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Ministry of Energy, Mines and
Petroleum Resources

MINERAL RESOURCES DIVISION
Geological Survey Branch

MAGNESITE, BRUCITE AND HYDROMAGNESITE OCCURRENCES IN BRITISH COLUMBIA

By Brian Grant

A contribution to the Canada/British Columbia Mineral Development Agreement, 1985–1990

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INTRODUCTION

Magnesium is the eighth most abundant element, forming about 2.06 per cent of the earth's crust and is the third most plentiful element dissolved in seawater where it has a concentration of about 0.13 per cent. Magnesium and magnesium compounds are mined from deposits rich in magnesite, hydromagnesite, dolomite, brucite and olivine.

Magnesite is magnesium carbonate ($MgCO_3$) and has a theoretical magnesia (MgO) content of 47.6 per cent. Hydromagnesite, or hydrated magnesium carbonate [$Mg_4(OH)_2(CO_3)_3.3H_2O$] may contain up to 43 per cent magnesia. Brucite, magnesium hydroxide [$Mg(OH)_2$], contains up to about 69 per cent magnesia. Dolomite is a double carbonate of calcium and magnesium ($CaCO_3.MgCO_3$) which has a theoretical magnesia (MgO) content of 22 per cent. The term dolomite is also used as a rock name applied to limestone which has been altered to the mineral dolomite. Olivine or chrysolite is a double silicate of iron and magnesium ($Mg_2Fe_2SiO_4$) and is a green to brown mineral used primarily as a foundry sand.

In addition magnesium compounds are recovered directly from seawater, bitterns, lake and well-water brines and their precipitates. Hydromagnesite commonly forms mechanical/chemical precipitates of limited extent but is usually contaminated with iron, clays and silica, which make it uneconomic as a source of magnesia compounds. With the exception of magnesium metal, magnesia compounds are normally utilized in intermediate industries to facilitate the production of other goods and materials.

One of the largest markets for magnesium compounds is for magnesia-based refractory brick used primarily as furnace linings in the iron and steel industry. Other high demand markets for magnesia-based compounds are as animal feed and fertilizer additives, ceramics, petroleum additives and for stack-gas scrubbing. In addition uranium processing, water treatment and the production of rubber, refractories, chemicals, oxychloride and oxysulphate cements, insulation and wallboard, sugar and candy, pharmaceuticals and pulp and paper all rely to some extent on magnesium compounds. Magnesium metal is used primarily as an alloy with aluminum which, because of its strengthened characteristics, may be used in the production of aircraft, automotive and machinery parts, or simply as beverage cans.

Estimated world production of magnesite in 1985 is slightly over 12 million tonnes with about 5.5 million tonnes of contained magnesium. Estimated world magnesite production capacity for 1990 is in the order of 16 million tonnes which would contain 7.5 million tonnes of magnesium metal. Production has been relatively constant during the first half of the 1980s and given present economic conditions, demand is not likely to exceed current production estimates in the near future

The principal magnesium ores, other than dolomite, are magnesite, brucite and hydromagnesite of which magnesite is the most significant. Current world magnesite reserves of various economic categories are in the order of 2800 million tonnes. In southeastern British Columbia the Cambrian age Mount Brussilof magnesite deposit, one of the largest and purest in the world, contains over 50 million tonnes of magnesite with a current production capacity of about 120 thousand tonnes per year of calcined product. Most of the Mount Brussilof production is utilized in refractories with lesser amounts channeled to pulp and paper and animal feed products.

Magnesite products are obtained from the primary ore minerals by calcining magnesium carbonate or hydroxide at different temperatures. CAUSTIC-CALCINED magnesia, as produced from Mount Brussilof, is a reactive oxide easily hydrated with water and is prepared by roasting the primary ores at temperatures up to 893°C. DEAD-BURNED magnesite or refractory magnesia is prepared at temperatures above 1450°C and is unreactive with water. It is a dense, stable material used primarily for refractories. PERICLASE is a special grade of dead-burned magnesia, prepared by heating 92 per cent to 98 per cent magnesia to about 1650°C. FUSED-MAGNESIA is a recently developed product for refractory applications used with advanced steel-making technologies. It is chemically superior to dead-burned magnesia and crystallizes out of molten magnesia at temperatures above 2800°C, which are reached using electric arc furnaces.

In addition to their mineral sources, production of magnesium compounds and metal from seawater and brines constitutes an important source of high-grade products. However, magnesia from these sources is characteristically contaminated with boron oxide at levels in the range of 0.1 to 0.3 per cent. The presence of boron, even in quantities less than 1 per cent, has a significant affect on the hot strength of refractories. In addition the cost of seawater/brine-sourced magnesium products is directly related to the price of energy which may constitute up to 75 per cent of the production cost. As a result, although new technology is being applied to produce a seawater/brine product comparable to that derived from crystalline magnesium minerals, coarsely crystalline magnesite still has a competitive edge in purity and cost of production.

GENERAL

The purpose of this open file is to document all the known magnesite, brucite and hydromagnesite occurrences in the Province of British Columbia. As part of that objective, a description of the geological settings has been prepared from available file sources, but without benefit of field examination. Corrections and/or updates to information on known or new occurrences would therefore be gratefully received by the Ministry of Energy, Mines and Petroleum Resources, Geological Survey Branch.

In this presentation an effort has been made to group the mineral showings within broad genetic categories. In detail, however, some occurrences may share characteristics common to several categories. For example, almost all altered ultramafic rocks exhibit late stage quartz and/or magnesite veining and in some cases the veins are of significant size, such as in the Bonaparte River deposit. Vein deposits have not been treated separately as, within a broad genetic context, they originated with the alteration of ultramafic host rocks to calcium carbonate and magnesite. Such veins have been treated as an 'ultramafic type' or 'carbonate-hosted' type of magnesite occurrence.

Where possible the accompanying descriptions contain what is considered to be the best available chemical analysis for the material at each site. For comparison purposes one should bear in mind the data presented have been acquired from sources of variable reliability. The nature and quality of each sample, or analytical laboratory, are rarely stated and the results may be presented in slightly different formats. In all cases analytical results are presented as weight per cent.

Each occurrence description is keyed both to the small scale location map included with this report and to the selected bibliography. The key consists of a mineral identifier, M for magnesite, B for brucite and H for hydromagnesite, together with a number. Minfile occurrence numbers are also included to facilitate access to Minfile records and the Property File.

GEOLOGICAL SETTING & GENERAL CHARACTERISTICS

Mineral occurrences containing significant amounts of magnesia are common throughout British Columbia. Although the host geological environments are varied, the occurrences have been grouped into six major categories. Four deposit types contain magnesite as the primary magnesium mineral. Brucite and hydromagnesite occurrences are each grouped as type deposits.

Deposit Classification:

(1) Sedimentary Carbonate-hosted Magnesite
(2) Sedimentary Quartzite-hosted Magnesite
(3) Ultramafic Alteration, including Shear and Vein-type Magnesite
(4) Ultramafic Lateritic Alteration Magnesite
(5) Brucite
(6) Hydromagnesite

SEDIMENTARY CARBONATE-HOSTED MAGNESITE

Crystalline magnesite occurs interbedded with carbonate rocks of Late Proterozoic and Cambrian age. Known deposits are concentrated in southeastern British Columbia and include the world class Mount Brussilof deposit. In central and northern British Columbia deposits of similar geological character occur at Lac La Hache, Chuyazega Creek and the O'Donnel River.

There is conflicting evidence whether these deposits are sedimentary or replacement in origin. They are usually massive and medium to coarsely crystalline. Locally there may be sharp contacts with host dolomites although gradational contacts, indicative of replacement phenomena, are also common. The presence of veins and veinlets of quartz and magnesite is suggestive of alteration but even minor recrystallization of a bedded deposit could account for such veining.

Magnesite is the primary mineral and variable amounts of dolomite, calcite and pyrite may be disseminated or present as a matrix to the magnesite. Minor associated minerals may include clays, talc and sericite. Rounded grains of quartz and narrow quartz veinlets are common.

SEDIMENTARY QUARTZITE-HOSTED MAGNESITE

Crystalline magnesite is associated with Cambrian quartzites in southeastern British Columbia. As with the carbonate-hosted type, it is difficult to classify the quartzite type, as either synsedimentary or replacement, with certainty. The best known deposit is the Marysville occurrence and similar occurrences are located in the Hellroaring Creek, Fort Steele and Driftwood Creek areas.

Medium to coarse-grained magnesite occurs interbedded with siliceous, clastic rocks. Mineralization may be podiform in nature although the Marysville occurrence is more stratigraphically continuous. Contact relationships with overlying and underlying beds are usually sharp although gradational contacts are common along strike as an individual horizon changes from magnesite to quartzite. Within horizons rich in magnesium carbonate, corroded quartz grains in a carbonate matrix are common. Dolomite and/or calcite, with minor pyrite, may form the matrix of the clastic sediments or be disseminated within magnesite horizons. Bedding plane shearing and late-stage quartz veining are present locally.

ULTRAMAFIC ALTERATION MAGNESITE

Magnesite associated with ultramafic rocks is common throughout the central interior of British Columbia. Magnesite occurs as the end product in the alteration of the host rocks. Peridotites and dunites alter first to serpentinite and subsequently to calcium or magnesian carbonates.

High-grade magnesite is best developed as podiform bodies along shear zones or as extremely fine grained bone magnesite in vein deposits. In addition, lower grade patches of magnesium carbonate, with variable proportions of calcium carbonate, may be scattered throughout the ultramafic host.

Magnesite alteration zones characteristically host networks of late-stage quartz and/or chert veinlets which locally contain magnesite, mariposite or sulphide minerals. In the Atlin area, quartz veining commonly carries minor free gold. The more resistant vein networks result in a very rough weathered surface on most ultramafic magnesite exposures.

Magnesium carbonate alteration zones, particularly in dunitic host rocks, commonly contain chromite resistant to the alteration process which destroys the olivines and other mafic minerals.

ULTRAMAFIC LATERITIC MAGNESITE

This deposit type is characterized by the Bonaparte River occurrence near Clinton. It is similar in most aspects to the deposits described above but is distinguished as a sheet-like zone of alteration at surface which grades into fresh ultramafic material at depth. Quartz and magnesite veining and concentrations of chromite grains are also characteristic of lateritic alteration. These surficial deposits are susceptible to erosion and are likely to be limited in size and economic potential.

BRUCITE

Brucite or brucitic carbonates are documented from the Vancouver Island and Atlin areas of British Columbia.

Brucite is an alteration product of periclase, which is a relatively high-temperature magnesian mineral formed during metamorphism of magnesian limestones or dolomites. It is typically found in metamorphic aureoles, having formed as a result of the dissociation of dolomite. Periclase is typically rimmed or entirely replaced by brucite which in turn readily alters to hydromagnesite. This results in the characteristic pitted surface of brucitic carbonate outcrops. The pits commonly contain a white fibrous mineral residue.

The limestone-dolomite-periclase-brucite-hydromagnesite alteration sequence illustrates the relationship of brucite to magnesian dolomite or limestone. Lower temperature alteration or limited magnesium results in development of magnesian limestone or dolomite. Higher temperatures, with sufficient magnesium, may result in the development of periclase and/or brucite.

The economic potential for the dolomitic type of magnesium mineralization is considered good due to the large tonnage potential of any given deposit. Brucite and/or periclase contact metamorphic minerals are usually more limited in extent, although the contained MgO may be locally significant.

HYDROMAGNESITE

Hydromagnesite characteristically forms sheet-like bodies of limited extent within swampy areas or small depressions in the overburden surface. They normally consist of an upper, relatively pure, white hydromagnesite horizon, 30 to 100 centimetres thick, with a characteristic, rough cauliflower-like weathered surface. A unit of yellow or cream-colored granular hydromagnesite usually underlies this surface zone and normally exhibits an increase of calcium with depth.

Impure hydromagnesite, with a significant component of silica, clay or calcium, may underlie the yellow-cream horizon or it may lie directly on overburden sand or clay. The lower contact of the deposit is commonly gradational with underlying soil or fine clay.

Bedrock occurrences of magnesite, particularly ultramafic magnesite, are common in the central interior of British Columbia near hydromagnesite accumulations.

SEDIMENTARY CARBONATE-HOSTED MAGNESITE OCCURRENCES

MOUNT BRUSSILOF (M1)

Type: Crystalline Magnesite - stratabound, carbonate host
Minfile: 082JNW 001 NTS: 082J 13E Elevation: 1500 m
Latitude: 50°47'20"N Longitude: 115°40'40"W
Alias: Rok, Baymag, Cross River, Mount Eon

Stratabound magnesite occurs in the Middle Cambrian Cathedral Formation on the west flank of Mount Brussilof and to the north on Mount Eon, along the ridge between Mitchell River and Assiniboine Creek (Figure 1). The deposit was discovered by Geological Survey of Canada personnel in 1966 and was mapped and evaluated during the late 1960s and early 1970s by Placer Development Limited. Baymag Mine Co. Ltd. later acquired the deposit and commenced mining operations in 1982.

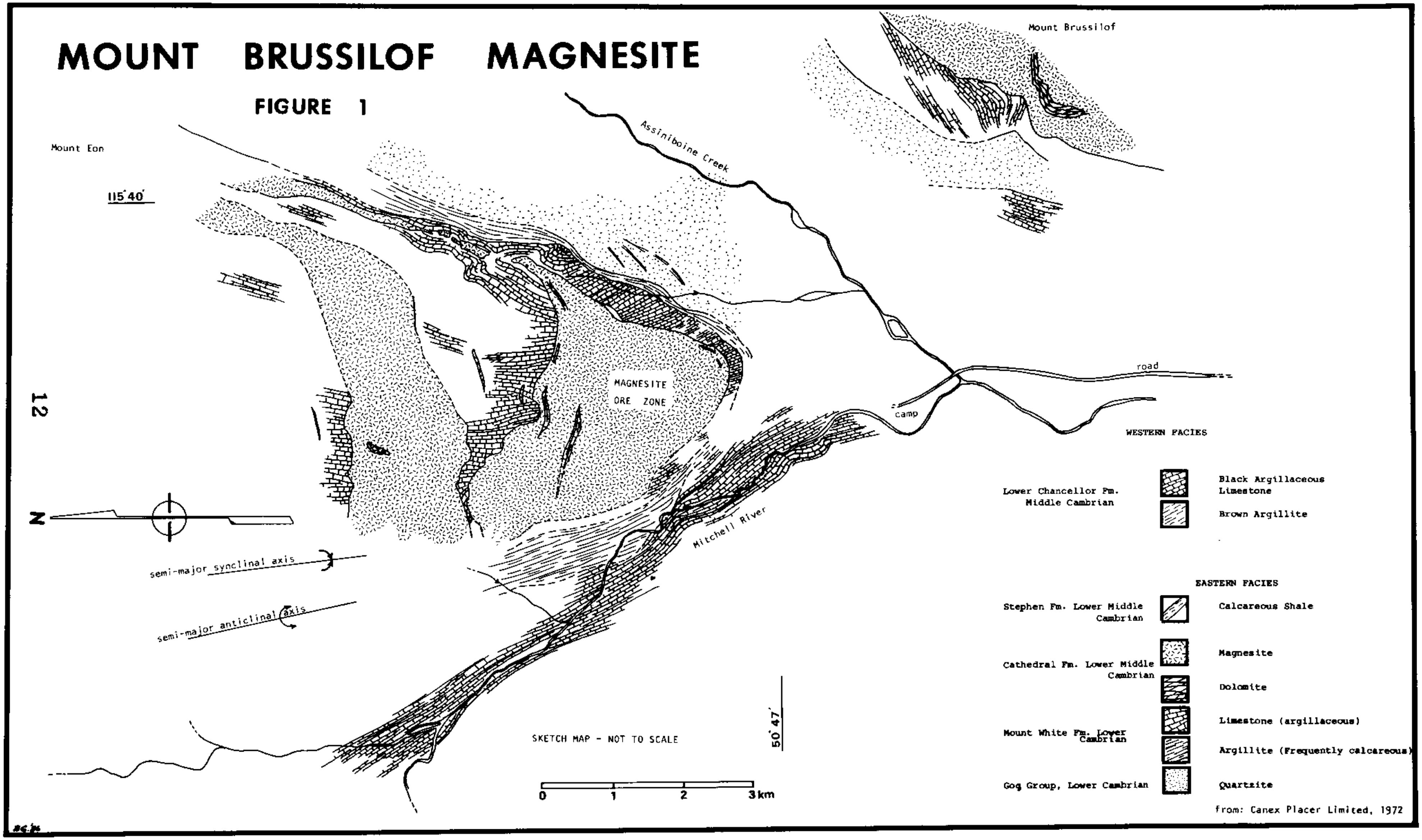
Lower Cambrian quartzites of the Gog Group and calcareous argillites and argillaceous limestones of the Middle Cambrian Mount White Formation underlie the Cathedral Formation. The argillaceous dolomites and magnesite of the Cathedral Formation are overlain by calcareous shales of the Stephen Formation. Middle Cambrian slates, phyllites and orthoquartzites of the St. Pirian Formation are exposed west of the Mitchell River fault.

The Cathedral Formation is a cliff-forming unit, 370 metres thick, composed mainly of sandy to argillaceous, fine-grained, light and dark grey dolomites. Magnesite occurs within the dolomites as massive, irregular lenticular bodies, 50 to 100 metres thick. North of Assiniboine Creek magnesite lies on the west-dipping limb of a broad anticline while on the north flank of Mount Brussilof two distinct horizons of high-calcium magnesite are exposed, separated by about 100 metres of Cathedral Formation dolomites. Contact relationships are variable and there are both gradational replacement and sharp conformable contacts with the host dolomites.

Magnesite occurs as a white to greyish, very coarse-grained crystalline rock which is quite resistant and weathers to a light buff colour. Magnesite is the dominant mineral and amounts of dolomite and calcite vary locally. Disseminated quartz grains account for 1 to 3 per cent of the rock by volume and may constitute as much as 10 per cent. Narrow, irregular stringers of finely crystalline pyrite and minor pentlandite may constitute 3 to 5 per cent of the rock. Other minerals which occur in trace

MOUNT BRUSSILOF MAGNESITE

FIGURE 1



amounts, but which partially account for the total alumina and silica content of the deposit, include talc, sericite, illite, leuchtenbergite, phlogopite, muscovite and palygorskite.

Surface sampling (1969) of the deposit returned the following analytical results:

Sample*	MgO	CaO	SiO_2	CO_2	Al_2O_3	Fe_2O_3	Insolubles ($BaSO_4$)
1	46.83	0.53	0.14	51.29	0.10	0.94	0.17
2	47.02	0.49	0.09	51.52	0.10	0.77	0.02
3	46.48	0.53	0.10	51.58	0.10	0.80	0.28
4	46.66	0.55	Nil	51.82	0.10	0.80	0.06
5	47.01	0.43	Nil	51.44	0.10	0.80	0.18

* sample # 1 bed "A" coarse-grained magnesite, west flank of Mount Brussilof
# 2 bed "B" medium to fine-grained crystalline magnesite, Mount Brussilof
#3, 4 & 5 main ore zone Baymag deposit

The Mount Brussilof deposit is reputed to be the largest and purest coarse crystalline magnesite deposit currently known in the western world. Utilizing strict selective mining techniques, the prime mining site north of Assiniboine Creek can consistently produce a magnesia product with an MgO content of 97 per cent or greater, without special ore benefication. At the present time the deposit is defined as an area about 790 by 500 metres on a northwest axis with a maximum thickness of at least 120 metres within the main magnesite zone. It is open in three directions with potential for substantial new reserves.

Current published reserves (calcined product) of all categories are about:

9.5 million tonnes >95 per cent MgO
13.6 million tonnes 93-95 per cent MgO
17.6 million tonnes >92.44 per cent MgO

BRISCO AREA

Six distinct magnesite occurrences and several small showings are associated with grey dolomites of the Proterozoic Mount Nelson Formation in the area between the Templeton River and Dunbar Creek, about 6 kilometres west of Brisco (Figure 2). The uppermost dolomite member of the Mount Nelson Formation hosts most of the deposits.

The magnesite is coarse grained and occassionally porphyritic and exhibits definite replacement textures. The magnesite contact with the country rocks is usually gradational but quite distinct. Most deposits are cut by, or adjacent to, major faults.

The Mount Nelson Formation has been subdivided into five members (McCammon, 1962). The lowest member is composed of a very fine-grained, cream to light grey dolomite with a sandy-brown weathered surface. A circular oncolite, bull's eye texture is distinctive. The unit also contains scattered quartz grains and some cherty horizons and near faults it is frequently altered to light cream-coloured, coarse-grained magnesite bodies of irregular shape.

Member 2 is a very fine-grained, dark reddish brown argillaceous dolomite which weathers to a lighter reddish brown. A strong foliation cleavage results in a distinctive platy scree. Sulphide-rich, bleached ellipsoidal spots, up to 5 centimetres in diameter and flattened parallel to bedding, are common. Magnesite is rarely developed in this member.

Member 3 is a siliceous, fine-grained, pale grey to buff dolomite which weathers to a pale grey or buckskin colour. Silica is conspicuous as intersecting veinlets and irregular masses of white quartz.

Member 4 is a white quartzite containing well-rounded clean quartz grains. The base of the unit contains brownish beds several centimetres thick while, at the top, the beds are more argillaceous, thin and platy, with a redder weathered surface.

The uppermost member of the Mount Nelson Formation is about 75 metres thick, very fine-grained, dark blue-grey dolomite with a rough, light grey weathered surface. It is finely laminated (hairline to 1 millimetre) and contains distinctive black chert as lenses and discontinuous, irregular thin layers parallel to bedding. Locally the dolomite has a brecciated texture, with large spaces between fragments healed by concentrically zoned dolomite in sheaf-like radial growths. The base of Member 5 is similar to Member 3 and the contact with the underlying quartzite is gradational.

Member 5, as defined by McCammon (1962), is the preferred host for magnesite mineralization. For a more comprehensive review of

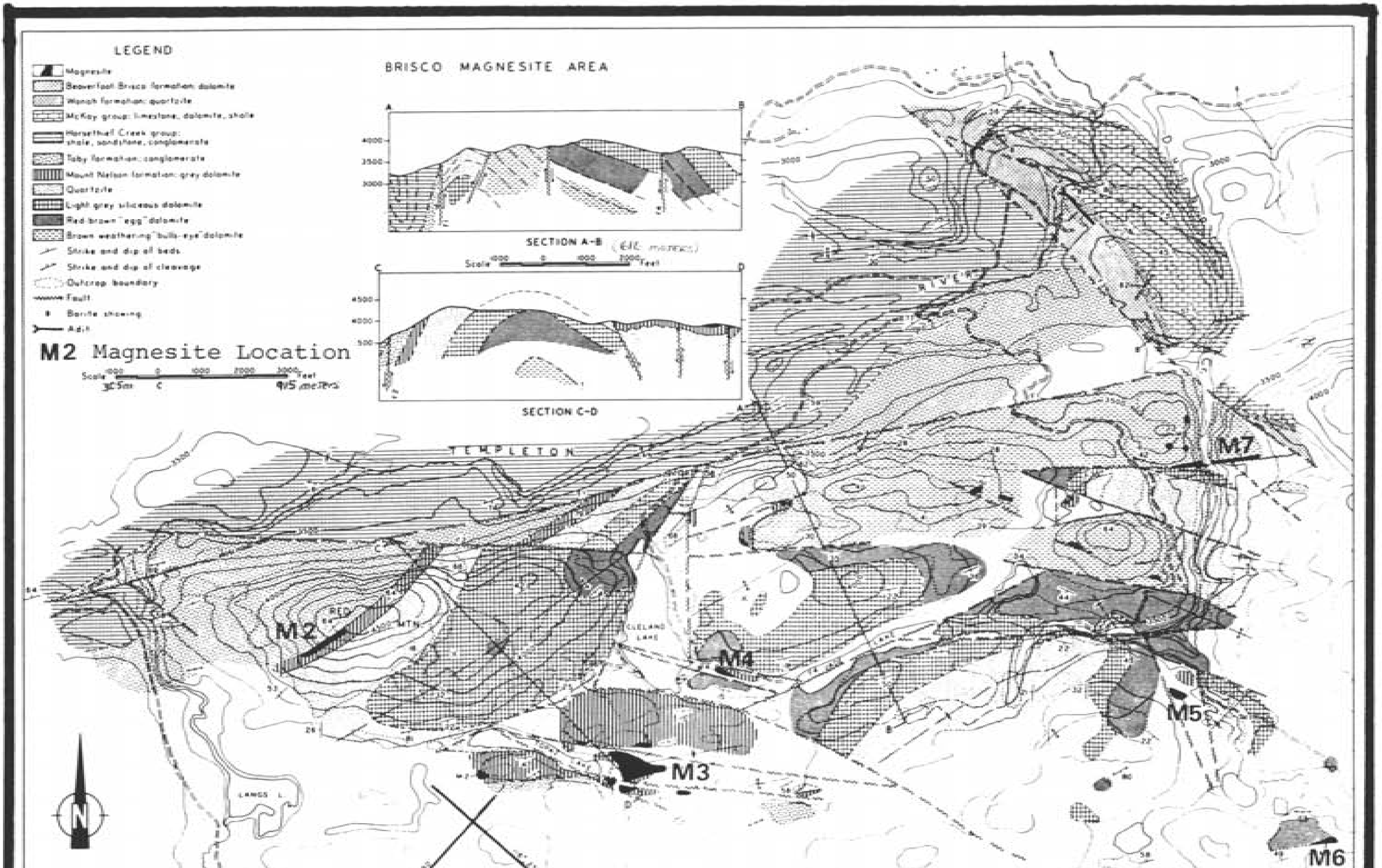


Figure 2

(From McCammon 1964)

the Mount Nelson Formation and current evaluation of its components and depositional environment, refer to Bennett (1986).

Analysis of Magnesite Samples - Brisco Area

Site	Sample	MgO	CaO	CO_2	SiO_2	Fe_2O_3
Red Mountain	M1	39.50	0.76	43.40	14.72	0.88
Topaz Lake	M2	42.79	1.04	46.72	6.48	0.87
	M3a	43.34	0.51	47.60	5.54	1.02
	M3b	44.85	0.73	49.20	3.47	0.95
Cleland Lake	M4	38.20	7.89	47.74	4.51	1.00
Jab	M5	44.02	0.47	43.82	8.99	0.99
Botts Lake	M6	35.97	8.57	46.02	8.69	0.12
Dunbar Creek	M7	41.41	2.84	47.48	3.97	2.07
	M8	42.28	2.67	48.28	3.22	1.03

RED MOUNTAIN (M2)

Type: Magnesite - stratabound, carbonate host
Minfile: 082KNE 034 NTS: 082K 16 Elevation:1370 m
Latitude: 50°50'52"N Longitude: 116°24'35"W

The Red Mountain occurrence consists of a zone of coarsely crystalline magnesite, 12 to 28 metres thick by 365 metres long, at the top of Member 5. The magnesite is pearl grey, coarsely crystalline with a buff-coloured weathered surface. It grades laterally into a cherty dolomite and is underlain by a fine-grained dolomite with chert layers 1 to 5 centimetres thick. Most of the magnesite occurs as crystals 1 centimetre long, and appears to replace dolomite near the basal contact. Locally the crystals have a distinct porphyritic appearance within a matrix of 0.5 millimetre grains of magnesite. Considerable silica is present as scattered remnants of cherty patches and partly replaced quartz grains.

Sample M1 consists of chips collected, at intervals of 90 centimetres, across 27.5 metres of the exposed eastern end of the occurrence.

TOPAZ LAKE (M3)

Type: Magnesite - stratabound, carbonate host
Minfile: 082KNE 015 NTS: 082K 16 Elevation: 1127 m
Latitude: 50°49'38"N Longitude: 116°24'01"W
Alias: Whitehorse

The Whitehorse claims, staked in 1960-61, cover the magnesite discovery at the south end of Topaz Lake. The occurrence is a triangular shaped mass about 425 metres long by 180 metres across at the widest point. Drilling indicates a thickness of 15 to 30 metres of coarse-grained magnesite (2 to 12 millimetre crystals) underlain by a fine-grained cherty dolomite. The magnesite forms the trough of a northwest-plunging syncline within the Mount Nelson dolomites and consists of a light to pearl grey rock with a rough, rusty brown weathered surface. Visible impurities include quartz in scattered veinlets and grains and talc on slip planes.

Sample M3a consisted of chips collected at random from the surface of the main exposure. Sample M3b is a grab sample from the central outcrop in a gully southwest of the main showing.

A smaller magnesite body, measuring about 60 by 60 metres, forms an apparent dip slope layer across the end of a low hillock about 150 metres from the northwest end of Topaz Lake. Its thickness is undetermined but it is underlain by a fine-grained dolomite containing abundant siliceous fragments. A chip sample, M2, was collected at random from the surface of the exposure.

A third showing, measuring 122 by 30 metres, is located about 150 metres south of the main showing. A fourth occurrence, measuring 60 by 120 metres, outcrops about 75 metres to the north, along a small ridge parallel to the main ridge. A very small magnesite occurrence is exposed about 45 metres east of Topaz Lake and almost 400 metres north of the main showing. There are several other small showings, one about 30 by 60 metres and a second about 15 metres in diameter, which form low mounds on a flat, 60 metres west of the main showing.

CLELAND LAKE (M4)

Type: Magnesite - stratabound, carbonate host
Minfile: 082KNE 038 NTS: 082K 16 Elevation: 1127 m
Latitude: 50°49'41"N Longitude: 116°23'15"W
Alias: Rainbow

A deposit of medium to coarse-grained magnesite, at the south end of Cleland Lake, is exposed on a dip slope, overlying a fine-grained dolomite typical of the top of the Mount Nelson Formation. It is exposed on the western side of a low ridge in a zone measuring about 30 by 185 metres, with a thickness of 3 to 6 metres. Sample M4 was chipped across 3 metres of the occurrence, perpendicular to bedding.

JAB (M5)

Type: Magnesite - stratabound, carbonate host
Minfile: 082KNE 014 NTS: 082K 16 Elevation: 1113 m
Latitude: 50°48'19"N Longitude: 116°21'30"W

The Jab claims were located over the first recorded magnesite discovery in the area. The magnesite forms a bare knoll about 15 metres high by 120 metres long and 30 to 50 metres wide. Most of the knoll consists of a medium to coarse-grained, structureless pale grey to white rock. Thin layers of magnesite, separated by slickensided films of talc and serpentine, occur at the southeast corner of the knoll. Visible impurities include patches of coarse white dolomite, talc-serpentine films, discontinuous stringers of quartz and chalcedony and scattered crystals and small lenses of pyrite. Sample M5 consists of chips collected at random over the top of the knoll.

BOTTS LAKE (M6)

Type: Magnesite - stratabound, carbonate host
Minfile: 082KNE 035 NTS: 082K 16 Elevation: 1110 m
Latitude: 50°47'27"N Longitude: 116°21'33"W

South of Botts Lake on Dunbar Creek, dolomite of Member 2 of the Mount Nelson Formation is altered to an impure, white, fine-grained magnesite which contains considerable calcite and quartz. The occurrence is about 120 by 30 metres in size. Grab sample M6 was collected from the showing.

DUNBAR CREEK (M7)

Type: Magnesite - stratabound, carbonate host
Minfile: 08KNE 036 NTS:082K 16 Elevation: 1067 m
Latitude: 50°48'45"N Longitude: 116°20'23"W

The Dunbar Creek showings are all alteration deposits hosted by the basal member of the Mount Nelson Formation. Magnesite is exposed at six places, all on or close to known faults. Grab sample M7 was collected close to Dunbar Creek where a near-vertical, northwest-striking fault surface forms a cliff face in dolomite. The dolomite is altered to a coarse-grained, highly irregular magnesite zone about 30 metres northeast of the fault.

North of this site and across Dunbar Creek partly altered dolomite forms a low hill containing several, irregular patches composed completely of magnesite. Sample M8 represents this material. Two small showings occur on the west side of the hill about 1 kilometre from sample site M7. Two more occurrences outcrop about 1.5 kilometres northwest of M7, close to a north-trending fault.

The Topaz Lake and Dunbar Creek occurrences have received a limited amount of exploration which included diamond drilling, trenching and some bulk sampling by the A.P. Green Fire Brick Company Ltd. in 1961 and 1962.

CHUYAZEGA CREEK (M8)

Type: Magnesite - carbonate host
Minfile: 093J 008 NTS: 093J 16 Elevation: 1370 m
Latitude: 54°58'24"N Longitude: 122°23'06"W
Alias: Anzac River

Lower Cambrian or older carbonates, quartzites, greywackes, slates and conglomerates are deformed by broad open folding along a northwest trend, parallel to the McLeod Lake fault system.

Magnesite occurs as coarsely crystalline units, 15 metres thick, interbedded with fine-grained dolomites. It outcrops along the west limb of a synclinal feature exposed in the upper reaches of Chuyazega Creek, just north of the Anzac River (Figure 3).

No detailed geological description or chemical analysis is available.

LAC LA HACHE (M9)

Type: Magnesite - carbonate host
Minfile: 092P 157 NTS: 092P 14W Elevation: 854 m
Latitude: 51°47'18"N Longitude: 121°27'42"W

Magnesite occurs in outcrop and as float at several locations on the railroad grade along the southwest side of Lac La Hache (Figure 4).

Regionally, Triassic volcanic and sedimentary rocks, including limestone and dolomite, are overlain by olivine basalt plateau lavas of Late Tertiary age. In situ magnesite is exposed as highly weathered sedimentary material immediately underlying the plateau basalts and also as short, narrow veinlets within the basalts.

Samples of magnesite float are dense, fine grained and white. Material associated with a contact zone (about 30 centimetres thick) is yellowish and highly decomposed, but effervesces in cold, dilute, hydrochloric acid and is quite plastic when wet.

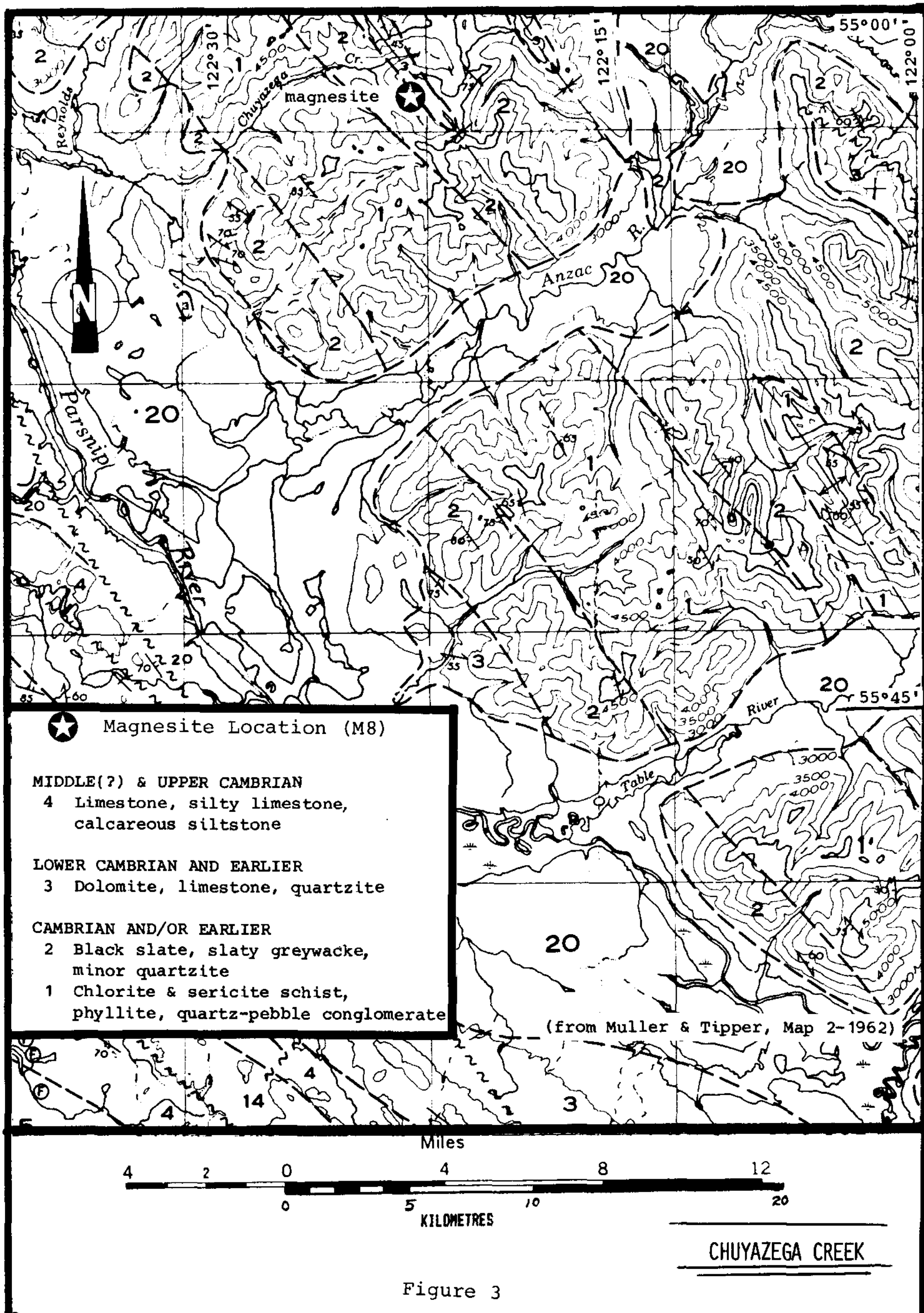

55°00'
122°00'
122°30'
122°15'
55°45'
magnesite
Chuyazega Cr.
Reynolds Cr.
Anzac R.
Parsnip River
Table River
Magnesite Location (M8)
MIDDLE(?) & UPPER CAMBRIAN
4 Limestone, silty limestone, calcareous siltstone
LOWER CAMBRIAN AND EARLIER
3 Dolomite, limestone, quartzite
CAMBRIAN AND/OR EARLIER
2 Black slate, slaty greywacke, minor quartzite
1 Chlorite & sericite schist, phyllite, quartz-pebble conglomerate
(from Muller & Tipper, Map 2-1962)
Miles
4 2 0 4 8 12
0 5 10 20
KILOMETRES
CHUYAZEGA CREEK

Figure 3

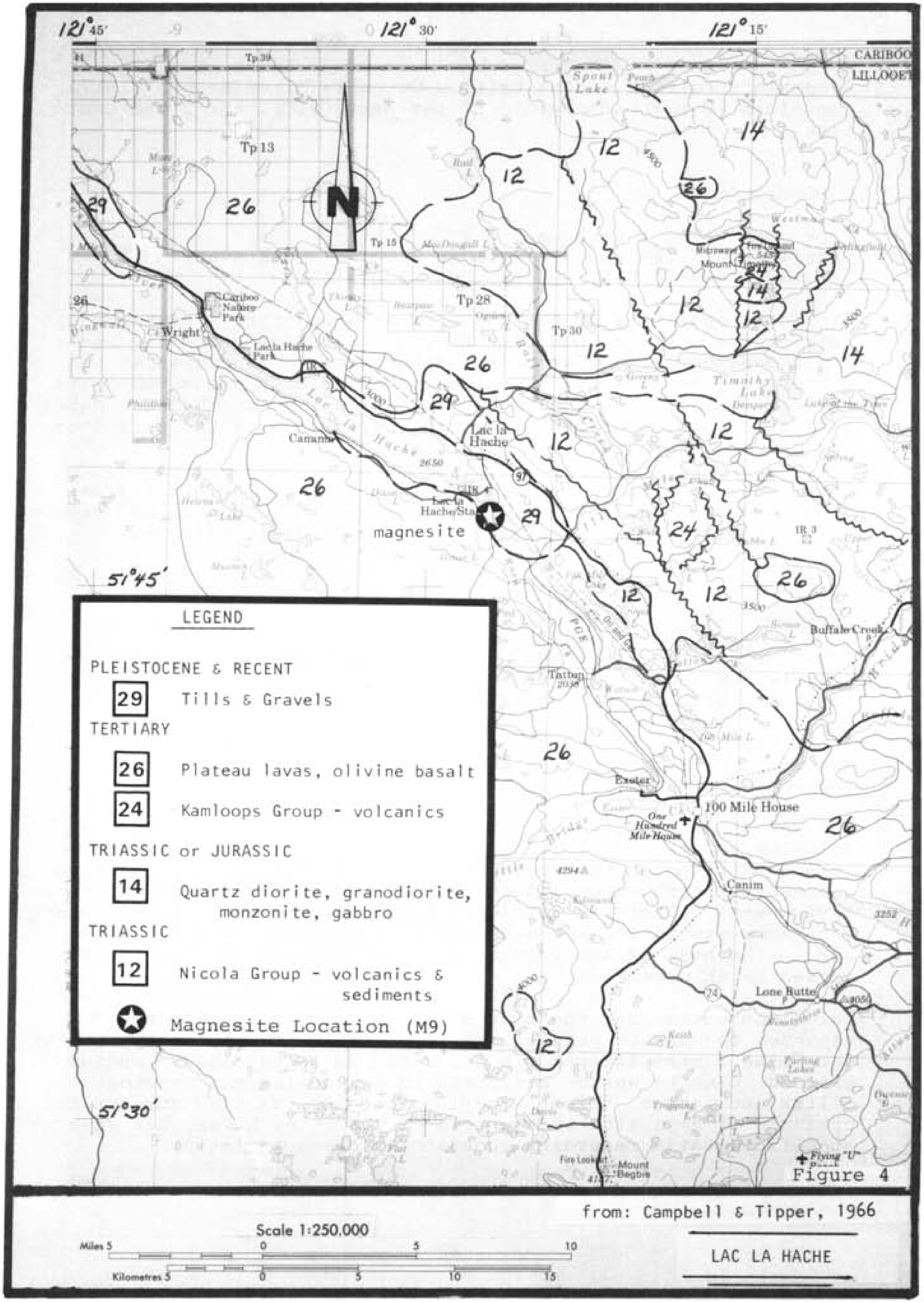


Figure 4

from: Campbell & Tipper, 1966

LAC LA HACHE

A sample submitted to the British Columbia Mines Branch (1917) contained 70 per cent $MgCO_3$, 27 per cent $CaCO_3$, and 2 per cent iron.

O'DONNEL (M10)

Type: Magnesite - carbonate host(?)
Minfile: 104N 095 NTS: 104N 012 Elevation: 800 m
Latitude: 59°19'30"N Longitude: 133°31'00"W

Carbonate sediments of the Cache Creek Group form a gentle ridge between the O'Donnel and Pike Rivers. Although dolomites and limestones comprise most of the stratigraphy, exposures at the O'Donnel River site have been described as high-grade magnesite (Fraser, 1915). The occurrence of hot springs in the carbonates suggests a source of fluids for the alteration of the dolomites and limestones to magnesium carbonate.

Other well-documented magnesite occurrences in the Atlin area appear related to ultramafic intrusions. The O'Donnel occurrence may be similar but limited geological data do not document ultramafic rock in the vicinity of the occurrence.

CHISCHA (M39)

Type: Magnesite - stratabound, carbonate host
Minfile: 094K 079 NTS: 094K Elevation: 1500 m
Latitude: 58°30'00"N Longitude: 124°35'00"W

About 950 metres of Helikian, Chischa Formation strata are exposed in the core of the Tuchodi anticline, in the upper section of the Tetsa River drainage.

The Chischa Formation consists of pale grey, very fine-grained dolomite and minor siltstone and contains some fine-grained orthoquartzites in the upper third of the stratigraphic section. Sedimentary structures indicate deposition in a shallow water environment. There is little evidence of alteration except where sediments are in contact with gabbroic dykes of late Helikian age. The base of the formation is not exposed but the top is marked by an unconformity.

Dolomitic units near the base of the Chischa Formation are reported to contain magnesite (Bell, 1986). These basal units of the Chischa stratigraphy are described as being fine to medium grained, pink to white, resistant to weathering and forming cliffs and ledges. Mineral exploration records also suggest the presence of magnesite in the area of the Tetsa River, but give no specific details regarding location or characteristics.

SEDIMENTARY QUARTZITE-HOSTED MAGNESITE OCCURRENCES

MARYSVILLE (M11)

Type: Magnesite - stratabound, quartzite host
Minfile: 082GNW 005 NTS: 082G 12 Elevation: 1060 m
Latitude: 49°35'30"N Longitude: 115°58'00"W
Claims: L.14784 to L.14797, L.14818, L.14906
Alias: Perry Creek

Crystalline magnesite was discovered in the early 1930s in Lower Cambrian Cranbrook Formation sediments immediately south of Marysville, between Perry Creek and the St. Mary River. Locally the bedding has a general northeast trend and dips to the northwest at 60 to 80 degrees. The succession is overturned, with younger beds to the east forming a structural footwall to the Upper Proterozoic sediments. From west to east it includes the Upper Proterozoic Kitchener and Siyeh Formations stratigraphically overlain by Cranbrook Formation quartzites and carbonates of Early Cambrian age. These are in turn overlain by Cambrian Eager Formation argillites (Figure 5).

The Cranbrook Formation in the showing area is about 300 metres thick and the upper third is magnesite rich (Figure 6). The Lower Cranbrook Formation is composed of clean, varicoloured, medium to coarse-grained quartzite beds which thin and contain argillaceous partings locally. Crossbedding, interstitial sericite and narrow crosscutting quartz veins are common.

The lower quartzites grade upward into about 65 metres (Hoy: Unit 20 to 27) of alternating medium-grained quartzites and carbonates which contain discontinuous magnesite horizons, followed by about 15 metres (Hoy: Unit 28 to 30) of massive, coarse-grained magnesite. An upper zone of carbonate, quartzite and magnesite, similar to the lower zone, overlies the massive magnesite and is in contact with argillites of the Eager Formation to the east. The belt of magnesite-rich sediments is traceable along strike for a distance of about 6 kilometres between the St. Mary River and Perry Creek, where the Cranbrook Formation is truncated by major faults.

The most complete description of the Marysville magnesite occurrence is by McCammon (1964) who describes it as follows:

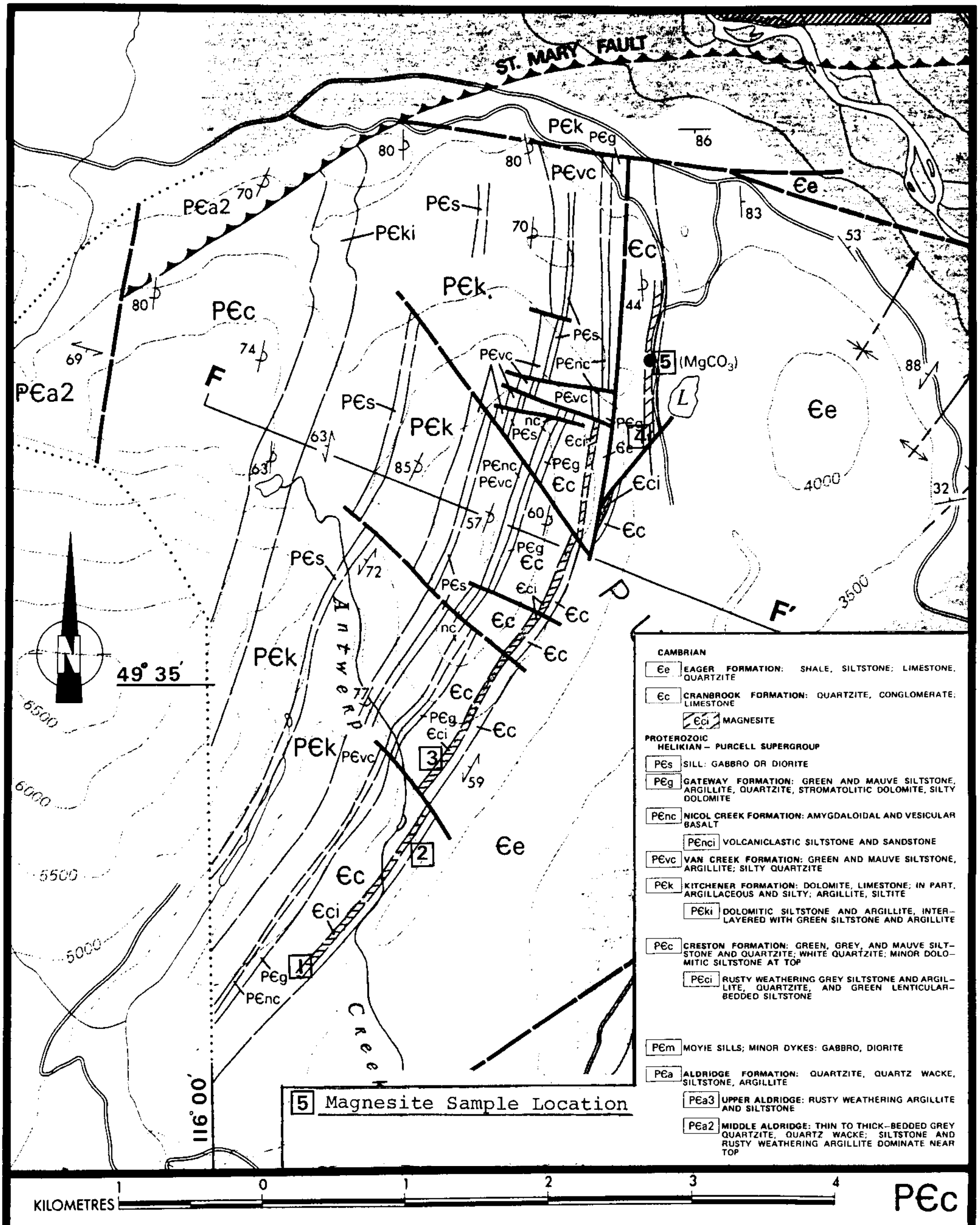
"...No completely exposed section across the whole series from pure quartzite through the carbonate zone to the overlying Eager argillites was found, hence accurate measurements of thicknesses are not known...

"In the lower interbedded rocks the carbonate seems to be predominantly magnesite. The beds average one-half inch to 2 inches (12 to 50 millimetres) thick but pinch and swell. At first glance they seem to be quite regular and continuous, but on closer examination it is found that any one band of quartz or magnesite does not persist many feet on strike before it is gradually replaced by the other mineral, although farther along on strike the first mineral may reappear. Across strike there are fairly sharp, though gradational, boundaries between magnesite and quartz bands. The quartz bands consist essentially of clear glassy quartz grains averaging slightly less than 1 millimetre in diameter, cemented by serpentine and what is now fine-grained magnesite in irregular masses that mould around and corrode the quartz grains and fill the interstices between them. Scarce calcite grains are also present. They appear to be remnants of grains partly replaced by magnesite. The magnesite bands consist of 1 to 3 millimetre grains of recrystallized magnesite with scattered and corroded remnants of quartz grains enclosed within and between the magnesite crystals. All grains show undulous extinction in thin-sections. Scattered through the thin magnesite bands are dark rectangular, circular, and oval shapes, up to 1 millimetre in maximum diameter, that consist of parallel or radial rows of black dots. These may represent some form of microfossil. None of the shapes were recognized in the quartz bands nor in the massive magnesite or top interlayered bands.

"The main magnesite band is composed of recrystallized magnesite in interlocked grains as long as 15 millimetres. Remnants of partially replaced quartz grains occur occasionally within some magnesite crystals. Some serpentine is present in patches and films between magnesite grains. The rock is pale buff to pearl grey or white on fresh surfaces and weathers brownish-buff. Here and there stringers and veinlets of white quartz cut the magnesite. Talc or serpentine are present on minor slip surfaces. The best magnesite is concentrated in one main band which can be traced discontinuously for most of the length of the map-area. In some exposures, one or more similar and parallel bands 2 to 10 feet thick are present.

"The interlayered series on top of the main magnesite band consists of beds of quartzite cemented by sericite and calcite alternating with bands of medium-grained, recrystallized, twinned calcite. In one outcrop near the centre of the area a few of the carbonate bands are composed of magnesite. The different bands pinch and swell along strike in the same way as those below the main magnesite band. Upwards in the series the carbonate content decreases rapidly and there is a transition into argillaceous quartzite."

The Marysville occurrence has been extensively tested by drilling, trenching, geological mapping and bulk sampling along a strike length of about 5.5 kilometres. In 1941 approximately

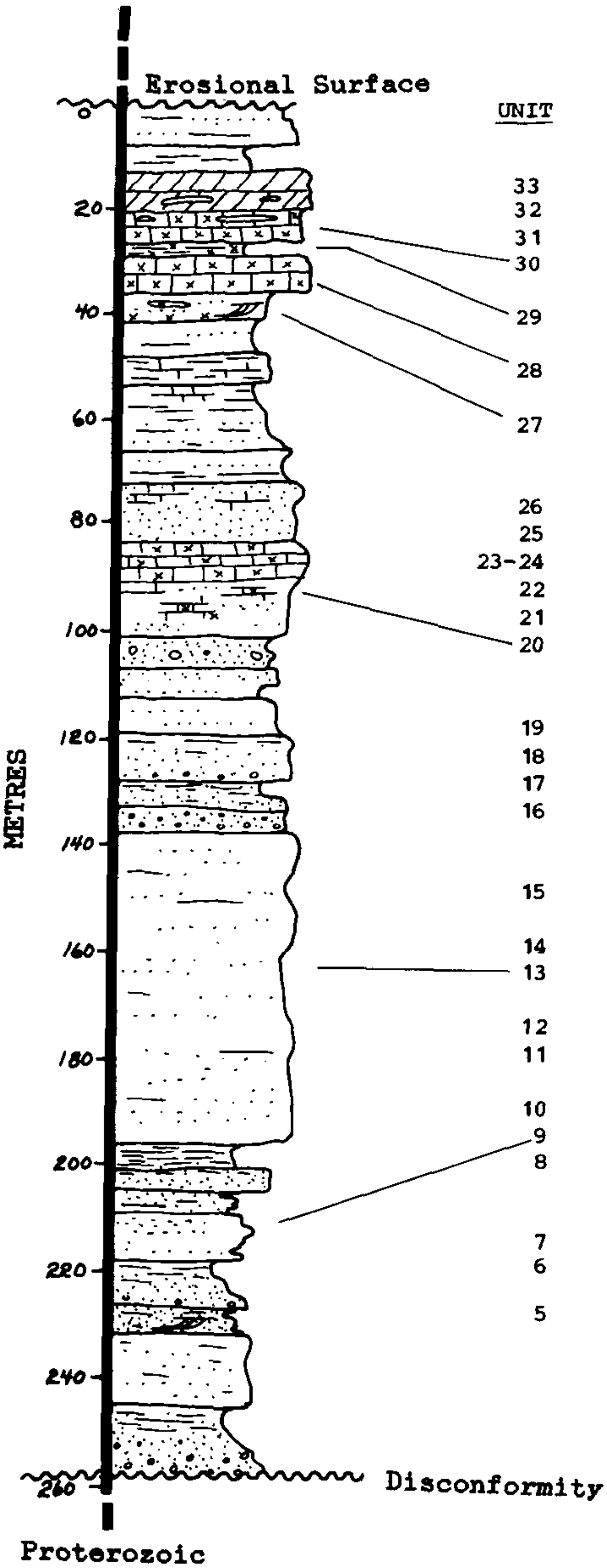


MARYSVILLE MAGNESITE

Figure 5
(after Höy, 1984)

CRANBROOK FORMATION

MARYSVILLE



UNIT

33 quartz wacke, siltstone beds
32 green siltstone, commonly graded
31 dolomite, brown, quartz nodules
30 magnesite, granular, 15-20% thin quartzite & siltstone lenses
29 magnesite, tan weathering, granular grades upwards to siltstone
28 magnesite, tan weathering, coarse grained
27 quartzite, pink with irregular lenses magnesite 20-30% magnesite at base, minor siltstone
26 siltstone, quartzite, mauve to purple
25 calcareous siltstone
23-24 grey to purple quartz wacke
22 quartz wacke minor calcareous cement
21 impure quartzite, calcareous lenses
20 magnesite, brown weathering, medium to coarse-grained quartz lenses at base, grades upwards to magnesite
19 quartz wacke, purple streaking
18 quartz-feldspar arenite
17 impure quartz arenite
16 fining upward sequence, quartz arenite at base through grey quartz arenite to green siltstone
15 fining upward sequence, grey quartzite up to thin-bedded green siltstone
14 white quartzite, coarse grained
13 quartz arenite, massive, rare argillite partings
12 green fissile siltstone
11 quartz arenite, grades upwards to unit 12
10 interlaminated quartz arenite
9 quartz arenite, thinner bedded at top
8 fining upward sequence, quartz arenite up to interlayered silstone and phyllite
7 quartz arenite, common crossbeds
6 thick-bedded quartz arenite with minor siltstone partings
5 fining upward sequence, pink quartz arenite up to green siltite

FIGURE 6

(after Höy, 1976)

2700 tonnes of material were shipped to Trail by Cominco Ltd. for testing but no commercial production has resulted.

At the south end of the Marysville occurrence and west of Antwerp Creek, a coarse-grained magnesite horizon was identified. It is 12 metres thick, dips 68 to 72 degrees northwest and extends 213 metres along strike. Channel samples 1A, 1B and 1C indicate the tenor of mineralization at this site (Figure 5, location 1).

Trenching exposed two showings northeast of location 1 (Figure 5 Location 2). The southernmost exposure is crystalline magnesite in a mound 9 metres high by 60 by 15 metres in area. About 75 metres north of the mound a bed of crystalline magnesite, 12 metres thick, is in contact with 40 metres of interbedded quartzites and magnesites to the west. Sample No. 2 in the following table consists of chips collected, at intervals of 30 centimetres, across a thickness of 12 metres at this northern exposure.

A coarse-grained magnesite bed 12 metres thick is exposed at location 3 (Figure 5). Strike is 035 degrees and the dip is 74 degrees west. The zone is exposed over a strike length of about 180 metres. Chip sample No. 3 was collected from a 7-metre adit driven into the magnesite.

Fifteen metres of crystalline magnesite, in contact with quartzites and carbonates to the west, is exposed intermittently along a strike length of about 290 metres at Location 4. The beds strike about 025 degrees and dip 70 degrees northwest. Sample No. 4 is composed of chips collected at 30 centimetre intervals along the walls of a 21-metre adit.

At the northern end of the Marysville occurrence Cominco Ltd. quarried about 2700 tonnes of magnesite in 1941 for bulk testing. At the quarry, Location 5, the magnesite is about 15 metres thick and exposed for about 105 metres along strike. It is in contact with interbedded quartzites and carbonates. Sample No. 5 consisted of chips collected, at 30-centimetre intervals, from across about 10 metres of the quarry face.

In 1932 Cairnes collected two surface chip samples (388-R and 330) from sites just south of the quarry at Location 5. The analyses of these samples are included in the following table of McCammon's 1964 sampling results:

Analysis of Marysville Magnesite Samples:

Sample	MgO	CaO	CO_2	SiO_2	Fe(total)	Al_2O_3
1A	45.13	0.80	45.92	5.42	0.89	-
1B	39.03	9.27	46.92	3.52	0.66	-
1C	45.35	0.70	48.00	4.40	0.67	-
2	39.58	0.48	43.64	7.38	1.20	4.48
3	44.26	0.45	50.36	2.17	0.90	tr
4	32.05	1.14	35.56	26.71	1.62	2.00
5	41.90	0.71	42.80	3.98	1.25	2.38
388-R	43.70	0.79	48.00	4.54	2.40	0.40
330	44.80	0.73	48.30	4.40	1.44	0.66

In addition to the main Marysville occurrence Rice(1937) also makes reference to a small magnesite showing on the east flank of Red Mountain immediately to the east. This is believed to be in the vicinity of latitude 49°36'00"N and longitude 115°56'00"W.

DRIFTWOOD CREEK (M12)

Type: Magnesite - stratabound, carbonate host
Minfile: 082KNE 068 NTS: 082K 15 Elevation: 1220 m
Latitude: 50°54'16"N Longitude: 116°34'30"W

Lower Cambrian Cranbrook Formation quartzites, dolomites and phyllitic argillites host medium to coarse-grained, crystalline magnesite. The occurrence is at the western end of the rocky ridge on the northern side of Driftwood Creek. The test quarries may be reached via the Driftwood Creek logging road, 9.6 kilometres from the Bugaboo road intersection.

Beds of slaty phyllite, overlain by a fine-grained, dark cherty dolomite, form the footwall to a strike exposure of about 110 metres of magnesite beds. (Figure 7)

A sequence of medium to coarse-grained magnesite beds, 65 metres thick and containing cherty blebs and lenses, overlies the dolomite to the southwest. This impure magnesite also contains two continuous horizons of massive magnesite 4.5 and 2.2 metres thick. A metallurgical test sample was collected from quarry 'A' in the stratigraphically lower, 4.5-metre-thick, magnesite in June 1983. Near the top of the magnesite section is a layer of white to yellow, fine-grained orthoquartzite, similar to that exposed below the slaty phyllites to the northwest.

The upper 45 metres of the section is a massive, medium to coarse-grained magnesite with no visible impurities and exposed along strike for several hundred metres. A bulk sample of this material was collected from quarry 'B'.

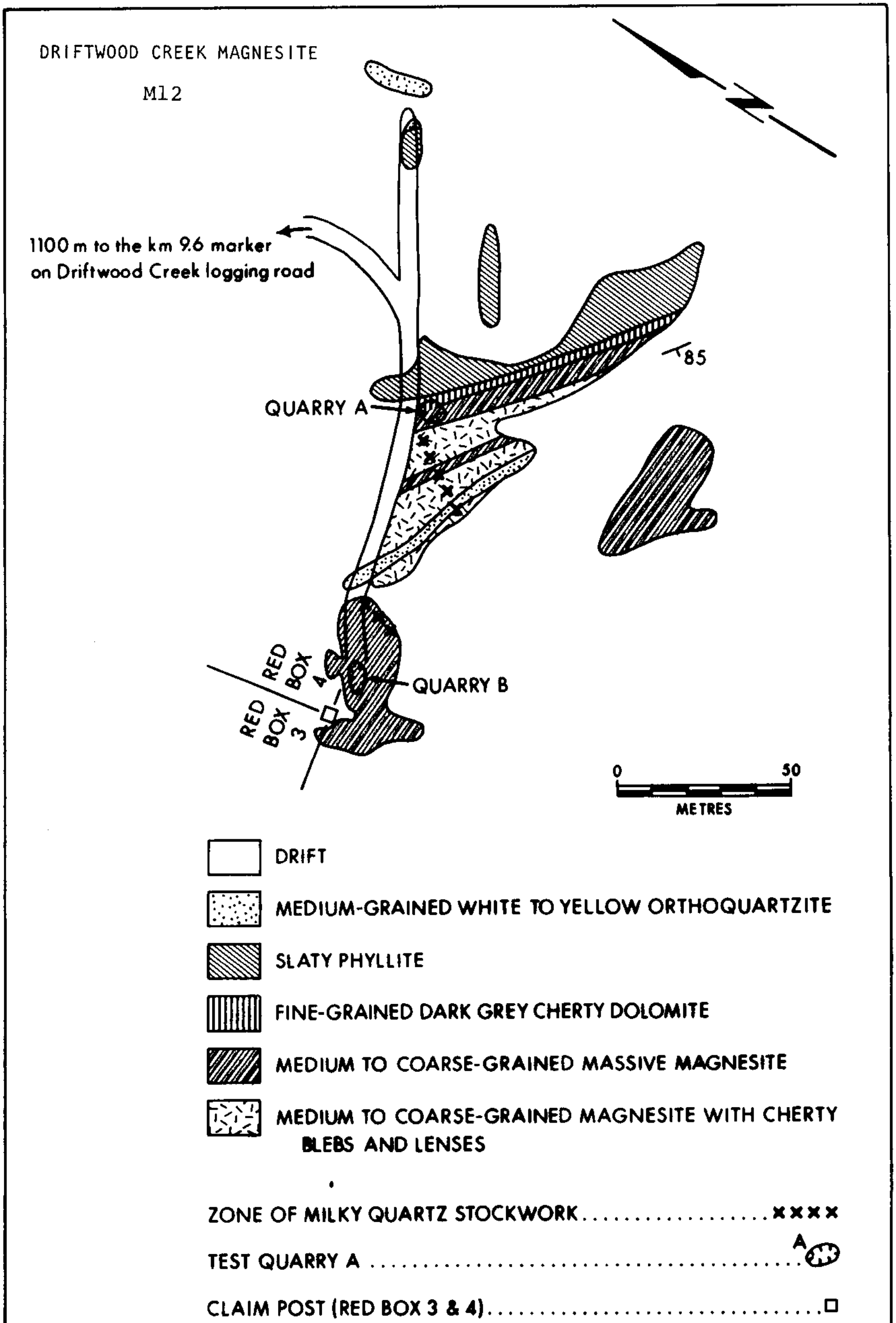


Figure 7 from: Hora, 1983

Results of the test sampling are as follows:

	MgO	CaO	SiO_2	Al_2O_3	Fe(total)
Quarry A	42.5	4.20	2.5	0.06	0.77
Quarry B	40.0	6.00	4.6	0.13	0.82

Diamond drilling and mapping by Kaiser Resources Ltd. in 1978 indicated a potential in the order of 22.5 million tonnes of magnesite.

HELLROARING CREEK

Two magnesite occurrences within Lower Cambrian, Cranbrook Formation quartzites are exposed south of St. Mary Lake on Hellroaring Creek. These are the Princess and Mallandaine Pass showings.

In the vicinity of the showings, the base of the Cranbrook Formation is a distinct erosional unconformity. The Cranbrook Formation is in contact with Proterozoic rocks of the Kitchener, Siyeh and Creston Formations and several blocks and cobbles of Creston quartzites have been identified in the basal conglomerates. The Eager Formation appears to conformably overlie the Cranbook Formation with a gradational transition zone in the order of 100 metres.

Near St. Eugene Mission, the type locality, the Cranbrook Formation consists of about 180 metres of massive coarse-grained, siliceous quartzite of variable colour, including white, rose-red, green and grey. The basal quartzites contain small clasts of the underlying argillite. Beds and lenses of pebble conglomerate are interbedded at various levels. At Goat River the Cranbrook Formation is richer in conglomerate and the basal units are coarse conglomerates containing cobbles and blocks of quartz and quartzite, up to about 30 centimetres, together with occasional small fragments of argillite. The cement is usually fine quartz grains but may be calcite or dolomite locally.

Schofield (1922) has correlated the Cranbrook Formation with some of the quartzites and conglomerates which overlie the Lower Cambrian Burton Formation in the Elko-Fernie area and Evans (1932) equates the Lower Cambrian, Lower Donald Formation of the Brisco-Dogtooth area with the Cranbrook Formation. The Lower Cambrian Hamill quartzites to the west are roughly equivalent in age but generally lack the coarse clastic sediments common in the Cranbrook Formation.

PRINCESS (M13)

Type: Magnesite - stratabound, quartzite host
Minfile: 082FSE 066 NTS: 082F 08E Elevation: 2225 m
Latitude: 49°25'00"N Longitude: 116°13'45"W

The Princess property consists of the Victoria, Princess, Prince and Monarch Crown Grants, lot numbers 14284 to 14287 inclusive.

Magnesite is exposed at the base and on the north wall of an irregular cirque at the headwaters of Hellroaring Creek. It occurs in a bed 3 to 6 metres thick, underlain by white quartzite of the Upper Cranbrook Formation and overlain by thin-bedded, green siliceous argillites of the Eager Formation. The rocks are folded into a tight northeast-plunging syncline. There is considerable shearing and fracturing parallel to the fold axis.

In the floor of the cirque the magnesite bed is exposed over a strike length of 130 metres. It is exposed again, about 215 metres along strike, in the north wall of the cirque. A small open cut exposed a sheared and fractured magnesite horizon containing abundant pods and veinlets of quartz. The magnesite varies from pearly grey to buff, is very coarse grained and has a brown weathered surface. Sample A is a chip sample collected by McCammon (1964) across a 10-metre face in the open cut. Sample B reported by Cairnes (1932) is of unknown character .

Sample	MgO	CaO	Fe(total)	SiO_2	CO_2	Al_2O_3	$Fe_2O_3+Al_2O_3$	Insoluble
A	40.47	0.78	2.07	5.97	44.02	3.98	-	-
B	42.09	1.79	-	5.92	-	-	5.11	2.39

MALLANDAINE PASS (M14)

Type: Magnesite - stratabound, quartzite host
Minfile: 082FNE 163 NTS: 082F 09W Elevation: 2040 m
Latitude: 49°30'45"N Longitude: 116°17'40"W

This occurrence is reported from several sources as being located along the ridge east of Mallandaine Pass and Mount McKay and within the main body of the Cranbrook Formation quartzites to the west of Hellroaring Creek.

An exact location and description of the magnesite occurrence is unavailable other than it is hosted by quartzites and is of 'good grade'.

FORT STEELE

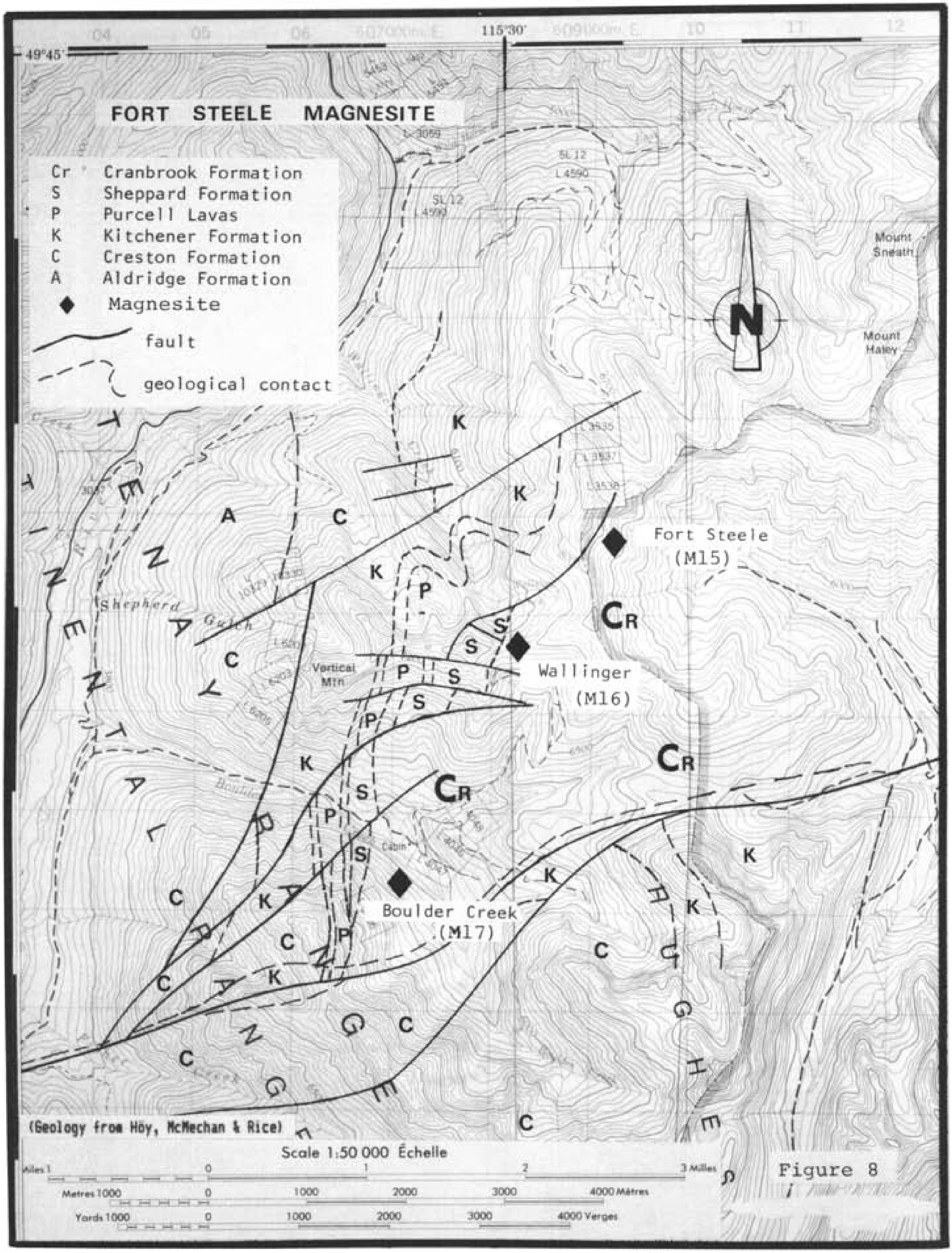
The Fort Steele occurrence consists of three separate magnesite showings (see table below), each hosted by Lower Cambrian Cranbrook Formation quartzites in a setting similar to the Marysville and Hellroaring Creek occurrences.(Figure 8)

Showing		Minfile No.	NTS	Latitude	Longitude	Elevation
FORT STEELE	(M15)	082GNW 053	82G 11W	49°42'10"N	115°29'05"W	2280 m
WALLINGER	(M16)	082GNW 047	82G 12E	49°41'45"N	115°30'10"W	2285 m
BOULDER CREEK	(M17)	082GNW 036	82G 12E	49°40'27"N	115°30'50"W	1525 m

Magnesite occurs as a bed of coarsely crystalline, light creamy grey magnesite, in the order of 45 metres thick. The magnesite is contaminated by quartz and calcite near its basal and upper contacts but a relatively pure magnesite usually forms a core zone about 12 metres thick. The magnesite exhibits a rough textured weathered surface. It grades upwards into a series of greenish quartzites with well-rounded quartz grains cemented by chlorite, serpentinite and talc with minor hematite, sphene and zircon.

In general the magnesite overlies typical, light-coloured Cranbrook Formation quartzites. In Boulder and Wallinger Creeks these basal quartzites are replaced, at least in part, by coarse conglomerates which rest unconformably on sediments of the Proterozoic Siyeh or Gateway Formations. This erosional unconformity at the base of the Cranbrook is identical to that described in similar sections from the Goat River area.

There are no data available indicating the grade or extent of these occurrences.


FORT STEELE MAGNESITE
Cr Cranbrook Formation
S Sheppard Formation
P Purcell Lavas
K Kitchener Formation
C Creston Formation
A Aldridge Formation
Magnesite
fault
geological contact
Fort Steele
(M15)
Wallinger
(M16)
Boulder Creek
(M17)
Mount Sneath
Mount Haley
Vertical Mtn
Shepherd Gulch
KENAY RANGE
HUGHES
(Geology from Höy, McMechan & Rice)
Scale 1:50 000 Échelle
Miles 1 0 1 2 3 Milles
Metres 1000 0 1000 2000 3000 4000 Mètres
Yards 1000 0 1000 2000 3000 4000 Verges
115°30'
49°45'
Figure 8

ULTRAMAFIC ALTERATION MAGNESITE OCCURRENCES

BRIDGE RIVER - YALAKOM RIVER AREA

The Bridge River - Yalakom River area lies on the eastern margin of the Cretaceous Coast Plutonic Complex, near the southwestern edge of the Chilcotin Plateau. The local sedimentary and volcanic strata range in age from Pennsylvanian through to Recent.

The Paleozoic stratigraphy occupies the eroded core of a broad, northwest-trending anticlinal arch or dome flanked by formations of Triassic and Cretaceous age. Units of the Shulaps ultramafic rocks flank the anticlinal structure and intrude the Paleozoic and Lower Triassic stratigraphy along a general northwest trend. These serpentinized and carbonatized peridotites form parts of the Shulaps and Cadwallader Ranges.

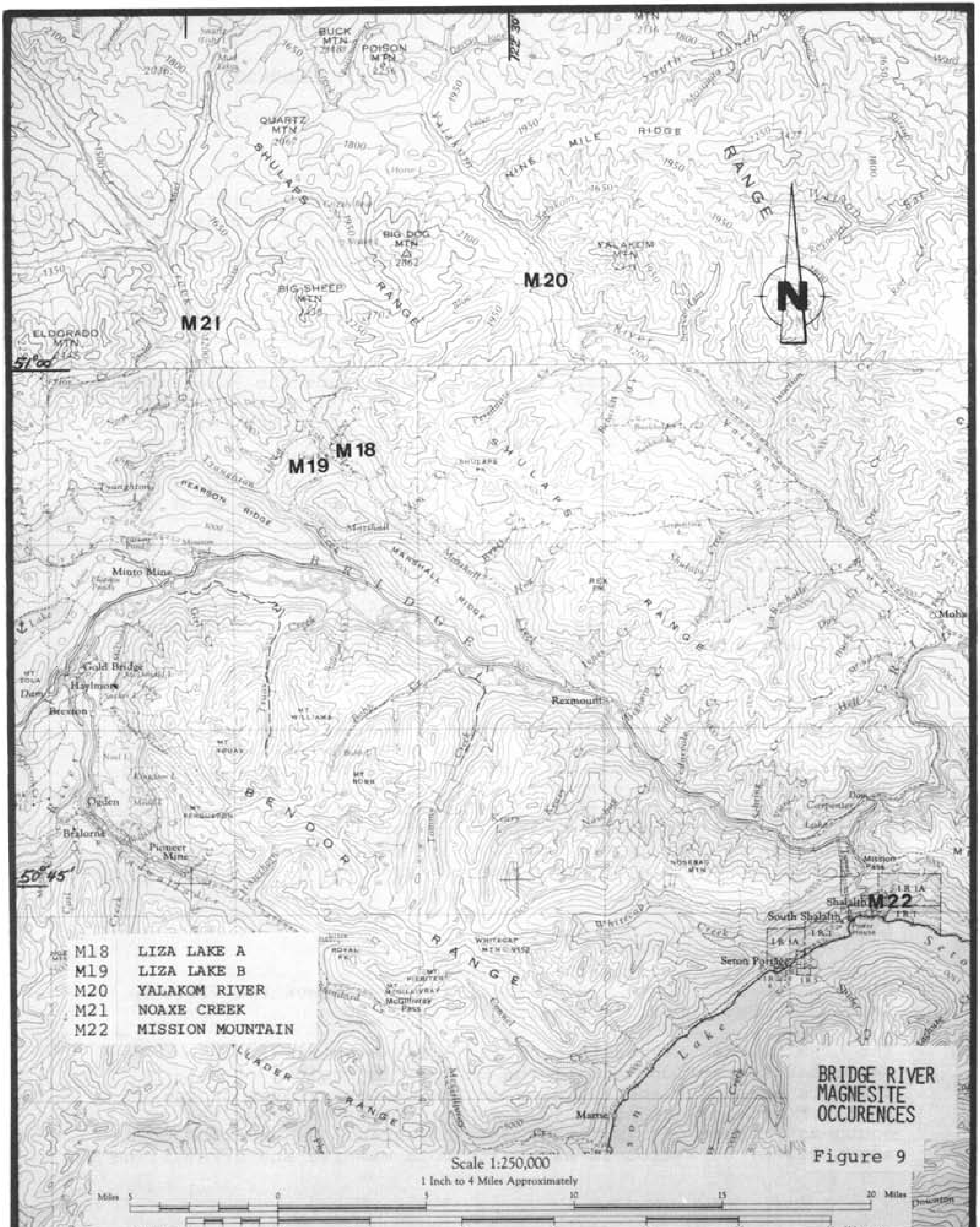
Veins, pods and lenses of siliceous magnesite alteration of serpentinized peridotite occur chiefly along the margins of the ultramafic intrusions and are generally associated with northwest-trending faults and shears. The magnesite bodies are cut by anastomosing veinlets of chalcedony and quartz and most outcrops contain late-stage veins of pure magnesite. The magnesite veins may vary from a few millimetres to several centimetres in thickness and in several cases magnesite veins of 2 to 3 metres width are known. The larger magnesite veins are composite, have a banded internal structure and yield assay values in the order of 30 to 45 per cent magnesite.

Outcrops are usually a buff or rusty colour. Magnesite is more resistant than the surrounding serpentinized peridotites and contains ridges and knobs of even more resistant chalcedony and quartz which give the exposures a rough texture. The magnesite is medium-grained, reddish or grey, flecked with red or green on fresh surfaces. Chromite grains, where present, show no sign of replacement by carbonate or silica although altered remnants of serpentinized peridotite are common (Figure 9).

LIZA LAKE A (M18)

Type: Magnesite - ultramafic alteration
Minfile: 092JNE 102 NTS: 92J 15E Elevation: 1310 m
Latitude: 50°57'00"N Longitude: 122°36'30"W

The Liza Lake A magnesite occurrence is associated with serpentinized peridotites of the Shulaps intrusions of Late Triassic age. The showing lies on the western slopes of the Shulap Mountains, at about 1310 metres elevation, near the southeast corner of Liza Lake. The occurrence is reported to be about 250 by 60 metres in size with both massive and crystalline



BRIDGE RIVER MAGNESITE OCCURENCES

Figure 9

magnesite cut by numerous veinlets of clear chalcedonic quartz. Locally the massive magnesite is vuggy with the vugs also filled with chalcedony. Minor mariposite and individual grains and clusters of unaltered chromite are common. A sample analysed by the Geological Survey of Canada in 1915 indicated the following:

MgO	CaO	FeO	Fe_2O_3	Al_2O_3	CO_2	SiO_2	H_2O
43.42	0.46	0.56	0.25	0.23	47.28	7.46	0.68

LIZA LAKE B (M19)

Type: Magnesite - ultramafic alteration
Minfile: 092JNE 127 NTS: 92J 15E Elevation: 1280 m
Latitude: 51°30'00"N Longitude: 122°44'00"W

The Liza Lake B magnesite occurrence is also associated with serpentinized peridotites of the Shulaps intrusions. The showing lies immediately northwest of Liza Lake and is reported to be in the order of 16 by 15 metres in size. It is similar to the Liza Lake A occurrence in texture and mineralogy. The Geological Survey of Canada analysed two samples from the Liza Lake B site, the first is a massive magnesite, the second a more dolomitic variety from the same location. Results, expressed as per cent, are tabulated below.

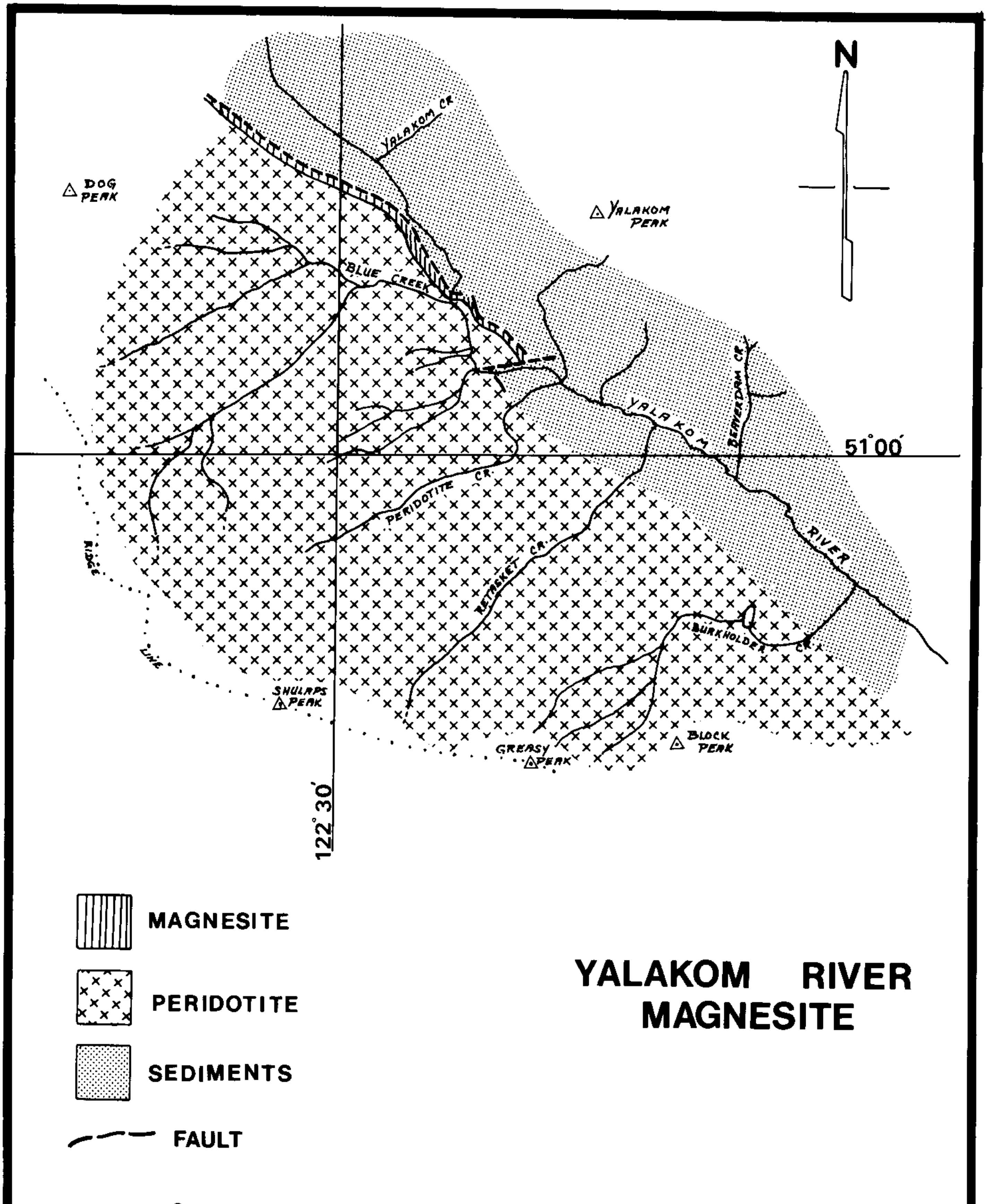
	MgO	CaO	Fe_2O_3	Al_2O_3	CO_2	SiO_2
Sample 1	42.20	3.25	0.9	0.59	48.55	4.08
Sample 2	28.14	18.48	1.64	0.92	45.18	4.08

YALAKOM RIVER (M20)

Type: Magnesite - ultramafic alteration + vein
Minfile: 092O 014 NTS: 092O 01W Elevation: 1372 m
Latitude: 51°02'30"N Longitude: 122°28'15"W
Alias: Sunny

A silica-carbonate alteration zone lies along the sharp ridge between Yalakom River and Blue Creek. It varies from 30 to 100 metres in width and is traceable intermittently, for about 5 kilometres, along a northwest trend coincident with the Yalakom Fault zone and the eastern margin of the Shulaps ultramafic intrusive. (Figure 10)

The zone contains gradations of alteration from serpentine to pure magnesite. Crystalline magnesite and quartz form banded veins which crosscut the silica-carbonate alteration and immediately surrounding rocks. Alteration margins are highly irregular in the ultramafics and locally there is some alteration and veining of the sediments. On fresh surfaces the silica-carbonate alteration is white but it is reddish if chalcedonic silica is abundant and flecked with green if



YALAKOM RIVER MAGNESITE

(Geology from Leech, 1947)

Fig 10

unreplaced serpentine is present. On a weathered surface the silica-carbonate is rough textured and buff coloured.

The most significant crystalline magnesite vein is about 4 metres wide by 915 metres along strike. It strikes 310 degrees and has a near vertical dip. Most of the veins however, are measured in centimetres with only composite veins being wider. The wider veins are vertical and parallel the trend of the alteration zone and Yalakom fault while the smaller veins pinch and swell and have a random orientation. The observed exposures indicate that most veins cannot be traced any great distance along strike.

Nine samples taken from the main magnesite vein along the ridge near the mouth of Blue Creek yielded analysis varying from 32 to 42.8 per cent magnesite.

OTHER SHOWINGS

There are two other magnesite showings in the Bridge River area for which no extensive descriptions are available. Recent mapping by British Columbia Ministry of Energy, Mines and Petroleum Resources geologists indicates that outcrops of altered peridotite are common. Although many such occurrences have the typical silica veining, the predominant carbonate may be calcium rather than magnesium rich.

NOAXE CREEK (M21)

Type: Magnesite - unknown association
Minfile: 092O 096 NTS: 92O 02 Elevation: 1220 m
Latitude: 51°01'20"N Longitude: 122°44'50"W

Magnesite outcrops a few hundred metres from the old Manitou mine road and about 16 kilometres north of the Bridge River Road, near the confluence of Noaxe and Tyaughton Creeks. The occurrence was sampled in 1941 by Ministry personnel but no further data are available.

MISSION MOUNTAIN (M22)

Type: Magnesite - ultramafic alteration
Minfile: 092JNE 128 NTS: 092J 16 Elevation: 1200 m
Latitude: 50°44'00"N Longitude: 122°14'00"W

Several bodies of magnesite or carbonatized serpentine are reported on the claims staked by a Mr. J.J. Devitt on Mission Mountain about 1940. The largest body is about 245 by 60 metres in size and is oxidized on surface to a maximum depth of 1 to 3 centimetres. Assay values are reported as about 3 per cent lime, 13 per cent iron and 40 per cent magnesite. The magnesite carries unaltered chromite as grains or small accumulations.

FERGUSON (M23)

Type: Magnesite - ultramafic alteration
Minfile: 092INW 091 NTS: 92I 14W Elevation: 750 m
Latitude: 50°56'00"N Longitude: 121°24'00"W

Late Paleozoic to Early Mesozoic serpentinized peridotite and pyroxenite in the Ferguson Creek area is host to numerous veinlets of silica in a porous and earthy material which contains some magnesite. The chemistry indicates low magnesia and high silica plus other insolubles.

Sample 'A' - stoney variety
Sample 'B' - porous & earthy variety

	MgO	CaO	Fe_2O_3	Insoluble
A	17.0	11.0	6.9	38.5
B	8.0	9.3	8.3	58.5

PINCHI LAKE (M24)

Type: Magnesite - ultramafic alteration + vein
Minfile: 093K 065 NTS: 093K 09 & 10 Elevation: 1067 m
Latitude: 54°39'40"N Longitude: 124°29'00"W

Carbonatization of serpentinites is widespread in the Pinchi Lake area. Carbonates are particularly well developed in the sheared and fractured zones associated with the Pinchi and Manson faults and in the numerous faults cutting the Trembleur ultramafic intrusions west of Middle River and Stewart Lake. Most of the faulted serpentinites have been altered to a buff, ankeritic carbonate, with associated cherty quartz and mariposite, which hosts a network of magnesite veinlets and quartz stringers up to 10 centimetres wide.

On the southwest face of Pinchi Mountain, Late Permian, serpentinized and steatized peridotites are in contact with limestones and quartzitic sediments of the Pennsylvanian-Permian Cache Creek Group along the Pinchi fault (Figure 11). Magnesite occurs as veins, 0.3 to 1.2 metres wide, and small lenses or irregular masses of magnesian carbonate veined by cherty quartz. It is best exposed on the cliff face on Pinchi Mountain where the ankeritic carbonate alteration contains 56.4 per cent $MgCO_3$, 16.1 per cent $CaCO_3$, 16.2 per cent $FeCO_3$ and approximately 12 per cent insolubles, mainly silica.

ANZAC (M25)

Type: Magnesite - ultramafic
Minfile: 092P 071 NTS: 092P 04E Elevation: 915 m
Latitude: 51°05'24"N Longitude: 121°34'00"W

Magnesite occurs as small white and grey angular fragments in overburden overlying Lower Paleozoic sedimentary and volcanic rocks. The occurrence is located on the slope south of Clinton Creek, about 1.2 kilometres southeast of Clinton. Small deposits of hydromagnesite occur in the valley bottom below the float occurrence (also see Clinton hydromagnesite).

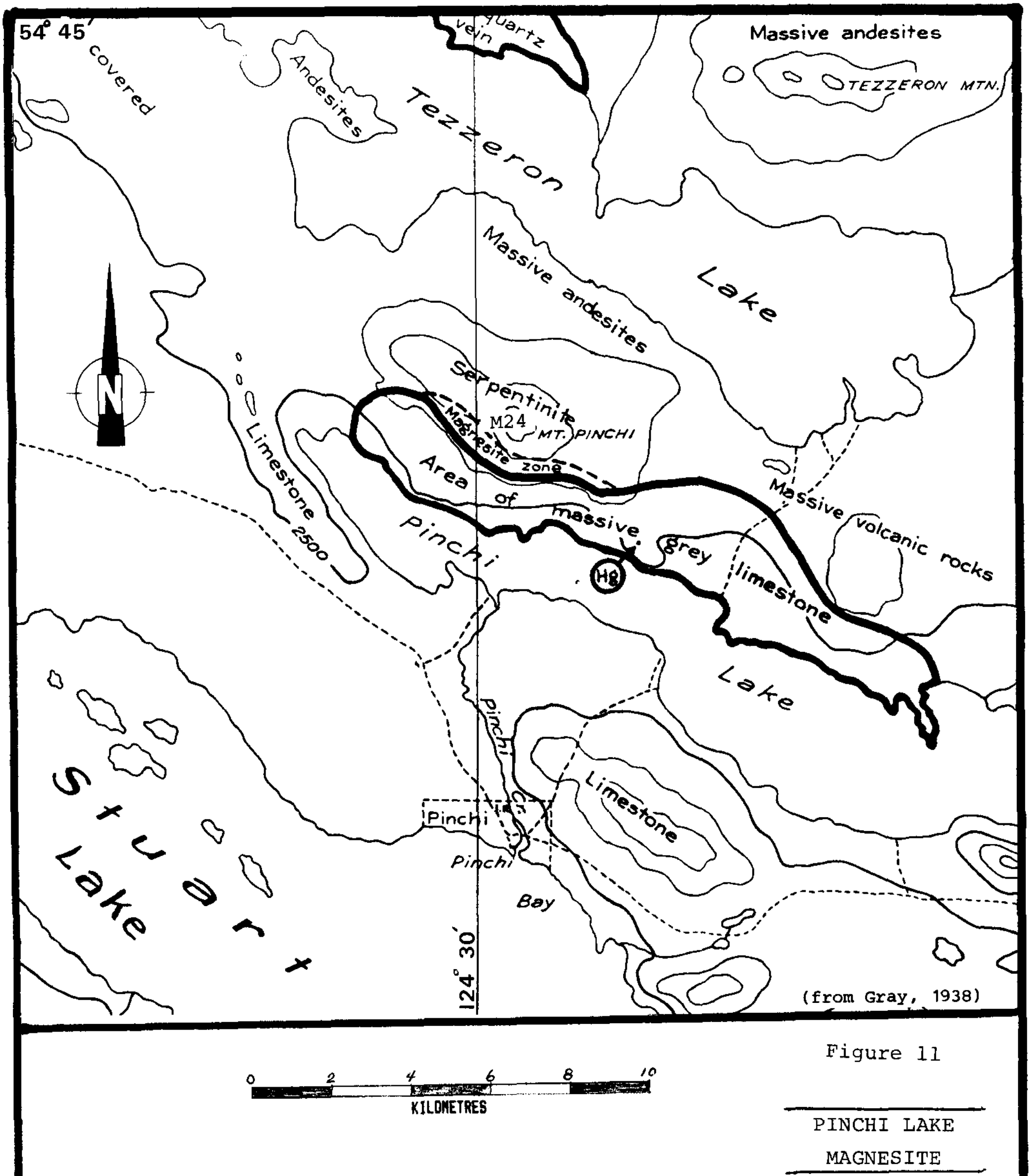


Figure 11

PINCHI LAKE MAGNESITE

ATLIN REGION

Magnesium carbonate occurrences in the Atlin area are generally associated with the Atlin ultramafic intrusions hosted by Pennsylvanian-Permian Cache Creek Group sedimentary and volcanic rocks. The magnesite forms a dense, white alteration phase of the ultramafics and usually has numerous late-stage quartz veins. In the Anaconda and Yellow Jacket occurrences quartz veins contain free gold and disseminated chalcopyrite. Pyrite is commonly reported as disseminations throughout the alteration zones. Fault or shear zones in the ultramafics are most prone to alteration and contain the larger deposits as they provide suitable channelways for the carbon dioxide rich fluids which are necessary in the alteration process. Active carbonated cold water springs are reported at a number of locations in the area.

RUBY MOUNTAIN (M26)

Type: Magnesite - ultramafic
Minfile: 104N 105 NTS: 104N 12 Elevation: 1300 m
Latitude: 59°42'00"N Longitude: 133°25'00"W

Small brown-weathering outcrops of magnesite are reported to occur in the drainage basins of Ruby, Birch and Boulder Creeks, north of Surprise Lake. The larger showings usually contain quartz veins and/or disseminated pyrite. Documentation of specific locations and geological character is poor.

PIKE (M27)

Type: Magnesite - ultramafic, vein
Minfile: 104N 103 NTS: 104N 12 Elevation: 700 m
Latitude: 59°21'40"N Longitude: 133°36'35"W

Cache Creek Group argillites (slates?) host a vein of white, compact, massive magnesite which contains about 10 per cent quartz. The occurrence is close to an exposure of an ultramafic intrusive which is about 3 kilometres northeast of the mouth of Pike River on Atlin Lake.

McKEE CREEK (M28)

Type: Magnesite - ultramafic alteration
Minfile: 104N 104 NTS: 104N 12 Elevation: 1280 m
Latitude: 59°28'30"N Longitude: 133°30'30"W

Brown-weathering outcrops of magnesite occur near the headwaters of McKee Creek, about 12 kilometres southeast of Atlin. Several small ultramafic plugs or stocks, intruding Cache Creek Group sediments, may be the source of the magnesite.

YELLOW JACKET (M29)

Type: Magnesite - ultramafic alteration
Minfile: 104N 043 NTS: 104N 12 Elevation: 885 m
Latitude: 59°35'50"N Longitude: 133°32'30"W

This occurrence lies about 10 kilometres east of Atlin on Pine Creek. The bedrock in the vicinity of the Yellow Jacket Crown Grant, Lot 191, is reported to be white crystalline magnesium carbonate. The extent of the carbonatized ultramafics is not documented, but a similar setting is noted on the Discovery Crown Grant, Lot 184, about 700 metres downstream. Small amounts of green chromiferous mica (fuchsite?) are associated with the carbonates and late-stage quartz veins are reported to carry minor magnesite and some free gold (Figure 12).

ANACONDA (M30)

Type: Magnesite - ultramafic alteration
Minfile: 104N 046 NTS: 104N 12 Elevation: 670 m
Latitude: 59°34'00"N Longitude: 133°42'00"W

A broad band of magnesium carbonates, greater than 300 metres wide, is associated with dunites and serpentinites of the Atlin ultramafic intrusion about a kilometre south of the town, near the lakeshore. The magnesite is cut by narrow quartz veins, stringers and lenses. Very minor gold associated with fuchsite is reported to occur in the veins and the main mass of carbonate alteration.

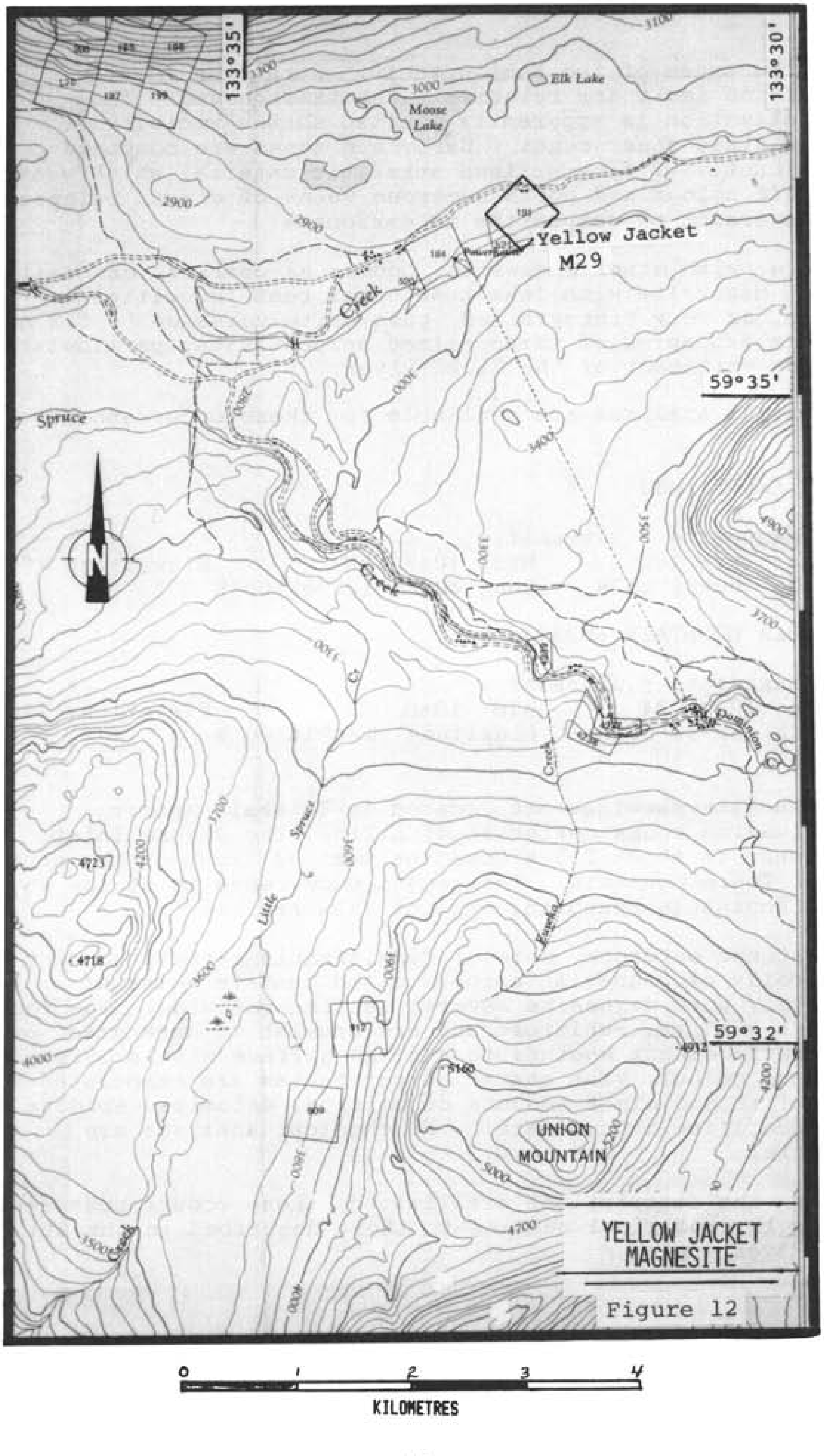
An analysis of the carbonate zone (1899) indicated 21.7 per cent magnesia, 27 per cent carbonic acid, 45.7 per cent silica, 5.1 per cent iron and 0.5 per cent loss-on-ignition plus water.

SLOKO RIVER (M31)

Type: Magnesite - ultramafic, shear zone alteration
Minfile: 104N 083 NTS: 104N 03 Elevation: 775 m
Latitude: 59°05'00"N Longitude: 133°15'00"W
Alias: Nahlin fault

Pennsylvanian-Permian Cache Creek Group rocks are in contact with Mesozoic and older strata along the Nahlin fault which parallels the Sloko River. Immediately northeast of the Nahlin fault, the Mount O'Keefe ultramafic intrudes the Cache Creek Group and is in fault contact with younger Laberge Group sediments and volcanics to the southwest. The northern margin of the ultramafic body exhibits both fault and intrusive contact relationships with Cache Creek Group volcanics and sediments.

A zone of carbonatized serpentinite, in the order of 100 metres wide, is exposed for over 30 kilometres within the ultramafics



YELLOW JACKET MAGNESITE

Figure 12

along the trace of the Nahlin fault. Strata on the southwest side of the fault are relatively unmetamorphosed. The carbonatization is apparently limited to the vicinity of serpentinized shear zones. Carbonate zones are composed predominantly of fine-grained ankeritic material which weathers to a buff colour and hosts numerous veins of quartz released by the conversion of serpentine to carbonate.

Dolomite, with minor magnesite, occurs as coarsely crystalline veins. Magnesite with less than 5 per cent impurities is present, as very fine-grained, pure white veins up to 1.2 metres wide, in exposures of carbonatized serpentinite, particularly in the area northeast of the Sloko River.

No chemical analyses are available for these occurrences.

GRAHAM INLET (M32)

Type: Magnesite - ultramafic
Minfile: 104N 102 NTS: 104N 12W Elevation: 760 m
Latitude: 59°38'00"N Longitude: 133°57'00"W

PENINSULA MOUNTAIN (M33)

Type: Magnesite - ultramafic
Minfile: 104M 034 NTS: 104M 09E Elevation: 730 m
Latitide: 59°49'00"N Longitude: 134°14'00"W

Two magnesite showings are located in Triassic and/or Pennsylvanian rocks northeast of Atlin. The Graham Inlet occurrence is about 5.5 kilometres west of Taku, on the south side of Table Mountain. The second occurrence is at the south end of Peninsula Mountain, east of Taku Arm.

Carbonatized outcrops, some of considerable extent, consist principally of magnesian carbonate and contain veins of relatively pure magnesite several centimetres wide. The rocks are fine grained, schistose and are greyish to dark green on fresh surfaces but weather to a rough surface with a bright gossanous colour. The magnesian carbonates are associated with plagioclase and minor amounts of calcite, dolomite, epidote and an unidentified iron mineral. No chemical analyses are available.

Although the descriptions are limited, these occurrences seem similar in geological setting to those described in the Atlin and Sloko River areas.

ST. JOSEPH'S MISSION (M38)

Minfile: 093A 157 NTS: 093A 04W Elevation: 700 m
Latitude: 52°04'00"N Longitude: 121°56'20"W
Alias: William's Lake

A group of 24 mineral claims was located near St. Joseph Mission, about 22.5 kilometres southeast of Williams Lake, by the B.C. Magnesium Co. Ltd. about 1940. A ridge of serpentinized Cache Creek Group rocks was tested by about 370 metres of diamond drilling in 1941. Drilling confirmed the presence of serpentine in a zone measuring 915 by 1370 metres and extending to a depth of about 60 metres but the extent of magnesian carbonate alteration was not reported.

ULTRAMAFIC LATERITIC MAGNESITE OCCURRENCES

BONAPARTE RIVER (M34)

Type: Magnesite - ultramafic, lateritic alteration
Minfile: 092P 082 NTS: 092P 03W Elevation: 730 m
Latitude: 51°07'48"N Longitude: 121°28'30"W
Alias: Mond Ranch, White Rock

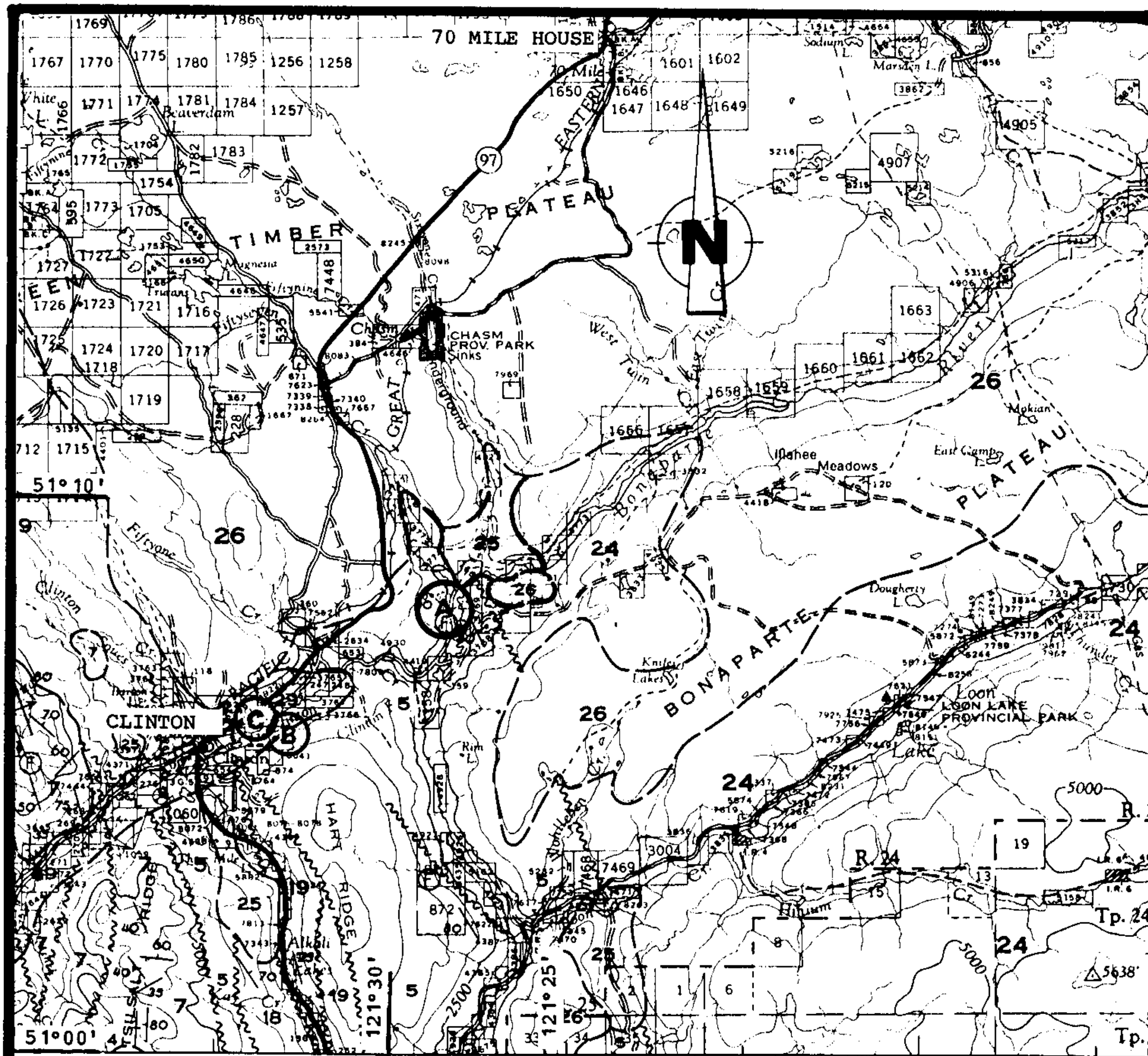
The Bonaparte River magnesite occurrence is located on the west slope of the Bonaparte River between Clinton and Fiftyseven Creeks and approximately 9 kilometres northeast of the town of Clinton (Figure 13).

Magnesite occurs as a surface alteration zone, 1 to 1.5 metres thick, associated with the Permian-Triassic Mika ultramafic body. Dunites and peridotites form a sill-like intrusive, trending 340 degrees, within the Lower Permian metavolcanics and metasediments of the Cache Creek Group. Magnesium carbonate is best developed in a broad, northwest-trending zone about 600 metres wide by 2500 metres long on the northeast margin of the intrusive. Although the main showing is to the west of the Bonaparte River, ultramafics with magnesite have also been identified to the east.

The ultramafic intrusions are zoned dunites and peridotites which are highly serpentinized and in places completely steatized. They are medium grained, light to dark green on fresh surfaces and weather to a green or reddish green. Magnesium carbonate alteration occurs preferentially in the dunites but there is a gradation from serpentinization and steatization with remnant pyroxene and olivine, to a compact cryptocrystalline, bone-white magnesite with no cleavage and a conchoidal fracture. In the early alteration stages brown ankeritic carbonates, possibly hydrous iron oxides, grains of magnetite, small veinlets of asbestos and black streaks of what may be manganese are common. Further alteration results in the appearance of small grains and masses of magnesite and associated ankeritic carbonates, within the serpentinized zones. In the most advanced alteration, usually near surface, magnesite replaces all serpentine and ankeritic carbonate and small, relatively pure veinlets of magnesite crosscut the alteration.

Analysis of the Bonaparte River occurrence indicates 97.8 per cent $MgCO_3$, 1.8 per cent $CaCO_3$ and 0.4 per cent Fe_2O_3 with no alumina and only traces of insolubles. This sample was apparently collected from a surface exposure (1931).

The ultramafics are also known to carry chromite as grains, small pods and veinlets within the dunitic units and locally within the magnesite. An area of about 150 by 450 metres immediately west of the magnesite showing contains variable amounts of chrome (Cr_2O_3) up to about 42 per cent and the occurrence has been



TERTIARY

MIOCENE AND/OR PLIOCENE

26 Plateau lavas, basalts, andesites

MIOCENE

25 Shale, sandstone, tuffs conglomerate, breccia

EOCENE

24 Kamloops Group

Skull Hill Formation - dacite, trachyte basalt, andesite, rhyolite

TRIASSIC AND/OR EARLIER

8 Serpentinites, serpentinized peridotites, dunites

LOWER PERMIAN

5 Cache Creek Group

Metavolcanics & metasediments

(from Campbell & Tipper, 1965)

A. Bonaparte River M34

B. Anzac M25

C. Clinton Hydromagnesite H2

0 5 10

Kilometres

Figure 13

BONAPARTE RIVER MAGNESITE

explored at various times, for its magnesite, asbestos and chrome potential.

OTHER MAGNESITE OCCURRENCES

Crystalline magnesite has also been reported from the following areas but there is little or no documentation to validate the occurrences:

SINCLAIR MILLS	(M35)	NTS: 93I	Lat: 54°03'00"	Long: 121°41'00"
ILLECILLEWAET	(M36)	NTS: 82N	Lat: 51°11'00"	Long: 117°45'00"
INVERMERE	(M37)	NTS: 82K	Lat: 50°31'00"	Long: 116°02'00"

BRUCITE OCCURRENCES IN BRITISH COLUMBIA

ATLIN ROAD (B1)

Type: Brucite - contact metamorphosed carbonate
Minfile: 104N 081 NTS: 104N 13W Elevation: 762 m
Latitude: 59°59'00"N Longitude: 133°47'30"W

Coast Range granitic intrusions of Jurassic age are the dominant rock type along the northeast side of Atlin Lake. Immediately south of the Yukon border and east of the Atlin Road high magnesian limestones of the Cache Creek Group have been thermally metamorphosed at their contact with the Black Mountain granite. Brucitic marble is associated with the contact metamorphic zone.

HURRICANE CREEK (B2)

Type: Brucite - contact metamorphosed carbonate
Minfile: 104N 082 NTS: 104N 08W Elevation: 1525 m
Latitude: 59°20'50"N Longitude: 132°26'00"W

Limestone and limestone breccias of the Cache Creek Group are thermally metamorphosed at the contact with Jurassic Mount McMaster granitic intrusions. Marble containing brucite is associated with the contact alteration zones in the area east of Hurricane Creek and south of Hayes Peak.

WEST REDONDA ISLAND (B3)

Type: Brucite - contact metamorphosed carbonate
Minfile: 092K 002 NTS: 092K 07W Elevation: 5 m
Latitude: 50°17'18"N Longitude: 124°51'00"W

The granitic intrusions of the Coast Plutonic Complex contain inclusions or roof pendants of limestone at various locations along Georgia Strait. The limestones are generally of limited extent and may belong to either the Permian Marble Canyon Formation and/or the Upper Triassic Quatsino Formation.

Two limestones, each about 30 metres wide, are exposed along the shore about 1.2 kilometres west of Gloucester (George) Point on West Redonda Island. The showings are about 100 metres northwest of the west corner of Lot 3439 and other smaller occurrences are exposed less than a kilometre to the west and northwest.

The more easterly of the two limestones was quarried in the 1920s and is exposed from sea level to over 200 metres elevation. It is bounded by a green-coloured rock which is in turn enclosed by a light-coloured, hornblende granite. The limestone is medium to coarse grained, white and grey with a mottled texture locally. A shear-related lamination occurs within a section of white limestone.

Brucite occurs as granules (1 to 3 millimetres) within alteration zones, particularly in the eastern margin of the limestone, where it constitutes about 30 per cent of the rock. Brucite grains have a concentric structure and most are surrounded by white dolomite within a calcite matrix. Tiny rounded serpentine grains constitute the main impurity although much of the brucitic limestone is free of it. Brucite alters to white hydromagnesite which readily dissolves and leaves a typically pitted surface. Brucitic limestone exposed to seawater is prone to having the calcite groundmass dissolved leaving brucite standing out in relief.

In 1944 Goudge collected sample 23 across the entire width of the quarry including the brucitic and non-brucitic limestone. Sample 23A was collected across about 6 metres of brucitic limestone:

	MgO	CaO	Fe_2O_3	Al_2O_3	SiO_2	CO_2	Water +105 C
Sample 23	9.22	46.27	0.32	0.22	1.28	39.94	2.94
Sample 23A	20.50	37.21	0.18	0.05	0.48	34.60	6.48

TLUPANA ARM (B4)

Type: Brucite - contact metamorphosed carbonate
Minfile: 092E 061 NTS: 092E 16W Elevation: 150 m
Latitude: 49°46'00"N Longitude: 126°29'30"W

Northwest-trending Upper Triassic Quatsino limestones and dolomites are exposed for over 1.5 kilometres along Deserted Creek. The Quatsino Formation is intruded by granitic plugs and stocks of the Jurassic-Cretaceous Coast intrusions.

About 1 kilometre southeast of the limestone quarry on Deserted Creek, hard dolomitic bands are exposed containing numerous scattered spots up to 5 millimetres in diameter. The spots contain crystals or crystalline aggregates which appear dark on fresh surface. The material is more soluble than the host rock and weathers to a white fibrous residue which is left in cavities or pits on the dolomite surface.

Goudge (1944) interprets the material as brucite which is a common component in contact-metamorphosed dolomites and which may be fibrous with anomalous birefringence in thin section. Parks (1917) reports similiar characteristics for the Tlupana Arm mineral.

KENNEDY LAKE (B5)

Type: Brucite - contact metamorphosed carbonate
Minfile: 092F 431 NTS: 092F 04E Elevation: 300 m
Latitude: 49°02'00"N Longitude: 125°30'15"W

Upper Triassic Quatsino Formation calcareous sediments are exposed along the south shore of Kennedy Lake and the north slope of Salmonberry Mountain. The Upper Quatsino limestones are thoroughly recrystallized to a medium or very coarse grain size and have been bleached white from a normal grey colour. Limited exposures suggest the upper limestone may form part of a southwest-plunging syncline which has been truncated by Coast Intrusions on the northeast slope of Salmonberry Mountain (Figure 14).

In general the limestones are fairly pure. Normally the units contain some rounded grains of quartz and locally a few grains of ankerite(?). Plates and nodules of brucite are developed within the altered limestones near intrusive contacts.

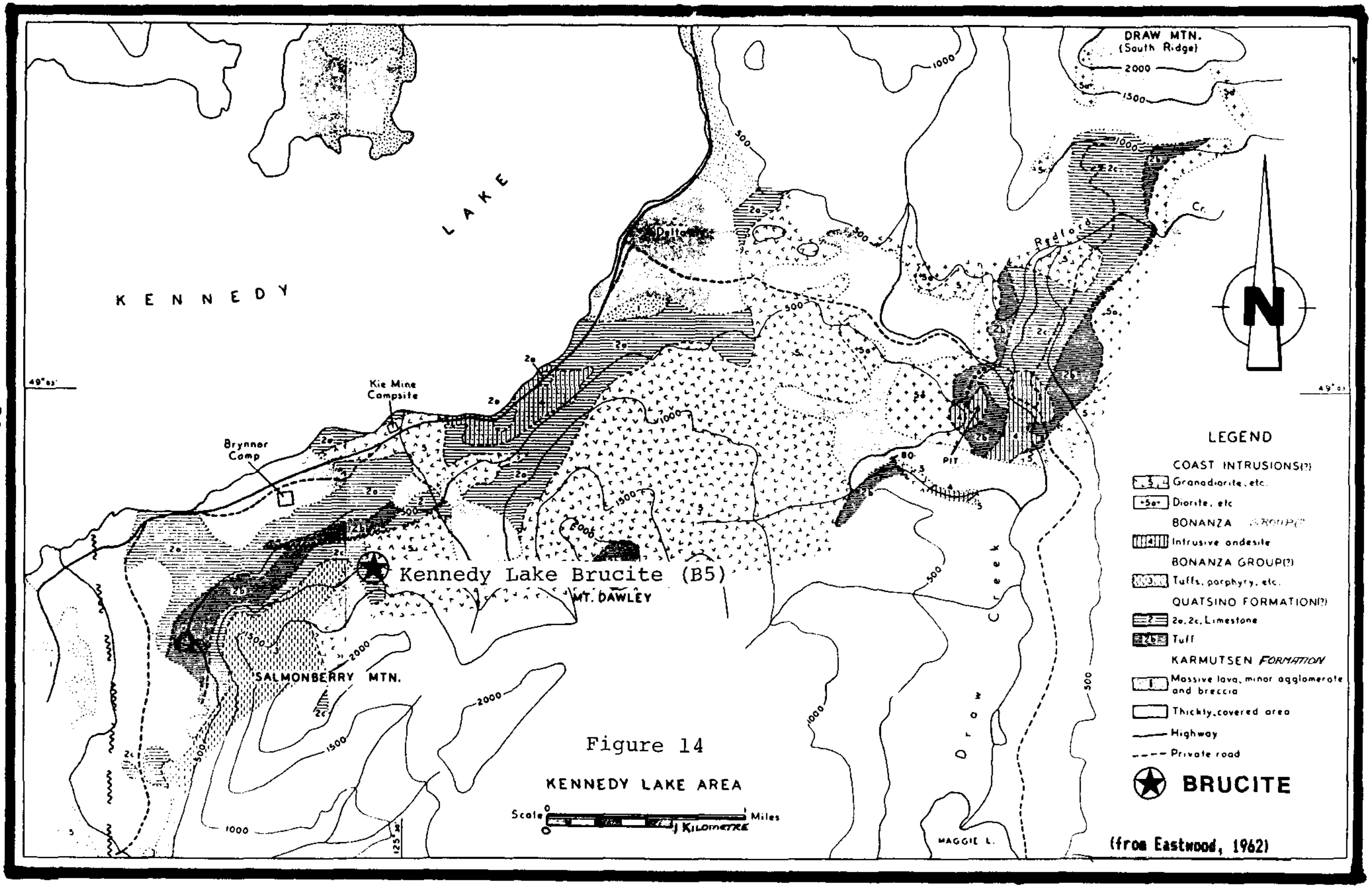


Figure 14

KENNEDY LAKE AREA

HYDROMAGNESITE OCCURRENCES IN BRITISH COLUMBIA

ATLIN (H1)

Type: Hydromagnesite
Minfile: 104N 079 NTS: 104N 12E Elevation: 685 m
Latitude: 59°34'55"N Longitude: 133°41'10"W

Accumulations of hydromagnesite are located within topographic lows immediately east of Atlin. In addition to the two main bodies, a number of small, isolated patches of hydromagnesite occur along the lakeshore in the vicinity of Atlin.

The largest deposit covers about 7.3 hectares to an average depth of 80 centimetres and has several smaller satellite bodies. It is located northeast of Atlin, north of the airfield road in a slight depression which opens northwest to a swampy area (Figures 15 and 16)

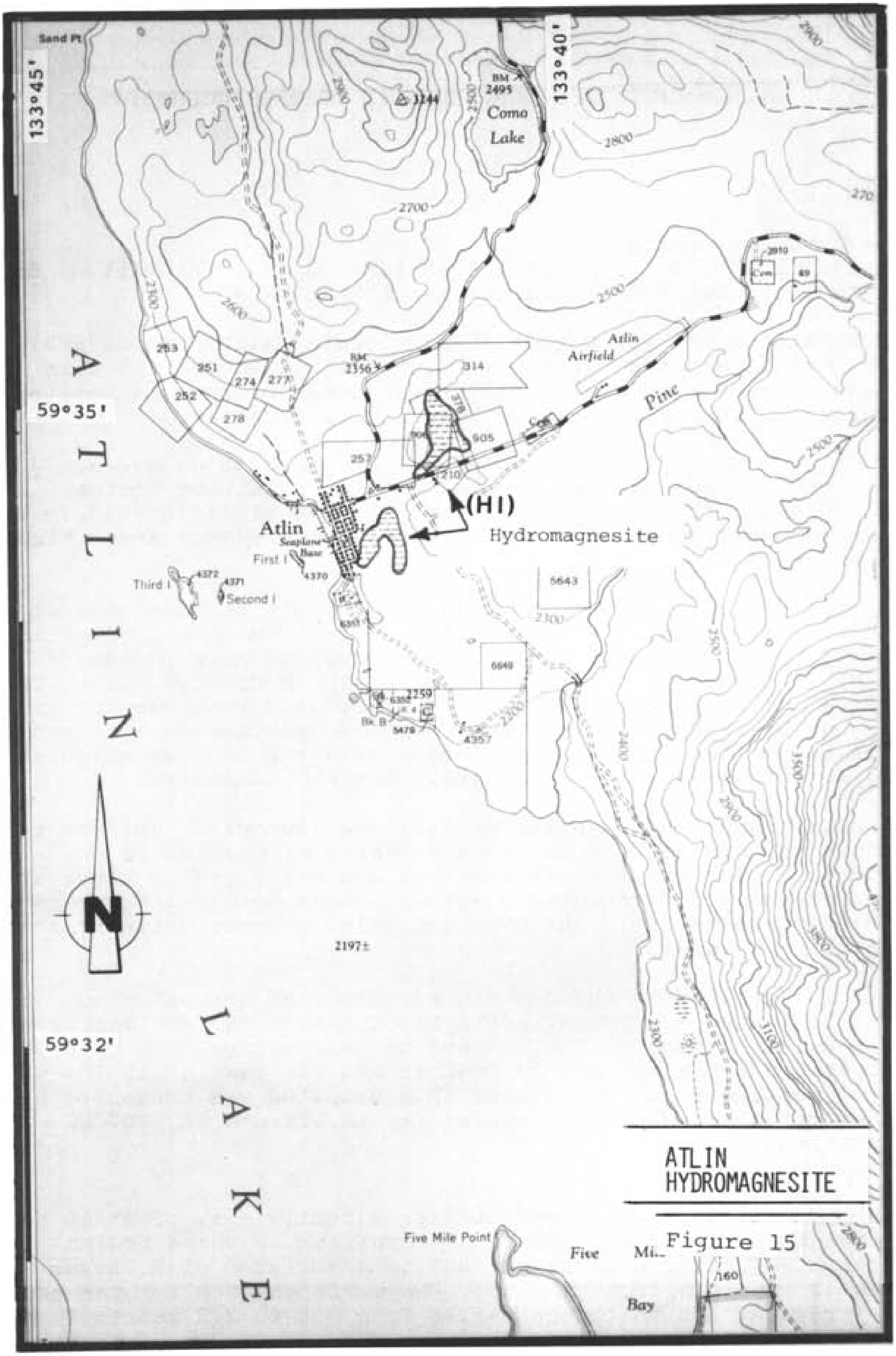
Glacio-fluvial materials underlie the deposit and the contact with the underlying clay-like soil and grit is sharp. Near the base of the deposit the hydromagnesite may be more porous and is cut by irregular vein-like films of glassy hydromagnesite. The surface of the deposit is slightly raised and hummocky and is crosscut by cracks and fractures up to 3 centimetres wide and 1 metre deep. The bodies are relatively barren of vegetation and have slightly irregular but sharply defined boundaries.

The hydromagnesite is white, powdery and remarkably uniform in texture and composition, with no evidence of bedding or structure. The white surface colour assumes a yellow tinge at a depth of about 30 centimetres although this colour disappears with exposure to air. The hydromagnesite becomes quite plastic, like clay, when wet.

Two holes drilled in the deposit were sampled and analysed. Hole No. 1 indicated a hydromagnesite thickness of 66 centimetres and was sampled at depths of 8, 33 and 58 centimetres. Hole No. 2 indicated a thickness of 1.07 metres and was sampled at 10, 42 and 71 centimetres. Results of this sampling are presented below as analytical results for samples 1A, 1B, 1C and 2A, 2B, 2C respectively.

A second hydromagnesite deposit lies directly east of Atlin and southwest of the main deposit. It consists of three bodies within topographic depressions and is associated with larger areas of impure hydromagnesite. The surfaces of all three bodies are irregular and thickness varies from 0.3 to 2.2 metres.

The first body covers an area of 1.8 hectares with a thickness varying from 0.3 to 1.5 metres and averaging about 1 metre.



Scale 1:50,000
1.25 Inches to 1 Mile approximately

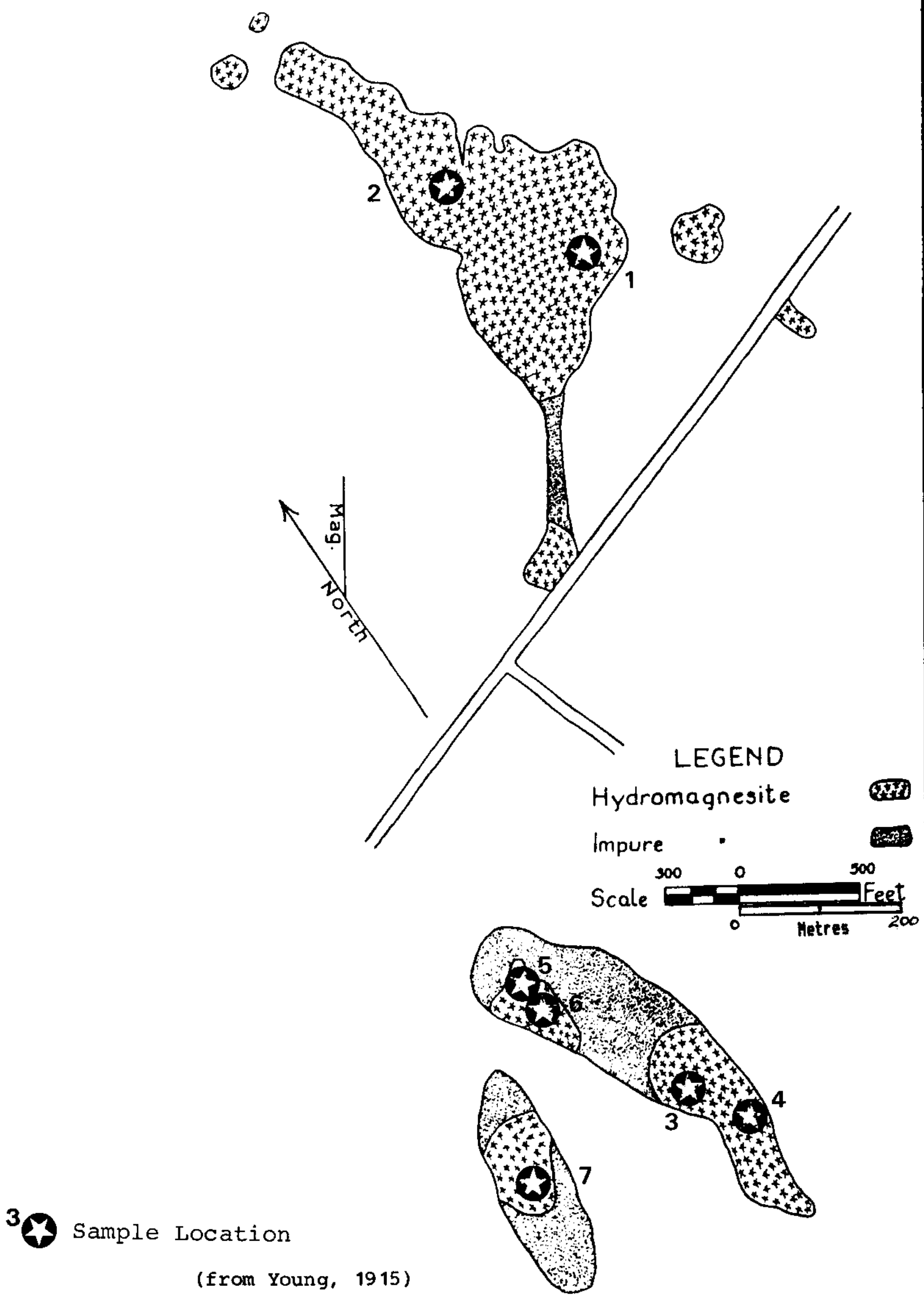


Figure 16

ATLIN HYDRO MAGNESITE

Sample 3 was collected at a depth of 53 centimetres near the centre of the body. Sample 4 was collected at a depth of 41 centimetres, about 30 metres from site 3.

The second body is northwest of the first. It covers an area of 0.3 hectare with a variable thickness from 1 to 2.1 metres averaging 1.5 metres. Near the northeast corner of this deposit the thickness is about 1.7 metres and Sample 5 was collected from a depth of 46 centimetres. The material is partly granular and somewhat clay-like with walnut-sized or smaller pieces of hardened hydromagnesite. Sample 6 is a surface sample where the thickness of the deposit is greater than 1.8 metres.

The third body covers an area of 0.4 hectare with a thickness of 0.3 to 1.0 metre. Sample 7 was collected about 10 centimetres above the base of the deposit at a depth of 51 centimetres. The material sampled is compact and cut by microveinlets of hydrous magnesium carbonate.

The Atlin deposits, in total, are estimated to contain in the order of 116 thousand tonnes of material containing over 41 per cent MgO with less than 3 per cent combined CaO, Al_2O_3, Fe_2O_3 and SiO_2. Several hundred tonnes were mined and shipped to the USA between 1904 and 1915.

Analysis of Hydromagnesite - Atlin Deposits

Sample No.	Deposit Thickness metres	Sample Depth cm	MgO	CaO	SiO_2	CO_2	Al_2O_3	Fe_2O_3	FeO	H_2O
1A	0.66	8	41.13	2.04	1.86	35.98	0.67	0.15	0.60	18.02
1B	0.66	33	42.35	0.82	0.90	36.10	0.10	0.09	0.45	18.95
1C		58	42.19	0.68	0.54	36.17	0.17	0.11	0.64	19.05
2A	1.07	10	40.56	1.26	1.22	35.96	0.67	0.18	0.63	19.04
2B		42	41.93	1.50	1.96	36.04	0.14	0.45	0.65	17.66
2C		71	35.23	6.44	9.22	37.70	0.94	0.73	0.78	8.20
3	1.00	53	42.85	0.32	0.74	36.35	0.35	0.15	0.66	19.10
4	1.00	41	38.94	0.42	3.48	34.31	2.85	0.56	0.81	18.10
5	1.73	46	43.04	0.16	0.96	36.21	0.23	0.12	0.53	19.26
6	>1.83	Surface	43.45	0.26	0.62	36.23	0.41	0.09	0.36	18.95
7	0.61	51	42.12	0.48	1.18	35.89	0.33	0.10	0.71	19.42

(analysis from Young, 1915)

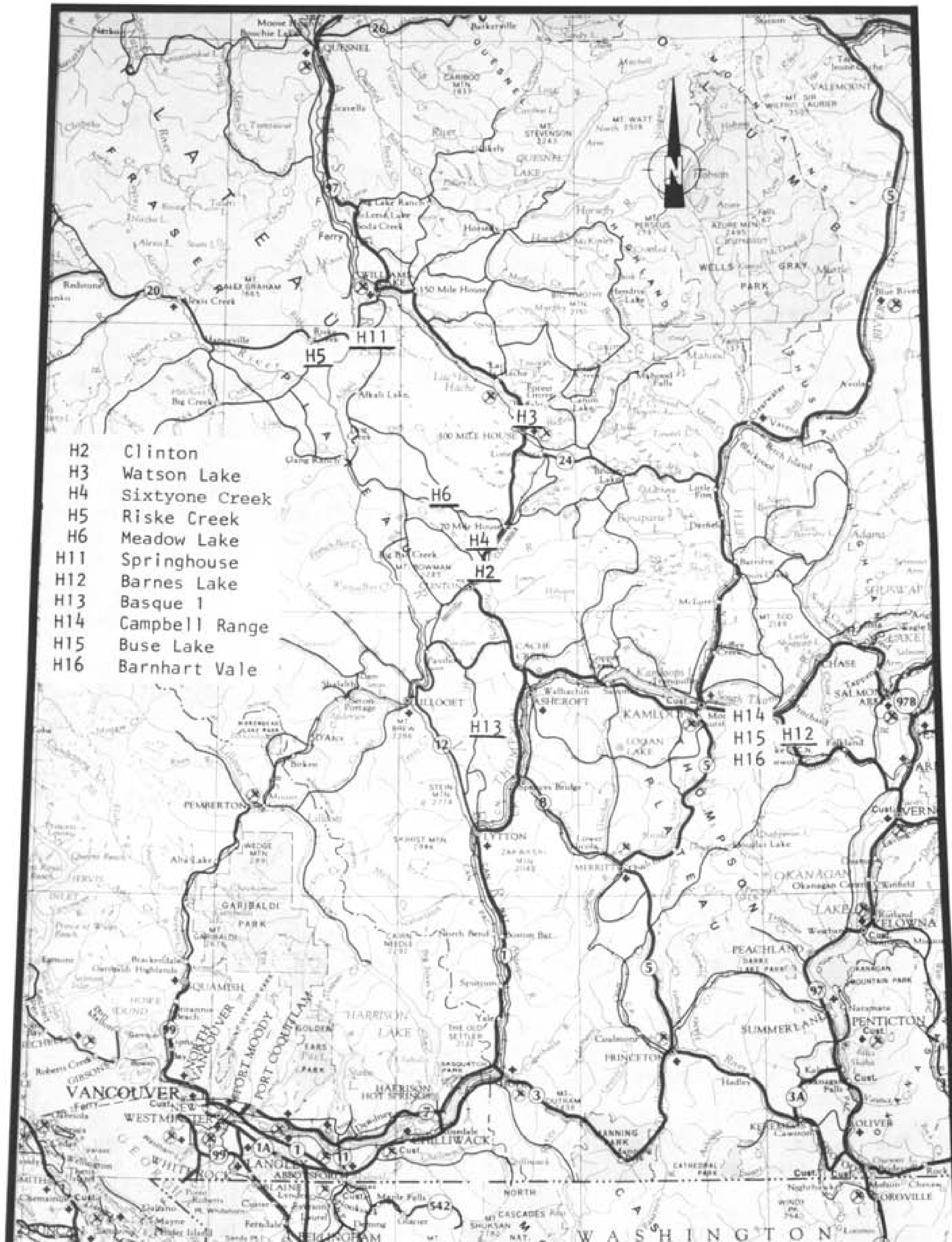

H2 Clinton
H3 Watson Lake
H4 Sixtyone Creek
H5 Riske Creek
H6 Meadow Lake
H11 Springhouse
H12 Barnes Lake
H13 Basque 1
H14 Campbell Range
H15 Buse Lake
H16 Barnhart Vale
SCALE - 1:2,000,000
Kilometres 20 0 20 40 60 80 100 120 140 160 180 200
VANCOUVER
WASHINGTON
QUESNEL
KAMLOOPS
LILLOOET
LYTTON
MERRITT
PRINCETON
PENTICTON
CHILLIWACK
PEACHLAND
SUMMERLAND
LOCATION MAP
HYDROMAGNESITE
CENTRAL B.C.

Figure 17

CLINTON (H2)

Type: Hydromagnesite
Minfile: 092P 072 NTS: 092P 04E Elevation: 870 m
Latitude: 51°04'35"N Longitude: 121°35'00"W

Three small areas of hydromagnesite occur about 1 kilometre east of Clinton in the valley of Clinton Creek. The three pure hydromagnesite deposits, within a larger area of impure hydromagnesite, cover a combined area of about 0.28 hectare. The material is 0.6 to 1.4 metres thick and is underlain by a brown hydromagnesite to a depth of about 1.5 metres. Sand and clay underlie the deposit.

Sample 1 (Reinecke, 1920) was collected from 0 to 61 centimetres from one of the three occurrences. Samples 2, 3 and 4 (Reinecke, 1920) were collected from the hillside above and to the southeast of the hydromagnesite and indicate the probable source of the mineral is within the actinolite schist and carbonaceous argillites of the Cache Creek Group.

	MgO	CaO	CO_2	SiO_2	Al_2O_3	Fe_2O_3	SO_2	H_2O +105	H_2O -105
1	41.60	0.22	35.88	2.30	0.63	0.13	0.36	17.53	1.12
2	2.49	23.04	14.64	42.00	1.75	2.25	6.29	3.73	3.62
3	2.39	3.30	2.52	77.54	3.87	4.04	0.51	3.82	1.97
4	3.33	13.84	10.44	60.10	2.62	2.69	1.37	3.07	1.76

#1 - Area 3, 0 to 61 centimetres depth
#2,3,4 - on hillside above hydromagnesite

WATSON LAKE (H3)

Type: Hydromagnesite
Minfile: 092P 077 NTS: 092P 11W Elevation: 885 m
Latitude: 51°42'05"N Longitude: 121°20'50"W
Alias: White Empress, Exeter, 108 Mile House

Several deposits of hydromagnesite, with some associated impure hydromagnesite, are located in a swampy depression about 500 metres to the southwest of Watson Lake and about 1.5 metres above the lake level.

The larger area, to the west, measures about 200 by 60 metres along a northeast trend. It has a variable depth up to about 2.2 metres and is underlain by dark grey mud. The hydromagnesite has a white surficial layer which varies between 50 and 100 centimetres thick with an average of about 58 centimetres. Underlying the upper layer is a cream to brown hydromagnesite with a higher calcium content, in the order of 1.5 metres thick.

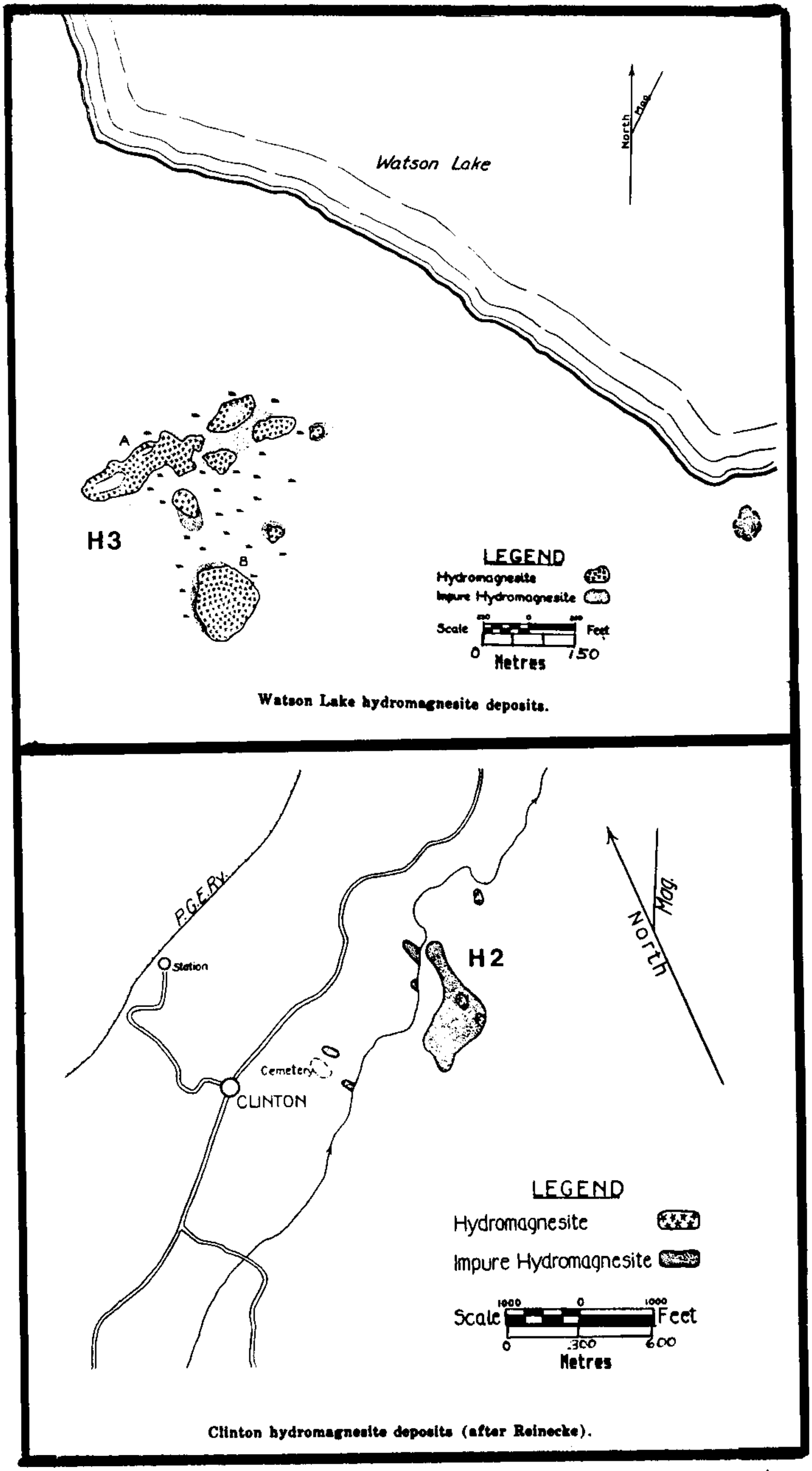


Figure 18 from: Cummings, 1940

Sample 1 (Reinecke, 1920) is of 66 centimetres of white hydromagnesite and part of the cream-coloured layer.

The second significant area is about 180 metres southeast of the first. The white surface layer is about 1 metre thick with fairly pure material to depths of 0.9 to 1.5 metres. Sample 2 is of white hydromagnesite collected from 0 to 92 centimetres from surface.

Sample 3 (Cummings, 1940) is a composite sample of white hydromagnesite collected from seven drill holes representing all deposits in the Watson Lake occurrence. Sample 4 (Reinecke, 1920) was collected from a small isolated patch of hydromagnesite located about 1.5 kilometres northeast of the main occurrence. It is estimated that, in total, the Watson Lake deposits cover an area of approximately 2 hectares and contain slightly more than 20 thousand tonnes of hydromagnesite.

	MgO	CaO	CO_2	SiO_2	Al_2O_3	Fe_2O_3	H_2O (+105)	H_2O (-105)
1	41.06	1.62	38.04	6.36	0.20	0.12	11.25	1.32
2	43.17	1.14	43.64	4.62	0.16	0.16	5.26	1.42
3	39.40	2.10	50.5	5.70	-> 1.30	<-	-	-
4	36.70	1.54	31.08	8.62	0.33	0.57	14.86	2.21

SIXTYONE CREEK(H4)

Type: Hydromagnesite
Minfile: 092P 078 NTS: 092P 05E Elevation: 1095 m
Latitude: 51°15'50"N Longitude: 121°30'55"W

Several deposits of hydromagnesite are located within a swampy area in the headwaters of Sixtyone Creek about 3 kilometres east of Goose Lake. The deposits adjoin a small swampy lake in a depression between low hills.

White hydromagnesite, with what is described as a typical cauliflower-like surface texture, covers about 1.1 hectares. The material has been pitted to a depth of 30 centimetres, but no data are available to indicate total thickness or the character of the underlying material.

Analysis of Three Surface samples:

	MgO	CaO	Fe+Al	SiO_2	H_2O	CO_2	H_2O+CO_2
1	38.00	1.6	1.7	9.80	16.0	32.9	-
2	34.4	1.76	0.69	11.60	-	-	48.16
3	32.75	3.32	0.67	12.40	-	-	47.74

RISKE CREEK (H5)

Type: Hydromagnesite
Minfile: 092O 087 NTS: 092O 15E Elevation: 930 m
Latitude: 51°58'25"N Longitude: 122°33'30"W

Deposits of hydromagnesite lie in low, swampy terrain along the Riske Creek drainage and south of the Chilcotin Road within Lots 178 and 1188. The deposit to the west, on Lot 1188, is estimated to cover about 0.65 hectare. White hydromagnesite is present to depths of 60 to 90 centimetres below which the material grades to a brown clayey soil. Sample 1 (Reinecke, 1920) was collected from the eastern end of this deposit from a depth of 0 to 66 centimetres. Sample 2 (Cummings, 1940) is a composite sample from five drill holes at various locations within the deposit and from 0 to 90 centimetres depth.

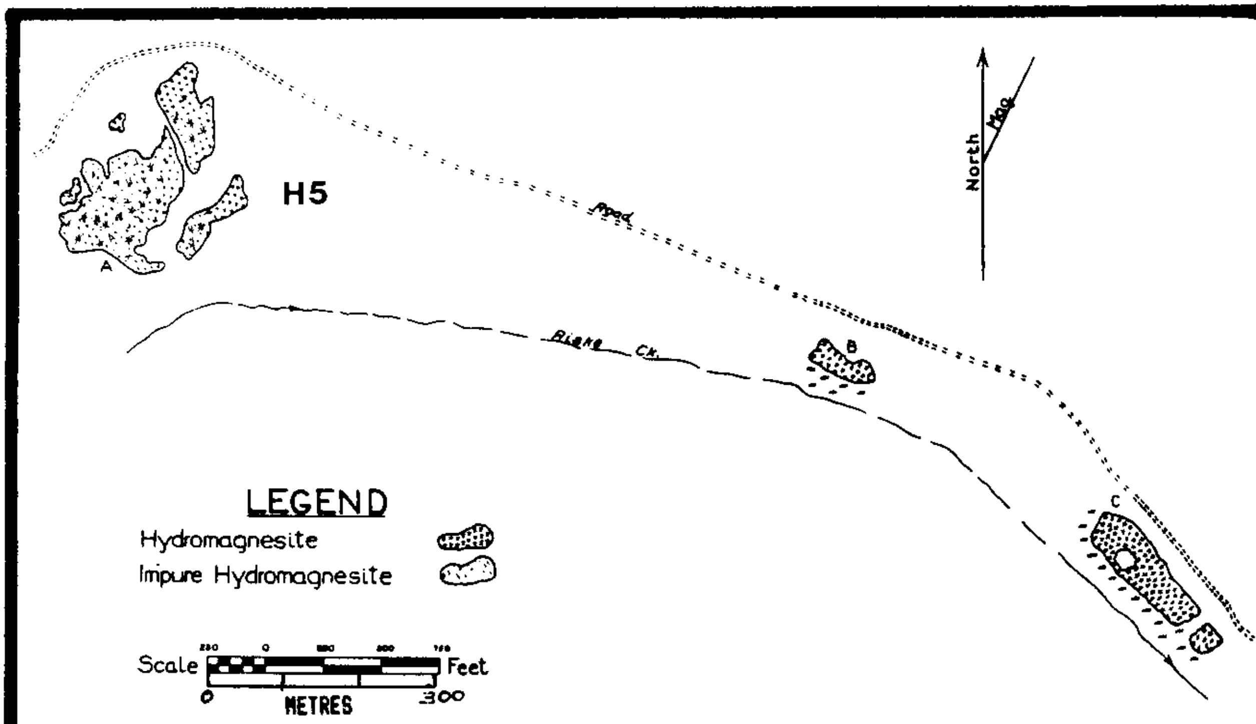
The eastern deposit, on Lot 178, estimated to cover about 0.8 hectares, is a white to cream-coloured hydromagnesite to a depth of 84 centimetres. Below this the material grades into a brown clay. Sample 3 (Reinecke, 1920) was collected from 0 to 61 centimetres from the centre of the deposit on Lot 178.

	MgO	CaO	CO_2	SiO_2	Al_2O_3	Fe_2O_3	FeO	SO_3	H_2O +105	H_2O -105
1	41.14	0.10	37.70	1.22	0.48	0.25	0.09	0.08	17.78	1.28
2	42.3	0.7	41.9	4.4	-> 1.0 <-		-	-	9.2	
3	41.74	0.17	40.85	1.85	0.48	0.20	0.16	0.11	12.98	1.67

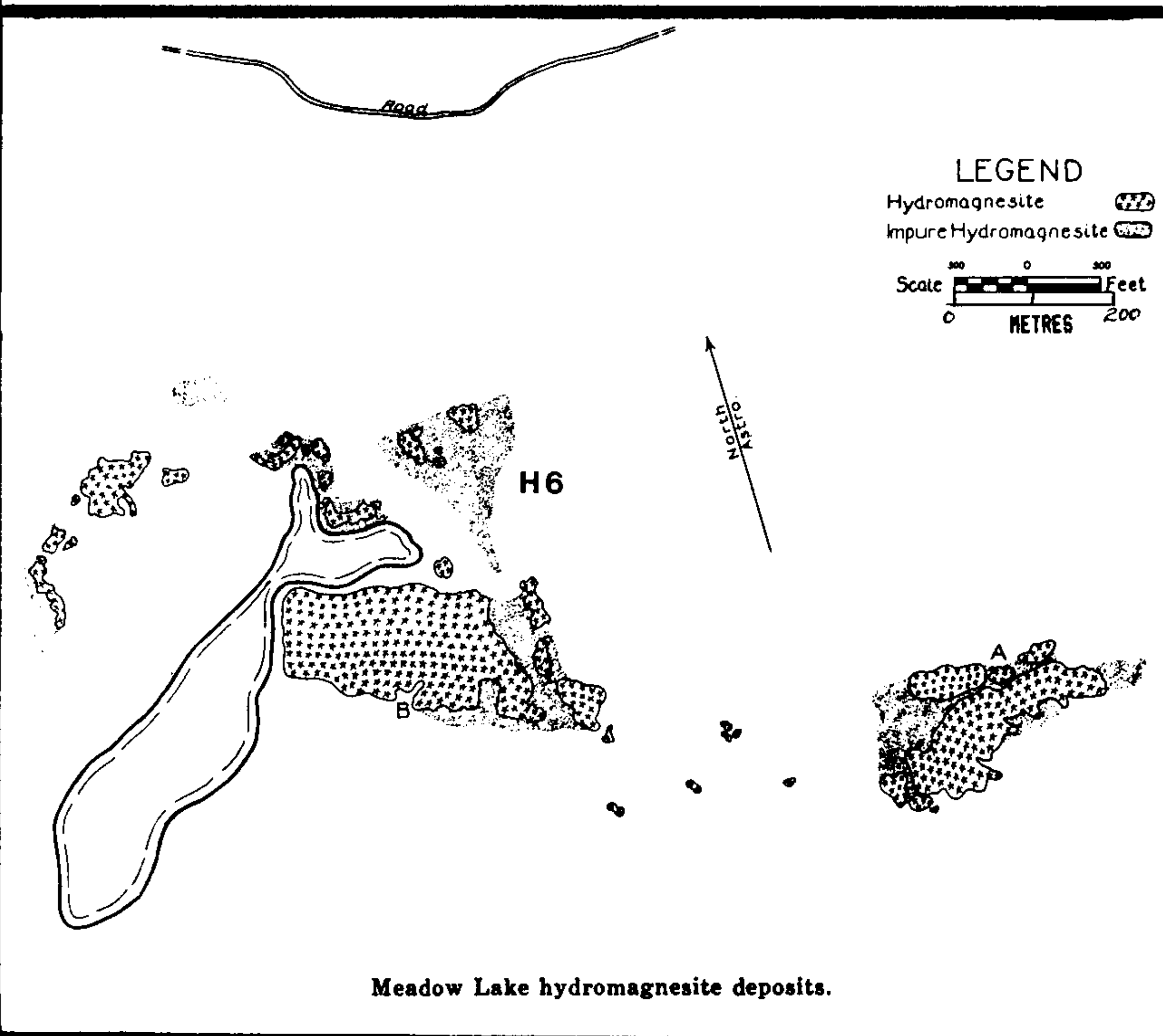
MEADOW LAKE (H6)

Minfile: 092P 074 NTS: 092P 05E Elevation: 1083 m
092P 075
092P 076
Latitude: 51°21'40"N Longitude: 121°42'57"W

The Meadow Lake hydromagnesite deposits lie south of the Clinton-Dog Creek highway along a westerly trend in the low swampy terrain east of Meadow Lake. The deposit consists of two main occurrences with numerous smaller patches of pure and impure hydromagnesite. All occurrences have irregular outlines and a typical cauliflower-like surface which is raised 10 to 60 centimetres above the surrounding swamp. The impure hydromagnesite occurrences have a flat, cracked surface of dense grey material. They occur both east and west of Meadow Lake and the individual deposits vary widely in composition but generally contain elevated values for calcium and silica. Sample 6 (Reinecke, 1920) is of 'grey earth' at the northeast end of Meadow Lake. It was collected 0 to 30 centimetres from surface and at the sample site the impure hydromagnesite is about 70 centimetres thick.



Riske Creek hydromagnesite deposits.



Meadow Lake hydromagnesite deposits.

Figure 19

from: Cummings, 1940

The pure hydromagnesite consists of two or more distinct layers in overall sheet-like deposits. The surface horizon is usually white, massive and has a low calcium content. A layer of creamy yellow, loosely granular hydromagnesite, which contains an increasing proportion of calcium toward the base, usually underlies the surface layer at a depth of 60 to 90 centimetres. This creamy hydromagnesite usually overlies a layer of impure hydromagnesite. Sample 7 (Reinecke, 1920) represents a composite of white hydromagnesite from a number of the Meadow Lake occurrences. Sample 8 is a similar composite but limited to white material from drill holes in areas A and B as described below. The two main deposits and the numerous smaller occurrences of pure or white hydromagnesite are estimated to cover about 20.4 hectares.

Area A is the second largest occurrence and white hydromagnesite covers about 5.9 hectares of swampy terrain roughly 325 metres southeast of Area B. At this location the hydromagnesite is from 30 to 90 centimetres thick with an average thickness of 41 centimetres.

The principal hydromagnesite deposit, Area B, lies on Lot 4878, about 1.5 kilometres east of Meadow Lake. Drilling confirmed the 11.9 hectares of white hydromagnesite has a thickness of 20 to 81 centimetres with an average of about 45 centimetres. Creamy yellow granular material underlies the white hydromagnesite in a layer 90 to 125 centimetres thick which is underlain in turn by impure hydromagnesite. Sample 1 is of material from 0 to 38 centimetres depth within the white hydromagnesite at the centre of the main deposit. Sample 2 is from 38 to 130 centimetres below Sample 1 and consists of cream-coloured hydromagnesite. Sample 3 is a cemented soil from 130 to 168 centimetres depth. Sample 4 was collected near Sample 1 and is from 0 to 99 centimetres but includes some yellow hydromagnesite. Sample 5, taken below Sample 4, is from 99 to 153 centimetres depth and is entirely within yellow, granular hydromagnesite.

Sample	From cm	To cm	MgO	CaO	CO_2	SiO_2	Al_2O_3	Fe_2O_3	FeO	H_2O +105	H_2O -105
1	0	38	41.38	1.32	37.67	4.00	1.36	0.14	0.23	12.12	1.48
2	38	130	35.68	6.38	36.63	11.33	2.88	0.24	0.20	4.15	2.29
3	130	168	20.34	25.55	-	7.60	-	-	0.22	-	-
4	0	99	36.63	2.86	35.64	13.10	1.34	0.11	0.17	7.00	2.58
5	99	153	24.32	20.12	38.64	10.32	1.35	0.49	-	2.93	1.45
6	0	30	20.14	9.20	20.24	36.78	1.54	0.84	0.59	6.80	3.52
7	composite		40.56	1.26	35.96	1.22	0.67	0.18	0.63	18.00	1.45
8	composite		38.80	0.80	38.70	7.40	->2.50<-		-	11.50	-

OTHER HYDROMAGNESITE OCCURRENCES

Other small scattered occurrences of hydromagnesite are reported from various locations in the interior of British Columbia. The following is a listing of such occurrences with available information:

TASEKO RIVER (H7) Minfile: 092O 086 NTS: 092O 05E
Latitude: 51°23'00"N Longitude: 123°39'00"W

Estimated to contain about 55 tonnes of hydromagnesite.

BIG CREEK (H8) Minfile: 092O 089 NTS: 092O 11E
Latitude: 51°42'00"N Longitude: 123°02'00"W

$MgCO_3$	$CaCO_3$	Al_2O_3	Fe_2O_3	H_2O	Insoluble	Na_2CO_3	SO_3
64.2	5.70	0.60	1.00	11.0	16.00	1.10	0.4

Estimated to contain about 500 tonnes hydromagnesite.

GAY LAKE (H9) Minfile: 092O 085 NTS: 092O 14W
Latitude: 51°57'00"N Longitude: 123°29'00"W

Estimated to contain about 100 tonnes hydromagnesite.

FLETCHER LAKE (H10) Minfile: 092O 084 NTS: 092O 14E
Latitude: 51°46'00"N Longitude: 123°05'00"W

Estimated to contain about 350 tonnes hydromagnesite.

SPRINGHOUSE (H11) Minfile: 092O 088 NTS: 092O 16E Elevation: 975 m
Latitude: 51°56'30"N Longitude: 122°10'00"W
Alias: Sorenson's Farm

White, clay-like material is reported to underlie 10 to 30 centimetres of soil in scattered locations. One occurrence close to the Williams Lake - Springhouse Road, near Boitano Lake, was sampled with the following results:

MgO	CaO	CO_2+H_2O	Fe+Al	Insoluble
33.1	4.90	42.00	4.30	14.80

BARNES LAKE (H12) Minfile: 082LNW 082 NTS: 082L 12W
Latitude: 50°37'30"N Longitude: 119°59'45"W

Impure grey hydromagnesite, up to 60 centimetres thick, underlies about 30 centimetres of soil near the north end of Barnes Lake about 43.5 kilometres southeast of Kamloops near the Kamloops-Vernon Road.

BASQUE 1 (H13) Minfile: 092INW 043 NTS: 092I 11W
Latitude: 50°36'04"N Longitude: 121°21'30"W

A small area of white hydromagnesite occurs close to the Basque epsomite deposits, about 19 kilometres southwest of Ashcroft.

CAMPBELL RANGE (H14) Minfile: 092INE 050 NTS: 092I 09E
Latitude: 50°35'00"N Longitude: 120°08'00"W

About 550 tonnes of white hydromagnesite is reported to be in a small, 75-metre diameter depression west of the Campbell Road about 19 kilometres southeast of Kamloops. One auger hole indicated a depth of about 90 centimetres of hydromagnesite while others intersected only sand and gravel.

Samples of this material have the following chemistry:

MgO	CaO	Al_2O_3	Fe_2O_3	Fe+Al	Insoluble	CO_2	H_2O	LOI
37.44	0.66	-	-	0.93	7.37	-	-	nd
41.00	nil	1.15	0.25	-	2.40	5.0	54.0	-

BUSE LAKE (H15) Minfile: 092INE 048 NTS: 092I 09E
Latitude: 50°37'00"N Longitude: 120°02'00"W

Hydromagnesite occurs near the east end of Buse Lake which lies about 27 kilometres east of Kamloops. The material lies in a depression which is about 430 metres long and 60 to 125 metres wide. Auger drilling indicated a hydromagnesite thickness of 30 to 76 centimetres overlain by 25 to 75 centimetres of drift material. A sample which may have been contaminated by the overlying drift returned the following analytical results:

MgO	CaO	Fe+Al	Insoluble	MnO	SO_3	H_2O	LOI
34.20	1.76	3.91	20.74	0.07	0.05	6.56	38.45

BARNHART VALE (H16) Minfile: 092INE 049 NTS: 092I 09E
Latitude: 50°37'25"N Longitude: 120°05'20"W

A deposit of hydromagnesite occurs within a depression near the road to Campbell Range about 2 kilometres north of the Campbell Range deposit and approximately 3 kilometres east of Barnhart Vale.

The depression is about 180 metres long by 155 metres wide and a second depression about 430 metres to the east is also reported to contain hydromagnesite. Auger drilling indicated hydromagnesite to a depth of 1.83 metres with about 15 centimetres of overburden. A sample of the hydromagnesite returned the following analytical results:

MgO	CaO	Fe+Al	MnO_2	LOI	Insoluble
27.44	5.71	3.56	0.05	nd	23.28

ALEXIS CREEK Lot 561 Minfile: 093B 041 NTS: 093B 03W
(H17) Latitude: 52°05'30"N Longitude: 123°29'00"W

Approximately 900 tonnes of hydromagnesite is reported from Lot 561 located along the Chilcotin River about 3 kilometres west of the town of Alexis Creek. Analysis of the material is reported as follows:

$Mg(HCO_3)_2$	CaO	$Al_2O_3 + Fe_2O_3$	Insoluble
84.00	nil	0.20	13.00

ALEXIS LAKE Lot 2833 Minfile: 093B 056 NTS: 093B 06W
(H18) Latitude: 52°15'11"N Longitude: 123°29'32"W

Approximately 1800 tonnes of hydromagnesite is reported from Lot 2833 about 1 kilometre east of Alexis Lake. Analysis for the material is as follows:

$Mg(HCO_3)_2$	CaO	Al_2O_3	Fe_2O_3	Insoluble	Mn
80.00	nil	1.00	0.20	9.20	tr

141 MILE HOUSE Minfile:093A 156 NTS: 093A 04W
(H19) Latitude:52°00'30" Longitude: 121°53'00"

Occurrences of hydromagnesite are reported to occur in the area of 141 Mile House along the Cariboo Road.

White and cream coloured hydromagnesite is deposited about 30 metres downslope from a mineral spring east of the railway tracks near 141 Mile House. The material contains freshwater shells and is predominantly calcium carbonate with magnesium carbonate and a small amount of alkalic carbonate. The texture is earthy and granulated, similar to the impure hydromagnesite underlying larger hydromagnesite deposits in other areas. Sample A was collected about 6 metres downstream from the spring, which is the source of the carbonate material. Sample B was collected about 30 metres downstream from the spring.

	MgO	CaO	FeO	Fe_2O_3	SiO_2	Na_2O	K_2O	SO_3	CO_2	H_2O	LOI
Sample A	12.14	34.31	1.32	3.58	8.78	0.10	0.58	Tr	36.84	3.1	Nil
Sample B	5.00	43.32	0.73	0.64	5.22	0.02	0.36	Tr	35.10	6.06	4.01

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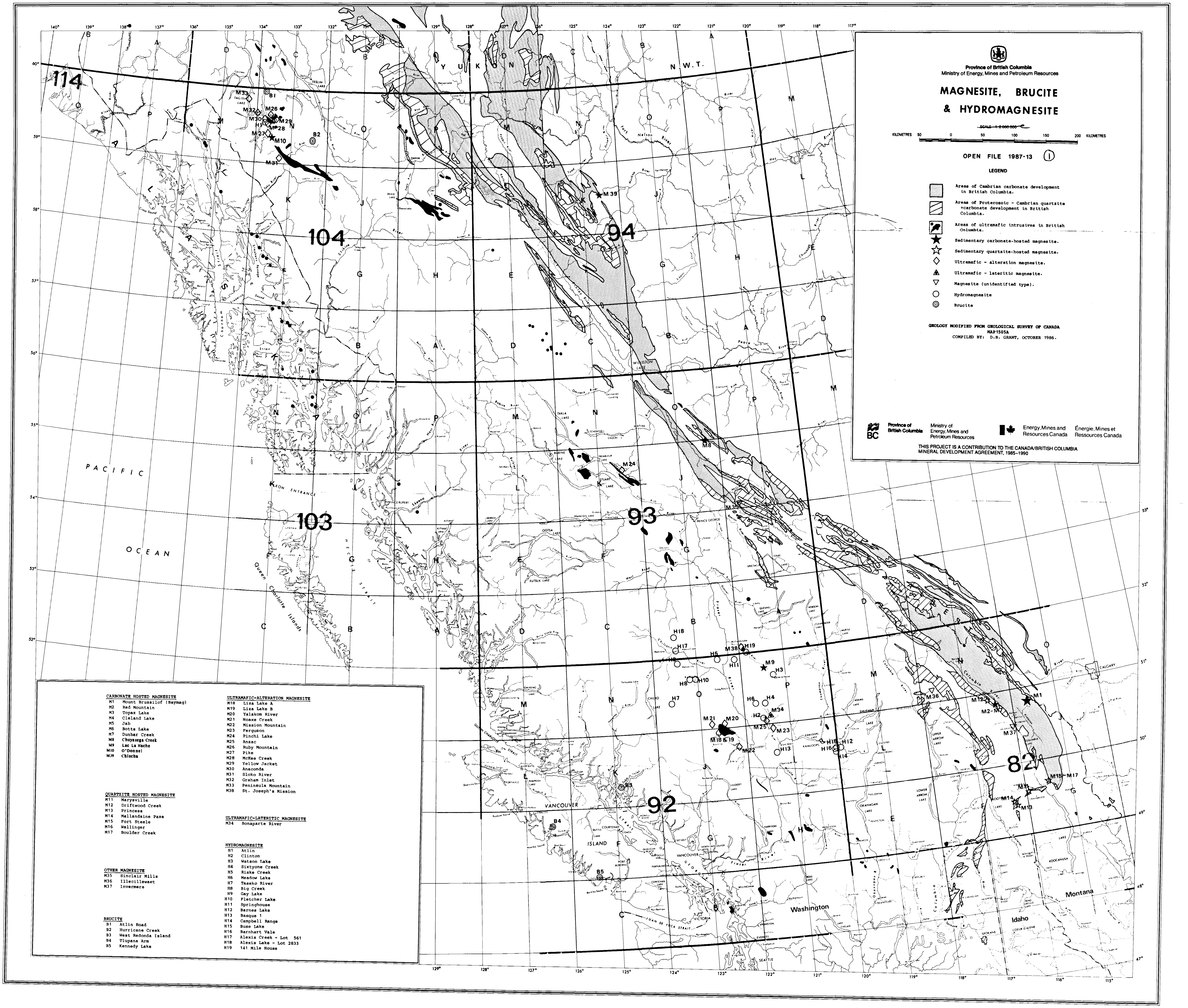
Province of British Columbia
Ministry of Energy, Mines and Petroleum Resources
MAGNESITE, BRUCITE
& HYDROMAGNESITE
SCALE 1:2 000 000
KILOMETRES 50 0 50 100 150 200 KILOMETRES
OPEN FILE 1987-13 1
LEGEND
Areas of Cambrian carbonate development in British Columbia.
Areas of Proterozoic - Cambrian quartzite +carbonate development in British Columbia.
Areas of ultramafic intrusives in British Columbia.
Sedimentary carbonate-hosted magnesite.
Sedimentary quartzite-hosted magnesite.
Ultramafic - alteration magnesite.
Ultramafic - lateritic magnesite.
Magnesite (unidentified type).
Hydromagnesite
Brucite
GEOLOGY MODIFIED FROM GEOLOGICAL SURVEY OF CANADA MAP 1505A
COMPILED BY: D.B. GRANT, OCTOBER 1986.
Province of British Columbia
Ministry of Energy, Mines and Petroleum Resources
Energy, Mines and Resources Canada
Énergie, Mines et Ressources Canada
THIS PROJECT IS A CONTRIBUTION TO THE CANADA/BRITISH COLUMBIA MINERAL DEVELOPMENT AGREEMENT, 1985–1990
CARBONATE HOSTED MAGNESITE
M1 Mount Brussilof (Baymag)
M2 Red Mountain
M3 Topaz Lake
M4 Cleland Lake
M5 Jab
M6 Botts Lake
M7 Dunbar Creek
M8 Chuyazega Creek
M9 Lac La Hache
M10 O'Donnel
M39 Chischa
QUARTZITE HOSTED MAGNESITE
M11 Marysville
M12 Driftwood Creek
M13 Princess
M14 Mallandaine Pass
M15 Fort Steele
M16 Wallinger
M17 Boulder Creek
OTHER MAGNESITE
M35 Sinclair Mills
M36 Illecillewaet
M37 Invermere
BRUCITE
B1 Atlin Road
B2 Hurricane Creek
B3 West Redonda Island
B4 Tlupana Arm
B5 Kennedy Lake
ULTRAMAFIC-ALTERATION MAGNESITE
M18 Liza Lake A
M19 Liza Lake B
M20 Yalakom River
M21 Noaxe Creek
M22 Mission Mountain
M23 Ferguson
M24 Pinchi Lake
M25 Anzac
M26 Ruby Mountain
M27 Pike
M28 McKee Creek
M29 Yellow Jacket
M30 Anaconda
M31 Sloko River
M32 Graham Inlet
M33 Peninsula Mountain
M38 St. Joseph's Mission
ULTRAMAFIC-LATERITIC MAGNESITE
M34 Bonaparte River
HYDROMAGNESITE
H1 Atlin
H2 Clinton
H3 Watson Lake
H4 Sixtyone Creek
H5 Riske Creek
H6 Meadow Lake
H7 Taseko River
H8 Big Creek
H9 Gay Lake
H10 Fletcher Lake
H11 Springhouse
H12 Barnes Lake
H13 Basque 1
H14 Campbell Range
H15 Buse Lake
H16 Barnhart Vale
H17 Alexis Creek - Lot 561
H18 Alexis Lake - Lot 2833
H19 141 Mile House
114
104
103
94
93
92
82
YUKON
N.W.T.
PACIFIC
OCEAN
Queen Charlotte Islands
VANCOUVER
ISLAND
PRINCE GEORGE
CALGARY
Washington
Montana
Idaho
U.S.A.