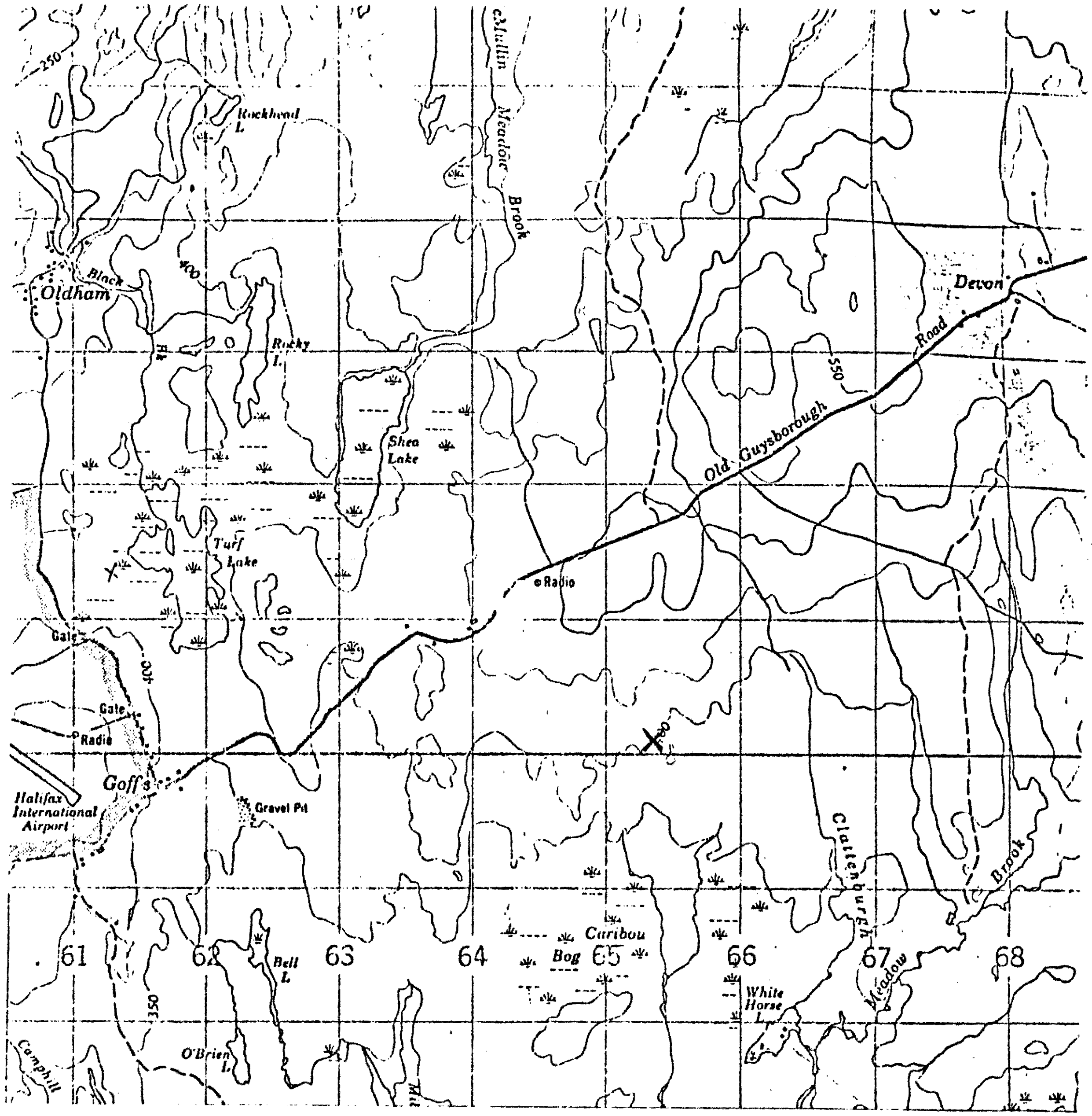
LOCATION MAP: Uncertainty approx. 100 metres 1:50,000

2



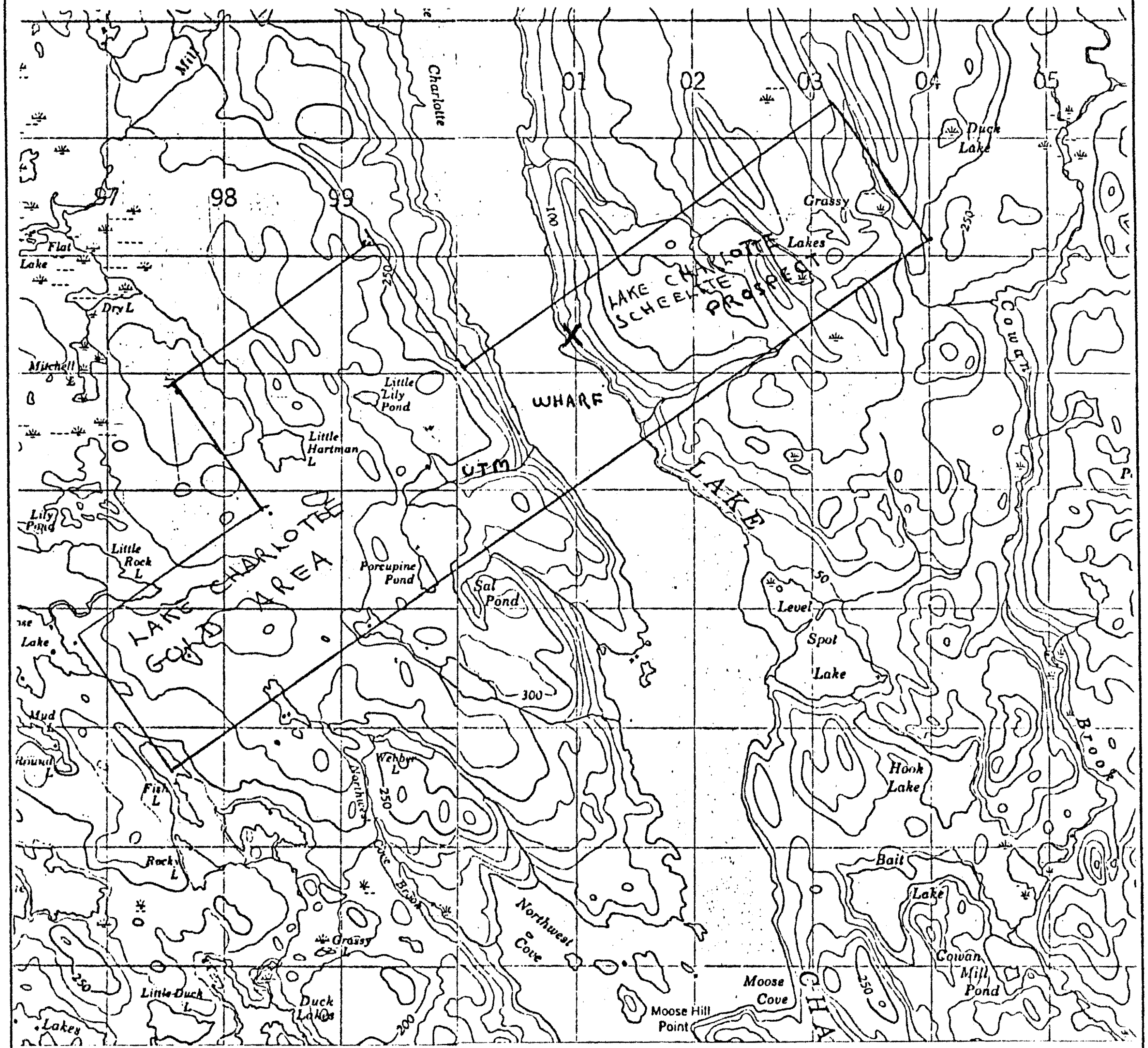
LOCATION MAP: Uncertainty approx. 300 metres 1:50,000

3



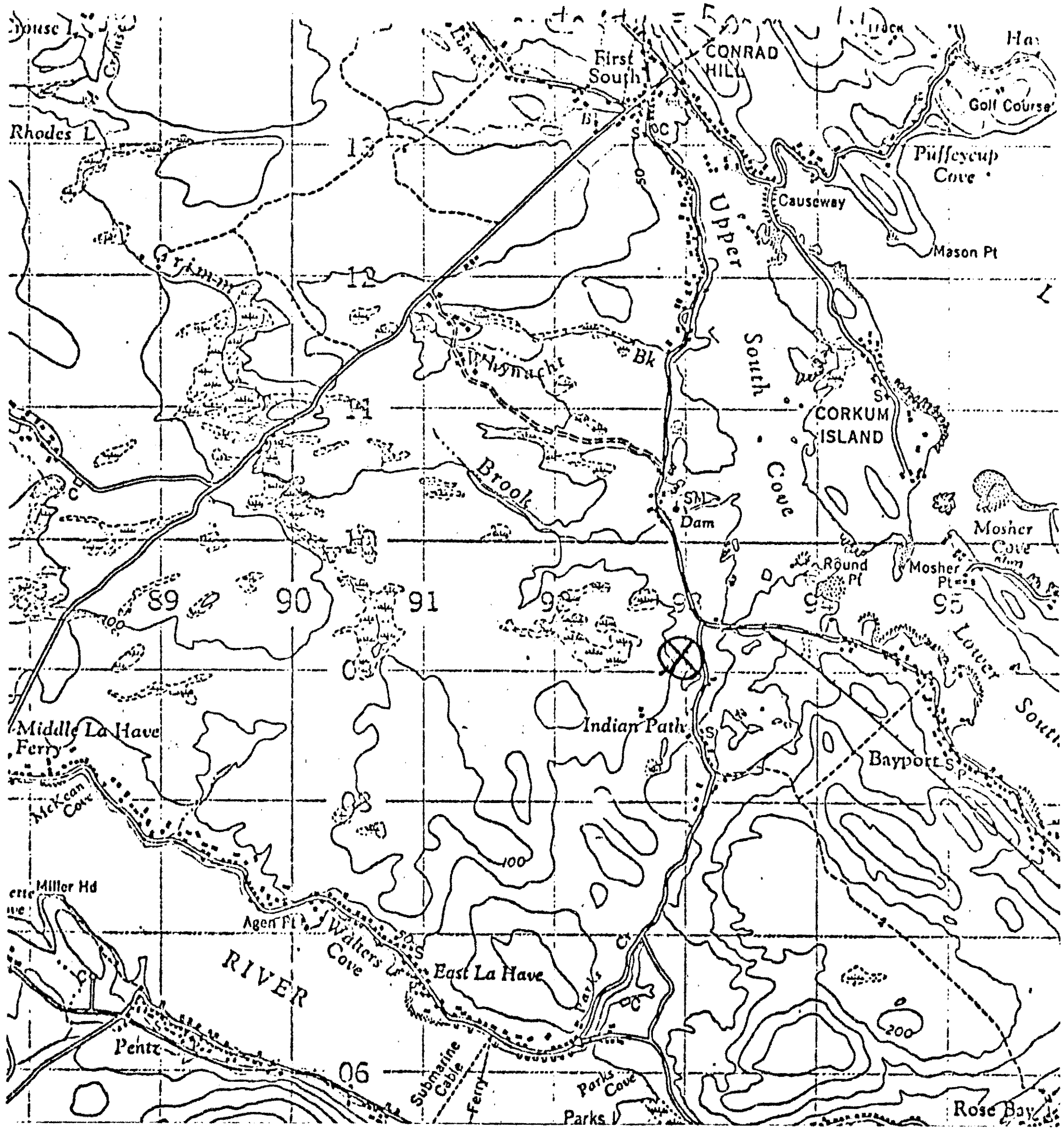
LOCATION MAP: 1:50,000

4 Uncertainty approx. 25 m



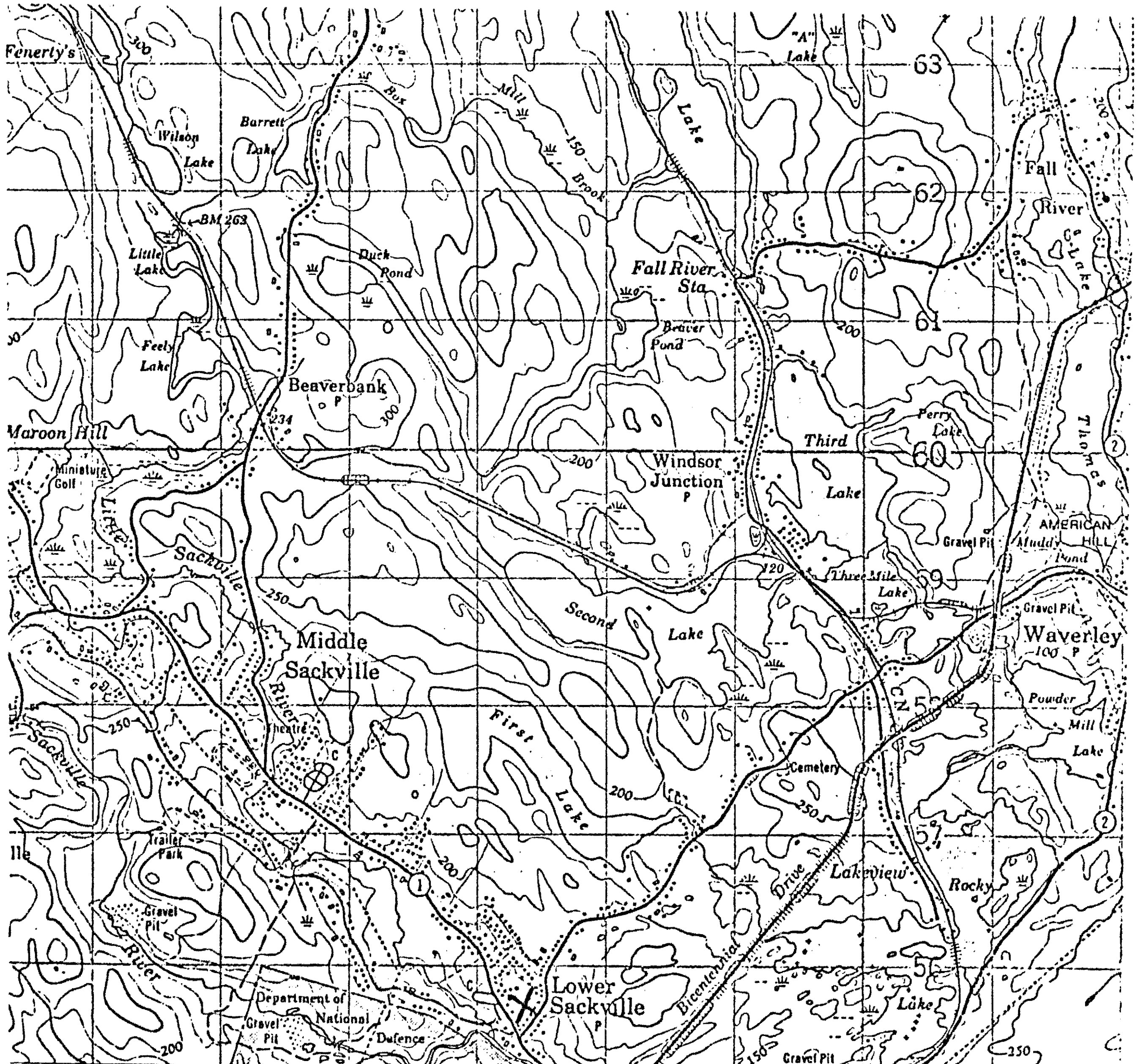
LOCATION MAP. Uncertainty ~ prox. 500 metres 1:50,000

5



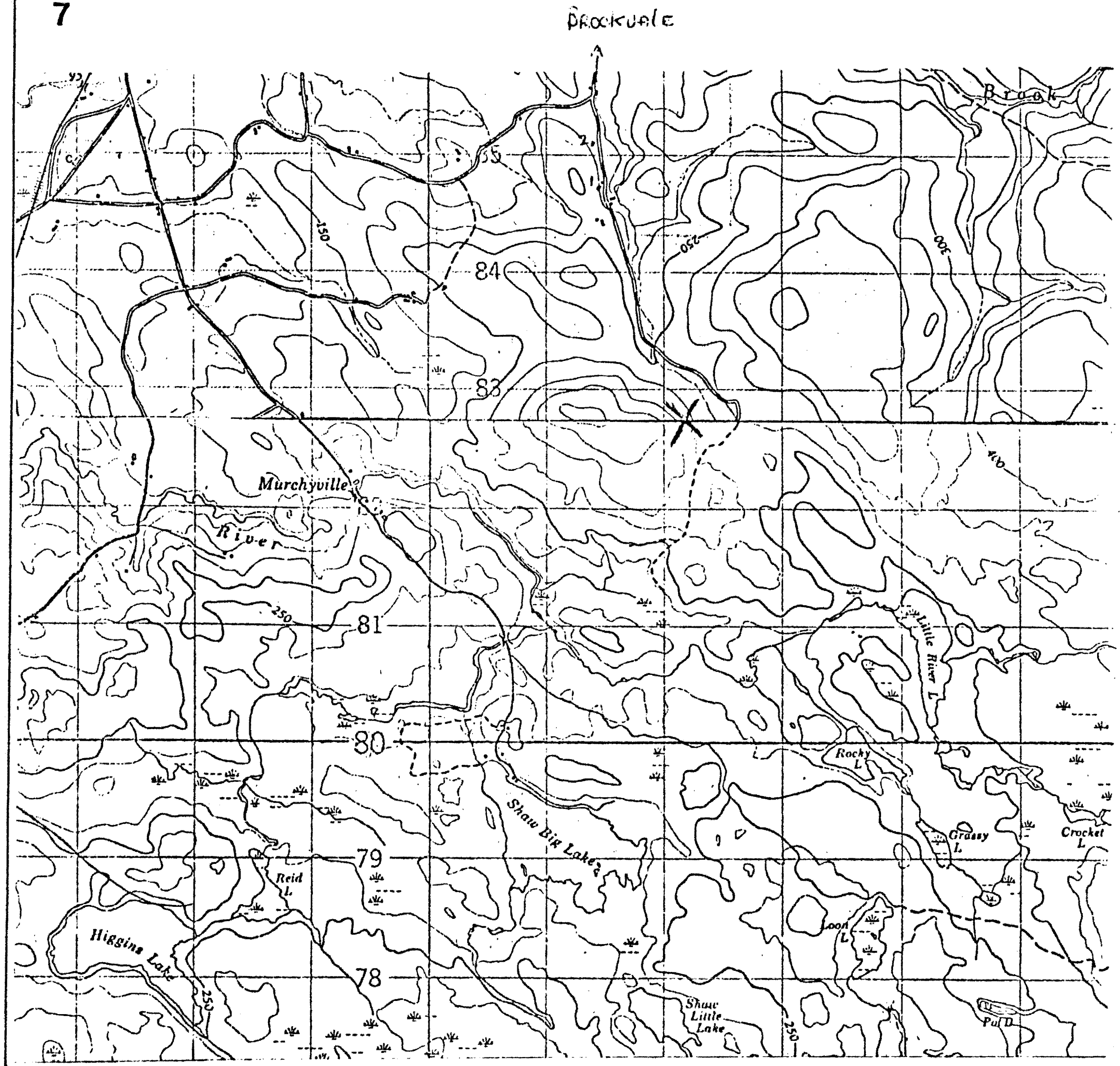
LOCATION MAP: Uncertainty approx.)-500 metres 1:50,000

6



LOCATION MAP: Uncertainty approx. 500 METERS 1:50,000

7

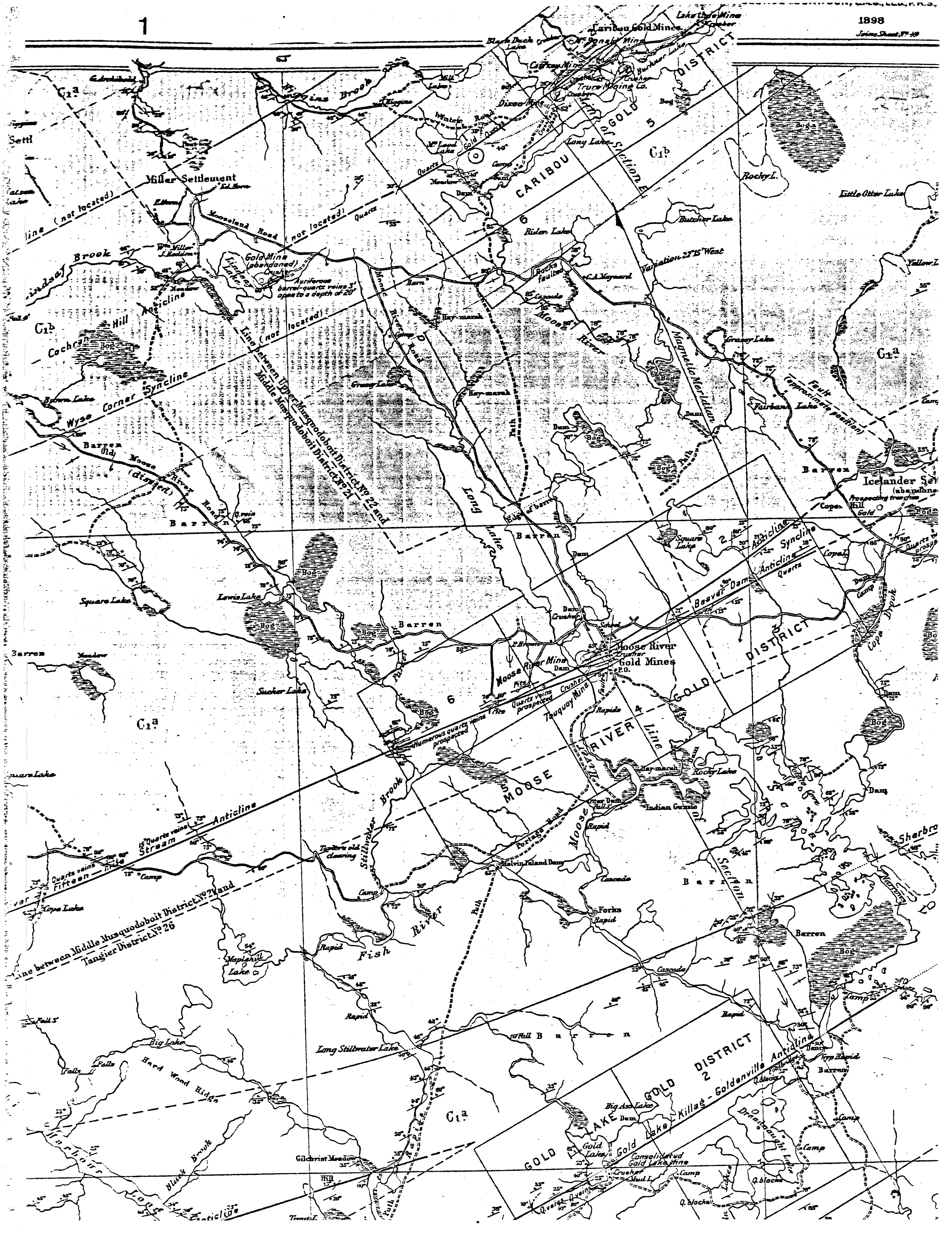


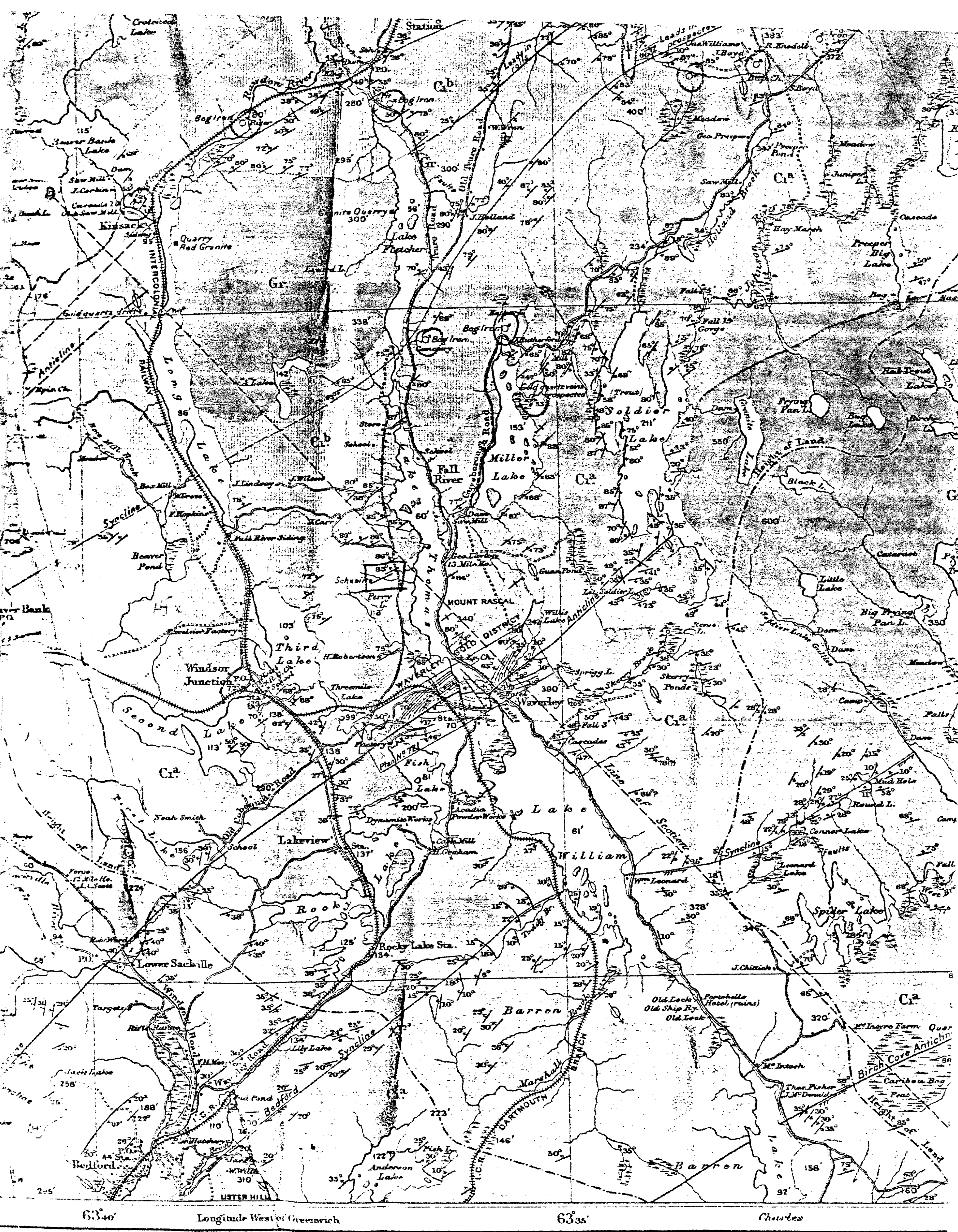
APPENDIX B

FROM FARIBAULT (1889-1939)

1" = 1 MILE

1) MAP #50 STILLWATER BROOK
2) #67 FALL RIVER
3) #66 55 / 67 54 GOFF
4) #51 LAKE CHARLOTTE
5) #89 INDIAN PATH
6) #67 LOWER SACKVILLE
7) #55 MURCHYVILLE


1
1898
Joins Sheet No 49
Caribou Gold Mines
Lake Lode Mine
Crusher
McGonagle Mine
Black Duck Lake
Carey Mine
Burkner Lake
Truro Mining Co.
Dixon Mine
Bog
McLeod Lake
Long Lake
CARIBOU GOLD DISTRICT
5
6
C1b
C1a
Rocky L.
Little Otter Lake
Miller Settlement
Mooseland Road (not located)
Quartz
Rider Lake
Butcher Lake
Lindsay Brook
Gold Mine (abandoned)
Crusher
Auriferous barrel-quartz veins 3' open to a depth of 20'
Lindsay Lake
Anticline
Cochran Hill
Rocks faulted
C.A. Maynard
Variation 21°15' West
Cascade
Moose River
Magnetic Meridian
Hay-marsh
Grassy Lake
Line between Upper Musquodoboit District No 22 and Middle Musquodoboit District No 21
Wyse Corner Syncline
Brown Lake
Fault (approximate position)
Fairbanks Lake
Barren
Old Moose River Road (disused)
Q. vein
Path
Long Lake
Icelander Settlement
Cope Hill
Gold
Prospecting trenches
Square Lake
Anticline
Syncline
Beaver Dam
Cope L.
Cope Brook
Lewis Lake
Square Lake
Crusher
School
Moose River Gold Mines
P.O.
Moose River Mine
Touquoy Mine
P. Brown
Quartz veins prospected
Numerous quartz veins prospected
Pits
Sucker Lake
Rapids
MOOSE RIVER GOLD DISTRICT
4
Line
Hay-marsh
Rocky Lake
Indian Guzzle
Otter Dam
Falls
Portage Road
Stillwater Brook
Fifteen Mile Stream
Quartz veins
Anticline
Camp
Cope Lake
Taylor's old clearing
Melvin Island Dam
Sherbrooke
Cascade
Section
Forks
Rapid
Fish River
Line between Middle Musquodoboit District No 21 and Tangier District No 26
Maplehill Lake
Cascade
Falls
Big Lake
Hard Wood Ridge
Long Stillwater Lake
Barren
GOLD LAKE GOLD DISTRICT
2
Killag - Goldenville Anticline
Big Ass Lake
Dam
Gold Lake
Consolidated Gold Lake Mine
Crusher
Camp
Q. blocks
Q. veins
Gilchrist Meadow
Black Brook
Anticline
Dreadnaught Lake



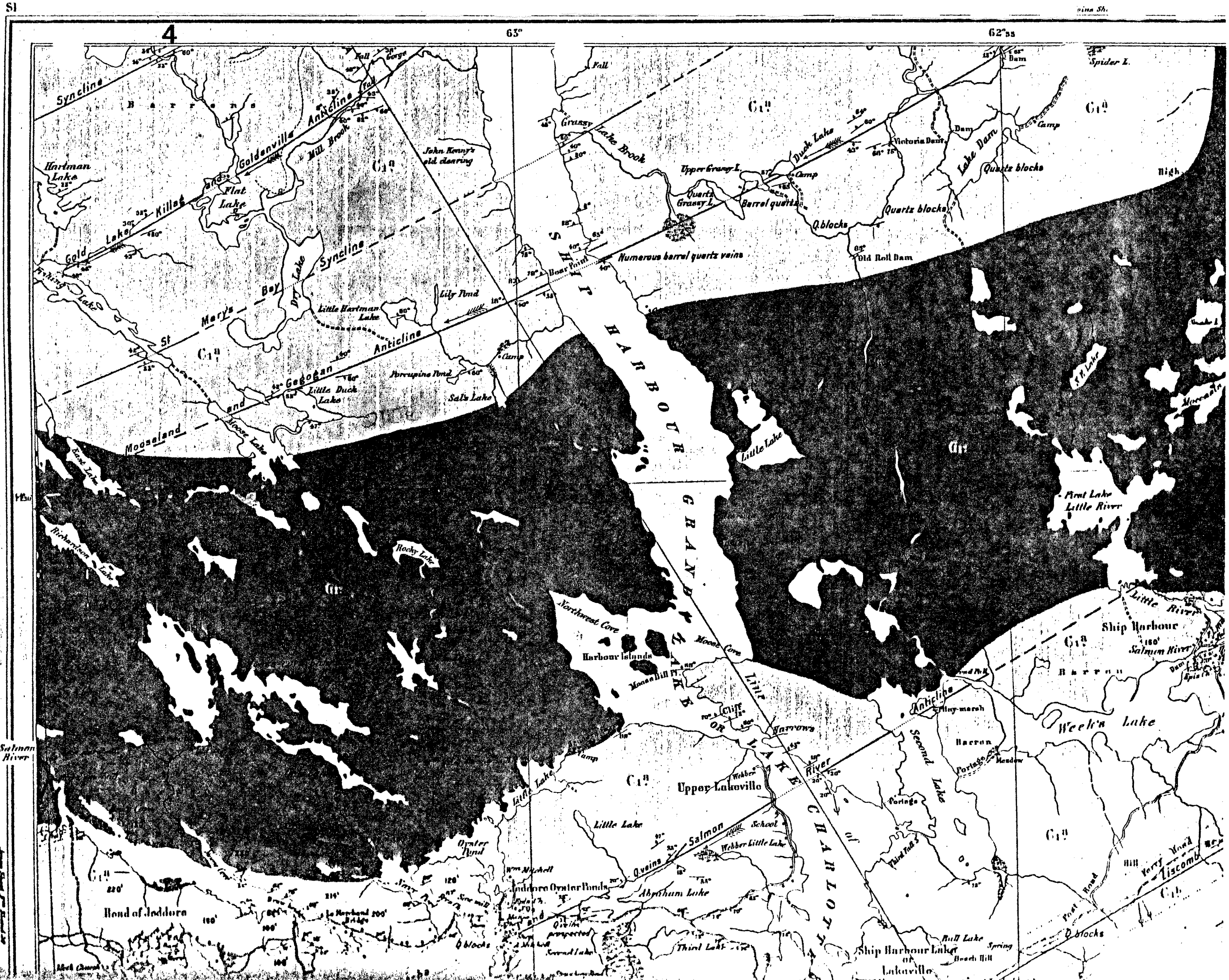
2

Base of Slate Divis

3


Gay River
Meagher's Grant District
Doyle Road
OLDHAM GOLD DISTRICT
Plan No. 652
Faults
Rocky L.
Shaw L.
District
Syncline
Anticline
Height of Land
Turf Lake
Bog
C1a
C1b
Lively Brook Anticline
Wyse's Corner
Guysborough Road
Goff
Barren
Miller Brook
Gold quartz prospected
Waverley Anticline
Waverley District
Old Track
Anticline
Syncline
King L.
Queen L.
Beckwood Lake
McKay Lake
Gold quartz
Hart's Nose R.
West Lake
Camp L.
Y. Lake
Lake No good
Horseshoe L.
Lake No-good Anticline
Syncline

81



4
63°
62°55
Syncline
Barrens
Goldenville Anticline
Mill Brook
Hartman Lake
Flat Lake
Gold Lake Killag
Fall
Gorge
John Kenny's old clearing
Grassy Lake Brook
Upper Grassy L.
Duck Lake
Victoria Dam
Dam
Lake Dam
Camp
Spider L.
Quartz blocks
Quartz Grassy L.
Barrel quartz
Q.blocks
Old Roll Dam
Numerous barrel quartz veins
Boar Point
St Mary's Bay Syncline
Dry Lake
Fishing Lake
Little Hartman Lake
Lily Pond
Gegogan Anticline
Porcupine Pond
Little Duck Lake
Salt Lake
Moose Lake
Mooseland and
SHIP HARBOUR
GRAND LAKE
OR LAKE CHARLOTTE
Little Lake
Gr
Rocky Lake
Richardson Lake
First Lake Little River
Little River
Ship Harbour
Salmon River
Barren
Anticline
Northwest Cove
Harbour Islands
Moose Hill
Moose Cove
Cliff
Narrows
Second Lake
Week's Lake
Hay-marsh
Portage
Meadow
Upper Lakeville
Webber
School
Little Lake
Salmon
Webber Little Lake
Q.veins
Abraham Lake
Oyster Pond
Jeddore Oyster Ponds
Head of Jeddore
Le Marchand
Bridge
Q.blocks
Third Lake
Bull Lake
Spring
Ship Harbour Lake or Lakeville
Q.blocks
Post Road
Ferry Road
Liscomb
Salmon River

HON. CHARLES STEWART, MINISTER; CHARLES CAMSELL, DEPUTY MINISTER.

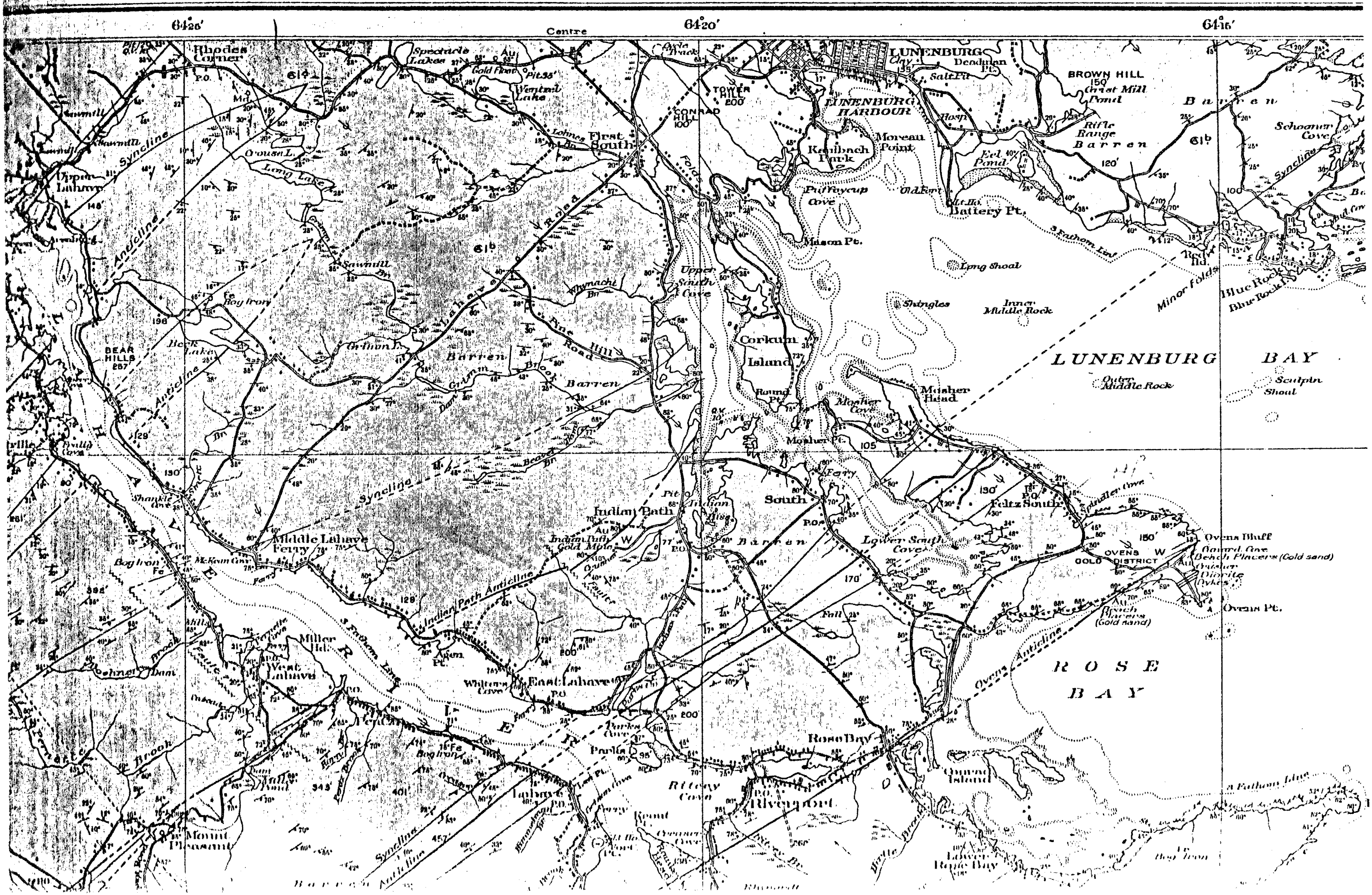
GEOLOGICAL SURVEY

W.H. COLLINS, DIRECTOR.

Issued 1929

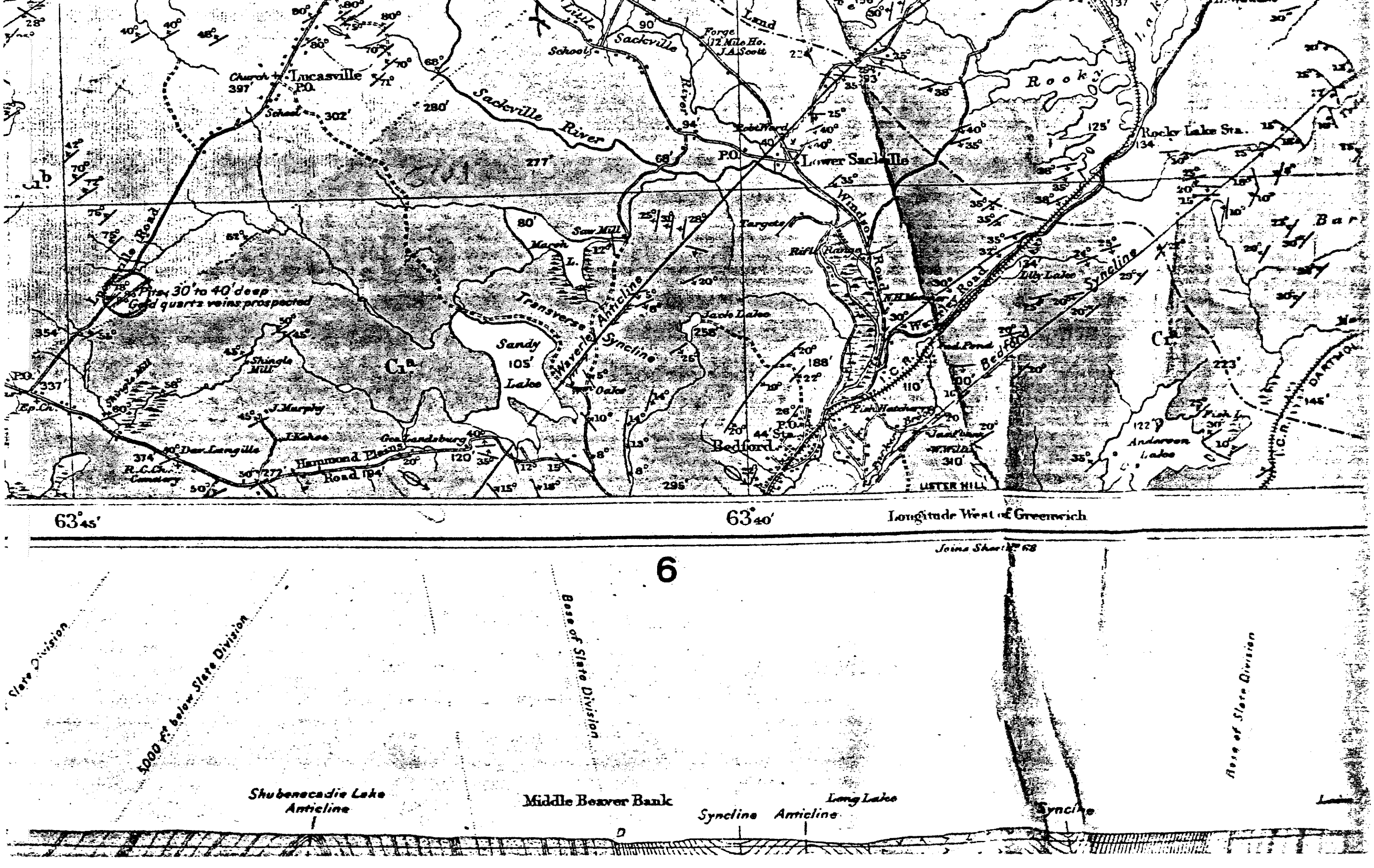
5

Joins Sheet No. 88

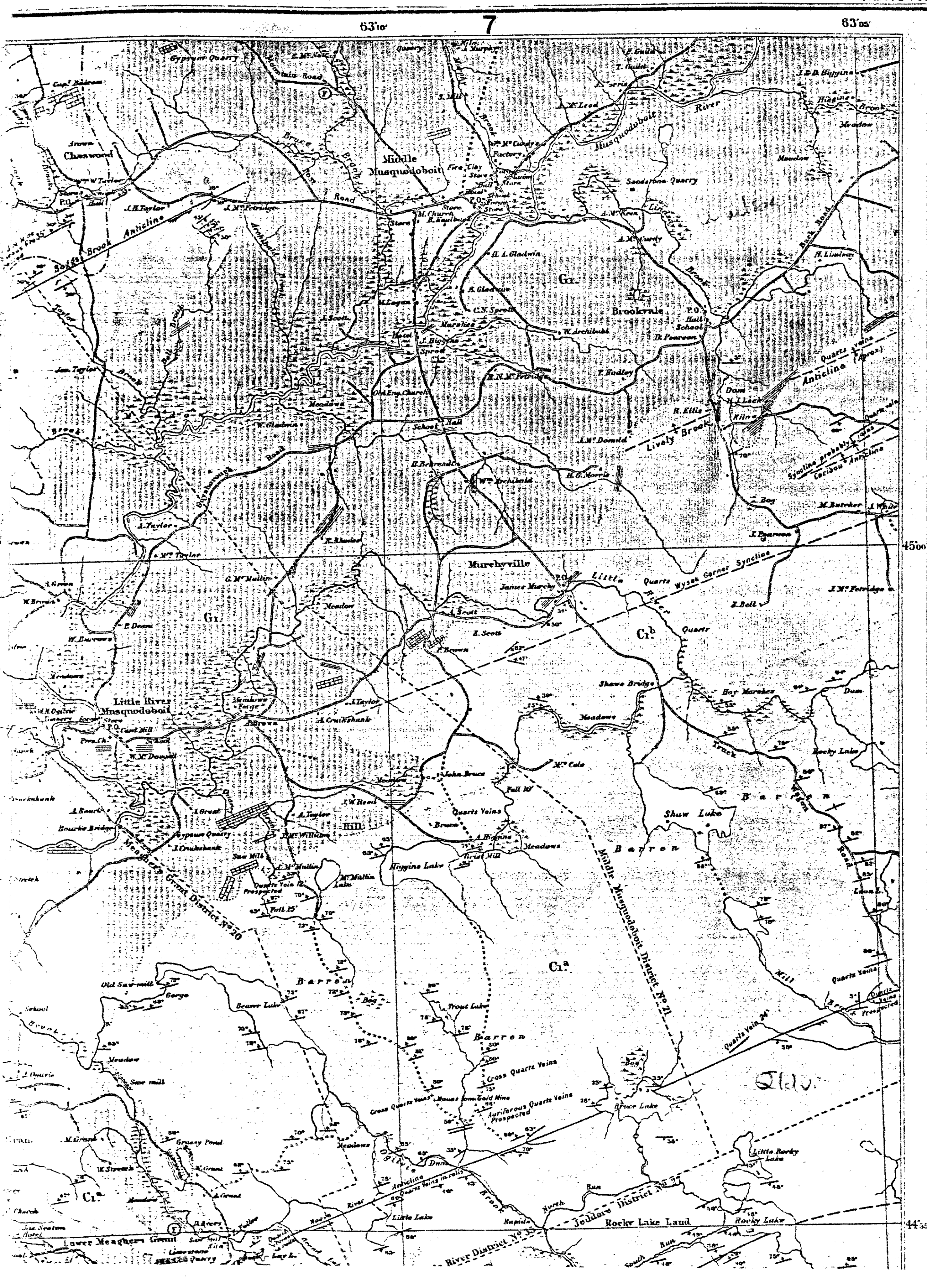


Kinsack
Quarry Red Granite
INTERCOLONIAL RAILWAY
DOMINION ATLANTIC RAILWAY
Line of Section
Hamilton Lake
Tucker Lake
Horseshoe Lake
Fenerty Long L.
Anticline
Syncline
Long Lake
Springfield Lake
Drain Lakes
Upper Sackville
MAROON HILL 406'
Coloured Settlement
Beaver Bank Sta. P.O.
Slate Quarry
Quartz Vein
Windsor Junction
Third Lake
Second Lake
Fall River
MOUNT RASCAL
WAVERLEY GOLD DISTRICT
Middle Sackville
Webber Lake
Dome
Lucasville P.O.
Sackville River
Little Sackville River
Lakeview
Rocky Lake Sta.
Lower Sackville
Height of Land
Old Cobequid Road
Windsor Road
Waverley Anticline
Transverse Syncline
Sandy Lake
Bedford
Hammond Plains Road
Pits 30' to 40' deep Gold quartz veins prospected
Anderson Lake
63°45'
63°40'
Longitude West of Greenwich

6



Joins Sheet No 68
Slate Division
5000 ft. below Slate Division
Base of Slate Division
Base of Slate Division
Shubenacadie Lake Anticline
Middle Beaver Bank
Syncline
Anticline
Long Lake
Syncline


63°10'
7
63°05'
45°00'
44°55'
Gypsum Quarry
Chezwood
Middle Musquodoboit
Musquodoboit River
Bruce Brook
Fire Clay
Sandstone Quarry
Brookvale
Lindsay Brook
Back Road
Gr.
Anticline (Approx)
Quartz Veins
Lively Brook
Syncline probably
Caribou Anticline
Sheet Harbour Road
Murchyville
Little River
Wyses Corner Syncline
Cr.b
Little River Musquodoboit
Shaws Bridge
Hay Marshes
Rocky Lake
Shaw Lake
Barren
Hill
Higgins Lake
McMullin Lake
Meaghers Grant District No. 20
Middle Musquodoboit District No. 21
Cr.a
Beaver Lake
Trout Lake
Cross Quartz Veins
Auriferous Quartz Veins Prospected
Bruce Lake
Little Rocky Lake
Jeddore District No. 37
Rocky Lake Land
River District No. 35
Lower Meaghers Grant
Limestone Quarry
Anticline
Joins Sheet No. 50

APPENDIX C

ELECTRON MICROPROBE DATA

1) A - RUTILE (FISHER, 1984)
   B - ANKERITE (FISHER, 1984)
   C - DOLOMITE (FISHER, 1984)
   D - CALCITE (FISHER, 1984)

2 - CARBONATES (SHAW, 1983)
   - STILLWATER BROOK

3 - SCHEELITE (SHAW, 1983)
   - STILLWATER BROOK

4 - ARSENOPYRITE (SHAW, 1983)
   - STILLWATER BROOK

1A

RUTILE

SAMPLE	Na_2O	MgO	Al_2O_3	SiO_2	P_2O_5	S	Cl	K_2O	CaO	Sc_2O_5	TiO_2	V_2O_5	Cr_2O_3	MnO	FeO	CoO	NiO	CuO	TOTAL
SB-37	—	—	—	1.07	—	0.26	—	—	—	—	96.71	—	—	—	1.97	—	—	—	100.01
	0.11	0.18	0.16	0.22	—	0.14	—	0.05	—	—	98.84	—	—	—	0.31	—	—	—	100.01
	0.16	0.14	0.15	0.33	—	0.14	—	0.25	0.06	—	98.49	—	—	—	0.28	—	—	—	100.08
SB-1	0.22	0.19	—	1.02	—	0.13	—	—	0.09	—	97.44	—	—	—	0.93	—	—	—	100.02
	0.14	0.17	—	0.14	—	—	—	0.05	—	—	99.50	—	—	—	—	—	—	—	100.00
	0.09	0.20	0.08	0.25	—	0.11	—	—	—	—	99.28	—	—	—	—	—	—	—	100.01
FR-36	0.36	0.25	0.22	0.42	0.12	—	0.07	0.30	0.22	—	98.14	—	—	—	—	—	—	—	99.98
	0.25	0.18	—	0.07	—	—	—	—	1.55	—	97.91	—	—	—	—	—	—	—	100.00
IP-31	0.06	0.16	1.09	1.79	—	—	—	0.31	—	—	96.60	—	—	—	—	—	—	—	100.01
	0.15	—	—	0.95	—	—	—	—	—	—	98.85	—	0.05	—	—	—	—	—	100.00
	0.18	0.07	0.47	1.02	—	—	—	0.29	—	—	97.97	—	—	—	—	—	—	—	100.00

1B

ANKERITE

SAMPLE	Na_2O	MgO	Al_2O_3	SiO_2	P_2O_5	S	CL	K_2O	CaO	Sc_2O_5	TiO_2	V_2O_5	Cr_2O_3	MnO	FeO	CoO	NiO	CuO	TOTAL
SB-1	—	29.04	—	—	—	—	—	—	53.07	—	—	0.20	—	4.35	18.29	—	—	—	100.00
	—	24.48	—	—	—	—	—	—	51.51	—	—	0.32	—	3.74	19.97	—	—	—	100.02
	—	25.12	—	—	—	—	—	—	51.15	—	—	0.25	—	4.26	19.20	—	—	—	99.98
SB-8	—	28.27	—	—	—	—	—	—	53.02	—	—	—	—	3.44	15.28	—	—	—	100.01
	—	30.87	—	—	—	—	—	—	52.96	—	—	—	—	2.57	13.58	—	—	—	99.98
	—	26.53	—	—	—	—	—	—	52.16	—	—	—	—	4.09	17.22	—	—	—	100.00
FR-29	—	30.45	—	—	—	—	—	—	52.97	—	0.09	—	—	6.40	10.09	—	—	—	100.00
	—	32.32	—	—	—	—	—	—	54.23	—	—	0.32	—	6.59	6.52	—	—	—	99.98
SB-25	—	24.87	—	—	—	—	—	—	52.10	—	—	—	—	2.21	20.79	—	—	—	99.97
	—	24.14	—	—	—	—	—	—	51.76	—	0.20	0.11	—	2.54	21.26	—	—	—	100.01
	—	23.32	—	—	—	—	—	—	51.22	—	0.19	0.19	—	2.63	22.44	—	—	—	99.99

1C

DOLOMITE

SAMPLE	Na_2O	MgO	Al_2O_3	SiO_2	P_2O_5	S	Cl	K_2O	CaO	Sc_2O_5	TiO_2	V_2O_5	Cr_2O_3	MnO	FeO	CoO	NiO	CuO	TOTAL
SB-37	—	38.33	—	—	—	—	—	—	55.65	—	—	—	—	0.63	5.39	—	—	—	100.00
	—	36.45	—	—	—	—	—	—	55.31	—	—	0.39	—	1.68	6.18	—	—	—	100.00
	—	38.60	—	—	—	—	0.06	—	55.27	—	—	0.39	—	1.10	4.58	—	—	—	100.00
SB-9	—	39.70	—	—	—	—	—	—	55.71	—	—	0.41	—	0.46	3.71	—	—	—	99.99
	—	38.89	—	—	—	—	—	—	56.14	—	—	0.26	—	0.75	3.96	—	—	—	100.00
	—	38.48	—	—	—	—	—	—	55.40	—	—	0.30	—	1.23	4.58	—	—	—	99.99

1D

CALCITE

SAMPLE	Na_2O	MgO	Al_2O_3	SiO_2	P_2O_5	S	Cl	K_2O	CaO	Sc_2O_5	TiO_2	V_2O_5	Cr_2O_3	MnO	FeO	CoO	NiO	CuO	TOTAL
FR-29	0.20	—	—	—	—	—	—	—	96.27	—	—	—	—	2.78	0.73	—	—	—	99.98
FR-36	0.61	1.19	—	0.24	—	—	0.23	0.23	92.38	—	—	0.17	0.17	2.20	2.58	—	—	—	100.00
	0.24	0.58	—	—	—	—	—	—	95.70	—	—	0.09	—	1.48	1.90	—	—	—	99.99

3

Table III-1. Electron microprobe analysis of scheelite grains from the Moose River mine (wavelength dispersive spectrometry).

	WEIGHT PERCENT						MOLE PERCENT
Grain	WO_3	MoO_3	FeO	MnO	CaO	Total	$CaMoO_4$
M.R. 3 - 1	83.39	0.06	0.07	0.10	18.91	102.53	0.12
M.R. 3 - 2	83.60	0.04	0.07	0.08	18.87	102.66	0.07
M.R. 3 - 3	82.37	0.06	0.07	0.10	19.01	102.11	0.12
M.R. 3 - 4	82.60	0.07	0.11	0.13	18.96	101.88	0.13
M.R. 1 - 1	81.55	0.03	0.10	0.07	18.80	100.55	0.05
M.R. 1 - 2	82.33	0.04	0.09	0.08	16.18	98.73	0.08
M.R. 1 - 3	82.72	0.06	0.07	0.04	18.73	101.62	0.11
M.R. 1 - 4	82.70	0.03	0.06	0.06	18.76	101.61	0.07
M.R. 5 - 1	81.64	0.07	0.08	0.06	18.73	100.58	0.15
M.R. 5 - 2	82.04	0.03	0.06	0.08	18.79	101.00	0.07
M.R. 5 - 3	82.11	0.03	0.08	0.11	18.79	101.13	0.07
M.R. 5 - 4	82.74	0.04	0.06	0.04	18.68	101.57	0.08
$\bar{x}$							0.09
s							0.03

2

Table III-2. Electron microprobe analysis of vein carbonate from Moose River mine (energy dispersive spectrometry).

Sample #	WEIGHT PERCENT FeO	MnO	MgO	CaO	Total	MOLE PERCENT $FeCO_3$	$MnCO_3$	$MgCO_3$	$CaCO_3$
M.R. I - 1	5.87	0.82	18.07	29.17	53.93	8	1	42	49
- 2	5.10	0.88	18.55	28.98	53.51	7	1	43	49
- 3	5.01	0.62	18.49	28.58	52.70	7	1	44	48
- 4	4.47	0.59	19.29	29.32	53.67	1	1	47	51
M.R. VI - 1	13.03	1.28	12.80	28.84	55.95	17	2	31	50
- 2	12.82	1.18	13.53	28.95	56.48	17	2	32	49
- 3	11.82	1.53	13.27	29.19	55.81	16	2	32	50
- 4C	10.86	1.81	13.80	29.14	55.61	14	3	33	50
- 4R	11.82	1.77	13.37	29.22	56.18	16	2	32	50
- 5	10.68	2.08	13.39	29.54	55.69	14	3	32	51
- 6C	10.78	1.89	13.95	28.74	55.36	14	3	34	49
- 6R	9.83	2.14	14.62	28.87	55.46	13	3	35	49
M.R. V - 1	3.86	0.29	19.60	29.18	52.93	5	1	45	49
- 2	4.69	0.63	16.90	29.29	51.51	7	1	41	51
- 3	4.90	0.66	18.47	29.34	53.37	7	1	43	49
- 4	4.93	0.71	18.53	29.87	54.06	7	1	42	50
M.R. III - 1C	12.34	1.58	13.23	28.92	56.07	16	2	32	50
- 1R	12.55	1.58	12.92	28.83	55.88	17	2	31	50
- 2C	9.52	2.34	14.74	28.69	55.29	13	3	36	48
- 2R	6.35	2.57	16.71	28.90	54.53	9	4	39	48
- 3C	9.97	2.19	14.43	28.60	55.19	13	3	35	49
- 3R	9.45	2.68	14.61	26.86	53.60	13	4	35	48
- 4	6.06	3.13	16.78	28.86	54.83	8	4	39	49

4

Table III-3. Electron microprobe analysis of arsenopyrite from the Moose River mine (wavelength dispersive spectrometry).

	WEIGHT PERCENT				MOLES PER 100 GRAMS			ATOMIC % As
	Fe	As	S	Tot.	Fe	As	S	
M.R. II - 1	34.98	44.87	19.70	99.56	0.626	0.599	0.615	32.55
- 2	35.12	44.88	19.86	99.87	0.629	0.599	0.619	32.43
- 3C	35.10	44.36	20.23	99.68	0.628	0.592	0.631	31.98
- 3R	34.93	44.08	20.01	99.01	0.625	0.588	0.624	32.01
M.R. I - 1	35.03	44.87	19.76	99.66	0.627	0.599	0.616	32.52
- 2	35.28	44.28	20.07	99.63	0.632	0.591	0.626	31.96
- 3	35.20	44.81	20.08	100.09	0.630	0.598	0.626	32.25
- 4	34.84	44.09	20.09	99.02	0.624	0.588	0.627	31.97
- 5	35.04	44.74	19.73	99.52	0.627	0.597	0.615	32.46
M.R. V - 1	35.09	45.18	19.75	100.02	0.628	0.603	0.616	32.65
- 2	34.81	44.52	19.78	99.11	0.623	0.594	0.617	32.39
- 3	34.76	45.26	19.79	99.81	0.622	0.604	0.617	32.77

Summary

	Atomic % As	S	n
Vein arsenopyrite	32.37	0.30	8
Wall rock arsenopyrite	32.24	0.29	4

APPENDIX D

WHOLE ROCK ANALYSIS

FROM SHAW (1983)

AT STILLWATER BROOK

	Cr	Ni	Co	As	Sb	Hg	Cu	Pb	Zn	Ag	W	Sn	Au	Mo	U	Th
G 1	80	8	5	100	0.5	<10	16	36	23	3	6	120	<80	<2	1.7	7
G 2	90	320	34	730	<0.2	10	150	20	130	<1	35	100	<80	<2	1.9	8
G 3	110	36	10	190	0.5	<10	7	44	30	<1	55	35	<80	<2	2.6	10
G 4	60	40	17	200	0.7	10	5	32	110	<1	22	120	<80	<2	1.2	5
G 5	100	N.S.	N.S.	1200	0.6	20	N.S.	N.S.	N.S.	N.S.	22	100	<80	N.S.	1.9	8
G 6	70	35	23	1100	1.0	10	15	16	35	<1	890	80	<80	<2	1.8	6
G 7	80	91	56	3700	2.1	<10	53	20	120	<1	990	55	<80	<2	1.9	6
G 8	140	53	11	4000	2.3	10	15	12	130	<1	28	80	<80	<2	3.6	8
G 9	170	94	35	720	<0.2	20	180	190	1100	<1	200	150	<80	4	7.2	13
G 10	20	37	10	110	0.2	<10	320	8	1700	<1	5500	8	<80	<2	0.4	1
L.H. 3	130	65	22	20	0.3	20	71	16	34	<1	20	<3	<80	40	11.4	14
L.H. 4	130	N.S.	N.S.	9	<0.2	<10	N.S.	N.S.	N.S.	N.S.	15	N.S.	<80	N.S.	3.9	9
L.H. 9	100	58	35	62	<0.2	<10	20	4	100	<1	10	<3	<80	<2	2.3	5
L.H. 10	110	59	23	210	1.2	10	46	8	110	<1	15	<3	<80	<2	2.4	6
L.H. 13	80	52	20	21	0.3	<10	35	4	110	<1	7	<3	<80	4	1.9	9
L.H. 15	80	43	21	4	0.3	<10	46	12	180	<1	4	N.S.	<80	4	2.2	8
L.H. 17	60	50	20	55	0.3	10	190	8	83	<1	7	<3	<80	4	3.1	8
F.I. 105	40	10	2	4	0.2	10	4	8	39	<1	4	N.S.	<80	<2	1.2	6

CONTINUED

	Cr	Ni	Co	As	· b	Hg	Cu	Pb	Zn	Ag	W	Sn	Au	Mo	U	Th
M.R. 12	<10	17	10	4,200	N.S.	N.S.	12	<2	50	<1	12	N.S.	<80	4	2.8	3
M.R. 15	80	20	13	18	0.2	<10	25	<2	84	<1	21	N.S.	<80	<2	2.4	9
M.R. 16	30	6	4	9	<0.2	<10	12	18	25	<1	3	<3	<80	<2	1.2	4
M.R. 17	100	33	15	<10,000	N.S.	<10	8	24	54	<1	390	N.S.	<80	4	2.1	7
M.R. 19	<10	2	1	2,200	2.4	20	10	16	9	<1	<10,000	N.S.	<80	4	0.4	<1

APPENDIX E

OXYGEN ISOTOPES

BF-1	SB-25	ANKERITE	-	STILLWATER BROOK
BF-2	SB-25	ANKERITE	-	STILLWATER BROOK
BF-3	CA-1	ANKERITE	-	LAKE CATCHA
BF-4	GF-9	ANKERITE	-	GOFF
BF-5	MG-4	ANKERITE	-	MONTAGUE
BF-6	OH-12	CALCITE	-	OLDHAM
F-7	FR-26	ANKERITE	-	FALL RIVER

OXYGEN & CARBON ISOTOPE DATA

OPERATOR: VEYSI BALI   DATE: 04/02/19.   TIME: 16.03.56.

CORE *N/A*   SPICIES: N/A

	DEPTH	DEL 45	DEL 46	C 13-PDB	O 18-PDB
BF1	.00	-26.414	-15.510	-24.855	-16.138
BF2	.00	-25.913	-14.871	-24.317	-15.480
BF3	.00	-22.525	-13.974	-20.689	-14.574
BF4	.00	-24.639	-8.591	-23.093	-9.154
BF5	.00	-23.775	-7.009	-22.186	-7.557
BF6	.00	-22.108	-14.982	-20.093	-15.506
BF7	.00	-23.820	-14.137	-21.940	-14.643

EQUATION OF THE BEST FITTED LINE FOR DEL 46
Y= -.000500*X -.459000

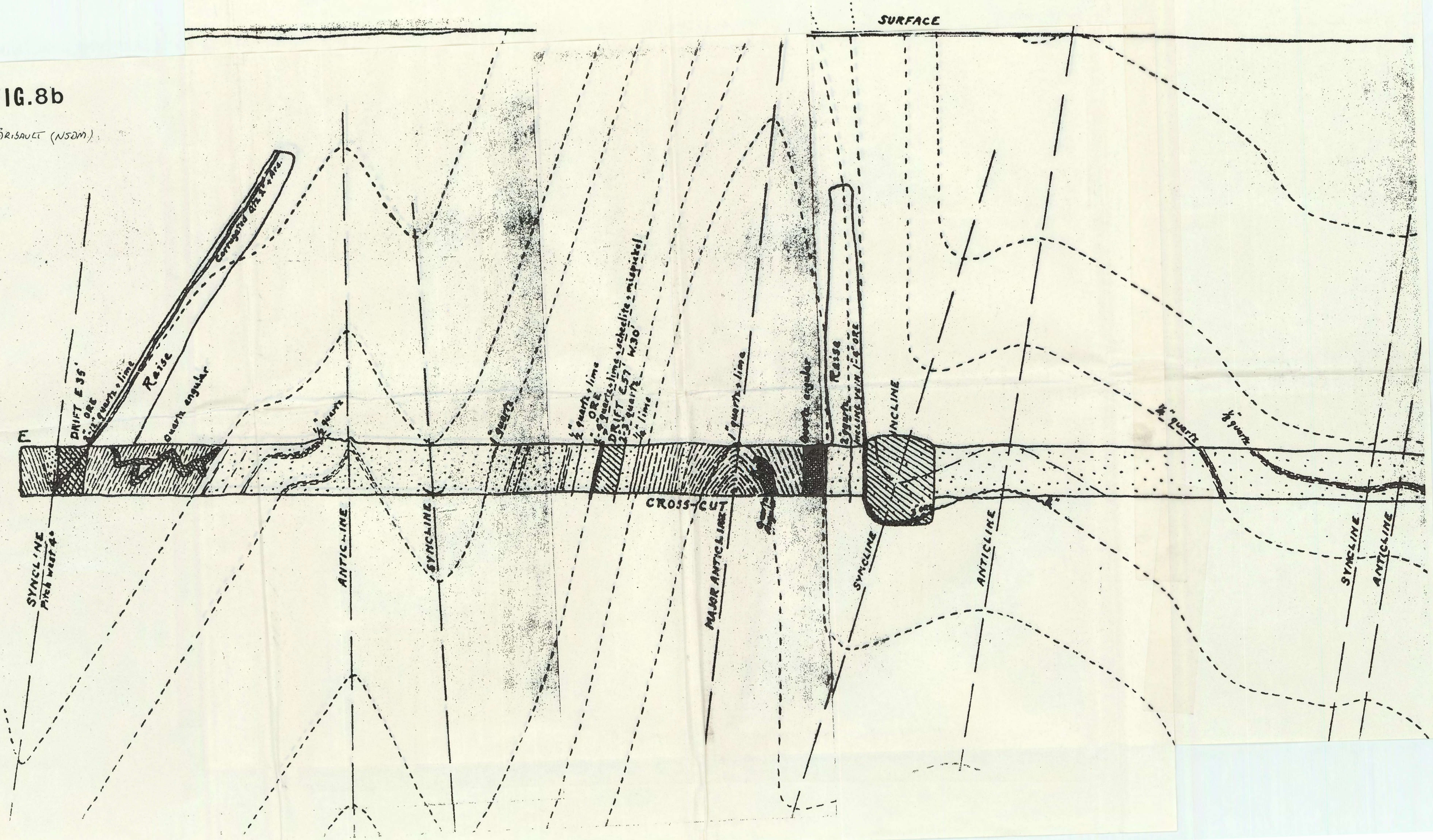
EQUATION OF THE BEST FITTED LINE FOR DEL 45
Y= -.000717*X -.043717

	CORRECTION FACTORS DEL 45	DEL 46	CORRECTED DATA DEL 45	DEL 46
BF1	-.108	-.502	-26.306	-15.009
BF2	-.131	-.522	-25.782	-14.350
BF3	-.161	-.539	-22.364	-13.436
BF4	-.202	-.572	-24.437	-8.020
BF5	-.235	-.589	-23.540	-6.420
BF6	-.272	-.616	-21.836	-14.366
BF7	-.285	-.630	-23.535	-13.508

DO YOU WANT TO CONTINUE? IF YES TYPE 1, NO TYPE 0
? 0

FIG.8b

From Faribault (NSDM)



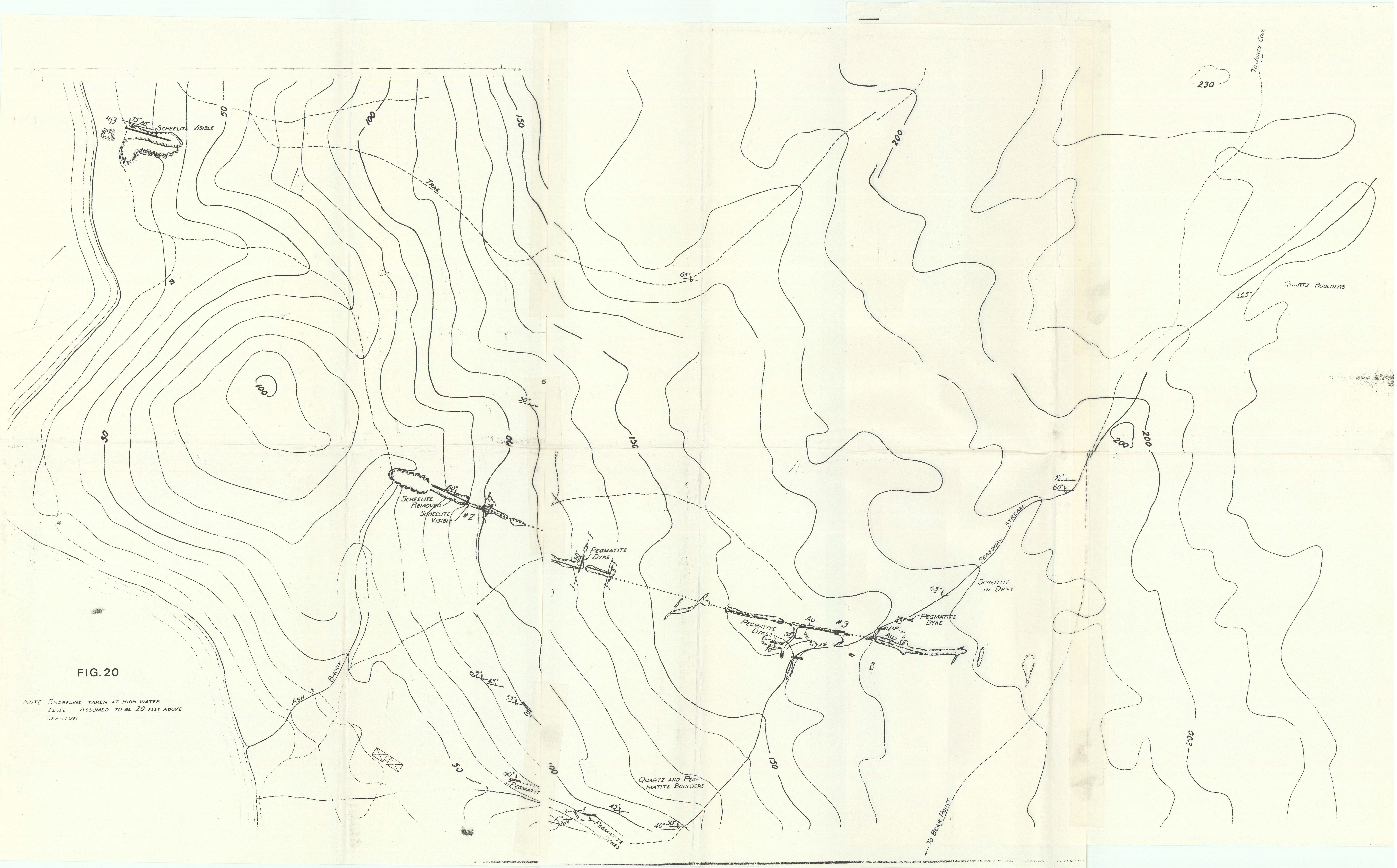


FIG. 20

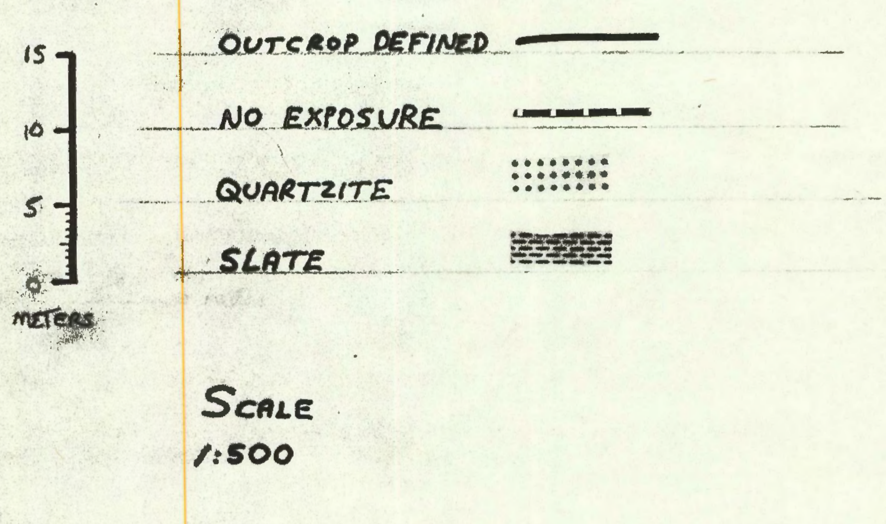
NOTE Shoreline taken at high water level. Assumed to be 20 feet above sea level

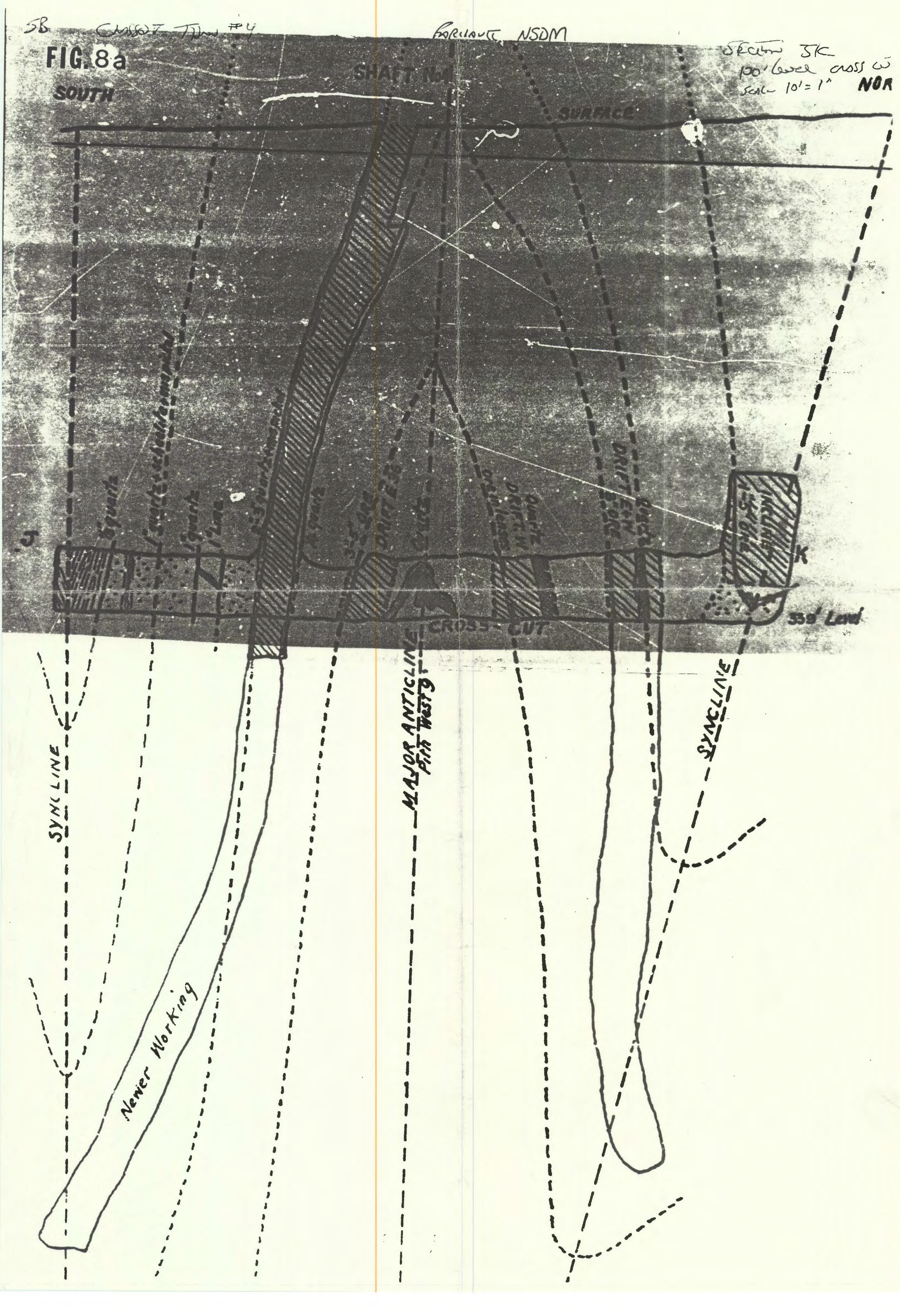
FIG.6B

Shaft No. 5
Shaft No. 6
Shaft No. 4
Shaft No. 15
Shaft No. 2
Shaft No. 9 Vert.
Shaft No. 7
Slate
Road
Well
Little Brook
Quartz Drift
Stillwater Mine
300
310
320
330
340

FIG. 25

LOWER SACKVILLE





5B CROSSCUT Tunnel #4
FIG. 8a
SOUTH
SHAFT No. 1
SURFACE
NOR
J
K
CROSS-CUT
339' Level
MAJOR ANTICLINE
Pitch West 9°
SYNCLINE
SYNCLINE
Newer Working
DRIFT E 38
DRIFT W
DRIFT E+W
INCLINE
Quartz

FIG. 6A

SCHEELITE PROPERTY,
MOOSE RIVER GOLD DISTRICT, HFX. CO.
OCTOBER,