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ROCK AND MINERAL COLLECTING IN BRITISH COLUMBIA

S. Leaming

1973

DEPARTMENT OF ENERGY, MINES AND RESOURCES

CANADA

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ABSTRACT

Many minerals of interest to the amateur collector occur in British Columbia. These occurrences are described as is the general geology of the province in order to assist the user in finding new collecting localities. An extensive bibliography and index to published maps and reports is included.

RÉSUMÉ

La Colombie-Britannique recèle de nombreux minéraux dignes d'intérêt pour le collectionneur amateur. Afin d'aider l'utilisateur à trouver de nouvelles sources d'approvisionnement pour les collectionneurs, l'auteur a décrit les venues de ces minéraux en s'inspirant de la géologie générale de la province. Le rapport contient en outre une bibliographie fouillée et un index des cartes et rapports publiés.

ROCK AND MINERAL COLLECTING IN BRITISH COLUMBIA

INTRODUCTION

The number of people interested in collecting rocks and minerals has grown rapidly during the last ten to fifteen years. The largest group of enthusiasts call themselves 'rockhounds'. Local clubs are found in many towns and villages throughout the continent, and particularly in British Columbia. Most clubs welcome new members and beginning collectors would find membership in a rock club of interest and value because collective knowledge of localities, identification of specimens, methods of collecting etc. are shared by all.

The initial interest of most rockhounds was the cutting and polishing of jade, rhodonite, petrified wood, and agate. These materials were ideal for amateur jewellery-making, and were usually cut en cabchon for ringstones, earrings, pendants, etc. Less exotic rocks and minerals which are not of gem quality are used for penstands and book ends. With so many people interested in the beauty of polished rocks it is not surprising that some with greater artistic insight and ability have used slabs and pieces of different rocks and minerals as an art medium and many beautiful mosaics or intarsias have appeared at various rock shows. The latest interest of more advanced rockhounds is the faceting of stones from gem quality quartz, tourmaline, aquamarine, topaz, etc. Much of the raw material for this work must be purchased, for local deposits are not common. Other collectors have become interested in minerals for their own sake and many fine collections of minerals have been built up by collecting, trading and purchasing.

Few collectors will be prepared or equipped to extract minerals from bedrock localities except for small specimens which may be removed by hammer and chisel in relatively soft rocks. The discovery of a very large boulder of a valuable rock also presents difficulties. Explosives should never be used. Most rocks will be adversely affected by the development of incipient fractures even if no apparent rupture or fragmentation occurs. The discoverer of a valuable gem stone too large to pick up could best protect his interest by staking (as a mineral or placer lease) the ground on which it lies and selling the stone to a dealer. Jade, especially, could be readily sold and the finder would get a supply of jade and profit as well.

Finders of specimens of value who cannot collect for one reason or another should not spoil the chances of someone else who may be equipped and qualified to do so. Admittedly there is a very strong temptation to try to extract a crystal or attractive mineral or rock from some difficult spot, even though the chances of success are obviously small. Prize specimens can rarely be divided.

It is the purpose of this report to make known to all amateur collectors the possibilities of finding material in British Columbia and to outline the geological association of rocks and minerals so that use can be made of geological reports and maps published by the Geological Survey of Canada and the Department of Mines and Petroleum Resources of the Province of British Columbia.

Original manuscript submitted: April 27, 1970
Final version approved for publication: August 8, 1972.

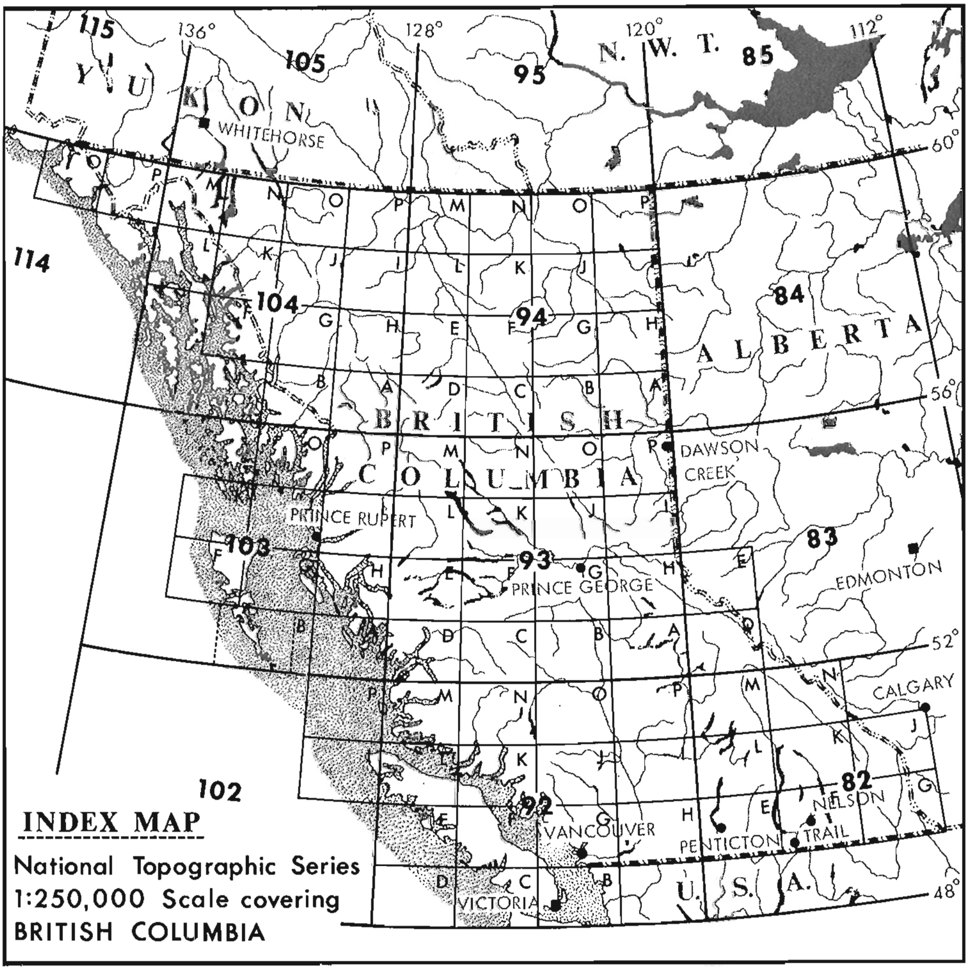
INDEX MAP
National Topographic Series
1:250,000 Scale covering
BRITISH COLUMBIA
YUKON
N. W. T.
ALBERTA
BRITISH COLUMBIA
U. S. A.
WHITEHORSE
PRINCE RUPERT
PRINCE GEORGE
DAWSON CREEK
EDMONTON
CALGARY
VANCOUVER
VICTORIA
PENTICTON
NELSON
TRAIL
115
105
95
85
114
104
94
84
103
93
83
102
92
82
136°
128°
120°
112°
60°
56°
52°
48°

Figure 1A.

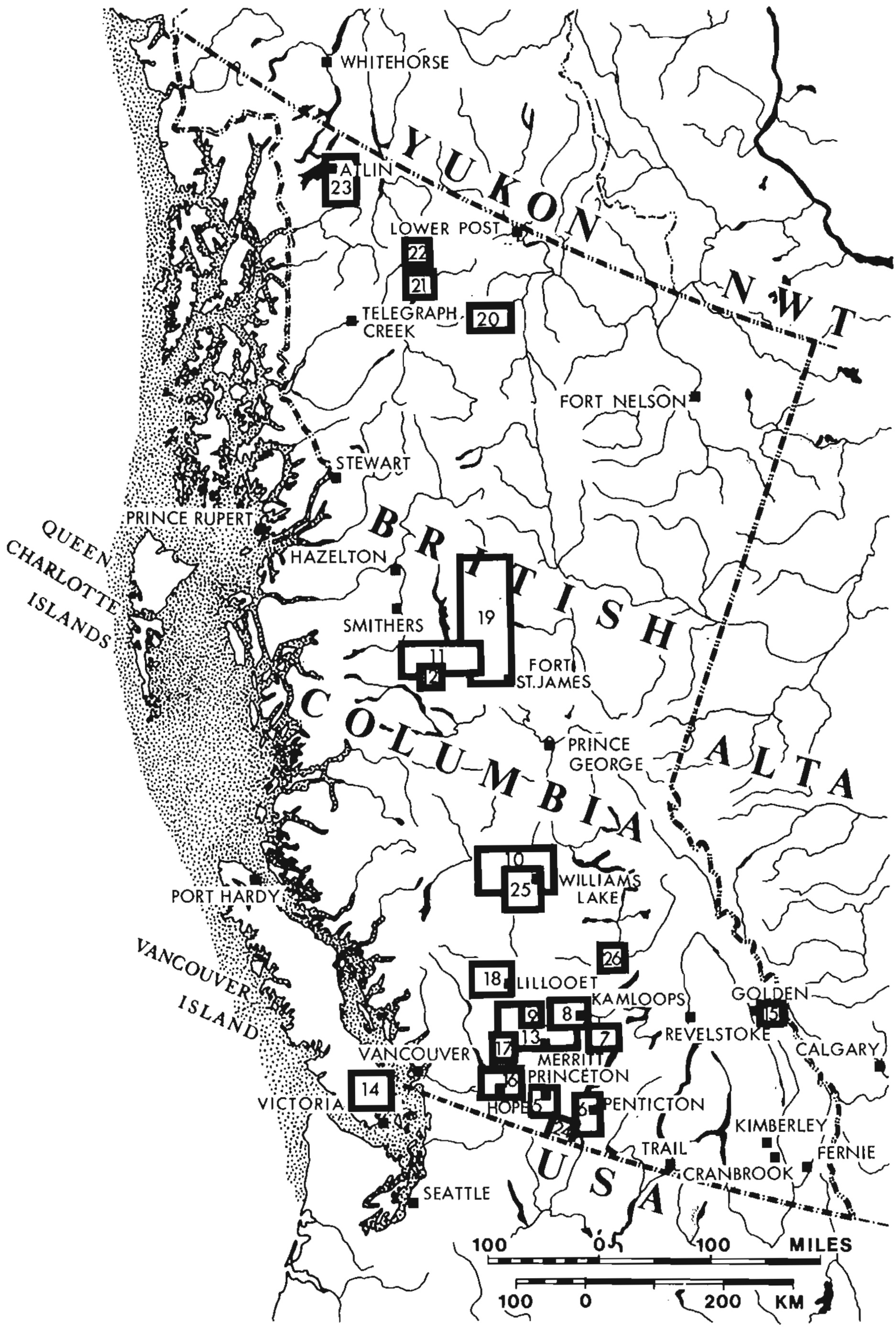

Figure 1B. Index to text-figures.

Many localities are described but the emphasis is on the possibility of new discoveries. No attempt is made to present an exhaustive record of collecting localities, an almost impossible task with the rapidly growing number of sites. The rock and mineral collector can be encouraged by the knowledge that probably many more and better collecting localities than those referred to in the text remain to be discovered. The index map to the National Topographic series of maps, Figure 1A, should be used in conjunction with Appendix B and List of References. Figure 1B locates some of the individual figures used to illustrate the text. A more complete index to publications is available from the Geological Survey of Canada, 6th Floor, 100 West Pender Street, Vancouver 3, B.C. or 601 Booth Street, Ottawa, Ontario, K1A OE8.

Field work in connection with this report was started in the summer of 1965. The author is indebted to many rockhounds for information and specimens.

ELEMENTARY GEOLOGY*

The earth's crust is composed of minerals, the solid form in which the elements and their inorganic compounds exist naturally. Minerals occur in the crust in two main ways - as rock-forming minerals and as mineral deposits. Rocks are fairly large and homogeneous bodies composed of mineral grains. There may be only one mineral, as in pure sandstone or limestone, but more commonly rocks comprise grains or crystals of tow or more minerals, thus accounting for the variegated appearance of granite and many other rocks. Mineral deposits are concentrations of one or more minerals occurring within rocks as veins, irregular masses, or in other ways. Such mineral deposits are common but the minerals may not be valuable, they may be valuable but not in sufficient quantity to be mined economically, or, as in relatively few instances, they may be of economic size and grade.

Geological phenomena cannot be understood without an appreciation of the vastness of geological time. Pioneer geologists concluded that the earth existed for many millions of years, basing this on such evidence as the amount of sediments deposited annually in bodies of water (for example, it was estimated that several thousand years would be required to deposit one foot of typical limestone), and equating these estimates with the great thicknesses of sedimentary rocks measurable in various places. This was corroborated by observations that particular fossils are characteristic of particualr groups of sedimentary rocks and that the plants and animals of which they are the remains must have evolved very slowly. Recently, more satisfactory methods of dating have been developed, based on the radioactive decay of certain elements such as uranium, which disintegrate into 'daughter' elements at constant rates. Such determinations are only beginning to become available in satisfactory quantities because they require mush searching for suitable material, careful sampling, and involved laboratory analyses. Most of the results date phenomena that affected rocks after they were formed, rather than the time of origin of the rock sampled. The oldest samples tested have yielded ages of 3,000 to 4,000 million years. Long before such methods were available, geologists agreed to divide geological time into eras and periods, most of which were terminated by unusually strong disturbances in the earth's crust. Eras are now grouped into longer time spans called eons. Time since the beginning of

*Taken (with some modifications) from Lang (1961).

TABLE 1

Sedimentary Rocks*

Origin	Unconsolidated	Consolidated	
Mechanical	Gravel	Conglomerates	Gravels consist of fragments of rocks and minerals of various kinds and sizes. They are more or less rounded. A conglomerate consists of such an assemblage cemented by deposition of minerals between fragments. Breccia has no rounded pebbles but angular fragments.
	Sand	Sandstone	Sands are incoherent masses made up of more or less well rounded grains of minerals or rocks. The grains are usually only a few millimetres in diameter. Ordinarily quartz is the most abundant mineral but the term sand has reference to the grain size, not to the kind of grain. A sandstone is a sand cemented by deposition of minerals around the grains. The cementing mineral may be quartz, calcite, iron oxide, or even bituminous material.
	Clay	Shale	Clay is made up of tiny flakes of kaolin and similar minerals. When it becomes consolidated the rock is a shale.
	Loess		Consists of wind-blown dust.
	Till		Unsorted glacial material.
Chemical		Salt; gypsum	Formed by evaporation of water of salt lakes.
		Chert, some limestone and dolomites	Formed by loss of carbon dioxide (CO_2) from solutions containing the bicarbonate. Chert is probably formed by coagulation of colloidal silica.
		Bog iron	Formed by coagulation of colloidal solutions of iron. Iron secreting bacteria may be instrumental.
Organic		Most limestone	Formed or composed of shells, or fragments of shells, chalk, marl, etc.

*Tables from Mining Textbooklet No. 1, Canadian Legion Educational Services.

GEOLOGICAL TIME CHART

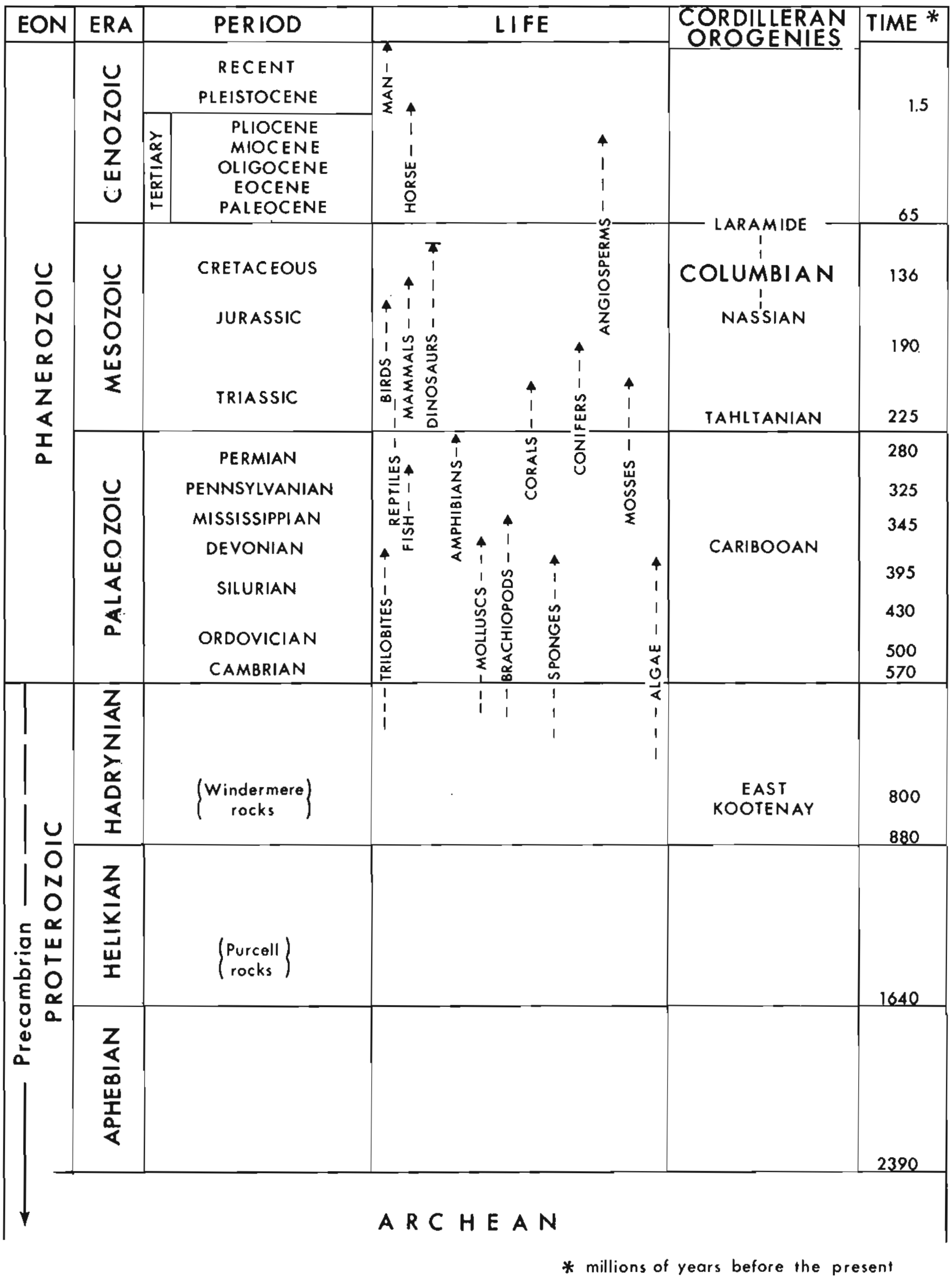

Figure 2.

the Paleozoic era (about 570 million years ago) is included in the Phanerozoic eon. Time before the beginning of the Paleozoic era is divided into the Proterozoic Eon beginning about 2,400 million years ago, and the Archean eon for all previous geological time which extends back for more than four billion years. Figure 2 shows the major divisions of geological time, with orogenies pertinent to the geology of the Cordilleran region, the progression of life forms, and the absolute ages of the beginning of each division as determined by radioactive decay methods.

Because of atmospheric conditions the rocks at the earth's surface have from early time been subjected to weathering and erosion similar to that which can be seen at work today in the disintegration or rocks surfaces, in the cutting action of streams, waves and winds carrying sand particles, in the spalling or rocks by frost action, in the gouging action of glaciers, in the levelling effects of landslides, and in the slow solution os soluble rocks such as limestone. Continued over millions of years, these agencies reduced even great mountain chains to flat or rolling surfaces. The debris was carried away and deposited in basins by streams, waves and winds as muc, silt, sand or gravel. In some places, the thickness of sediments may be relatively small, and in others hughe thicknesses accumulate in large trough-like depressions called geosynclines (part of the Caribbean Sea near the Lesser Antilles is a modern example). Also, compounds dissolved in water were deposited chemically in the bottoms of seas and lakes. In time, sediments become solid sedimentary rocks by the compaction caused by overlying sediments and by the cementing of grains by material deposited from solutions. Thus mud, sand and gravel, respectively, becane shale, sandstone and conglomerate and chemical precipitates became limestone, dolomite, or beds like salt, or gypsum. Although limestone may be formed by the consolidation of chemically precipitated calcium carbonate, most limestones are formed through the agency of living organisms which extract the dissolved material to build their shells, which upon death accumulate to form beds. Table 1 sets down the three main classes of sedimentary rocks and the most important memebers.

In addition to sedimentary varieties there are two other fundamental classes of rocks - igneous and metamorphic. Igneous rocks are commonly formed by the crystallization of molten material, of which lava is a surface manifestation. If crystallization takes place beneath the surface it is slow, resulting in coarsely crystalline rocks such as granite, which may be exposed long afterwards as a result of erosion. If, on the other hand, the molten material reaches the surface from a volcano it crystallizes quickly to form fine-grained stratified volcanic rocks such as rhyolite and basalt. Commonly associated with volcanoes are clouds of volcanic ash which settle to form sedimentary rocks called tuffs.

Igneous rocks are classified according to the kind and percentage of a few common minerals, mainly quartz, feldspar, amphibole, pyroxene and olivine. Petrologists have found it necessary to develop hundreds of rock names, but those include in Table 2 are the most common and the only ones the amateur need remember.

Intrusive rocks are typically coarse grained, i.e. the individual mineral grains can be easily seen by the naked eye. Extrusive rocks are typically fine grained so that a hand lens or microscope is needed to identify the individual minerals. There are some rocks which combine both these features. These are the porphyritic rocks in which individual crystals called phenocrysts stand out in a matrix of fine-grained minerals. Quartz and feldspar are the most abundant phenocrysts; hence quartz and feldspar porphyries are common rocks. They may exhibit an intrusive relationship with the enclosing rock as in some dyke rocks but lava flows may also be porphyritic and these are extrusive rocks. The forms of intrusive rocks have been given special names. Very large bodies of intrusive rocks are called batholiths. Small apophyses of a batholith are called stocks. Instusive rocks commonly assume tabular form. Those which conform to existing strata are called sills. Those tabular bodies which cut across the enclosing strata are called dykes. They are commonly vertical or steeply dipping. Laccoliths are concordant bodies which make room for their entry by bowing up the roof rocks.

Metamorphic rocks are formed from sedimentary or igneous rocks by the action of heat or pressure, or both, which in some cases merely produces new minerals by re-arrangement of the elements already present to form new minerals that are more stable under the changed conditions; the latter are commonly platy minerals like mica. Thus shale may become slate, sandstone may become quartzite, and limestone may become marble. Other common results of metamorphism are foliated or banded rocks like schist and

TABLE 2

Igneous Rocks[1]

Amount of Quartz	Proportion of Potash Feldspar to total Feldspar	More than 10% Feldspar — Composition of Plagioclase: Albite $An_0 - An_{10}$	Oligoclase $An_{10} - An_{30}$	Andesine $An_{30} - An_{50}$	Labradorite, etc. $An_{50} - An_{100}$	Less than 10% Feldspar	Monomineralic[2] Commonly less than 10% extraneous minerals
More than 10% Quartz	More than 2/3	**GRANITE** *RHYOLITE*					
	1/3-2/3		**QUARTZ MONZONITE** *QUARTZ LATITE*				
	Less than 1/3	**ALBITE GRANITE** *RHYOLITE*	**GRANODIORITE** *QUARTZ LATITE*	**QUARTZ DIORITE** *DACITE*	**QUARTZ GABBRO** *QUARTZ BASALT*		
Less than 10% Quartz	More than 2/3	**SYENITE** *TRACHYTE*				PERKNITE PERIDOTITE More than 5% Olivine	PYROXENITE HORNBLENDITE DUNITE ANORTHOSITE
	1/3-2/3		**MONZONITE** *LATITE*				
	Less than 1/3	**ALBITE SYENITE** *TRACHYTE*	**SYENODIORITE** *LATITE*	**DIORITE** *ANDESITE*	**GABBRO** *BASALT*		
	COMMON CONTENT OF DARK MINERALS	0 - 10	10 - 40		40 - 70	70 - 100	

GENERAL TERMS FOR FINE-GRAINED ROCKS

FELSITE *(light coloured on fresh surface)* TRAP *(dark coloured on fresh surface)*

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[1]Table from I.C. Brown and other officers of the Geological Survey of Canada.

[2]Rocks consisting almost entirely of a single mineral.

Note: Names of coarser-grained (plutonic) rocks are in heavier type, and those of finer-grained rocks (dyke and volcanic rocks) are in lighter type (slanting).

gneiss, which may be formed from various rocks and in which the foliation is commonly caused by the parallel orientation of platy minerals. In some gneisses banding is caused partly by thin parallel injections of granitic material. Metamorphic rocks are commonly formed in the 'core' of a mountainous belt, where heat and pressure are high. Granites and other coarse-grained igneous rocks are also commonly formed there. Some granites and related rocks appear to have been formed as a final stage of metamorphism and recrystallization, without having been melted. Table 3 identifies some of the commonest metamorphic rocks.

Segments of the crust were elevated from time to time by forces connected with mountain building, earthquakes and volcanic activity. Sometimes segments were uplifted in a flat or tilted manner, or in broad, gentle flexures so that streams and other erosive agencies could again begin their work of degradation, transportation and deposition. Or, particularly where great accumulations of sediments took place in geosynclines, the rocks were cast into arched or crumpled 'folds' such as may be seen on the sides of mountains carved out of sedimentary or volcanic strata. Commonly accompanying such processes were dislocations along fractures, the strata at one side of a fracture no longer matching those at the other; these are called faults, and the vibrations caused by movement along a fault produce earthquakes. Thus the earth's crust is not static, but subject to slow cyclical changes that are continuing at various places today and that culminate from time to time in pronounced disturbances called orogenies. When the highlands formed by an orogeny have been worn down and covered by later rocks, a pronounced change in the kinds or structural conditions of the rocks, called an unconformity, marks the ancient erosional surfaces.

Glaciation during the Pleistocene period brought Canadian landscapes virtually to their present forms. Because of fluctuations in the climate, great ice-sheets pushed slowly across almost all Canada, from centres in the Cordillera, Keewatin and Ungava. Rocks frozen in the bases of the ice-sheets and glaciers gouged and smoothed rock surfaces, and vast loads of rocks and rock particles carried by the ice were dumped as gravel or sand, or deposited as silt or clay in large temporary lakes formed by the melted ice. Both the erosive and the depositional actions greatly disorganized the pre-glacial drainage patterns, resulting in the numerous lakes, muskegs and irregular stream patterns of many localities, particularly in the Shield. Glacial deposits obscure bedrock in most places except in the higher parts of mountains and in certain parts of the Shield where glacial scouring was more pronounced than deposition. Elsewhere outcrops are scattered, generally forming less than 10 per cent of the surface, or are completely lacking in areas many miles in extent.

The geological processes outlined above accounted in one way or another for the raw materials of Canada's mineral industry, which includes the production of the fossil's fuels - coal, petroleum and natural gas. Metals are won from deposits containing metal-bearing minerals. Non-metalliferous products such as asbestos, gypsum, sand, gravel, and building stone, are derived from serpentinite bodies (asbestos), from beds of sedimentary rock (gypsum), or from rocks like limestone or granite (building stone), or from unconsolidated sediments (gravel, sand or clay). Coal is formed by alteration of beds in which leaves and other woody material accumulated between layers of typical sediments. Petroleum and gas are believed to have resulted mainly from the fats of the innumerable organisms that inhabited the seas of former

TABLE 3

Metamorphic Rocks

Original rocks	Affected by	Physical character	Metamorphic rock
A. FROM SEDIMENTS			
Ouartz sands and sandstones	heat or pressure and solutions;	cemented	quartzite
	differential stress	schistose	quartz schist
Impure sands and sandstones	heat or pressure and solutions;	cemented	arkose
	differential stress	schistose or gneissic	paragneiss
Mud and shale	heat or pressure and solutions;	dense appearance and fine-grained	staurolite, chloritoid and andalusite rocks;
	differential stress		slate, phyllite, and chlorite schist
Limestone	all agents	recrystallized	crystalline limestone
B. FROM IGNEOUS ROCKS			
Granite, syenite, diorite, gabbro	differential stress	foliated	orthogneiss
Rhyolite and trachyte	differential stress	foliated	quartz-sericite schists, and sericite schists
Andesite and basalt	uniform pressure and solutions;	massive	greenstone
	differential stress	schistose	chlorite schist, talc schist, actinolite schist, hornblende schist

*Tables from Mining Textbooklet No. 1, Canadian Legion Educational Services, as reprinted in "Prospecting in Canada", Geol. Surv. Can. 1971. Econ. Geol. Rept. No. 7.

times, which became trapped in sediments. The fats decomposed slowly to form oil and gas which migrated through pores and fractures in unconsolidated sediments or sedimentary rocks to accumulate in places where geological structures were favourable and where impermeable strata overlay in such a way as to prevent escape of oil or gas. Most metal deposits are found in ancient mountain-built areas where igneous processes were once active, and which have been eroded deeply. Some non-metalliferous minerals, such as asbestos, are found under analogous conditions and others occur mainly in relatively undisturbed sedimentary rocks. Coal, oil and gas are found only in accumulations of sedimentary rocks younger than Precambrian because suitable organisms were absent before the Paleozoic era. Coal may be present in much-disturbed or undisturbed areas, but oil and gas are found only in moderately disturbed or undisturbed sedimentary rocks because much disturbance permite their escape.

Gemstones are in most cases, rare varieties of relatively common minerals. Those with superior hardness, colour and other optical properties include diamond, emerald, ruby, sapphire, peridot, topaz, garnet and zircon. Gemstones may also be varieties of rocks such as jade or obsidian. A few organic substances also are considered gemstones. These include, pearl, amber and coral.

The principal gemstones found in British Columbia are jade, agate and rhodonite. Gem tourmaline and peridot occurrences are known but are not abundant. Precious opal has been reported and although the authenticity is not questioned, occurrences in British Columbia are few and very small, amounting to only a few specimens from three or four localities.

Almost any hard rock or mineral may be of use as a gemstone if it possesses a distinctive colour or interesting pattern. Pillow breccia – called 'dallasite' by the rockhounds (Pl. VII) is a good example and "yalakomite" is another.

PHYSICAL FEATURES OF BRITISH COLUMBIA

The Cordilleran Region of British Columbia is a northwesterly-trending belt about 400 miles wide composed of high mountains and lower plateaux and valleys (<u>see</u> Fig. 3) and includes all of British Columbia except the northeastern corner. Individual mountain groups and plateaux are arranged in a complex pattern divisible into three parallel northeasterly-trending zones. In most places these zones are distinct and are called the Western, Interior and Eastern Systems. Because the Western and Interior Systems are distinct geologically from the Eastern System they are grouped as the Western Cordillera in some geological literature, as opposed to the Eastern System or the Eastern Cordillera. The greater part of the Western System is composed of the high, rugges Coast Mountains along the mainland coast of British Columbia, which are up to 13,260 feet in elevation (Mt. Waddington). In southern British Columbia a fairly small area is formed by the Cascade Mountains. Separated from the mainland by the Insular Passage are ranges forming Vancouver and Queen Charlotte Islands, with peaks up to 6,968 feet in elevation. The Interior System is a complex group of plateaux and mountains respectively up to 6,000 and 11,000 feet above sea-level. Its principal plateaux are the Nechako in central British Columbia, and the Fraser farther south. Some authorities separate the southern part of Fraser Plateau as the

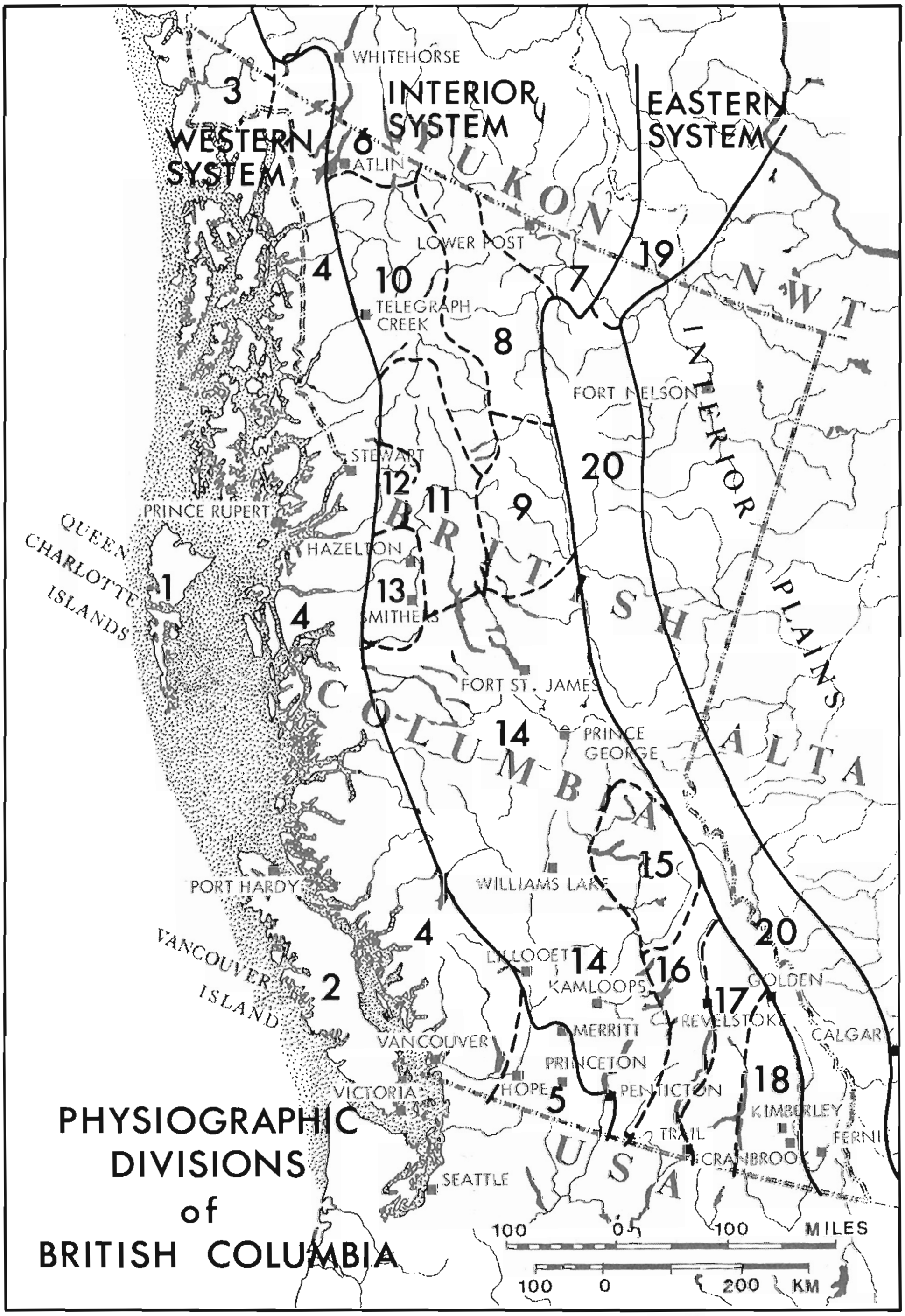

Figure 3. Taken with modifications from Geology and Economic Minerals of Canada, 4th Ed. (1957).

LEGEND FOR FIGURE 3 (opposite)

1.	Oueen Charlotte Mountains	
2.	Vancouver Island Mountains	
3.	St. Elias Mountains	WESTERN SYSTEM
4.	Coast Mountains	
5.	Cascade Mountains	
6.	Yukon Plateau	
7.	Liard Plain	
8.	Cassiar Mountains	
9.	Omineca Mountains	
10.	Stikine Plateau	
11.	Skeena Mountains	
12.	Nass Basin	INTERIOR SYSTEM
13.	Hazelton Mountains	
14.	Interior Plateua	
15.	Cariboo Mountains	
16.	Monashee Mountains	
17.	Selkirk Mountains	
18.	Purcell Mountains	
19.	Liard Plateau	EASTERN SYSTEM
20.	Rocky Mountains	

Kamloops Plateau, which extends to the 49th Parallel near the Okanagan River. The principal mountain division of the Interior System are the Cassiar, Omineca, Skeena, and Hazelton Mountains in northern British Columbia, and the Cariboo, Monashee, Selkirk, and Purcell Mountains in the south-central part of the province, east of Fraser and Kamloops Plateaux.

The highest peak, 11,590 feet in elevation, Mount Sir Sandford is in the Selkirk Mountains. The Eastern System comprises the Rocky Mountains, and a plain and plateau along the Liard River near the British Columbia-Yukon boundary. The Canadian Rockies are composed of high, serrated ranges extending northward from the 49th Parallel; the elevation of the highest peak, Mount Robson, is 12,972 feet. Flanking them on the east are the Rocky Mountain Foothills which form a transition with the Plains. The Rocky Mountains, although extensive, are but a relatively small part of the mountains of Western Canada; therefore the popular tendency to apply the name to the entire Canadian Cordilerra is inadmissible.

GENERAL GEOLOGY OF BRITISH COLUMBIA.

The geology of British Columbia is generalized on Figure 4. Greater geological detail is contained in the Geological Survey's Geology and Economic Minerals of Canada, Economic Geology Series No. 1 5th ed. (1970).

Most of British Columbia was the site of a great geosyncline in which strata were laid down intermittently since at least late Precambrian time.

In parts of the Interior of British Columbia highly metamorphosed rocks bearing some resemblance to the Archean of the Shield are exposed. All available evidence indicates, however, that these are partly late Precambrian and younger strata that were metamorphosed partly during Precambrian but predominantly in later times.

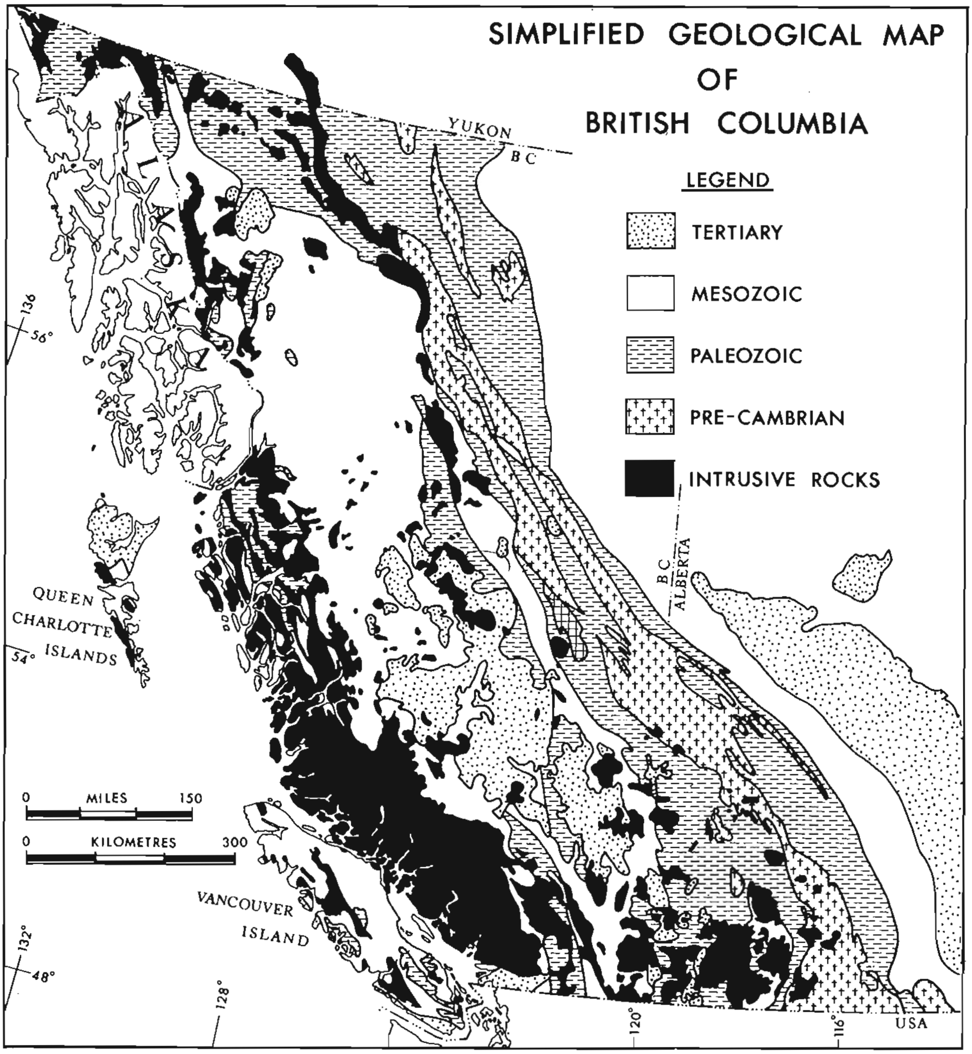

Figure 4. Reference: Map 1250A - Geological Map of Canada.

The oldest strata whose age is clear are beds of quartzite, argillite, dolomite and other sedimentary rocks totalling many thousands of feet, in thickness that outcrop principally in the Cariboo, Purcell, Selkirk and Rocky Mountains. In places, these unfossiliferous beds are overlain by others containing Early Cambrian fossils. In general, the Cambrian rocks rest unconformably an older rocks but in many places there is no marked unconformity. It is concluded, therefore, that at least some of the Precambrian strata may be younger than any strata classed as Proterozoic in the Canadian Shield and may have been deposited during the time when the Shield was being eroded and before Paleozoic sediments were deposited on it.

In the western part of the region the principal Paleozoic strata exposed are volcanic and sedimentary strata, largely limestone, of Carboniferous and Permian ages. More extensive are great accumulations of volcanic and sedimentary strata of Triassic, Jurassic and Lower Cretaceous ages. In the Eastern Cordillera the Paleozoic rocks are better represented and comprise limestone, dolomite, quartzite, shale and other rocks ranging in age from Triassic to Late Cretaceous. The combined thickness of strata of different ages exposed in various parts of the Rocky Mountains, including the Precambrian beds mentioned earlier, is estimated at more than 40,000 feet. In many parts of the Rocky Mountains, partiuclarly along the eastern border, low angle faults thrust Precambrian and Paleozoic strata over younger beds.

As already indicated, some evidence now largely obliterated by later events, points to early orogenic activities. The principal mountain-building and igneous processes for which good evidence remains, began locally in early Mesozoic time, culminated in the Western Cordillera in the Columbian orogeny in late Jurassic and early Cretaceous time, but was not significant in the Eastern Cordillera until the Laramide orogeny early in the Tertiary. Thus the Western Cordillera were formed much earlier than the Eastern.

The strata in the Western Cordillera are intruded by many small to large bodies of igneous rocks. Most are granodiorite or diorite, but many others are granite, gabbro, or other related types. Still others are ultramafic, i.e., composed mainly of iron and magnesium minerals. Most are of Mesozoic age but some must have been intruded in early Tertiary time. The intrusions are scattered widely, the largest concentration being the Coast Intrusions which form the greater part of the Coast Mountains. In general, this belt of intrusion swings easterly in southern British Columbia and is represented by many large and small bodies in the Kamloops Plateau and the Monashee, Selkirk and Purcell Mountains. Intrusive rocks are uncommon in the Eastern Cordillera.

In the Interior belt much lava was deposited on the plateaux at various times during the Tertiary, mainly in or about Miocene time. The lavas are chiefly basalt and apparently issued from long fissured rather than from volcanoes. Sandstone, shale and volcanic ash were deposited in local freshwater basins in the same belt.

Mountain building in the western part of the United States formed the Cascade and Coast Ranges during late Tertiary or early Pleistocene times. These movements, which took place over considerable time and were accompanied by much volcanic activity, are related to the Cascadian orogeny, equivalent to late haramide. In the Canadian Cordillera this orogeny was mainly limited to uplifts and some volcanic deposition. Some volcanic activity occurred locally as late as the post-Pleistocene, as evidence by lava and ash resting on glaciated rocks and glacial debris and by a well-preserved cinder cone in northern British Columbia.

Glaciation was widespread in the Cordillera during the Pleistocene, and glaciers persist today in many places, chiefly in the Coast Mountain and the Columbia Ice Field in the Rocky Mountains. Information on direction of ice movement are given on many geological maps and can be of great aid to mineral and rock collectors searching for boulders not in place.

ASSOCIATION OF ROCKS AND MINERALS AS A GUIDE TO COLLECTING

Many minerals are found mainly with certain rock types. This is the primary guide for prospectors in the search for ore minerals and it can be applied to the search for lapidary materials as well. Rock type is however only one variable in the genesis of minerals. Thus jade is associated with serpentine but not all serpentine contains jade; beryl is associated with granite pegmatite, but not all granite pegmatite contains beryl. Nevertheless, because of the close relationship between specific minerals and rocks the descriptions of mineral localities in this paper are grouped according to the lithology and age of the host rocks. Of course, much lapidary material may be picked up from loose boulders transported along rivers and hence removed from the parent rock.

EXTRUSIVE ROCKS

A wide variety of extrusive (volcanic lavas or flows) rocks are found in British Columbia but the most important for mineral collecting are basalts. Basaltic lavas are commonly vesicular, that is, full of voids which may later be filled with agate, calcite or zeolite minerals to become amygdaloidal lavas. Amygdaloidal lavas are very common in British Columbia and in many places agate in seams, geodes with quartz-lined centres, and many kinds of zeolites may be collected. The most productive flows are those of Tertiary age such as those in the Kamloops Group (Cockfield, 1948; Jones, 1959; Duffell and McTaggart, 1952). Princeton Group (Rice, 1947) and Endako Group of Fort St. James map-area (Armstrong, 1949).

TERTIARY EXTRUSIVE ROCKS

The main areas of Tertiary rocks in British Columbia lie in the central Interior, on Graham Island in the Queen Charlotte Islands, and in northern British Columbia north and east of Telegraph Creek. Graham Island is famous for agates, but little is known of the potential mineral collecting value of the northern area. Most rockhounds are aware of the large number of localities in the Kamloops-Vernon-Princeton areas and those around Francois Lake. Many of these localities have been exploited for years, so that good material is increasingly hard to find. Very little material can be obtained without laborious hammer and chisel work. New localities might be discovered by searching talus slides in stream gulleys in any of the areas of Tertiary rocks shown on Figures 5 to 12. Large parts of these areas are covered by overburden and bedrock exposure may be less than 25 per cent. Hence the initial search must be for rock outcrops.

Best hunting areas are on bare, steep hills and canyons where a sequence of many flows may be exposed. Not every flow will be amygdaloidal or porphyritic; massive flows may intervene and these contain few openings for minerals such as agate or zeolites. Barren flows can be quickly determined and by-passed for more productive amygdaloidal and fractured ones. Prospecting the base of cliffs and talus slides will reveal the possibility of minerals in place. Much good material was found by the writer in this way on the north shore of Kamloops Lake, east of Westwold, and east of Spences Bridge.

There are few areas in British Columbia where late Tertiary or possibly Pleistocene and Recent volcanic rocks contain gem quality olivine (peridot). These localities are the sites of volcanic cones built by layers of ash, breccia and flows. Most of the olivine occurs as granular masses or bombs. In most cases the individual crystals are too small to be of much use, but crystals large enough to facet are found. Two localities for peridot of workable size are known in British Columbia. These are Lightning Peak in the Kettle River (Little, 1957) and Takomkane (Big Timothy) Mountain in the Quesnel Lake map-area (Campbell, 1936b).

Lightning Peak is a small remnant of olivine basalt of Tertiary age which may be an eroded volcanic cone. The olivine occurs dispersed throughout the rock and in nests several inches across. In some of these clear crystals up to an inch in diameter have been found. Olivine basalt forms the upper part of the peak which is underlain by greenstone, limestone and paragneiss of the Anarchist Group. A number of prospect shalfts and adits lie along the north side of the mountain and some fine native silver specimens have been found on the dumps. Cairnes (1931a) mentioned wollastonite in limestone, and large crystals of amphibole and pyroxene on the slopes below the peak.

A few small areas of olivine basalt occur elsewhere (Map 6-1957; Little, 1957); some bear resemblance to the Lightning Peak deposit and may be worth investigating for peridot. Access to the area is by dry-weather road branching off Highway No. 6 about 22 miles from Edgewood.

The Takomkane (Boss) Mountain locality mentioned by Sabina (1964) may now easily be reached from 100 Mile House on the Cariboo Highway. It is 60 miles from the highway to Brynnor mine on the east side of Takomkane Mountain. Access to the peridot is by way of a trail climbing about 1,600 feet in about 2 miles from the mine property. Permission to use the trail should be requested from the management. The best part of this locality is on the northeast side of the north hill. Olivine bombs containing tiny olivine crystals are very common but gem quality peridot large enough to facet are rare. The olivine basalt formed a cinder cone now modified by erosion. It is of Pleistocene or late Tertiary age.

The possibility of new discoveries of peridot is considered good for the Quesnel Lake-Bonaparts Lake map-areas where clusters of peridot grains in fist-sized aggregates are known from Mount Timothy north of Timothy Lake and the hill on the north side of Jacques Lake. Olivine basalt is abundant in the southeast corner of Quesnel map-area (Campbell, 1963b) and can be considered favourable to the occurrence of peridot. Access to this area is provided by the road from No. 5 Highway at Clearwater on the North Thompson River.

Not all tertiary rocks are volcanic. In some areas they are sedimentary elsewhere both sedimentary and volcanic rocks occur interbedded or in successions dominantly either sedimentary or volcanic. In places old forests have been buried in sediments or covered by advancing lava flows. Much of the wood found in British Columbia is charred, but in some places, silicification has taken place forming petrified wood. Good material, however, seems rare; the best or at least some of the best material comes from the Vermilion Bluffs in the Princeton area. Rice (1947, p. 29) describes silicified wood on Mount Jackson about 2 miles southwest of Tulameen. Partly silicified wood from Perry Ranch, Kalamalka Lake and White Lake is generally of poor quality.

Occurrences of jasper, agate, perlite etc.

Princeton Area (Fig. 5)

Tertiary rocks in the Princeton area are well-known to most British Columbia rockhounds as a source of agate, petrified wood and fossils. Favourite localities include Vermilion Bluffs on the north side of the Tulameen River about four miles west of Princeton, and McCormacks Flats, which lies south of the Tulameen River opposite Vermilion Bluffs. Fossil localities along Whipsaw Creek and around the coal mines on McCormacks Flats yield plants, insects and fish. Older rocks contain deposits of copper minerals. Placer deposits of gold and platinum occur in Tulameen and Similkameen Rivers.

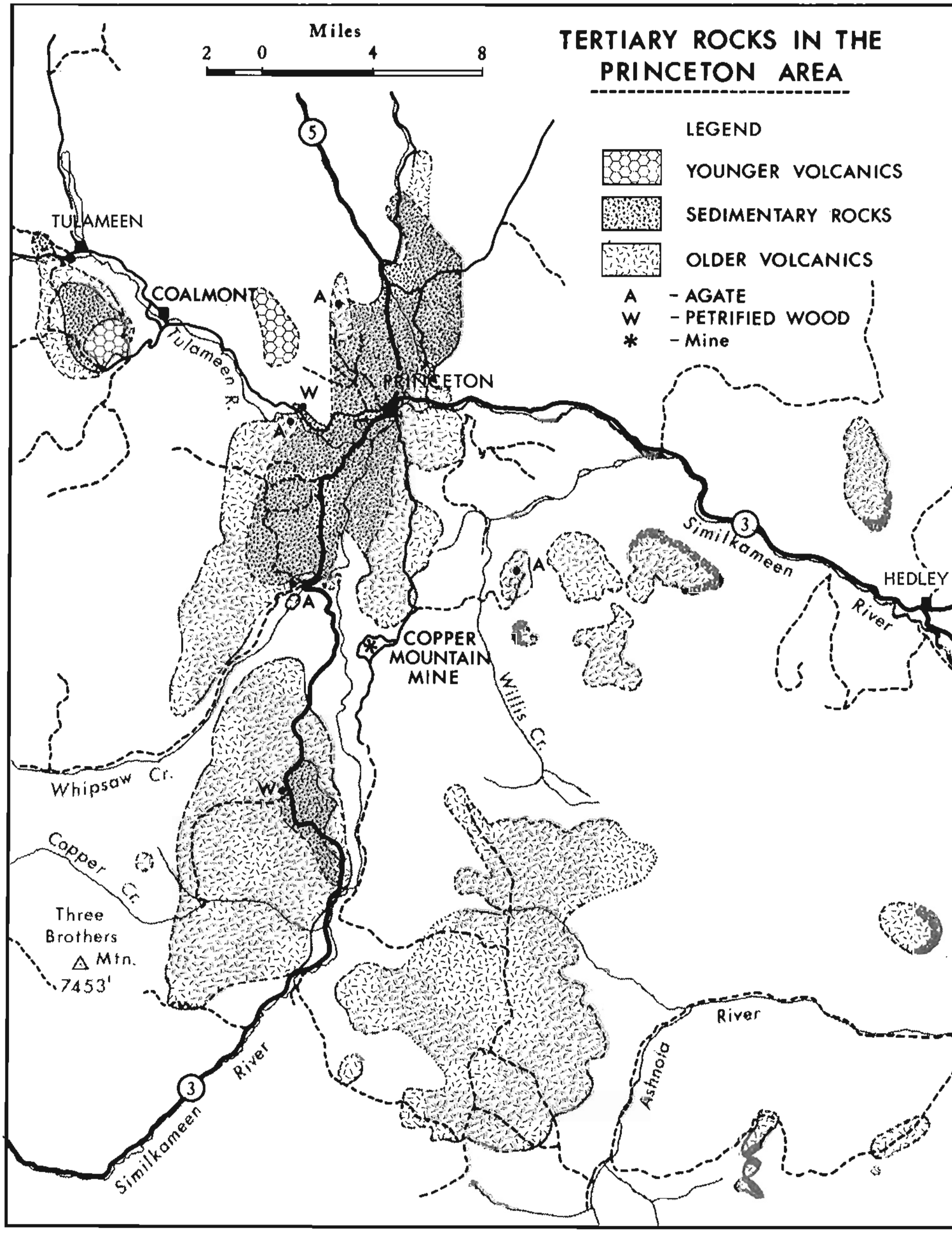

Figure 5. Reference: Geology: map 888A Topography: map 92H

Volcanic and sedimentary rocks of Tertiary age occur in the Princeton area. The sedimentary rocks are overlain and underlain by volcanic rocks and silica-bearing solutions associated with the latter have produced agate in fractures in volcanic rocks and replaced organic matter in sedimentary rocks thus giving rise to petrified wood. Further discussion of petrified wood in this area is included under the head of "altered rocks - silicification".

The volcanic division makes up most of the Princeton Group. These rocks are mainly andesite and basalt, commonly porphyritic or massive but in places flows are vesicular or amygdaloidal. Agate occurs in some flows as fracture fillings or amygdules. Zeolites are not noticeably abundant but may occur. Localities for agates within Tertiary lavas include the upper part of Vermilion Bluffs, northern parts of McCormacks Flats and Currie Ranch. Adjacent areas may well be as rewarding. The areas surrounding Placer Mountain and Friday Mountain probably have some occurrences of agate, opal, petrified wood and zeolites.

The main reference to the geology of the Princeton area is Memoir 243 (Rice, 1947). The report is accompanied by a coloured geological map (888A) and a mineral locality map (889). As well as the mineral localities, a number of fossil localities are described.

Penticton Area (Fig. 6)

Tertiary rocks in the Penticton area include volcanic flows and agglomerate with interbedded tuff and shale and local sedimentary basins with conglomerate sandstone, shale, and coal considered Eocene or Oligocene in age. Most of the volcanics are andesite or trachyte. Later volcanics of Miocene (?) age are mainly basalt or olivine basalt.

The area is well known for agate, opal and a variety of zeolites, as well as feldspar crystals, jasper, and rhodonite in non-Tertiary rocks. Precious opal has been reported (Vernon, 1965) but the precise locality was not stated. It is said to be 4 miles southwest of Princeton and hence may be somewhere north of Yellow Lake, less than 200 feet off the road.

Zeolites are abundant along the north side of Yellow Lake (see Plates I and II). They occur as nodules up to 2 to 3 inches in diameter and include natrolite, heulandite, laumontite, thompsonite and analcime. The rocks are trachyandesite flows. The hills north of Yellow Lake are reported to be good prospecting group for alluvial or residual occurrences of zeolites (N. Church, per. comm.).

Several localities for rhodonite are shown on Figure 5. They will be discussed later as they do not occur in Tertiary rocks. The Shingle Creek sanidine locality is also shown on this figure.

Figure 6 shows other mineral localities which are discussed elsewhere in the text. The principal geological reference for this area is map 15-1961 (Little, 1961). No memoir or report to accompany the map has been published by the Geological Survey. Further details of the Tertiary rocks in the White Lake Basin are given by Church (1971).

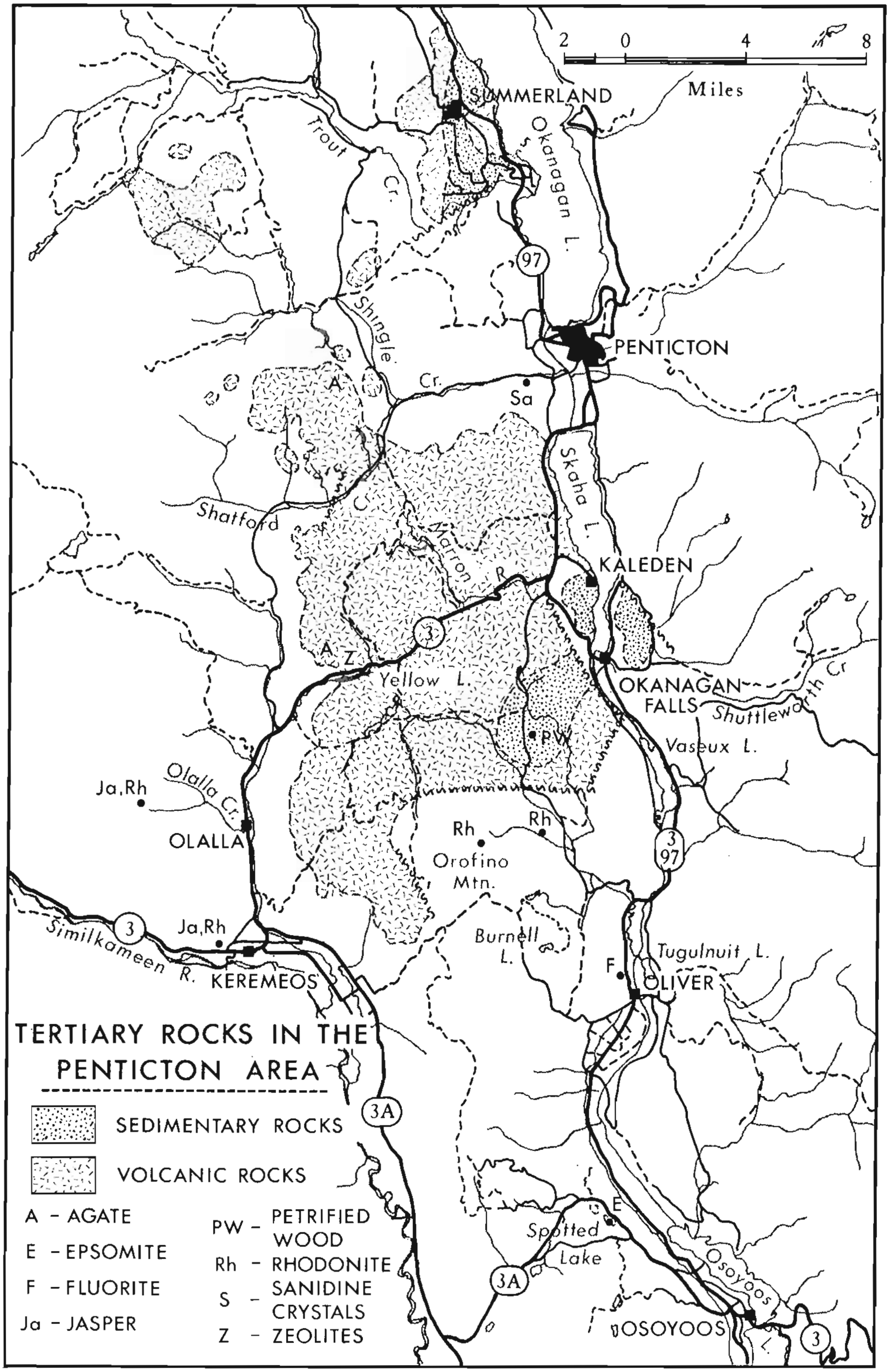

Figure 6. Reference: Geology: map 15-1961, Kettle River (W 1/2).
Topography: map 82E. Penticton.

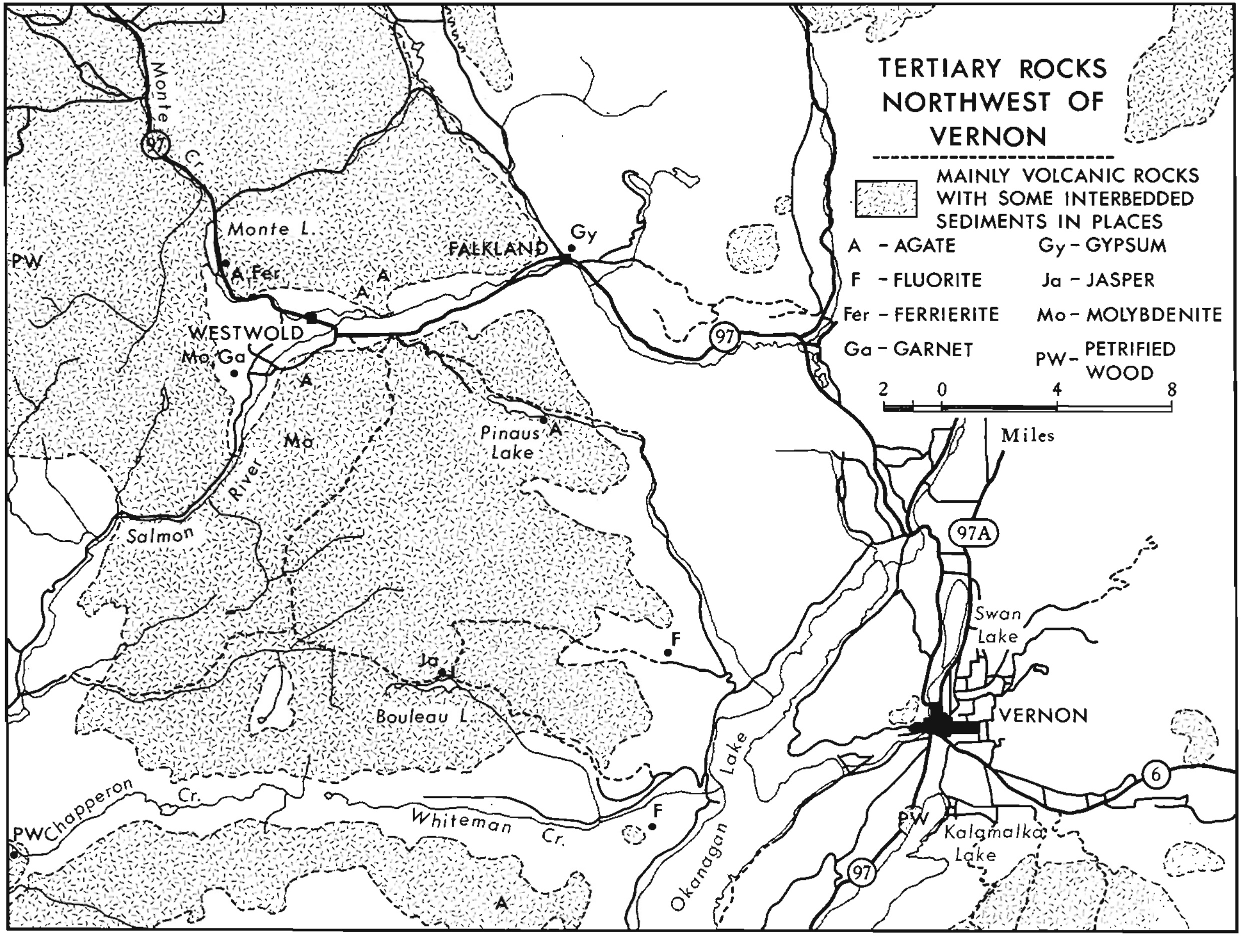

Figure 7. Reference: Geology: map 1059A, Vernon. Topography: map 82L, Vernon.

Vernon area (Fig. 7)

Tertiary rocks occupy a large part of the west half of the Vernon map-area. Most of the rocks are volcanic but sedimentary rocks occur. The volcanic rocks are mainly basalt but some andesite, and trachyte are found. Many of the flows are vesicular or amygdaloidal with zeolite, agate, opal, and calcite filling the vesicles. Fracture fillings contain irregular masses of agates. Amygdules and veins of agate are common around Monte Lake, Westwold, Lumby, Enderby, Squilax. Jasper is also found around Pinaus, Bouleau Lakes and Mount Ida south of Salmon Arm. Petrified wood is known in a few localities.

Distribution of Tertiary rocks in the Vernon map-area is shown on map 1059A published by the Geological Survey of Canada (Jones, 1959). Many of the known localities in this area are described by Sabina (1964). The widespread occurrences of agate in the Tertiary rocks is indicative of the potential for new discoveries. The writer has found agate in many places not recorded previously in the area south of Monte Creek and no doubt many more remain to be found. Figure 7 shows some of the favourable areas in the Vernon area. Some of the known localities include:

Monte Lake Agate occurs along Highway 97 at the south end of Monte Lake. Recently, ferrierite has been found in this locality (see Plate III).

Robbins Creek Agate and amethyst-lined geodes occur in the bluffs of columnar basalt. This locality has been hunted for years so that material is less abundant than formerly; most of the specimens are laboriously chiselled from the parent rock.

Douglas Lake Road The hills west of Douglas Lake road at a point about 7 miles from Westwold contain lumps and seams of agate.

Pinaus Lake Agate and jasper occur in the basalt flows along the south side of Pinaus Lake.

Westwold Forest Access Road A forest access road leaves Highway 97 at Westwold and winds up into the hills east of the village. Agate in various shapes and colours can be gathered loose or chiselled from basalt from the flows at the top of the plateau.

Adelphi Creek Agate was found by the writer along the cliffs at the head of Adelphi Creek southwest of Westwold.

Bouleau Lake Agate and jasper occur in the flows and float around Bouleau Lake.

Shorts Creek Amygdules of agate were found along a logging road leading to the plateau north of Shorts Creek.

Kamloops area (Fig. 8)

Tertiary rocks are widely distributed in the Kamloops area. A number of localities for agate, petrified wood, geodes and jasper are known but the best collecting areas appear to be in the hills north of Kamloops Lake and on Mount Savona. Figure 8 shows the distribution of Tertiary rocks in part of the Nicola map-area (Cockfield, 1948) and some of the best known collecting areas.

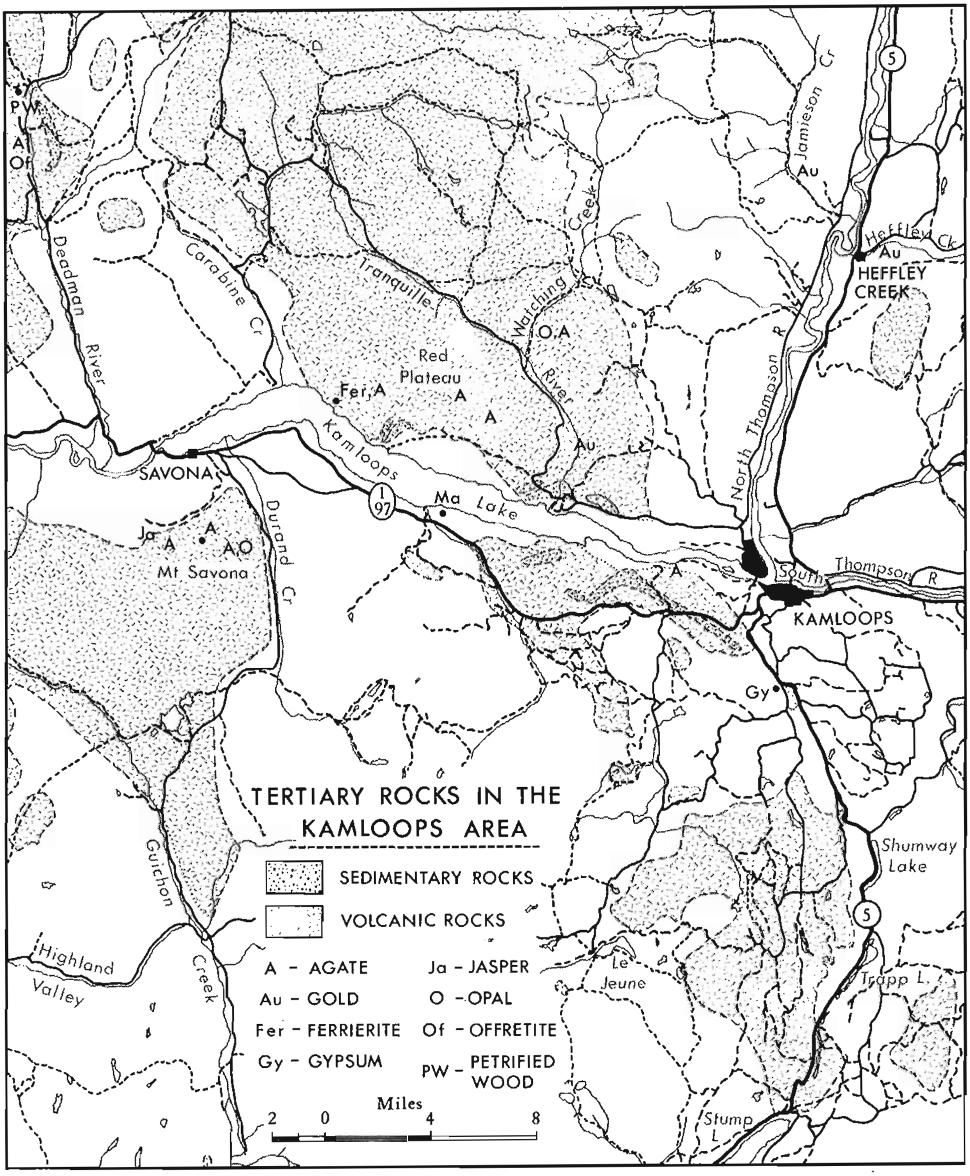

Figure 8. Reference: Geology: map, 886A, Nicola. Topography: map 92 I, Ashcroft.

The volcanic rocks are dominantly basaltic flows and breccias, but rhyolite, trachyte and andesite are also found. Sedimentary rocks occur in the volcanic sequences and petrified wood has been found in a few places, notably 13 miles up the Deadman Creek road from Highway 7.

Agates are abundant in the Kamloops area particularly in the hills along the north shore of Kamloops Lake from Tranquille to Copper Creek. Some nodular forms are geodes with amethyst-lined central cavities. Banded and plain agate (chalcedony) occur as vesicle fillings, irregular masses and as ribbons of seam agate filling fractures and spaces in brecciated flows. In places the agate has a pink cast but the usual colours are white to grey. The rare zeolite, ferrierite, occurs with agate and calcite in masses 3 to 6 inches long. The agate may be banded or plain. Ferrierite occurs as radiating spherical or conical groups of acicular crystals up to half an inch in length. The best collecting locality is marked by a rock-cut on the Canadian National Railways line near mile-post 17, three miles east of Carabine Creek. Specimens may be picked up along the lake shore in the beach gravel. Weathered material is brick red.

Agate is common in the bluffs overlooking the lake above the ferrierite locality. Collectors should be aware of the presence of rattlesnakes in this area.

Mount Savona is a good collecting locality. Access may be grained by the road, not suitable for cars, to the microwave tower at the summit. It leaves Savona-Merritt road about 7 miles south of Savona, approaching Mount Savona from the southeast. Best collecting areas are along the cliffs below the microwave tower site. Green opal, agate and geodes may be extracted from the cliffs of brecciated lava.

Jasper-agate and prehnite occur along the pipeline right-of-way on the Indian Garden Ranch west of Mount Savona (Sabina, 1964).

Fire opal is reported (Eric Larsen, pers. comm.) from a single nodule found in Watching Creek north of Kamloops Lake.

Cache Creek area (Fig. 9)

Tertiary rocks cover many square miles north and east of Cache Creek in Ashcroft map-area (Duffell and McTaggart, 1952) an area well known for agate, zeolite, petrified wood and opal, as well as copper, zinc, antimony, and chromium minerals. Figure 9 shows the distribution of Tertiary rocks in Cache Creek area and a number of known localities including some in rocks other than those of Tertiary age.

Rocks of the Kamloops Group of Miocene age extend from the Nicola map-area westward to Cache Creek and occur in isolated patches across the north half of Ashcroft map-area. In Cache Creek area they consist of flows, breccia and tuff, with an aggregate thickness of 3,500 feet. Amygdaloidal flows are common with the amygdules of agate, calcite, or zeolite minerals. In places the deposition of silica in irregular openings along fractures and between bombs and blocks give rise to masses of chalcedony which may be plain or banded, as in agate, or vuggy with crystalline quartz projecting into the unfilled cavity. Organic material in the flows or in interbedded sedimentary rocks locally forms deposits of petrified wood. Several zeolite minerals have been collected from these rocks, most notable is ferrierite, a mineral found nowhere else in the world.

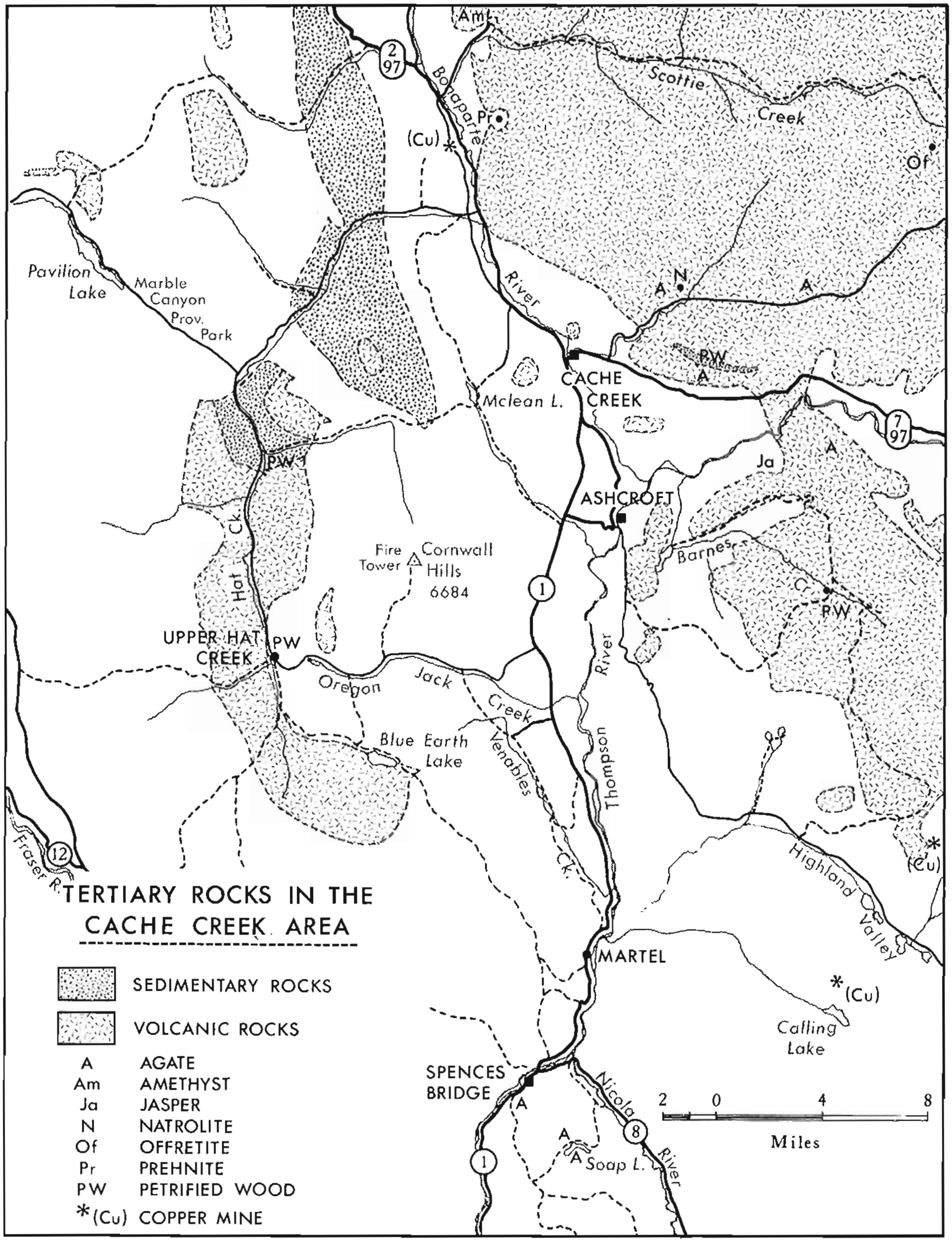

Figure 9. Reference: Geology: map 1010A, Ashcroft. Topography: Map 92I, Ashcroft.

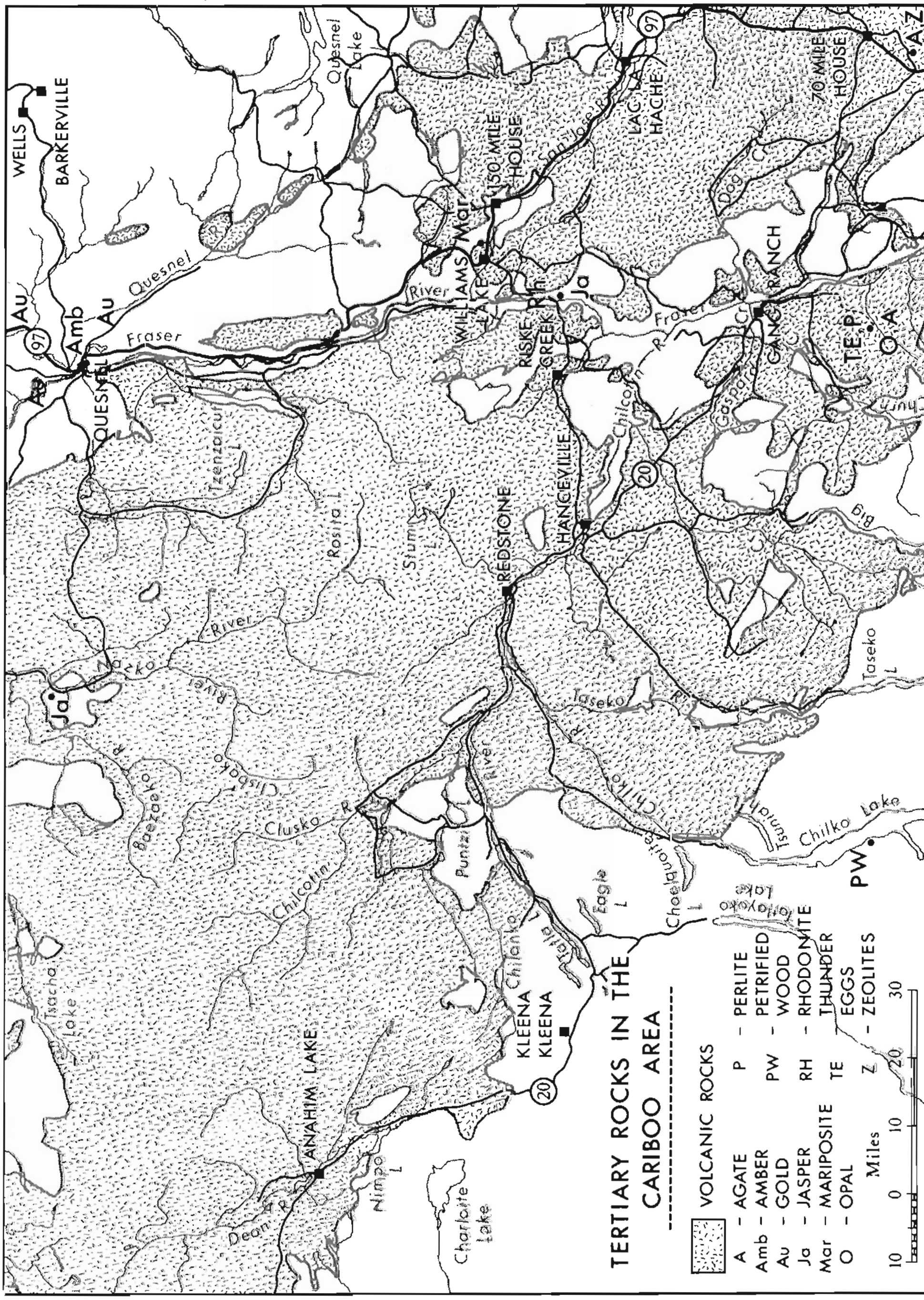

Figure 10. Reference: Geology: maps 29-1963, Taseko Lakes; 12-1959, Quesnel. Topography map: 920, Taseko Lakes; 93B, Quesnel.

Cariboo Area (Fig. 10)

Tertiary rocks are widespread in the Cariboo District centred on Williams Lake. However, there are few reports of agate, zeolite, jasper or geode localities in the western part of this area. Probably the area has not been extensively prospected as access is difficult and much of the area is drift-covered. There seems to be no reason why some valuable discoveries of lapidary materials should not be made in the Quesnel, Anahim and Taseko map-areas for which maps by Tipper (1957, 1959, 1963a, b) are available.

In the Cariboo District, the plateau basalt consists of numerous flows of fine-grained grey basalt of very even texture and is generally barren of agate. However, in one locality, the Painted Chasm, about 2 miles east of Highway 97 at a point about 12 miles north of Clinton (see Pl. V) zeolite and opal are abundant in amygdules. No doubt a few others will be found but in general it has been found that plateau basalts are generally barren of agate or zeolite. Large parts of the Bonaparte Lake, Taseko Lakes and Quesnel map-areas are covered by plateau lavas from which few localities of agates, opal or zeolite have been reported. Older lavas, however, are widespread and localities are known.

It should be borne in mind that in places older Tertiary rocks may be exposed beneath younger flows in cliffs, canyons and steep hillsides. Hence the mapping of an area as essentially plateau basalt does not preclude the possibility that older volcanic rocks will be found under them.

A few collecting localities are known near Williams Lake. Figure 10 shows the distribution of Tertiary rocks and some of the known localities. Localities outside the Tertiary areas are also plotted but are considered elsewhere in the text. Thus, the occurrences of chert and rhodonite and considered under sedimentary rocks.

The following localities include the best known collecting places and have been described by Sabina (1964).

Agate, opal, jasper and "thundereggs" are found in Tertiary rocks in the vicinity of Black Dome Mountain in the Empire Valley region west of Fraser River. The locality is shown on Figure 10 although it has not been visited by the author. A trip to Empire Valley was described by Sutherland (1958) and access is also described by Sabina (1964). The area is somewhat remote and no supplies or services are available once the Cariboo Highway is left 12 miles north of Clinton. The round trip is nearly 200 miles thus it is important to have enough gasoline and other supplies to last. The route to Empire Valley follows Meadow Lake road to the Dog Creek bridge over the Fraser River. On the west side of the river the road forks, one branch leading to Gang Ranch the other to Empire Valley. Agate, thundereggs and perlite occur on the property of Empire Valley ranch and beyond. The geology of the area is described by McCammon (1950) who stated that stringers and nodules of chalcedony are contained in a basic volcanic porphyry underlying perlite. Many of the thundereggs are equal in quality to the Oregon locality at Purdy's ranch. There are at least two localities for thundereggs and possibly more will be found. The area also contains opal and jasper.

The Painted Chasm, a gorge cut in Tertiary flows, contains an amygdaloidal flow with zeolites and opal near the top of the section. Similar flows are exposed in road-cuts about a mile south of the turnoff to the Chasm.

Burns Lake area (Fig. 11)

Tertiary rocks in the Burns Lake area comprise two groups of volcanic rocks, each with minor sedimentary formations. The older, Ootsa Group (Tipper, 1963b) is mainly rhyolite and dacite with minor andesite, basalt and sedimentary rocks. The younger, Endako Group, as defined by Armstrong (1949) consists of relatively flat-lying lava flows up to 2,000 feet thick. They are mainly dacite, andesite and basalt and commonly are vesicular or amygdaloidal with fillings of agate, zeolite, calcite, prehnite and pectolite.

The rhyolitic rocks contain glass, particularly the variety known as perlite. In Empire Valley, thundereggs are found associated with perlite and rhyolitic glass but none have been reported from the Burns Lake country. The possibility of their occurrence should be kept in mind.

Zeolites are common in vesicle fillings in many parts of the area. Stilbite as radiating groups and clusters occur in vesicles and fractures along the road north of Tchesinkut Lake. Banded agates are also found in the same place. The collecting localities are the rock-cuts along the road on the north side of the lake, and in the bluffs between the road and the lake.

Collinsite, a rare phosphate mineral (see Pl. VI) is found in a "vein" in Tertiary lavas on the property of Mr. C. Snyder on Brown Road (Fig. 12). Permission of access should be requested from the owner. The deposit lies along and near the top of a small hill overlooking an unnamed lake about 1/2 mile south of Mr. Snyder's house. A number of shallow pits through the overburden mark the locality. Black pitch is associated with the "vein" which is essentially flat-lying and probably marks the contact between two lava flows. Collinsite occurs in contorted veinlets and spherical nodules with radiating light brown fibres. The veinlets are commonly 1/4 to 1/2 inch thick. Tiny (1/8 inch) double terminated quartz crystals may be found in the pitch. Banded agate is also found in an amygdaloidal flow at the top of the hill. Further details are given by Armstrong (1949).

The Burns Lake area contains one of the few known localities of precious opal in British Columbia. Mr. John Shelford at Bruns Lake found two pieces of precious opal along Eagle Creek about 4 miles southwest of Burns Lake village. The locality was staked as a mineral claim but no further discoveries were made. The area is underlain by volcanic rocks of the Endako Group. Common opal and agate are plentiful.

Tertiary lavas along the shore of Francois Lake are well known for agate including the pink variety. Zeolites, opal and jasper are also present.

TRIASSIC EXTRUSIVE ROCKS

On Vancouver Island and Quadra Island volcanic rocks of the Karmutsen Formation of Triassic age contain brecciated pillow lavas of particular interest to rockhounds. These rocks have been named "dallasite" (see Pl. VII) from Dallas Road beach in Victoria where they were first found.

Pillow lavas are ellipsoidal masses of volcanic rock formed usually under water and produced by flowage of molten liquid within a crystallizing crust. Presumably a critical viscosity is needed and this is most often attained by submarine extrusion of lava. In some circumstances, continued flowage causes the skin to rupture so that broken fragments of the rim are mixed with tuffaceous material giving rise to a breccia prone to alteration. On Vancouver Island, alteration in places consists of replacement of the matrix by chlorite, epidote, pumpellyite, or quartz.

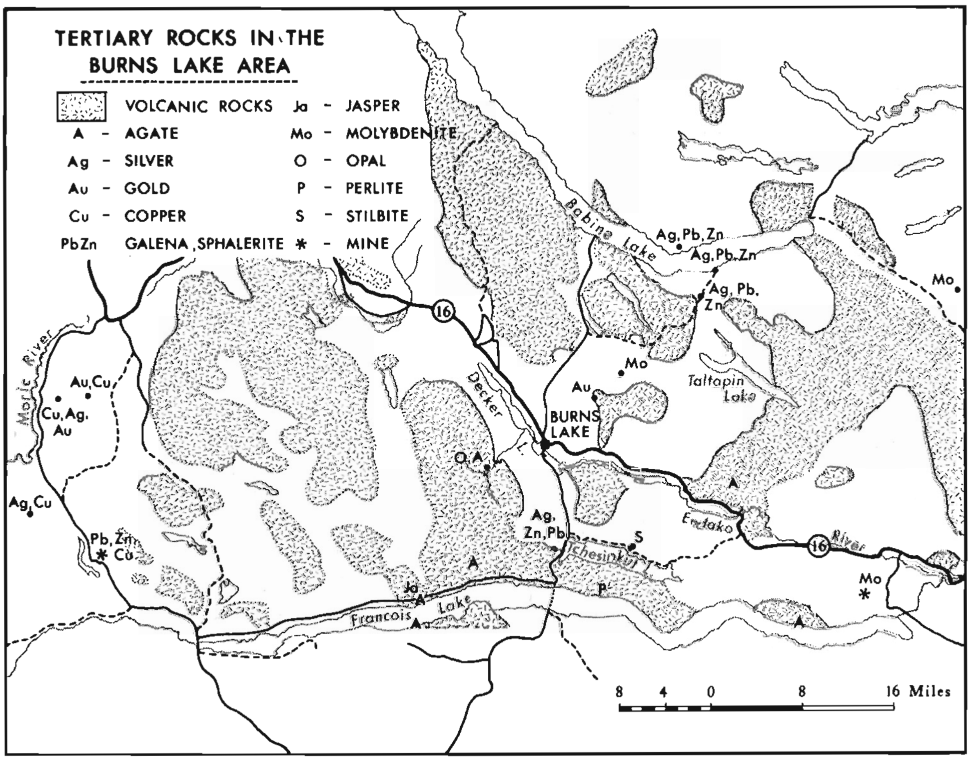

Figure 11. Reference: Geology: map 971A, Smithers – Fort St. James, Topography maps 93K, Fort Fraser; maps 93L, Smithers.

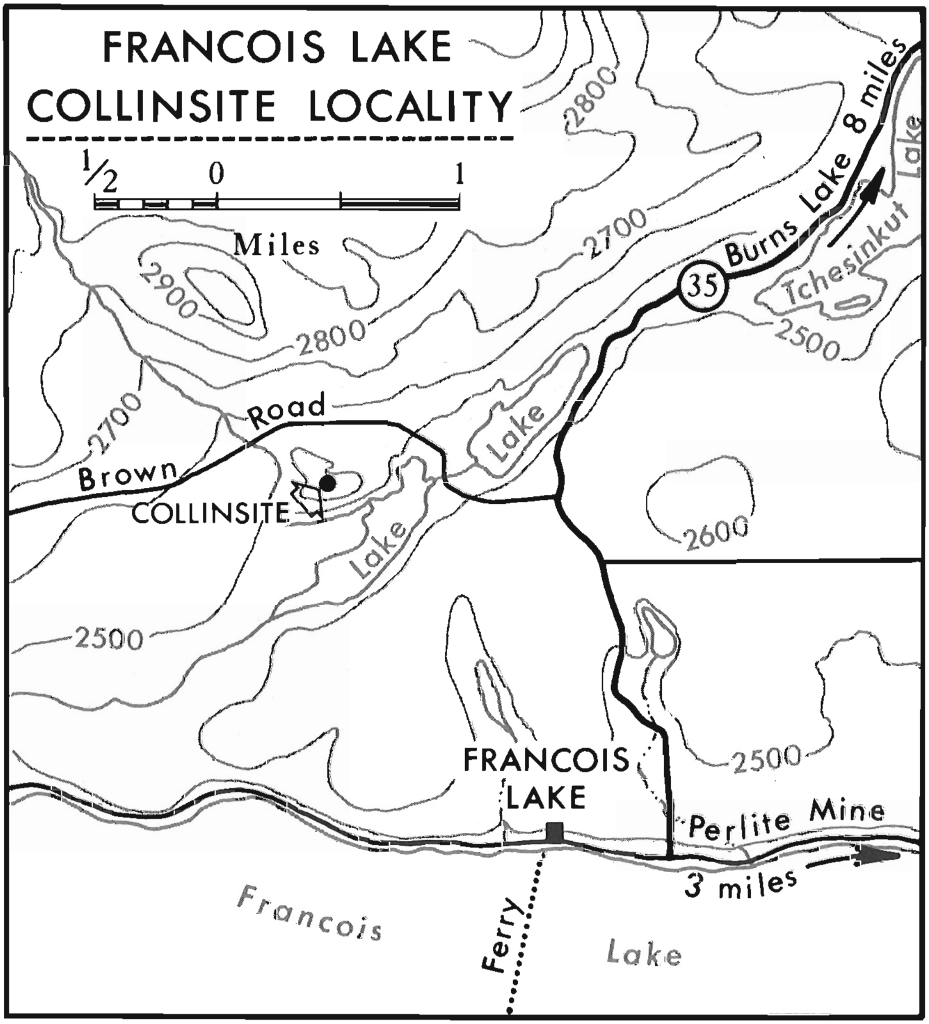

Figure 12. Reference: Geology: map 631A, Fort Fraser (W 1/2) Topography: map 93 K/4 (W 1/2)

Not everywhere has alteration produced an attractive rock, some pillow breccias are rather drab as the fragments and matrix are similar in colour and textures. Pillow breccias are known from the Tertiary Metchosin volcanics on southern Vancouver Island and possibly the original "dallasite" came from this formation.

"Dallasite" is abundant along the east coast of Vancouver Island. The Parksville areas include Horne Lake and Buttle Lake. In 1965, an in situ deposit was found along Elk River on the Elk River Timber Company road near milepost 35 a few miles west of Upper Campbell Lake. Dibb (1965) reported alluvial boulders were also found along the banks and bed of Elk River in this vicinity. Bedrock there has been mapped by Muller and Carson (1969) as Karmutsen volcanics of Triassic age. Pillow breccias are fairly common features of the Karmutsen although not everywhere is the matrix replaced in a manner to produce "dallasite" (Pl. VII).

Pillow breccias are abundant on Quadra Island. These rocks are also part of the Karmutsen Formation; Carlisle (1963) has discussed the formation of the structures and gives an account of geology. The rocks are similar if not identical to those found on Vancouver Island. Presumably much "dallasite" remains to be found on Quadra Island.

Pillow lavas of the Karmutsen Formation are also found on Texada and Lasqueti Islands. While no occurrence of pillow breccias is known to the writer, the possibility should be kept in mind by collectors.

CRETACEOUS EXTRUSIVE ROCKS

In south-central British Columbia, large areas of Cretaceous volcanic rocks are noted for agate localities (Fig. 13). Best known localities include the Shaw Springs area east of the Thompson River. The host rocks for these deposits are members of formations within the Spences Bridge and Kingsvale Groups. The full extent of these groups is shown on the maps of Ashcroft, Nicola, Princeton map-areas which were used for the compilation of Figure 13.

The Spences Bridge Group comprises a sequence of flows and pyroclastic rocks with minor amounts of sedimentary rocks. The volcanic rocks are mainly andesite and dacite but basalt and rhyolite are present. Breccias and agglomerates are common. Agate and zeolites are common in certain flows (see Pl. VIII). Known localities are shown on Figure 13 but it is possible that many good localities remain to be found.

The Kingsvale group comprises a succession of andesite and basalt flows, breccias, and tuffs with some sedimentary rocks at the base. Agates in amygdules and seams are common in some flows.

PERMIAN EXTRUSIVE ROCKS

The Sicker Group of Permian or earlier age on Vancouver Island contains numerous amygdaloidal flows of interest to collectors because of the bright red jasper associated with them. The rocks are described by Fyles (1955) but unfortunately his report is out-of-print.

The amygdules may be quartz, calcite, chlorite, or epidote. No mention is made of agate.

The rocks are distributed around Cowichan Lake, particularly on the north side. Cherty beds of the Sicker Group contain several rhodonite localities (see Fig. 14) and extend to Saltspring Island to the east and Alberni to the northwest. Jasper is associated with the sedimentary rocks in the group as well as with the volcanic rocks. The former are well known for several rhodonite localities (see under Sedimentary Rocks).

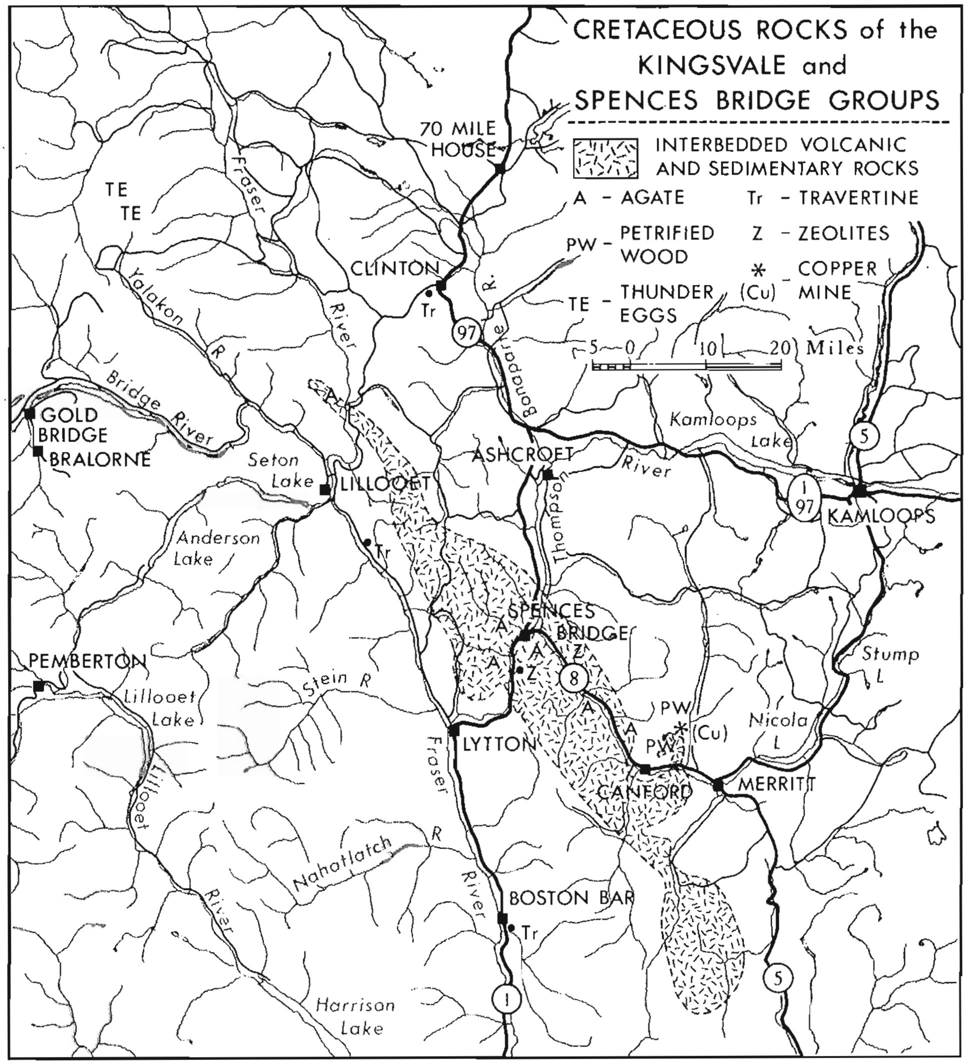

Figure 13. Reference: Geology: map 1010A, Ashcroft. Topography: map 92I, Ashcroft.

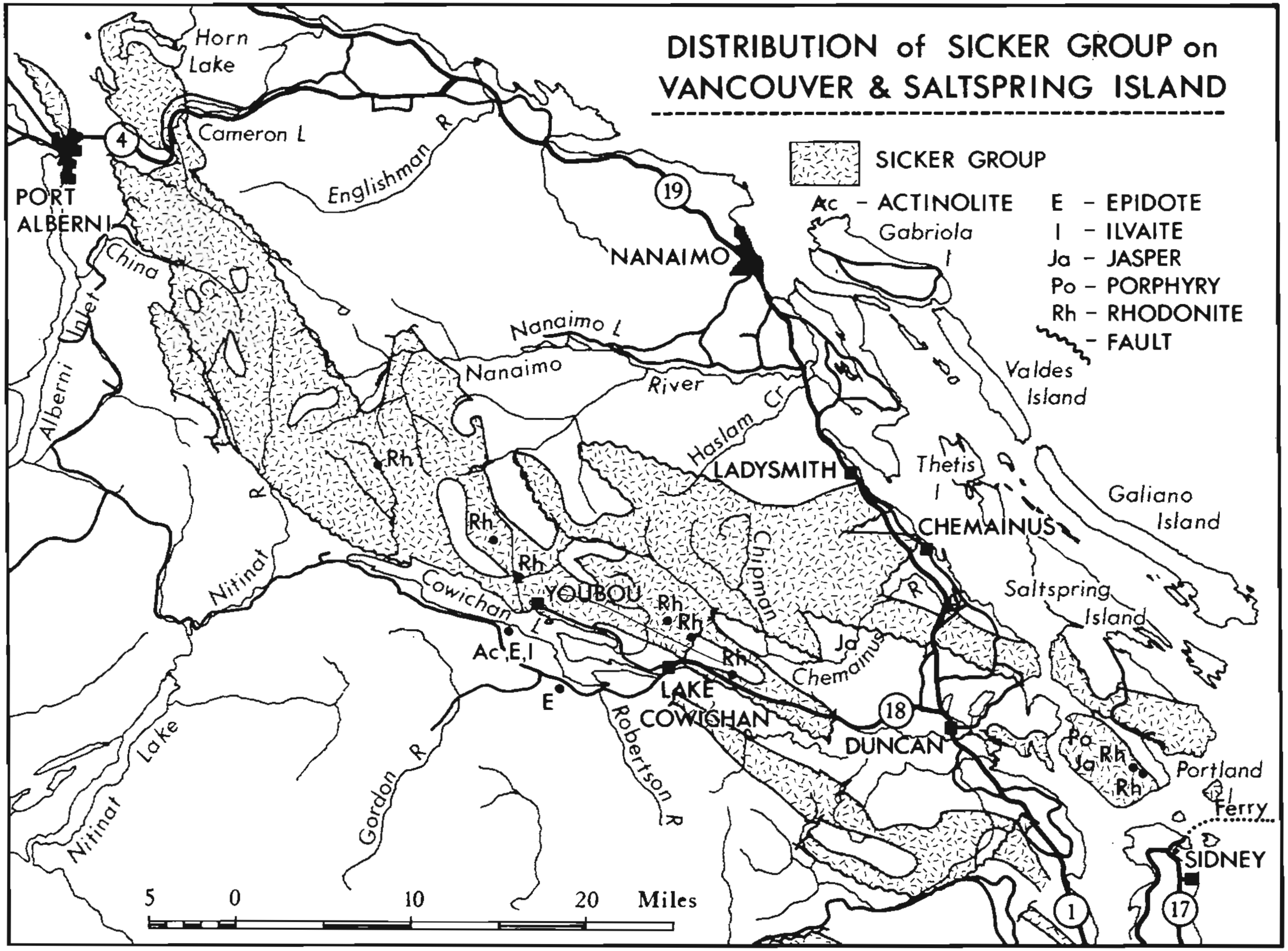

Figure 14. Reference: Geol. Surv. Can., Open File Report 61 - Reconnaissance map of Vancouver Island and Gulf Islands.

INTRUSIVE ROCKS

Intrusive rocks include a wide variety of coarse-grained rocks of little value for collectors. They may have very coarse grained phased, called pegmatites however, which yield specimen-sized samples of various minerals. Most pegmatites are granitic in composition and consist of quartz and feldspar with perhaps a little mica. These are the simple pegmatites. Complex pegmatites may contain in addition to quartz and feldspar, large crystals of beryl, tourmaline, garnet, spodumene, and muscovite.

Simple pegmatites are common in British Columbia but complex pegmatites are rare.

The Shuswap and Wolverine Complexes contain many pegmatites, a few of which contain beryl, tourmaline and garnet. The Bayonne batholith along the southern part of Kootenay Lake, and the White Creek batholith west of Canal Flata are good examples.

Syenite pegmatites associated with the Ice River Complex contain good specimens of aegerine, feldspar, nepheline, sodalite, tourmaline, kyanite and corundum. Unfortunately the best localities are inside the boundaries of Yoho National Park where collecting is prohibited.

The basic rocks may also have pegmatitic phases but they are uncommon in British Columbia.

PEGMATITE LOCALITIES

Mica Mountain locality

Pegmatite occurs on Mica Mountain about 5 miles south of Tete Jaune Cache in the upper Fraser River Valley. Large sheets of muscovite were mined at this locality as long ago as 1898. Little has been done since that time and there is no easy access to the property. Logging roads on the north side of the mountain provide access to the lower slopes but from there a climb of about 4,000 feet through alders and devils club is necessary. The pegmatite dykes contain garnet, beryl, tourmaline, apatite, and kyanite in addition to the mica. Topaz has been reported (Sabina, 1964). The rocks enclosing the dykes are garnetiferous mica schist which locally contains staurolite, kyanite and apatite. De Schmid (1913) gave a general account of the occurrences and a photograph of the locality as seen from the railway.

Mount Begbie locality

Pegmatite dykes on the northeast slope of Mount Begbie south of Revelostoke were reported by Jones (1959) to contain black, green and red tourmaline, beryl, red garnet and lepidolite. The tourmaline occurs close to the snowfield. Anyone intending to search the area should delay the trip until late August or early September to allow maximum melting along the edge of the snowfield.

Kootenay Lake area

Blue-green beryl is reported by Mulligan (1960) in pegmatites along Midge Creek about a mile west of Kootenay Lake. Garnet and tourmaline are also present. The occurrence lies in the Bayonne batholith in which dykes and irregular masses of pegmatite are numerous (Rice, 1941).

Cranbrook area

Pegmatite dykes and irregular masses are common in some places of the White Creek batholith. Reesor (1958) noted that pegmatite dykes are particularly abundant in the porphyritic quartz monzonite especially at the headwaters of Skookumchuck Creek. Beryl, tourmaline and garnet are fairly common accessory minerals. Logging roads provide access to the area, the main access road running west up Skookumchuck Creek from Skookumchuck station on the Canadian Pacific Railway about 30 miles north of Cranbrook.

Beryl occurs in pegmatites exposed along the road running south from St. Mary Lake about 25 miles west of Cranbrook.

Black tourmaline is also present. The geology of the area has been mapped by Leech (1957).

Adams Lake area

Pegmatites are abundant near Tumtum Lake in the Adams Lake map-area (Campbell, 1963a). Pegmatites are especially abundant on the east side of the valley at the south end of the lake. Books of mica are the main accessory mineral but the possibility of finding tourmaline, garnet, and kyanite must be considered good. Access is by way of a forestry road from Vavenby.

GRANITIC ROCKS

Granitic rocks are extensively used as ornamental and building stone. They are little used by collectors but they could be used for penstands and book ends. Most granitic rocks take a good polish and are attractive as specimens.

Collecting from Quarries will provide the best material because it may be collected from fresh unweathered rock. The following table gives the location and rock type of some of the quarries in British Columbia.

SYENITE ROCKS

Syenite rocks are light-coloured coarse-grained intrusive rocks consisting essentially of feldspar with minor pyroxene and/or hornblende. They are deficient in silica and hence they contain little or no quartz. Some varieties of syenite have produced some interesting lapidary material, notably sodalite.

TABLE 4

Some Rock Quarries in British Columbia

Quarry	Location	Rock Type	Remarks
Lefroy	east side of Okanagan Lake, 4 miles south of Okanagan Landing.	granite	light reddish
Vernon Granite + Marble	2 miles south of above quarry.	granite	pinkish, fresher than above.
Findlay Sinclair	1 miles east of Agassiz.	granodiorite	grey
Seabird Bluff	between Wahleach and Ruby Creek on main line of C. P. R.	granodiorite	dark grey
Gilley Bros. Limited	west side of Pitt River, 3 miles below the lake	quartz-diorite	-
Coast Quarries	east side of Indian Arm near the head	granodiorite	slightly gneissic
Vancouver Granite Co.	Nelson Island	granodiorite	even-grained
Granville Island	Granville Island.	granodiorite	mica, main dark mineral
Nelson Quarry	3 miles west of Nelson Island.	granodiorite	-

The main syenitic intrusion in British Columbia is the Ice River Complex in Yoho National Park, but National Parks policy prohibits rock collecting. The best the collector can hope for is the possibility that the many minerals associated with the Ice River Complex may be found as float in the drainage from the area. The most promising area is the headwaters of Moose Creek (Fig. 15) which approaches the southern boundary of the park. Allan (1914) described the geology of the area and mentioned sodalite, zeolite minerals, scapolite, and tremolite at the head of Moose Creek.

PORPHYRITIC INTRUSIVE ROCKS

Porphyritic intrusive rocks may contain large (1 to 4 inches) crystals of feldspar in a finer grained matrix. In a few places in British Columbia, porphyritic rocks weather in such a way that the phenocrysts are easily removed from the parent rock. One of the best collecting localities for feldspar crystals is on the side of the road up Shingler Creek west of Penticton (Fig. 6). There narrow dykes from the main mass of the dyke-like intrusion

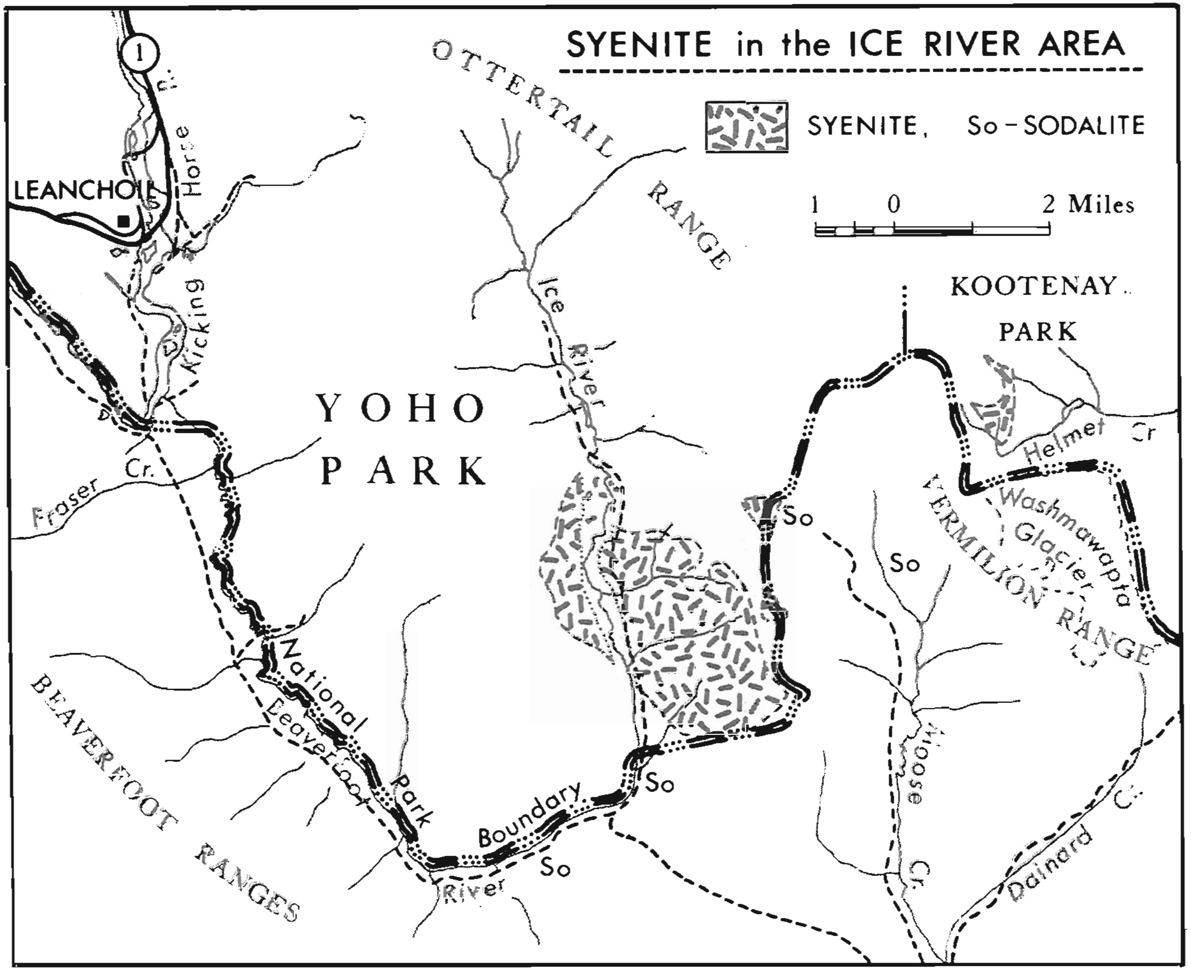

Figure 15. Reference: Geology: map 142A, Field map-area. Topography: map 82 N, Golden.

are exposed in rock-cuts along the public road. The remainder of the intrusion lies on an Indian reserve which is not open to collectors. The geology and mineralogy of the occurrences have been described by Bostock (1966).

The feldspar, a variety of orthoclase, occurs as single and twinned crystals up to four inches long. The most easily recovered crystals are slightly weathered on the crystal faces. Care must be exercised in removing the crystals from the matrix because of the tendency to fracture. The intrusion also contains phenocrysts of quartz up to one-half inch long. They exhibit bipyramidal faces and prism faces are short or absent.

Feldspar phenocrysts occur in porphyritic rocks of Rock Creek, near Downie Creek, and in the Monashee Mountains along Highway 6, but in none of these localities do the crystals weather out to the extent of the Single Creek locality.

The so-called snowflake porphyry which intrudes the Sicker Group on Salt Spring and Vancouver Island is of interest to collectors (see Pl. IX). The snowflakes or rosettes are plagioclase feldspar phenocrysts set in a matrix of gabbro or diorite.

BASIC ROCKS

Basic rocks are those consisting of calcium feldspars with hornblende or pyroxene as important constituents. Basic rocks include diorite, gabbro, and anorthosite. Some building and ornamental stones are cut from basic rocks but they are of little interest to collectors. Alteration of basic rocks may produce epidote which may make gemstones when cut en cabochon.

ULTRAMAFIC ROCKS

Ultramafic rocks are those rich in magnesium and iron and are dominantly olivine and/or pyroxene-bearing. Very commonly these rocks are altered to serpentine. Ultramafic rocks are of great importance because of the association of asbestos, nickel, chrome, platinum, iron, and titanium with them. Of interest to collectos, especially rockhounds, is the association of jade with ultramafic rocks. Until recently the association of jade and ultramafic rocks was only suspected because of a spatial association of the jade boulders. Recently the genetic relationship has been proven by the finding of jade in place in a number of localities in British Columbia.

In some respects jade should be considered under the heading of metamorphic and metasomatic rocks for there is little doubt that it is commonly formed by chemical changes of rocks in contact with ultramafic rocks. Many jade occurrences are associated with rodingites. They appear as light coloured bodies engulfed in or bordering serpentinite.

Little research has been done on jade in British Columbia. Reports on ultramafic areas rarely mention the mineral. Probably the main reason for this omission is the paucity of material in situ. The main source of jade has been the alluvial boulders found along the Fraser, Bridge, and Coquihalla Rivers in southern British Columbia, in the Mason Creek area of Fort St. James in central British Columbia and at Wheaton Creek and Dease Lake in northern British Columbia. The boulders rarely resemble the gem quality material sawn from the unweathered interior. The exterior usually is not

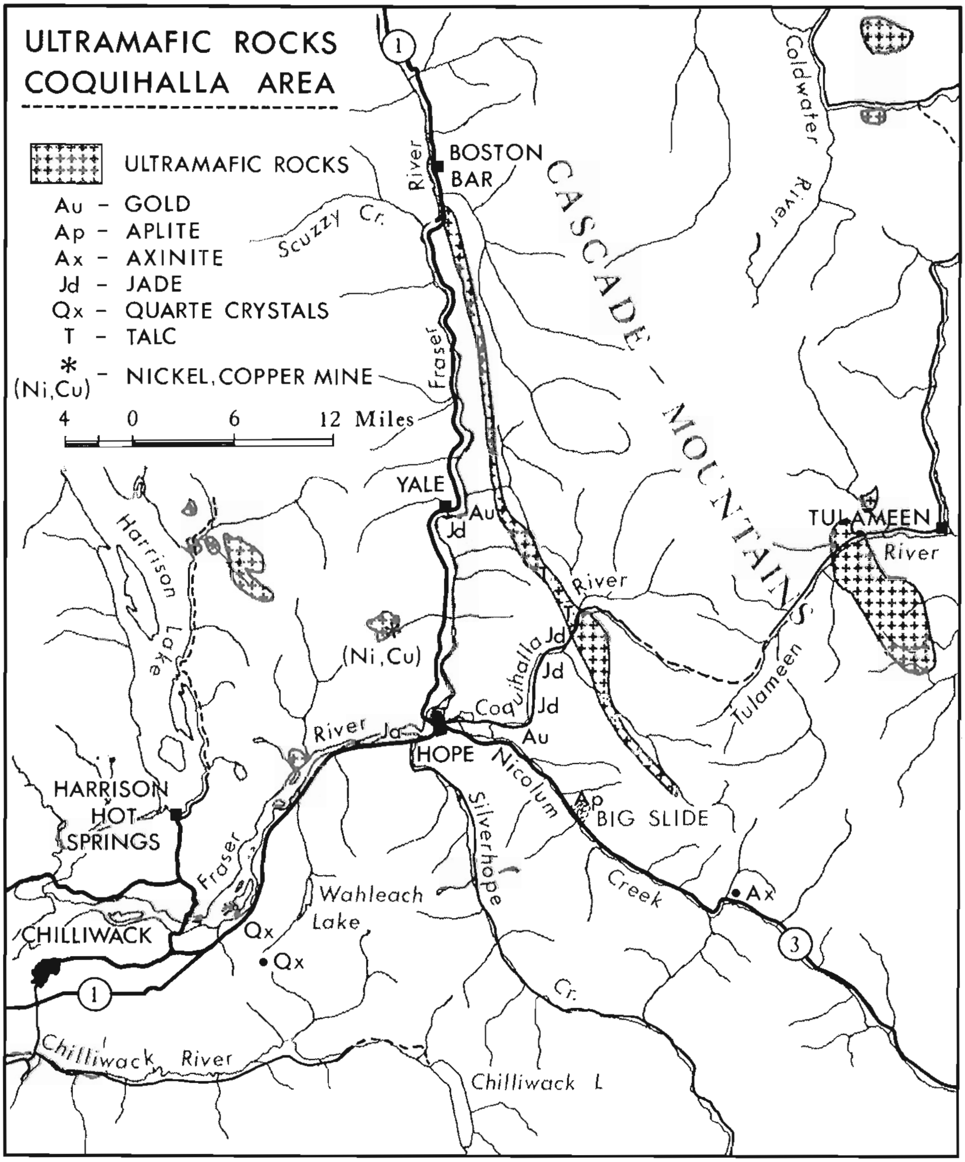

Figure 16. Reference: Geology: map 12-1969, Hope. Topography: map 92 H, Hope.

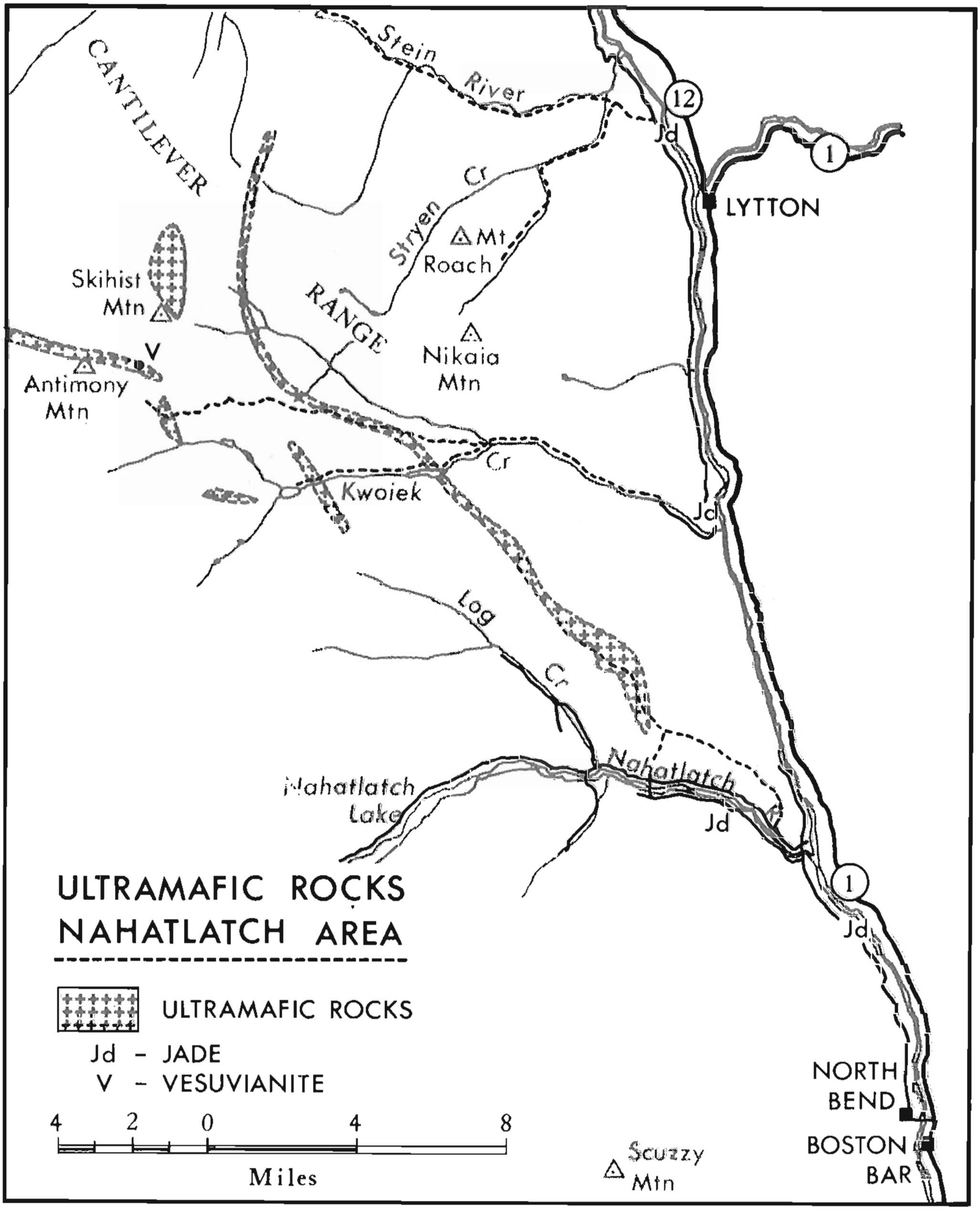

Figure 17. Reference: Geology: map 1010A, Ashcroft. Topography: map 92 I, Ashcroft.

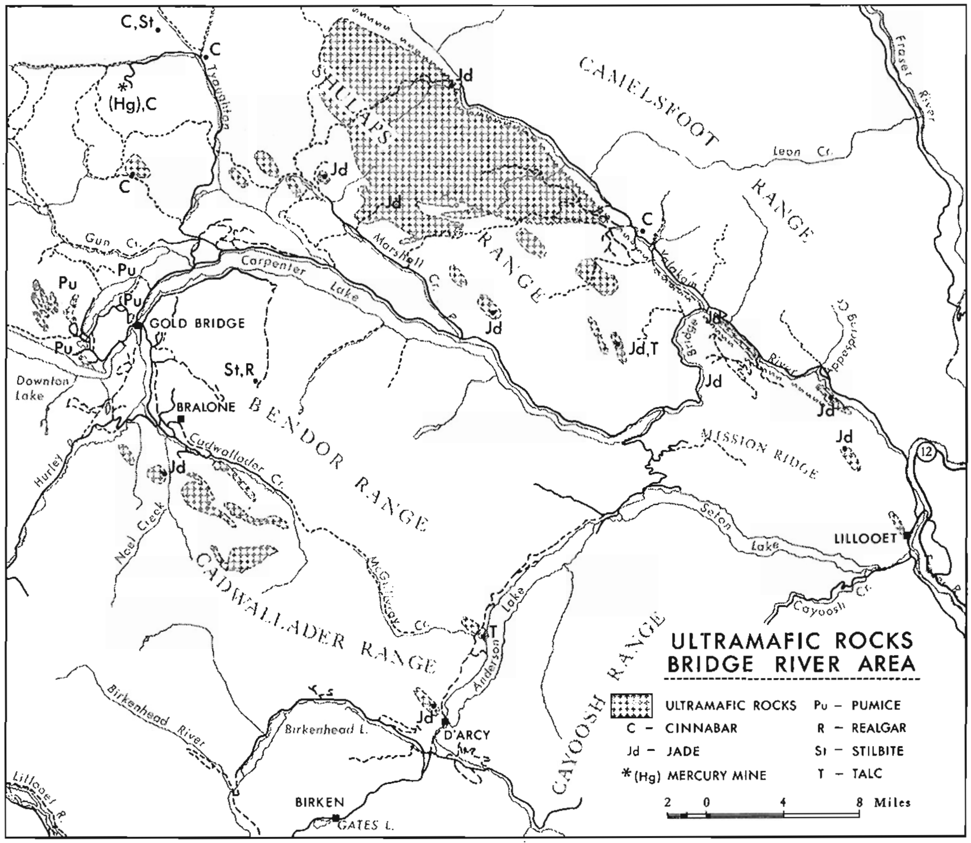

Figure 18. Reference: Geology: map 1882, Bridge River. map 430A, Gun Lake. map 431A, Cadwallader Creek. Topography: Map 92J, Pemberton.

green, and may br rough and knobby, black, grey, tan or orange. Experts recognize jade by a rough platy structure and, on a broken surface, a hackly fracture, and translucency of the thin edge. Jade in British Columbia is the variety made up of fibres of nephrite, a variety of tremolite-actinolite amphibole. It is the interwoven bundles of tiny fibres of nephrite which give jade its toughness (Pl. X). In most jade specimens there is a preferred orientation of the nephrite fibres which gives boulders a particular aspect recognizable to the trained eye.

JADE (NEPHRITE) OCCURRENCES

Coquihalla area

Jade has been found as boulders along the Coquihalla River from Jessica to the confluence with the Fraser River. It is evidently derived from zones within the belt of serpentine which crosses the valley at Jessica. Best occurrences of jade are reported from Sawaqua Creek (see Fig. 16). The serpentine belt extends along the east side of the Fraser River for about 20 miles and could account for most of the jade boulders found along the river on various bars from Hope to North Bend.

Nahatlatch area

A break in the continuity of the serpentine belt occurs between Boston Bar and Keefers. Serpentine then appears north of Nahatlatch Valley where several narrow bands of serpentine have yielded jade in the drainage basin of the Nahatlatch River. Figure 17 shows the distribution of serpentine bands in this area.

Vesuvianite is found in serpentine two miles southwest of Skihist Mountain. Some gem material was reported by Duffell and McTaggart (1952) but most of the material is massive and opaque; the best is apple-green and translucent. The mineral occurs in the serpentine with a white rock flecked with green. Float from the locality may be found in the Nathatlatch Valley. Jade is reported from this area by Mr. W. Zacharias (pers. comm.).

Bridge River area

Jade has been found along the course of Bridge River from its confluence with the Fraser upstream to the dam which now floods the upper reaches of the river. Most of this distance is either on Indian Reserve lands or is held by lease by individuals and is accordingly out-of-bounds to collectors in general. A short stretch of the river bed downstream from the dam is open to all, but little jade has been reported here. Bouvette's Motel in Lillooet holds a lease on which their guests may hunt with certain restrictions.

The source of the jade in the Bridge River area is the serpentinized rocks which extend along the river north of Lillooet, the large mass of serpentinized rock of the Shulaps Range between Bridge and Yalakom Rivers, and serpentine bodies in the vicinity of Bralorne. Jade is found in place at the head of Hell Creek, a tributary of Bridge River, about 2 miles upstream from the confluence with Yalakom River.

The deposit is held by Mr. Oscar Messeser of B.C. Gem Supply Limited. Several 'veins' of jade are found on the property but the main supply has come from one vein about 8 feet wide lying between serpentine and slightly metamophosed argillaceous sediments (Pl. XI).

The jade-sediment contact is a fault; the jade-serpentine contact is gradational and varies from jade to talc to serpentine. About 1,000 feet north of the deposit, granite interrupts the continuity of the jade zone.

Yalakom River drains the northern part of the Shulaps Range and contains many serpentine boulders but there are few, if any, authentic reports of jade boulders. Yalakom River is well known to rockhounds as the source of "yalakomite", an alteration product accompanying serpentinization of ultrabasic rocks. The main constituent is magnesite and quartz, but it is coloured by pink jasper and green mariposite and makes attractive penstands and bookends, etc. This rock is called simply quartz-carbonate rock in the United States but gold mining distric in the Ural Mountains it is called listvenite.

Marshall Creek drains much of the southeast part of Shulaps Range and many large boulders of jade have been recovered from the lower part of the river. Because much of this ground is held by lease, collectors should inquire at the provincial Government Agent's office in Lillooet for current status. Jade has been reported in place in several parts of the Shulaps Range. Most of the localities are above timerline and would not be of interest to older collectors or those with little time to hunt. Jade occurs in situ up Brett Creek which flows into Marshall Creek about 6 miles from the Bralorne Road.

Greenbay Mining produces jade from a location on Brett Creek, a tributary of Marshall Creek. There the jade occurs along the contact between a block of chert and the surrounding serpentine. At the time of the writer's visit, only small amounts of jade were visible and it was impossible to estimate the size of the deposit.

Serpentinite occurs throughout the Cadwallader Range. The extreme eastern end of the range is at Anderson Lake where a small jade lobe was found by Mr. Harry Street (see Pl. XII).

Jade is found up Noel Creek in the vicinity of the Bralorne Mine (see Pl. XIII) at the western end of the Cadwallader Range. Mr. H. Street, owner of the Royal Jade Mine is producing jade from the contact zone between diorite and ultrabasic rocks (H. Street, pers. comm.).

Although the association of jade and serpentine rocks is now firmly established (Holland, 1962), few professional reports mention jade in those areas where it is now found by amateurs. The reports are of use mainly as a guide to the distribution of serpentinized rocks.

Useful maps and reports for the Bridge River area include those by Leech, 1953; Drysdale, 1915, McCann, 1922; Cairnes, 1937.

Fort St. James Area

Jade has been found in many places in the Fort St. James area (Fig. 19). Initial discoveries were from alluvial boulders but in recent years in situ deposits have been reported. Productive streams for alluvial jade include Vital, Kwanika, Ogden and Quartz Creeks, and Fall River west of Manson Creek. O'Ne-ell, Van Dekar and creeks on the north side of Mount Sidney Williams have produced to a lesser extent.

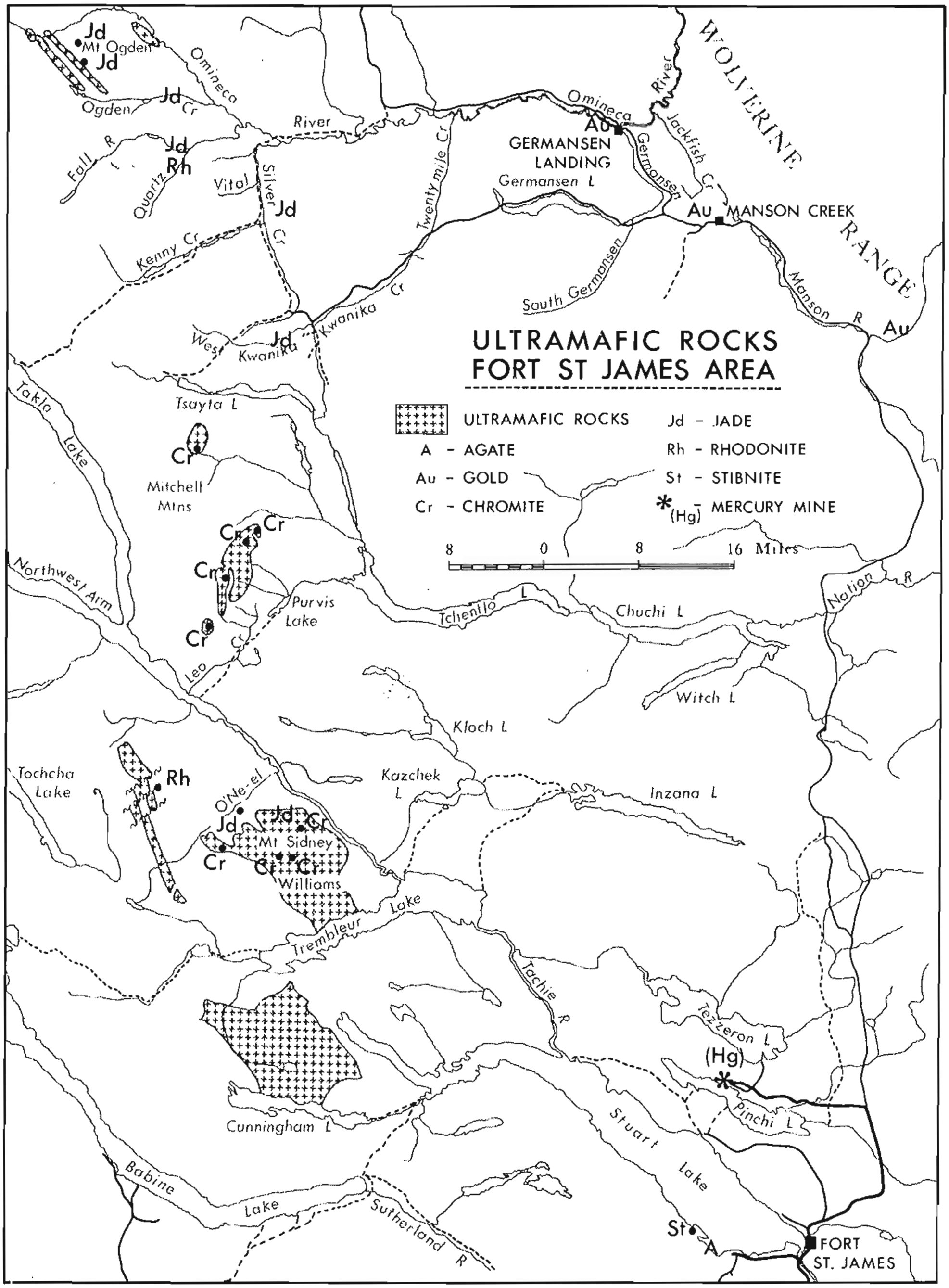

Figure 19. Reference: Geology: map 907A, Fort St. James. Topography: map, 93K, 93N.

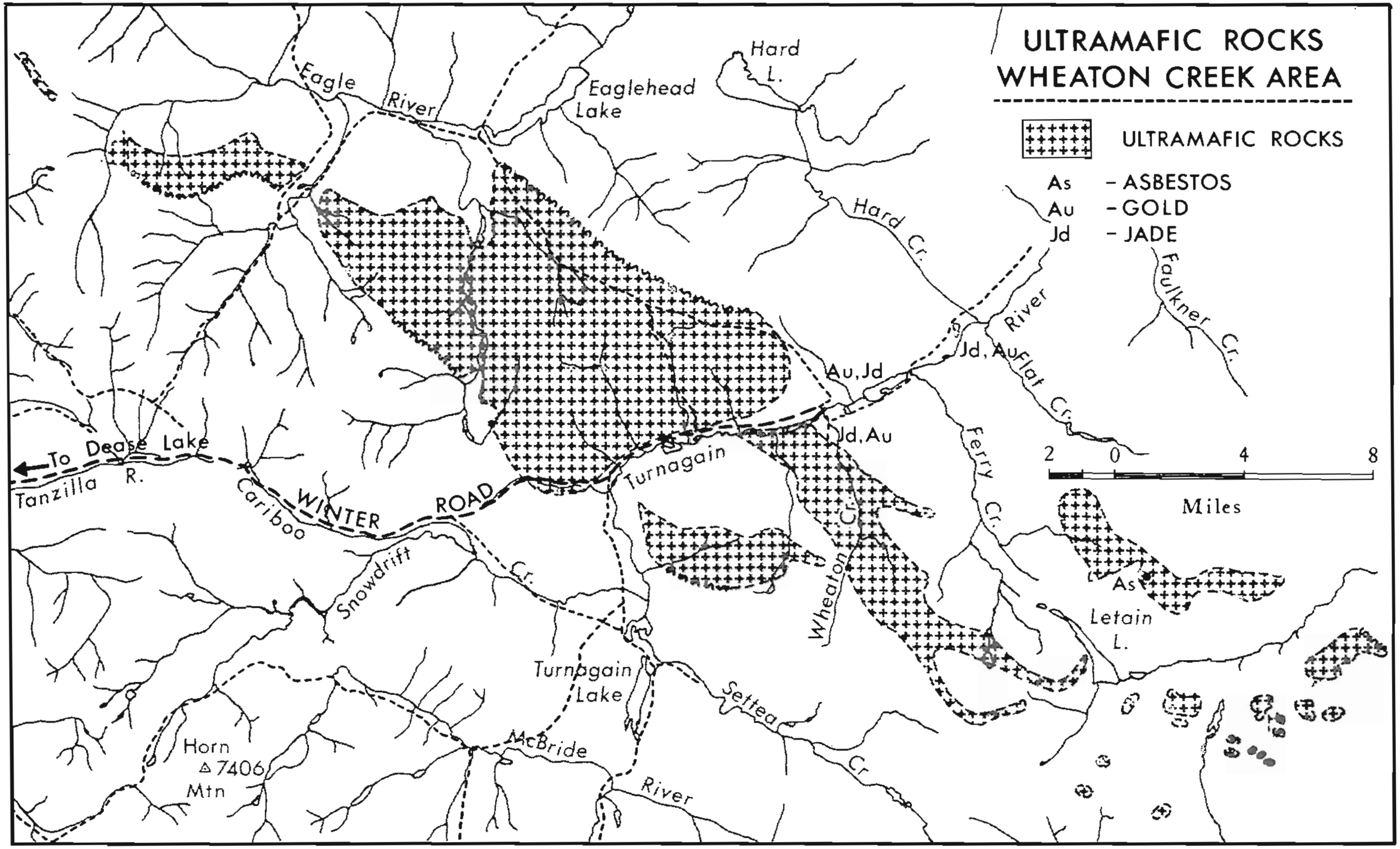

Figure 20. Reference: Geology: map 29-1963, Cry Lake. Topography: map 104 I, Cry Lake.

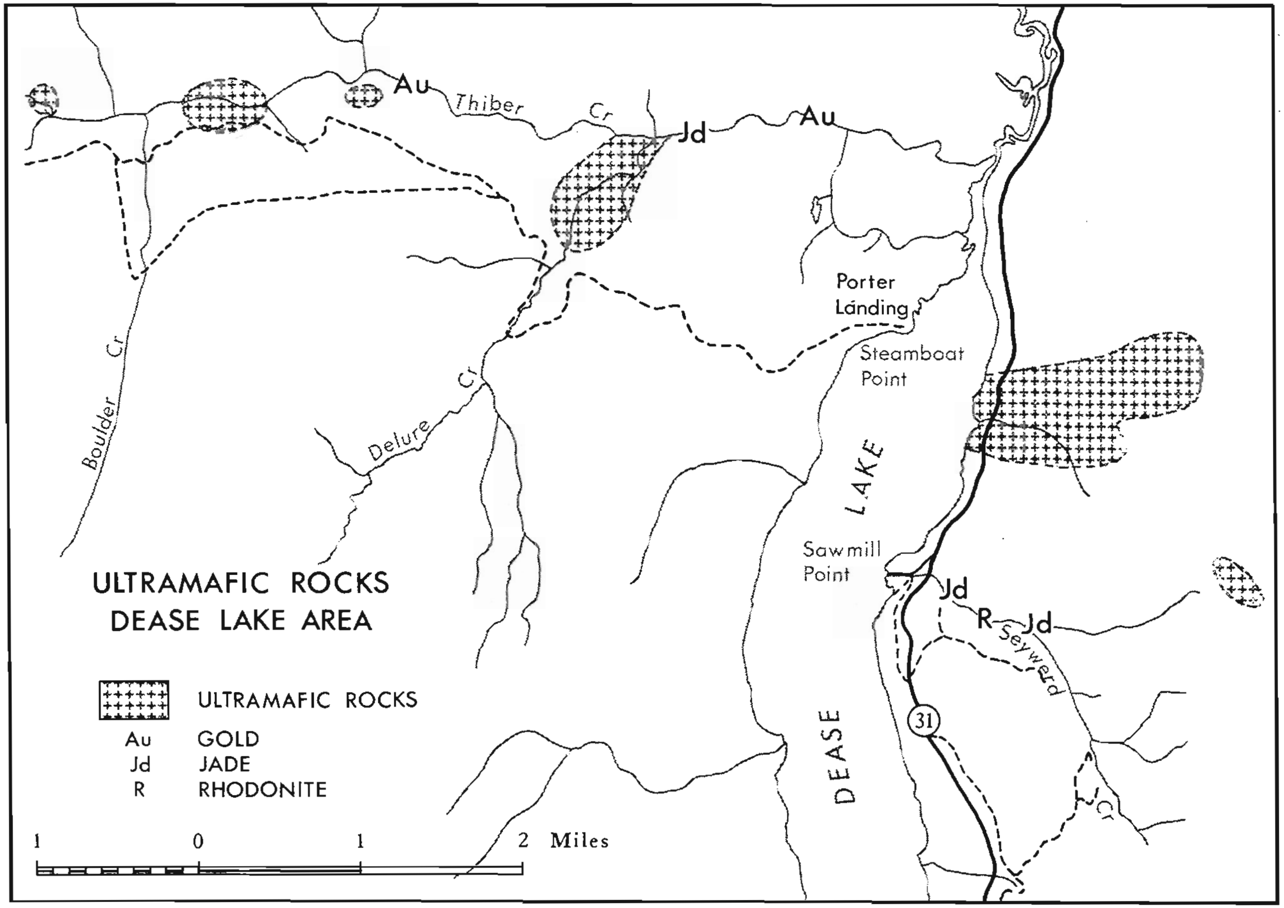

Figure 21. Reference: Geology: map 21-1962, Dease Lake. Topography: map 104J, Dease Lake.

Two deposits of jade in situ are known in this area. It is unlikely that these account for the widespread alluvial deposits and further bedrock occurrences may be expected.

The Jade Queen mine lies near the head of O'Ne-ell Creek on the north side of Mount Sidney Williams about 50 miles north-northeast of Burns Lake. Large blocks, slabs and boulders led to the discovery of the in situ deposit along a serpentine-granite contact. The deposit has not been seen by the writer. The discoverer of the deposit, Mrs. Winnifred Robertson donated specimens from the property. The material is typical of B.C. nephrite jade ranging from good gem material to mottled and schistose rock of inferior quality. A reserve of 8,000,000 pounds has been claimed for the property.

Another bedrock occurrence in the area is that of Teegee Explorations on Mount Ogden about 54 miles west northwest of Manson Creek. This deposit was found by Mr. L. Owens and Mr. S. Porayko of Manson Creek who were prospecting for jade at the head of Ogden Creek.

This deposit was seen by the writer during the early stage of development when most of the production came from loose parts of the deposit and blocks and boulders in the vicinity of the outcrop. Development had proceeded far enough to demonstrate the nature of the occurrence which was seen to be in a contact zone between serpentine and rocks of the Cache Creek Group. The deposit is exposed for 150 feet along trend. Part of the zone consists of talc schist and rodingite or "white rock" which together with the jade is up to 10 feet wide. Except at the outcrop, the zone is concealed by overburden, but the aeromagnetic map (Geol. Surv. Can. 5286G) indicates a possible continuation for at least a mile.

A third possible bedrock occurrence lies about 2 miles northwest of the Teegee deposit. However, the owner was working on an 80-ton block which was clearly not in place. Several large blocks are located on the property and these will be cut up before the in situ deposit will be given any attention. This property owned by Mr. L. Barr is known as Far North Jade Mines. Production is reported at several tons mostly cut into small blocks of the best material on the property.

Wheaton Creek area

Jade was first reported on Wheaton Creek (Fig. 20) in 1938 (Holland, 1962) but it was not until 1957 that any of the material was brought out for sale. Since then there has been continued production. In 1965, 25,000 pounds of jade were flown out of the Wheaton Creek placers (B.C. Min. Mines Ann. Rept., 1965, p. 250).

Most of the boulders reported are large; a few may be as large as 10 to 15 tons; some are said to be as small as 300 pounds. The size of the large boulders presents a problem to casual collectors as few are equipped or prepared to break up the large pieces into managable size. Most commercial operators construct portable field saws to sample the boulders as much as to reduce their size. In these remote areas it is not economical to bring out inferior rock.

Serpentinized rocks are distributed in a belt about 50 miles long by 8 miles wide centred on Wheaton Creek (see Fig. 20) and it is highly probable that many more localities for jade will be found in the future. The distribution has been mapped by Gabrielse (1962b). His map, on a scale of four miles to one inch, is invaluable to anyone contemplating prospecting for jade in the Wheaton Creek area. Many streams besides Wheaton Creek drain serpentine areas and potential ground can be postulated from an inspection of the map.

The jade-bearing rocks are serpentinized peridotites of late Paleozoic age. They occur associated with diorite and altered diorite of uncertain age which extend into the adjoining map-area. At one time a road led into Wheaton Creek from the south end of Dease Lake but on last report (1965) it was impassable.

Dease Lake area

Ultramafic bodies have been mapped in the Dease Lake area by Gabrielse and Souther (1962). Large bodies of serpentine and peridotite in the northwest corner of the map-area are not known to have any associated jade. Serpentine bodies extending along a fault zone from the north end of Dease Lake (Fig. 21) along Thibert Creek have yielded jade boulders to the streams. Large jade boulders in the creek at Sawmill Point on the east side of Dease Lake presumably came from the nearby serpentine. These occurrences are the most accessible of the known localities in the northern part of British Columbia, being adjacent to the Cassiar-Steward Road. The ground along the creek at Sawmill Point has been staked for placer leases for at least 1/2 miles, and these may still be valid.

McDame area

Ultramafic bodies of jade-bearing potential are abundant in northwestern British Columbia but few jade discoveries are known. Recently jade has been recovered from Cassiar Asbestos mine. No reference to jade can be found in the literature but certain statements may be construed as highly suggestive of the presence of jade. Thus Gabrielse (1963, p. 71) referring to ultramafic rocks in a contact zone with the Cassiar batholith stated, "...farther from the contact the periodtite contains considerable tremolite ... Tremolite has replaced both olivine and pyroxene." Also Gabrielse described tremolitization in these words, "In a few instances an almost monomineralic tremolite hornfels has formed", (particularly along the contacts between volcanic rocks and ultramafic intrusions).

The area shown on Figure 22 is accessible if somewhat remote. In prospecting for jade in this area it should be remembered that the last ice-sheet moved in a northerly direction over the Cassiar ultrabasic rocks and hence most, if any, boulders formed during pre-Pleistocene weathering should be disposed on the north side of serpentine outcrops. Best prospecting ground then is likely to be at the head of, and down Little Blue River.

A body of ultramafic rocks about 17 miles north-northwest of Cassiar has received special study by Wolfe (1965) who mapped an area of amphibole-bearing dunite and peridotite which may be jade in part.

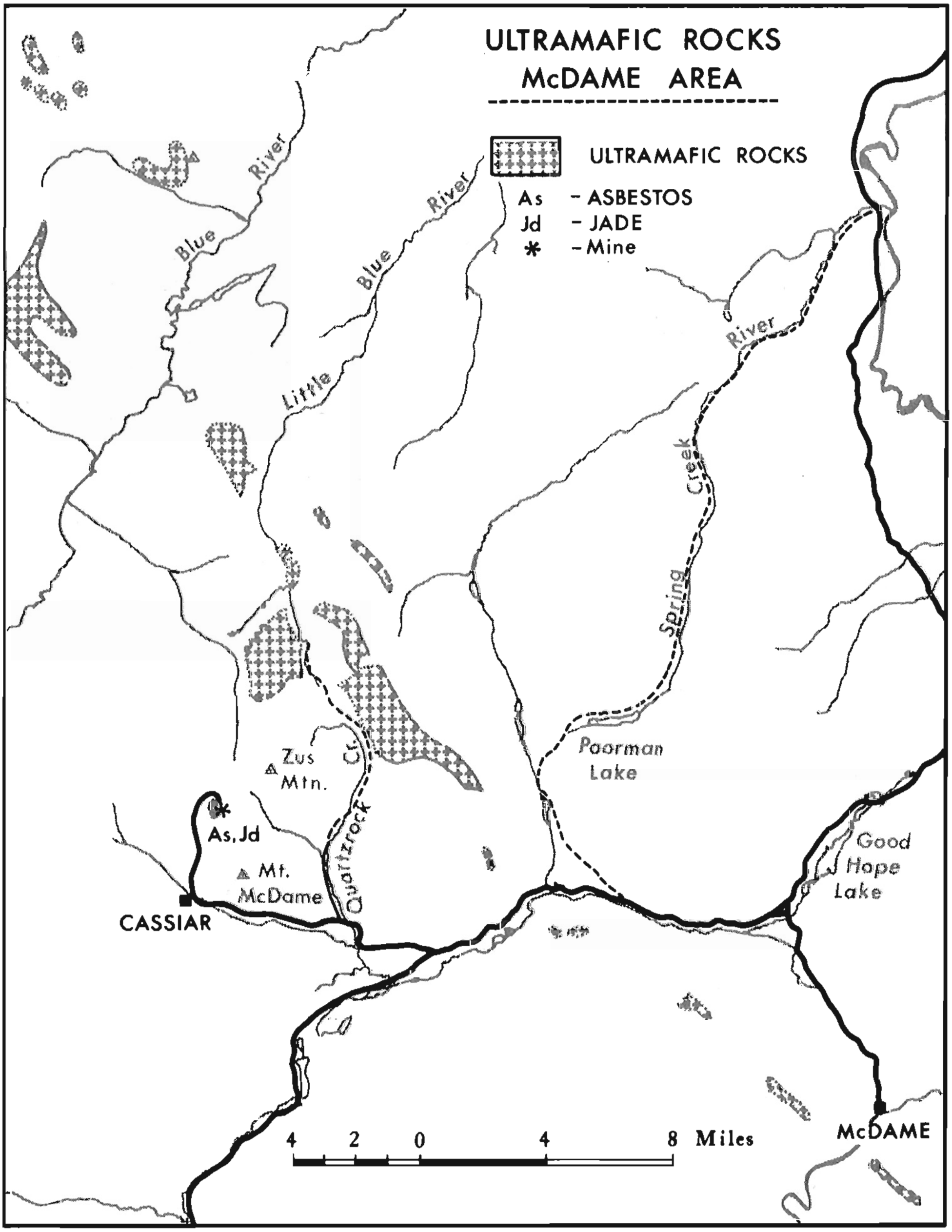

Figure 22. Reference: Geology: map 1110A, McDame. Topography: map 104P, McDame.

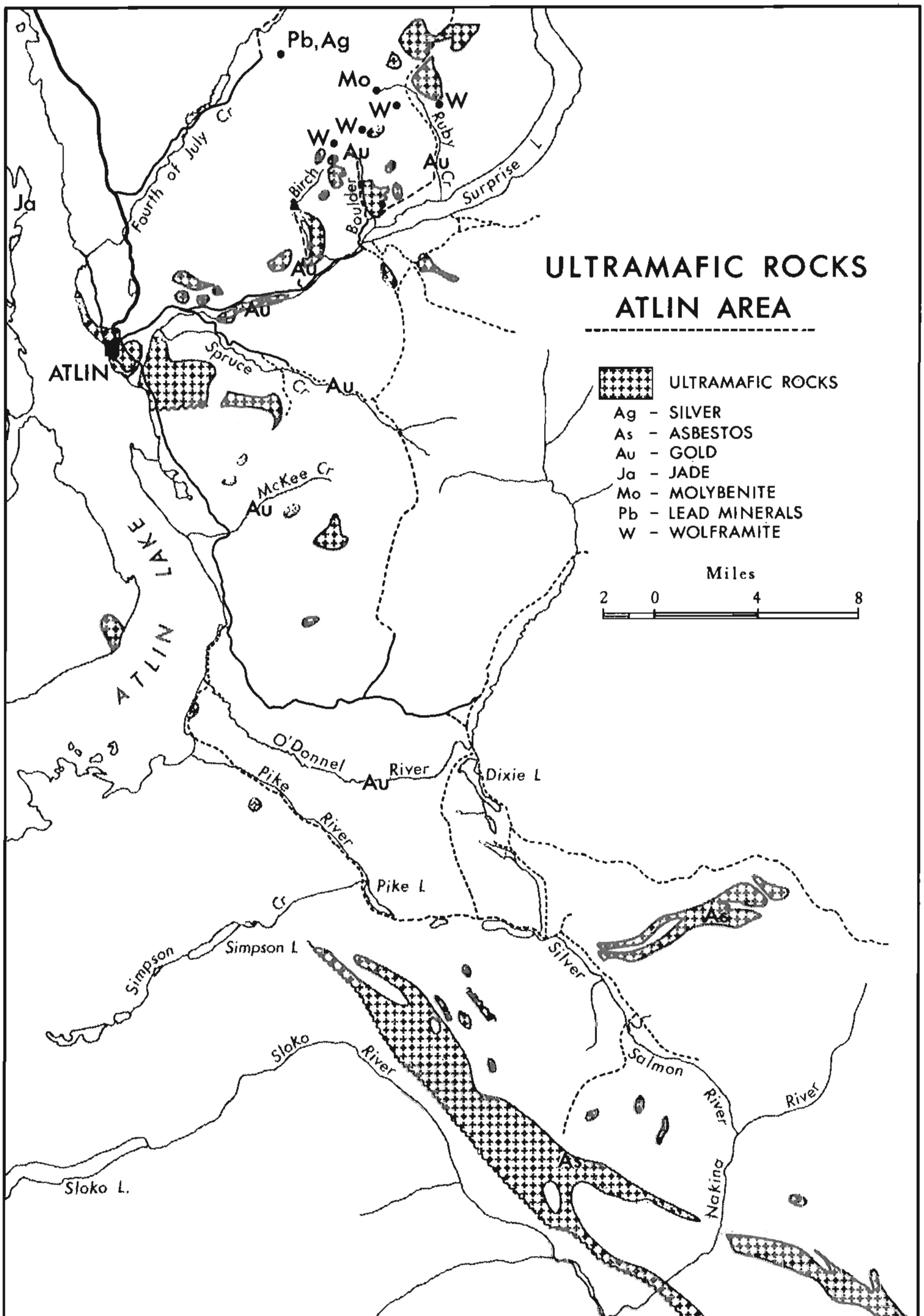

Figure 23. Reference: Geology: map 1082A, Atlin. Topography: map, 104N

Atlin area

Ultramafic rocks and their serpentinized varieties occur in the Atlin map-area (Aitken, 1959) in a belt 60 miles long and 16 miles wide running from the southern border along the 59th parallel to north of Surprise Lake (Fig. 20). The fresh rocks include peridotite and dunite disposed in numerous bodies up to 20 miles long and 3 miles wide. Some are completely serpentinized and may, in advancing metamorphism, give rise to "progressive replacement by talc and tremolite" (Aitken idem, p. 36). It is this reference which is suggestive of the possibility of jade occurrences in the Atlin map-area. Prospecting possibilities include the greenstone ultramafic contact where, according to Aitken (idem, p. 37), "In the course of dynamothermal metamorphism exchange of material across greenstone ultramafic contacts has resulted in the development of talc and tremolite in the ultramafic rocks by introduction of silica and lime, and the chloritization of greenstones by introduction of magnesia. These effects are limited to narrow reaction-zones at the contacts." Streams draining contact areas offer the possibilities of containing jade boulders.

The last ice movement during the Pleistocene glaciation in the Atlin area was in a general northerly direction. Hence ice-borne boulders should be expected on the north side of the intrusions. Suggested hunting grounds include the course of Nakina River, Silver Salmon River, McKee, Spruce, and Pine Creeks as shown on Figure 22.

DYKE ROCKS

Dyke rocks may include any intrusive rock exhibiting discordant or cross-cutting relationship to the invaded rocks. Some dykes may be porphyritic and many are fine grained. Few are of much interest to collectors but one dyke rock of interest is the aplite which came down at the Big Slide on the Hope-Princeton Highway in 1964. This rock takes a good polish and resembles so called Bruno jasper.

SEDIMENTARY ROCKS

Sedimentary rocks are those formed from the consolidation of material deposited in a fluid environment. In most cases the fluid is water but it may also be air and thus volcanic ash is considered a sediment. The material may be the clastic sediments, gravel, sand, silt, and clay which on consolidation becomes conglomerate, sandstone, siltstone or shale; or it may be chemically precipitated calcium sulphate, sodium chloride, silica, or potassium chloride which become gypsum, halite, chert, or sylvite. It may also be organically precipitated calcium carbonate which become limestone.

Some sedimentary rocks are of value to industry but few are of much interest to rock collectors. An exception is chert which occurs in a variety of colours and structures and, being hard, takes a high polish. The variety of chert called jasper is of particular interested to lapidarians. It may occur in sedimentary rocks but it is not always of primary sedimentary origin.

Limestone and shale may be highly fossiliferous. Fossil localities are marked on most geological maps and descriptions of fossils are included in the text of most geological reports. Collectors in some of the areas of Tertiary rocks in British Columbia may find agate, petrified wood, zeolites and fossils all within a few square miles. The Princeton area is a good example.

The Tertiary rocks in Princeton area are divisible into a volcanic division and a sedimentary division. The sedimentary rocks occur in two basins and comprise conglomerate, shale and, locally, coal. In places volcanic rocks are interbedded with the sedimentary rocks. Silicification is attributed to volcanic processes and agate in the volcanics and petrified wood in the sediments have been produced in many places. Rice (1947) mentioned sticks of wood completely silicifies on Mount Jackman. Agatized limb casts are found at Vermilion Bluffs and opalized and agatized wood on Opal Mountain.

Fossil plants are abundant in shales of the Tertiary sediments. They include ferns, horsetails, ginkos, conifers, and various angiosperms such as birch, oak, elm, ash, and beech.

Fossil insects include types of grasshopper, flies, plant lice, cockroaches, bees, and wasps. Teeth from a specimen of a Tertiary mamal, a primitive form of mammal unlike any known today, from the Princeton sedimentary basin has been described by Russell (1957).

Of interest to collectors is the material referred to as "opalized bog" found near the old Taylor No. 1 Coal Mine in lot 88, 4 miles west of Princeton. The location cannot be adequately plotted on Figure 5 so the reader is referred to topographic map 92H/7 which shows the road crossing Lot. 88. The coal mine is adjacent to the road near the centre of Lot 88.

The so-called "bog" lies in a seam beside the opening to the coal mine. The bog is largely replaced by opalline silica, but no semblance to cell structures are apparent at least in the specimens donated by Hector Hazle of the Richmond Rock Club. The material has a brecciated appearance possibly due to differential replacement of the organic matter.

Petrified logs occur in Tertiary sediments along Chapperon Creek. Some of the logs are at least ten feet long and a foot in diameter. The locality is shown on Figure 7. The Douglas Lake Cattle Company control the access roads and these are posted against trespassers.

Charred wood and some silicified material is found in agglomerate along the highway just north of Sunday Summit about 21.5 miles south of Princeton (see Pl. XIV).

Travertine is of interest to collectors because of the varied pattern which is found in many of the deposits. It is formed by the solution of limestone and the later deposition in openings in rocks at atmospheric pressure.

Massive gypsum is used as a carving medium by some hobbyists. Epsomite crystals form in some of the saline lakes in the interior of the province.

In British Columbia most rhodonite localities are found within sedimentary formations although they might not be sedimentary in origin. They are mainly found in cherty rocks of late Paleozoic or early Mesozoic age and more particularly in rocks of the Sicker and Cache Creek Groups, and in the Shoemaker Formation. Rhodonite is also found in hydrothermal veins.

CHERT

Chert is crypto or microcrystalline quartz. It has a tough splintery to conchoidal fracture, is generally thinly banded, and may be highly colourful, although commonly it is grey, greenish grey, or yellowish brown. Jasper is an opaque variety commonly red but may be blcak, brown, yellow, and green.

The origin of chert is debatable. Many think it is of replacement origin whereas others think it may be a direct chemical precipitate. Most chert specimens are uninteresting to collectors but a red and green banded variety found in Barriere River is attractive. Jasper is a favourite gemstone for many collectors and some localities yield stone of considerable beauty when cut and polished.

Localities for jasper are numerous in British Columbia. It is most easily collected as boulders, cobbles and pebbles along the streams draining areas of cherty rocks, particularly those underlain by Cache Creek Group in central part of the province, the Sicker Group on Vancouver Island, the Shoemaker Formation around Keremeos, and the Fennell Formation north of Kamloops.

Jasper is also commonly found associated with volcanic rocks as replacements and fracture fillings. Some of the better localities include: Nechako and Fraser River bars in the vicinity of Prince George, Hixon and Ahbau Creeks, Cottonwood River north of Quesnel, Yalakom River, Savona Mountain west of Kamloops, and Pinaus Lake near Falkland in the Vernon area.

RHODONITE-BEARING SEDIMENTARY ROCKS

Rhodonite is one of the favourite lapidary materials and ranks next to jade in commercial importance in British Columbia. It is not a sedimentary rock but because it is usually found within sedimentary rocks it is included here.

Rhodonite is a manganese silicate crystallizing in the triclinic system. It was formerly considered to be a member of the pyroxene group although it is now known to be a distinct species. The mineral has two directions of easy cleavage and these show in the coarser material from some of the localities. The colour varies from pale pink to deep red and is attributed to variations in chemical composition. Rhodonite is never pure managanese silicate but contains some calcium and usually some ferric and ferrous ions replacing manganese atoms in the crystal structure.

Rhodonite deposits in British Columbia contain quartz, garnet and manganese oxides. In most localities they occur in lenses in thin-bedded sediments with chert or jasper of late Paleozoic or early Triassic age.

The origin is either by replacement of the sediments by manganese-bearing solutions or the metamorphism of manganiferous sediments. In a few localities the origin is attributed to hydrothermal solutions.

Rhodonite is always coated with black manganese oxides in natural exposures and in some climates oxidation is deep and extensive, giving rise to deposits of manganese ore. The primary silicates are not amenable to economic extraction of the manganese content. The closest approach to manganese ore in British Columbia was the deposit on Hill 60 near Cowichan Lake where oxidation had proceeded to an extent such that a few hundred tons of black manganese oxides were extracted. This deposit has since been staked as a source of rhodonite. Most of the known deposits of rhodonite have only a thin surface crust of manganese oxide and a blow from a hammer easily reveals the unaltered primary silicate beneath.

Jasper is associated with the sedimentary rocks in the group as well as with the volcanic rocks. The former are well known for several rhodonite localities (see under Sedimentary Rocks).

Rhodonite in the Sicker Group

The association of rhodonite with thin-bedded chert and jasper is widespread in the province and constitutes a clue for the discovery of new deposits. The best prospecting ground is in Sicker Group rocks extending from Saltspring Island to Port Alberni (Fig. 14) where at least eight separate localities are known. The best known of these, Hollings' claims on Saltspring Island and Hill 60 near Cowichan Lake, are staked and will probably be held indefinitely. Some of the smaller occurrences north of Cowichan Lake may also be staked but as they are smaller deposits and of less interest they may be open from time to time. The locality north of Youbou has been staked by a Nanaimo rock club for general amateur use but the current status is unknown. Anyone wishing to collect from known localities should determine the status from the nearest mining recorder. Cowichan Lake is in the Victoria Mining Division. Enquiries should be made at the office of the Geol Commissioner in Victoria.

Saltspring Island

Two occurrences of rhodonite are known on Saltspring Island. The best known is that owned by Mr. Fred Hollings of Fulford Harbour (see Pl. XV). The material is sold in blocks, slabs or lumps of various sizes from Mr. Hollings' home. The locality is not a collecting site.

Adjoining the Hollings claim to the southeast, a mineral claim held by Mr. J. L. Newbigging has some shallow parts revealing pink rhodonite veined with black oxides similar in quality to the Hollings material. The deposit has not been extensively opened up and production has been very limited.

The geological setting of the Saltspring Island deposits is similar to those along the north side of Cowichan Lake in that they are lenticular bodies within thin bedded cherty rocks of the Sicker Group. Careful prospecting along the strike of the two known deposits may reveal others. However much of the island is privately owned and there may be little Crown land left.

Hill 60

This locality is difficult to reach. In 1965 the owner had put in an access road which was posted against trespass. The road was passable only by four-wheel drive vehicles from a logging road running northwest along the north slope of Hill 60. The locality is shown as Crown-granted mineral claims 12G and 13G on map 92 B/13 west half issued by the Surveys and Mapping Branch, British Columbia Department of Lands. For those wishing to visit the property (assuming it is open to them) the following directions are offered: take Highway 18 west from Duncan. At a point approximately 10 miles from Duncan turn right (north) up a road marked by a sign 'Hill 60 Lookout'. Follow this road for a mile where it crosses a logging road; turn left (west) for 1.2 miles to the junction with a much poorer road identified by a sign 'Private Property'. This leads to the rhodonite locality known Hill 60 (see Pl. XVI).

The deposit consists of an irregular mass of rhodonite with secondary manganese oxides, and siliceous impurities (partly a type of garnet) enclosed in cherty quartzite and jaspery sediments.

Lookout locality

If Hill 60 is posted against trespass, the collector may find that the small deposit on the west end of the prominence from Hill 60 is open. The locality is marked by a forestry lookout tower about 5 1/2 miles west of the turn-off to the Hill 60 Locality described above. The locality is easily found being about 500 feet from the tower in a direction south 60 degrees west. The deposit is above the road at the second last switch-back from the tower. On the writer's visit there was plenty of loose scattered material and much good pink rhodonite could be had without difficulty.

Shaw Creek locality

The rhodonite at the head of Shaw Creek was known as the Black Prince Group in the older reports (see Hanson, 1932, Brewer, 1919). The locality was not visited by the author. It is described by Fyles (1955).

Rhodonite in the Shoemaker Formation

The Shoemaker Formation, widely distributed around Keremeos in southern British Columbia, contains a number of rhodonite localities (see Fig. 24). The formation consists of chert with some greenstone and tuff of Triassic or earlier age. On the mountain at Keremeos (see Pl. XVII) the rhodonite occurs near the top of the formation and close to the overlying Old Tom Formation which consists mainly of volcanic flows. Jasper is intimately associated with the rhodonite. The collecting locality lies on the north side of Highway No. 3 at the west end of the village of Keremeos.

Rhodonite and jasper occur in the old Iron King mine west of Olalla. The property may be reached by road from Highway No. 3 at Olalla but

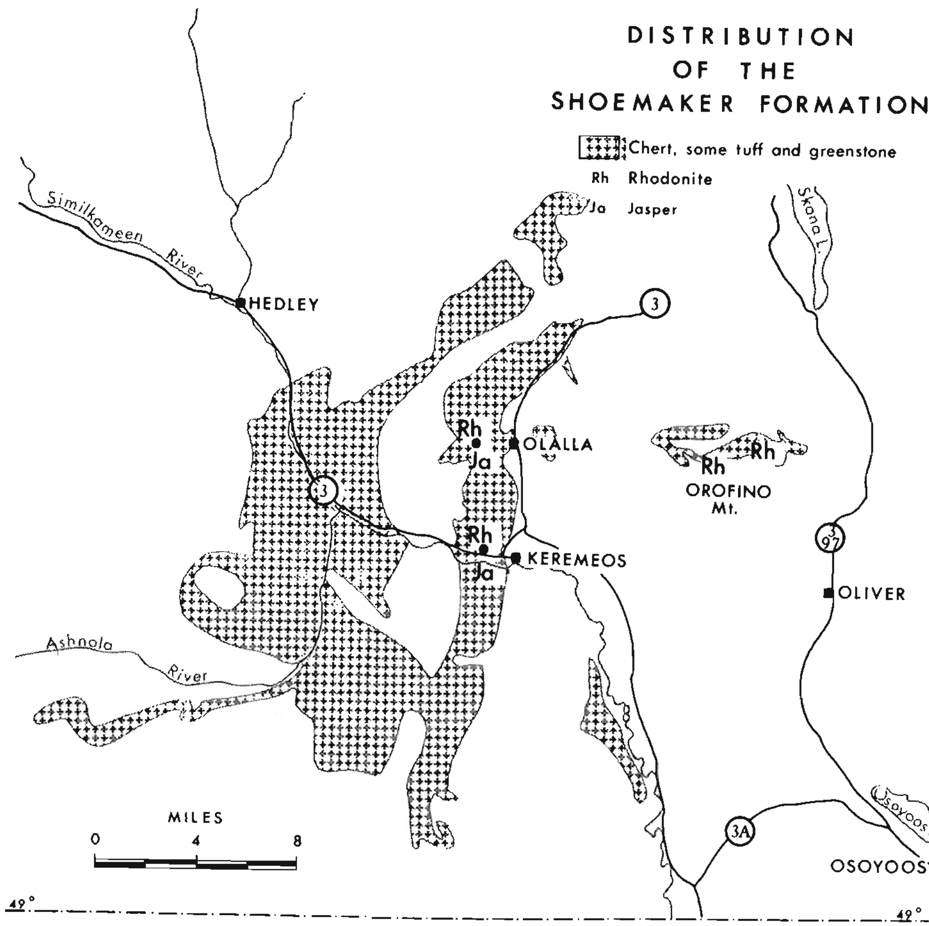

Figure 24. Reference: Geology: map 888A, Princeton; 15-1961 Kettle River (west). Topography: map 92H, Hope; 82E, Penticton.

probably the last mile or so may not be passable for vehicles because of slides. The access road which can be seen climbing up the steep hillside west of Olalla has two branches, the first leads to a copper-molybdenum prospect, the second, marked by a crossing of Olalla Creek, leads to the rhodonite locality. Jasper and rhodonite may be gathered around the mine dump. Rattlesnakes may be present and the collector is advised to be cautious.

Orofino Mountain locality

Rhodonite is reported from the north slope of Orofino Mountain but the exact locality is not known. Figure 23 shows the approximate location.

Meyer's Flat locality

Rhodonite occurs in chert in an exposure along Orofino Creek about a mile up the road along the creek from the turnoff on Meyer's Flats west of Oliver. The road is marked by an abandoned farmhouse about one half mile from the road through Meyer's Flats. This turnoff is about 4 miles south of White Lake radio-telescope site.

Rhodonite and jasper have rolled down to the road level from the workings which are about 100 feet above the road.

Marron Valley area

Rhodonite is reported from Marron Valley, north of Keremeos (R. Schramm, pers. comm., 1965). The locality is unknown but presumably a small window of Shoemaker Formation is exposed within an area of mainly Tertiary volcanic rocks.

Ashnola Valley area

Rhodonite is reported from the Ashnola Valley as float boulders and in situ near the confluence with Ewart Creek (R. Schramm, pers. comm., 1965). The area is considered favourable because of the presence of Shoemaker Formation in the lower part of the drainage basin of Ashnola River.

Rhodonite in the Cache Creek Group

The Cache Creek Group comprises rocks of late Paleozoic to early Mesozoic age and consists of many kinds of rocks of which limestone, greenstone and chert are most abundant.

Several localities for rhodonite associated with the chert are known in the Fort St. James map-area and in the vicinity of Williams Lake.

Tsitsutl Mountain locality

Rhodonite occurs in a vein on the north slope of Tsitsutl Mountain in the Middle River Range between Babine and Takla Lakes. The occurrence is described by Armstrong (1949) who states that a 20-mile packtrail from Middle River leads to the property at an elevation of 5,500 feet. The vein is probably hard to find as it is only exposed along a length of 24 feet and is less than two feet wide.

Rhodonite is reported from the west end of Stuart Lake and McKelvie Island but this locality was not seen by the writer. Jasper is common in many places in the cherty parts of the Cache Creek Group and may be associated with rhodonite in some of the localities.

Fort Fraser locality

Secondary oxides of managanese are known in a few places in cherty Cache Creek rocks where rhodonite is absent. It may be that these secondary deposits are formed by oxidation and solution of nearby primary silicates. Two such deposits are known in the Fort Fraser area and further prospecting for the source rocks may reveal rhodonite deposits.

One deposit of psilomelane and pyrolusite occurs 1 1/2 miles due north of the second canyon on the Nechako River below Fraser Lake. Another is about a mile to the northeast. Both deposits consist of secondary manganese oxides in cherty Cache Creek Group rocks. They are briefly described by Armstrong (1949 p. 195).

Quartzite Creek locality

Placer diggings on Quartzite Creek, which flows into Falls River 6 miles west of Old Hogen, have yielded boulders of rhodonite and jade. The locality is an area of chert which is one of the factors in the genesis of rhodonite and it would be surprising if other deposits of rhodonite were not found in this environment.

Williams Lake area

Cache Creek Group rocks outcrop along the Fraser River south of Williams Lake and probably are the source for rhodonite boulders near Sheep Creek bridge on Highway 20 at the crossing of the Fraser River about 14 miles southwest of Williams Lake (Fig. 25).

A deposit of jasper and chert with manganese stain is shown on map 29-1963 (Tipper, 1963). The deposit lies about one mile south of Sheep Creek bridge on the east side of the Fraser River and about 1,000 feet above the river level. The deposit may be reached by going south along the road on the east side of Fraser River to a gate marking the property of Canyon View Ranges Limited. About 300 yards south of the gate a dry gully crosses the road. The gully leads up to the outcrops and prospect trenches (see Fig. 24). The author checked this locality as a possible source of rhodonite but none was found. It is, however, likely that a bedrock occurrence will be found in the vicinity as the rhodonite boulders along the Fraser River must have had a local origin. Careful prospecting in Cache Creek Group rocks in this area is warranted.

During periods of low water in the Fraser River, the bars are good hunting grounds for rhodonite, jasper, thulite, and chert. Rhodonite is said to occur on the west side of the river about half a mile north of the bridge but this is not confirmed. Cache Creek rocks are exposed there and may be considered potential collecting ground.

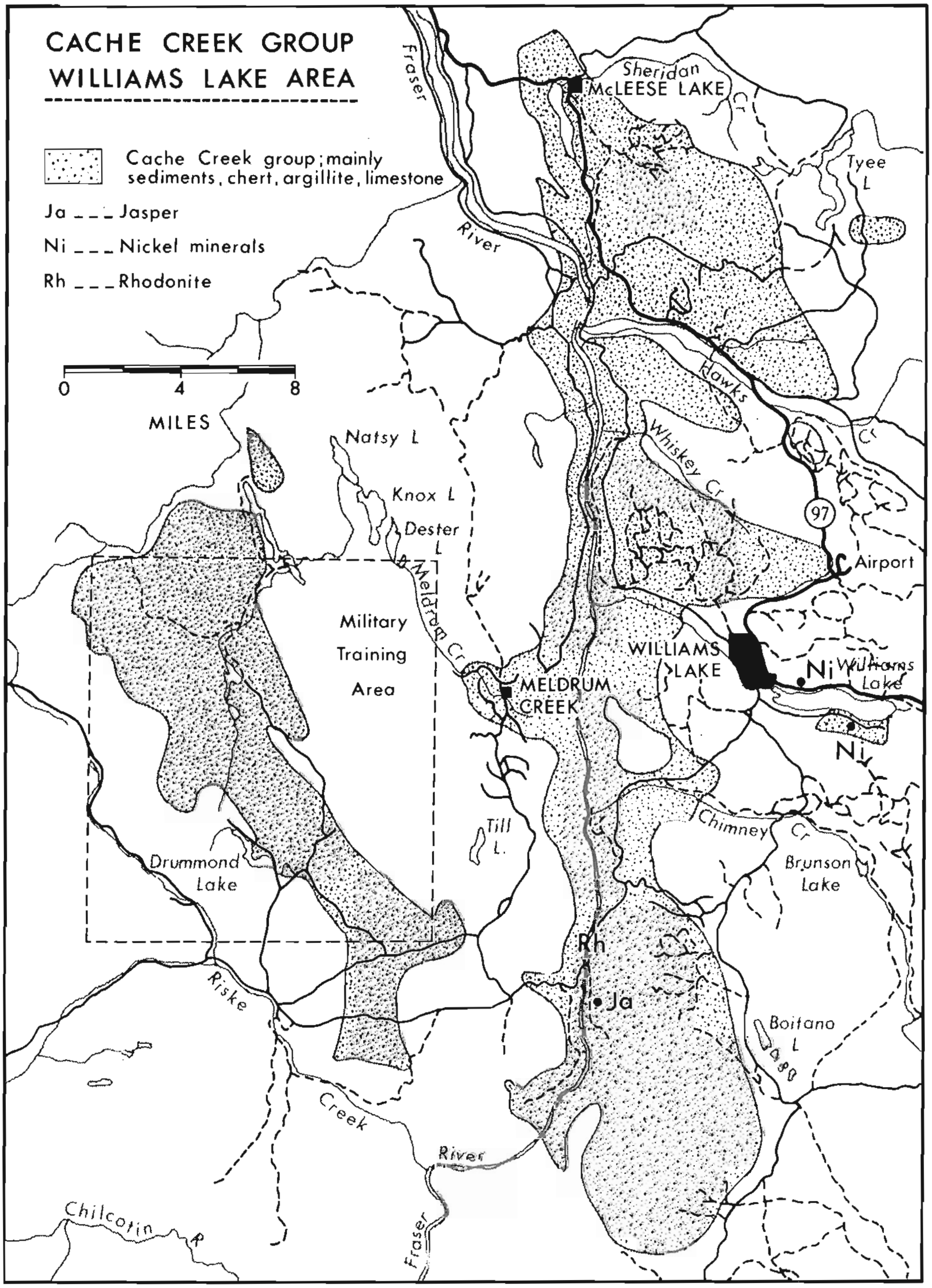

Figure 25: Reference: Geology: maps 12-1959, Quesnel; 19-1963 Taseko Lakes. Topography: maps 92O, Taseko Lakes; 93B, Quesnel.

Rhodonite in the Fennell Formation

The Fennell Formation of Mississippian age (Fig. 26) comprises volcanic and minor sedimentary rocks. Much of the formation along No. 5 Highway consists of pillow lava. The sedimentary rocks include chert, argillite, and limestone. Banded chert and jasper are presumably associated with the sedimentary members of the formation. Rhodonite in place is reported but has not been seen by the author.

Joseph (Boulder Creek) and Barriere River are collecting localities for boulders of jasper, rhodonite, and green and red banded chert. Joseph (Boulder) Creek discharges into the North Thompson River about 3 miles north of Little Fort but on the opposite (east) side of the river. It may be reached by a road running north from the ferry landing across the river from Little Fort. An enormous fan covering 500 to 600 acres lies at the mouth of the creek. Jasper and chert boulders are common whereas rhodonite is rare. Barriere River, about 40 miles north of Kamloops in the North Thompson Valley, is a more productive stream for rhodonite. The best part of the river seems to be about 4 miles upstream from the bridge over Highway 5. Logging roads off the public road along the north side of the river provide easy access. In times of low water, the stream bed is the best source of material but some boulders may be found along the bank. The extent of the Fennell Formation, shown in Figure 26, is compiled from the published maps of Campbell (1963a) and Campbell and Tipper (1971).

Rhodonite in Quartz Veins

Kaslo area

Rhodonite occurs in quartz veins with rhodochrosite, garnet and manganese oxides west of Kaslo along the highway which follows the former railroad grade from Kaslo to New Denver. Hanson (1932) gives the location in reference to Zwicky, a siding on the railroad which no longer exists. The author spent some time searching for the old deposit or float from it, but none was found. A more diligent search might locate the deposit. The quartz veins occur in sediments or along the contact with sediments of Carboniferous to Middle Triassic age. Johnson and McCartney (1965) describing quartz veins on the Hart Group state "the footwall rocks of one vein are greenish schist composed of quartz, calcite, a little garnet, considerable graphite or pyrolusite and rhodonite, the latter occurring in masses, streaks and disseminations".

Rhodonite is mentioned at Erickson-Ashby Mines Limited on Mount Erickson in Taku River area (Hedley, 1966). The deposit, which is not easily accessible, is a silver-lead-zinc prospect in a brecciated and silicified limestone band.

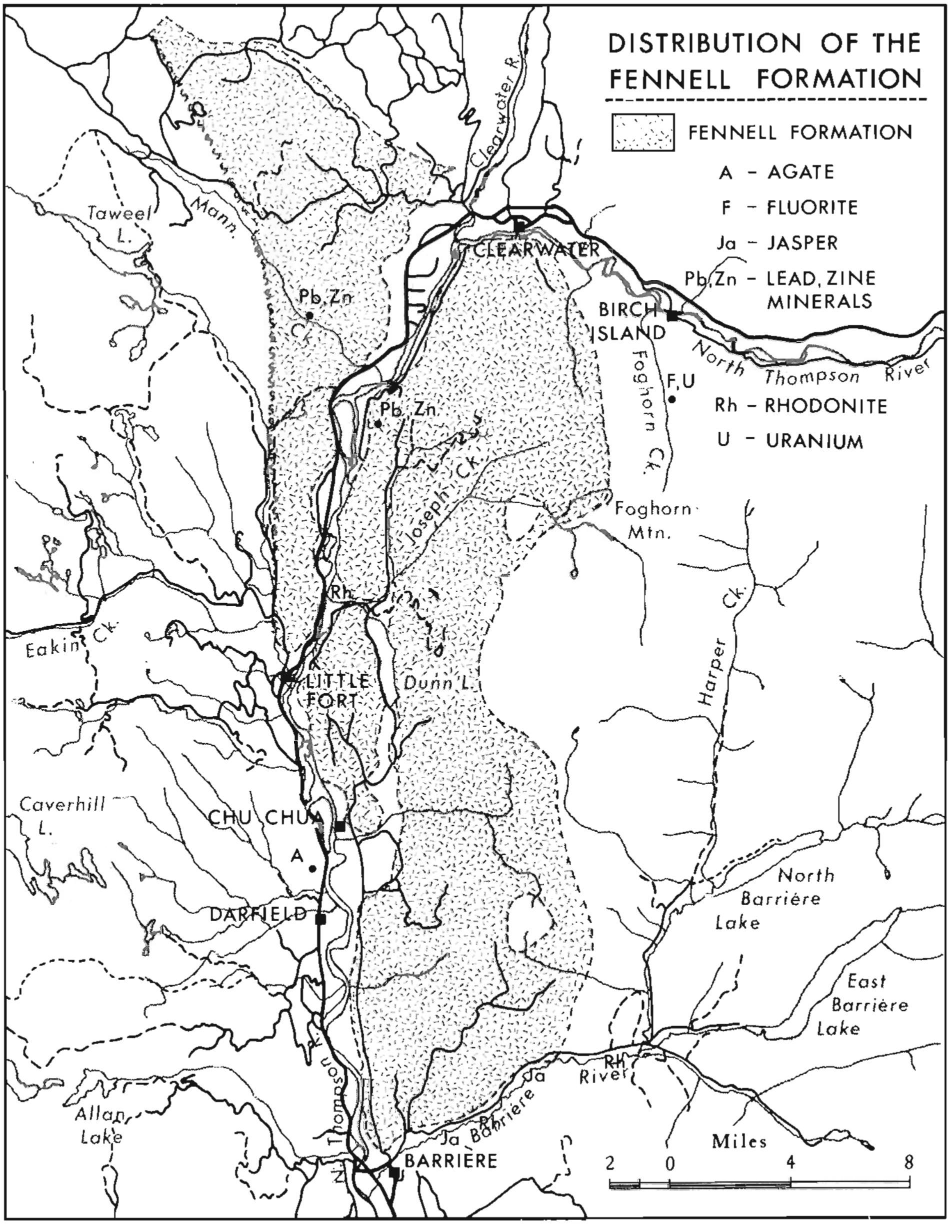

Figure 26. Reference: Geology: map 48-1963, Adams Lake. Topography: map 82M, Seymour Arm

OTHER SEDIMENTARY DEPOSITS

TRAVERTINE

Travertine is a type of limestone formed by rhythmic precipitation of calcium carbonate from surface waters. The material is too soft for most lapidary purposes but the intricate banding makes attractive slabs and most collectors acquire a few specimens for show. Travertine is likely to be found in most limestone terrains especially around springs. Spring deposits are usually porous and friable and are called calcareous tufa. Travertine often develops on calcareous tufa but may form on any rock.

Travertine occurs as crusts and stalactitic masses on calcareous tufa in a quarry about 1 mile south of Clinton just off the Kelly Lake road. The deposit straddles the British Columbia Railway line. The best travertine was seen in the middle of the rock-cut through which the railroad passes. A moil or rock chisel is needed to collect the material.

Tufa also occurs on the west side of the railway about 100 yards south of Clinton station. No travertine was seen, but this deposit has not been exploited and further search seems warranted.

Travertine occurs along No. 12 Highway about 11 miles south of Lillooet. The Department of Highways loosened up much of the deposit during road work and dumped the rocks over the side of the road where it may be collected in convenient sizes (see Pl. XVIII). Some fine material remains in place in the rock-cut, but a ladder and chisel would be needed to reach and collect it. The locality is easily found, being marked by a very large talus slide just south of the exposure and a widening of the highway at an access road marked "Walter Fredriksen" - a private house on the lower side of the road.

Travertine is reported (W. Zacharias, pers. comm.) at the north end of the aerial ferry at North Bend in the Fraser Canyon but has not been seen by the writer.

Travertine occurs on blocks of rock removed by the Department of Highways on No. 1 Highway, 6 miles east of Golden at the crossing of the Kicking Horse River. The material came from the uphill slope but material may be found on the blocks pushed off the road between the highway and the river on the east side of the highway bridge.

Two deposits of travertine occur in the Rosedale area near Chilliwack in the lower Fraser Valley: (1) about 1 1/2 miles southeast of Rosedale; (2) Marble Hill, 4.9 miles southwest of Rosedale. These occurrences are described by Mathews and McCammon (1957).

Some travertine is found with calcareous tufa on the power-line road along the north side of Anderson Lake between D'Arcy and Seton Portage.

Gypsum

Massive gypsum is usually of sedimentary origin but there are exceptions. Gypsum, as individual crystals (selenite), occurs in places as a result of chemical precipitation, or reactions between limestone and oxidizing pyrite. Massive gypsum is sometimes used as a carving medium. Material for this purpose may be gathered from the abandoned quarry at Falkland.

Gypsum crystals are reported from the brine of Spotted Lake adjacent to the Richter Pass Highway west of Osoyoos. The writer found none, but specimens of epsomite may be collected here. Gypsum crystals were noted by Mathews (1963) in the Fort St. John area, where crystals up to 3 inches in length are common in glacial lake clay.

Limestone

Limestone is a very common sedimentary rock but, except for a few varieties such as crinoidal, silicified, or brecciated limestones, is not of much interest to collectors. Slabs of limestone rich in fossils may make interesting specimens.

Limestone is particularly abundant in the Rocky Mountains of eastern British Columbia. In central British Columbia the Cache Creek Group contains limestone formations, and the Marble Canyon Formation in the Ashcroft map-area is noted for its purity and quality of limestone.

Diatomite

Diatomite is a sediment composed of the skeletons of primitive plants called diatoms. The material has use in many industrial applications as a filtering agent and filler in paper, paint, insecticides, insulation, and fertilizers. The largest deposits in Canada are found along the Fraser River in the vicinity of Quesnel. These deposits are of Tertiary age.

The material has no lapidary value and is only of interest to collectors who may want a sample for display. The most convenient collecting locality is on Lot 6182 on the east bank of the Fraser River. Access is by means of old Highway No. 2 to Moose Heights. The deposit is about 200 feet northwest of the first bend near the start of the climb from the airport terrace to Moose Heights.

Amber

Amber or fossil resin occurs in a number of localities in British Columbia.

It is reported (Bauerman, 1860) from the Nanaimo area. The writer has not seen this reference and has no further information.

Johnson (1923) mentioned fossil resins (amber) in a borehole at Port Haney.

Amber occurs in Tertiary sediments at Princeton. According to Camsell (1907) some of the beds in the Princeton coal basin contain much retinite (amber or amber like substances). Exposures of coaly beds should be searched for specimens.

Amber occurs in peaty beds in clay along the west side of the Pacific Great Eastern Railway at Quesnel. The site lies about 100 yards north of Bowron Avenue where it ends at the railway right-of-way along the west side of Quesnel River. The site lies close to the railway tracks in a cut bank made to maintain the proper grade, hence caution should be used both from the point of personal safety and good relations with the railway company. Amber is not overly plentiful but some pieces up to an inch in diameter have been found. The material is present in peaty layers enclosed in the clay.

Amber was collected from the bank of Nechako River south of Fort Fraser. Harrington (1878) in describing the material stated that it is not strictly amber and should be called mineral resin. The writer was unable to find any specimens but perhaps the high-water level in the Nechako was the main reason. However, he knows of no recent mention of this occurrence.

METAMORPHIC ROCKS

Metamorphic rocks are produced by the action of heat and stress on older rocks. The heat may be supplied by the cooling of hot liquid intrusions which crystallize as igneous rocks. Stress is supplied by tectonic forces which produce deformation of the rocks. As either agent may be dominant it is conventional to speak of thermal metamorphism when heat is the main factor, dynamic metamorphism when stress is the main factor, and regional metamorphism when both agents are important. The effects of metamorphism depend both on the intensity of the agents and the chemical composition of the affected rocks. The simplest effect is one of recrystallization in which minerals already present grow to larger sizes with better development of crystal faces as in the case of marble developing from limestone. More complicated reactions between different minerals give rise to minerals that did not previously exist in the original rock. Metamorphism is a process which progresses in solid rocks so that commonly vestiges of the original textures and structures are preserved. In the highest grades of metamorphism the rocks approach igneous rocks in texture and in fact may become mobile and intrusive.

In British Columbia, large areas of metamorphic rocks provide interesting terrains for mineral collectors. Such typical metamorphic minerals as garnet, kyanite, staurolite, wollastonite, and tremolite are common. Figure 27 shows the distribution of high grade metamorphic rocks in British Columbia which constitutes good prospecting ground for the common metamorphic minerals.

Marble

Limestone that has become recrystallized by metamorphic processes is called simply crystalline limestone. Marble is a commercial term applied to crystalline limestones which possess superior qualities of appearance and texture for ornamental purposes.

Crystalline limestone is very common in British Columbia but marble is rare in commercial quantities. Collectors may find suitable pieces for specimens and for use as a carving medium in some of the quarries, now inactive, which are located in many places across the province. Probably the best material will be found at Marblehead, north of Kootenay Lake. Some of the best localities for marble are included in Table 5 taken mainly from Parks (1917).

Skarn

Skarn is a metamorphosed rock, commonly developed from impure limestone. The impurity may be mainly quartz which gives rise to the lime-silicate minerals, wollastonite, tremolite, and calcite. Garnet, epidote, ilvaite, and pyroxene are also commonly developed.

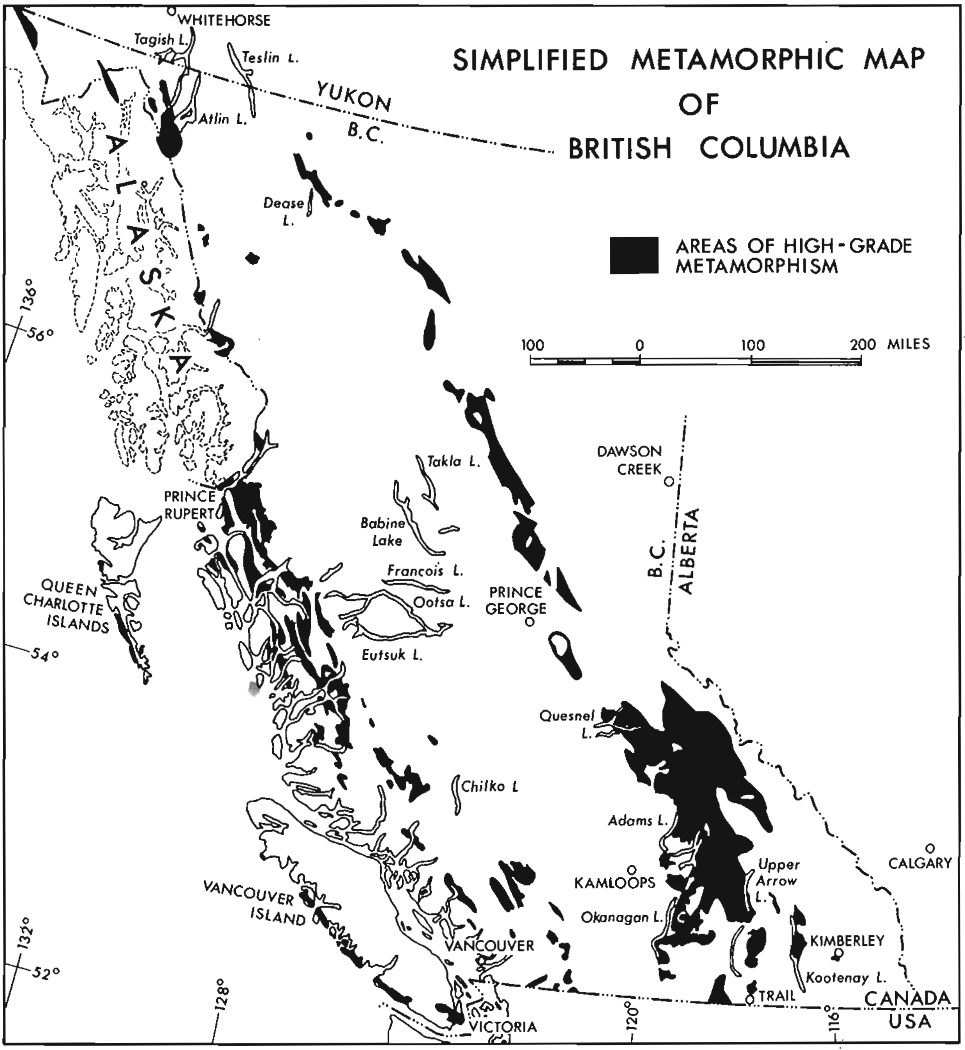

Figure 27. Reference: map 1322A; Metamorphic map of Canadian Cordillera

TABLE 5

Some Marble Localities in British Columbia

Age	Formation	Locality	Description	Reference
Cambrian	Badshot	Marblehead – 1/4 mile north of Marblehead near Duncan Lake dam.	Quarry-white to light blue, some grey. Some statuary quality.	Parks, (1900), p. 128 Goudge, (1944), p. 207
Cambrian	Lardeau	Kaslo (1) east side Kootenay Lake oppósite Kaslo.	Quarry – interbanded crystalline limestone to dolomite; contains tremolite. Some yellowish bands.	Goudge, (1944), p. 216
		(2) one mile south of Kaslo on west shore of Kootenay Lake.	Quarry – bluish-white, laminated. Contains mica and graphite.	Parks, (1917), p. 135
		(3) south fork of Kaslo Creek, 5 miles from Kaslo.	Blue and white mottled, fine grained.	Parks, (1917) p. 138
Cambrian	Badshot	Arrowhead, 4 miles north of Arrowhead, east of railway.	White with irregular bluish bands – parallel to stratification.	Parks, (1917), p. 140
Precambrian	Grand Forks	Grand Forks, left side of Kettle River, 7 1/2 miles below Grand Forks.	Quarry – very coarse grained, white with greenish to brownish spots.	Parks, (1917), p. 140
Cambrian		Grand Brook; main line of C.N.R. near Alberta boundary, Highway 16 east of Moose L.	Small quarry – white, blue, pink, rose coloured dolomite.	Parks, (1917), p. 143
		Sheep Creek, 7 miles from Salmo.	Quarry – white to bluish, medium grained.	Parks, (1917), p. 148
Triassic	Anderson Bay	Texada Island Anderson Bay, south end of Island.	Pink, red, white, mottled, and variegated types.	Parks, (1917), p. 150
Jurassic	Sutton	Bamberton – west shore of Saanich Inlet.	Quarry – Ocean Cement – active. Dark mottled dolomitic limestone	Parks, (1917), p. 157

Skarn zones may be found in limestone areas in contact with igneous rocks. Many deposits of potential economic value occur in this association. Copper-iron ore bodies on Vancouver Island and Texada Island are examples. Skarn may develop in volcanic rocks but usually limestone is nearby.

Skarn minerals occur at the following mines and prospects where permission to collect may or may not be granted.

Ilvaite is reported in two localities in British Columbia. (1) A skarn zone on the property of Nadira Mines Limited at the headwaters of Horse Creek, a tributary of Parker Creek, which enters Nitinat River 7 miles northwest of Nitinat Lake. The property is about 6 miles west of Cowichan Lake on Vancouver Island. (2) Boulders of skarn containing ilvaite have been found in Millar Creek about 2 1/2 miles west of Honeymoon Bay on the south side of Cowichan Lake.

Quartzite

Quartzite is a metamorphosed sandstone in which the original boundaries of quartz grains have been eliminated by recrystallization. Impure quartzites may become schist with the development of micaceous minerals. Quartzite is generally of little interest to collectors. Although it is hard enough to take a polish, rarely do particular features make it attractive as a gemstone. Quartzite with sillimanite and dumortierite occurs on the bars of the Fraser River, from the Canyon south. Local rockhounds have collected this rock for lapidary purposes. It has generally been misnamed 'mutton fat' jade (see Pl. XIX).

Quartzite is used as a building stone and a few quarries have been opened in various places in the province. It is a very common metamorphic rock and particularly in the formations or groups as listed in Table 7.

Slate and Argillite

Slate is a metamorphic rock resulting from the regional metamorphism of mudstone. It possesses a close fissility so that slabs may be obtained for ornamental work such as flagstones, fireplace hearths, etc.

Argillite is essentially a non-fissile slate. It has been used as a carving medium, especially by the West Coast Indians. Good carving material is not common but possibly more exists than is known. Potential prospecting ground for slate and argillite is outlined in the following table.

Argillite, from a locality along the Squamish Highway, has been used for carving purposes by local rockhounds. The collecting locality is 10 miles north of Horseshoe Bay in an area of Gambier Group rocks. Some fine specimens of ammonites have also been collected from the specimens of rock.

Schist and Gneiss

Schist and gneiss are of little interest to most collectors. Gneiss may, however, be useful material for book-ends, penstands, etc. Some schist and gneiss, particularly those derived from argillaceous rocks, may provide fine specimens of garnet, staurolite, sillimanite, kyanite, and chloritoid. Areas for collecting include Kinbasket Lake area, Vernon map-area and Kootenay Lake map-area.

TABLE 6

Some Skarn Deposits in British Columbia

Mine	Locality	Remarks
Oro Denoro,	1 1/2 miles south of Eholt. 1 1/2 miles north or Phoenix cut-off on Greenwood-Grand Forks highway.	epidote, garnet magnetite on old dump
Lucky Four Group,	Summit of Cheam Range	garnet, zoisite, calcite, quartz crystals, chalcopyrite
Texada Mines, Limited	Texada Island	garnet, actinolite, epidote magnetite
Orecan Mines,	4 miles southwest of Sayward, V.I.	magnetite, epidote, actinolite, garnet.
Brynnor Mines; Kennedy L. Division	2 1/2 miles southeast of Kennedy Lake, V.I.	magnetite, garnet pyroxene
Sunnyside Prospect,	south side of Cowichan Lake	actinolite, epidote
Queen Victoria Mines,	1 mile north of Beasley near Nelson.	garnet, epidote

TABLE 7

Some Quartzite-Bearing Rocks - in British Columbia

Rock-unit	Map Area	G.S.C. Map	Reference
Kaza Group	Quesnel Lake (W/2)	3-1961	Campbell, (1961)
Yanks Peak Fm.	"		"
Brew Group	Ashcroft	1010A	Duffell and McTaggart (1952)
Monashee Group Chase Formation Hamill Group	Vernon	1059A	Jones, (1959)
Wolverine Complex	Fort St. James	907A	Armstrong, (1949)

Kinbasket Lake area

Kinbasket Lake is an enlargement of Columbia River southeast of Boat Encampment. Metamorphism of sedimentary rocks has produced garnet, kyanite and staurolite, and chloritoid. Geology of the area has been reported by Wheeler (1963) and Fyles (1960).

Along the Columbia River in the vicinity of Kinbasket Lake, the Rocky Mountains comprise three lithologic units; the Sullivan quartzite, the Tsar Creek argillite, and the Kinbasket limestone in ascending order of age. From Surprise Rapids to Boat Encampment these rocks are metamorphosed to garnetiferous quartzite, garnet mica schist, and crystalline limestone.

Along Tsar Creek small porphyroblasts of chloritoid occur in the lower beds of the Sullivan quartzite. Along the strike of these rocks interbedded schists contain garnet and staurolite. North of Cummings River garnet-mica schist contains euhedral garnets up to an inch in diameter.

Kyanite occurs in the impure quartzite about a mile west of Cariboo Creek. The deposit has been opened by short open-cuts along the highway.

Vernon map-area

Vernon map-area includes a large part of the so-called Shuswap Complex, an assemblage of metamorphic rocks of uncertain age and relationship. Rocks of the Shuswap Complex are considered by some writers to be Precambrian in age but others consider that Paleozoic formations are included and that the whole assemblage was affected by Paleozoic metamorphism.

Jones (1959) divided the Shuswap rocks into three groups as follows:

1. Chapperon Group, mainly schist derived from igneous and sedimentary rocks,
2. Mount Ida Group, mainly schist derived from sedimentary and volcanic rocks and
3. Monashee Group, mainly gneiss derived from sedimentary rocks.

Rocks of the Monashee Group are of most interest to collectors in that garnet, sillimanite, staurolite, and kyanite are commonly developed in the gneisses of this group.

Jones mentions some specific localities:

Kyanite and staurolite – 2 miles southwest of Sugar Lake,
5 miles southeast of Sugar Lake Hills, east of Armstrong.

Pegmatites are common intrusions in the Monashee Group and in a few places are known to contain tourmaline, beryl, garnet, and lepidolite. Most pegmatites, however, are simple aggregates of quartz and feldspar.

Jones mentioned red and green tourmaline in a pegmatite dyke on the northeast side of the peak on Mount Begbie. South of Revelstoke kyanite is found along Columbia River downstream from Mica Dam, 90 miles north of Revelstoke.

Kootenay Lake area

Metamorphic rocks are common in the Kootenay Lake area from Kaslo to Proctor. They consist of metamorphosed sedimentary rocks of the Windermere series of Precambrian age, Lardeau Group of late Paleozoic,

TABLE 8

Slate and Argillite-bearing rock-units

Rock-unit	Map Area	G.S.C. Map	Author
Chapperon Group	Vernon	1059A	Jones, (1959)
Dewdney Creek Group	Princeton	888A	Rice, (1947)
Aldridge Formation Creston Formation Kitchener Formation Dutch Creek Formation	Neslon	603A	Rice, (1941)
Cache Creek Group	Nicola	886A	Cockfield, (1948)
Takla Group	Fort St. James	907A	Armstrong, (1949)
Lillooet Group	Ashcroft	1010A	Duffell, and McTaggart, (1952)
Agassiz Group	Hope	12-1969	Monger, (1970)
Gambier Group	Vancouver North	1152A	Roddick, (1965)

TABLE 9

Some Talc Deposits in British Columbia

Locality	Location and Access	Reference	Remarks
1. Coquihalla River,	Logging road along old railway grade.	(Wilson, 1926)	Talc associated with serpentine.
2. Gisby Group,	west side of Fraser River at confluence of Nahatlatch River	(Wilson, 1926)	Talc and silica mined and 100+ tons shipped.
3. Cayuse Road,	southwest of Lillooet on side of Cayuse Creek, Forest Development Road	(Wilson, 1926)	Schistose talc.
4. Lucky Janes, Anderson Lake	2 miles east of D'Arcy along P.G.E. right of way.	(Wilson, 1926)	Talc in shear zones up to 10 feet wide
5. Illecillewaet,	C.P.R. 1/4 mile west of station	(Wilson, 1926)	Talc 2 to 4 feet wide
6. Asbestos Group,	east of Columbia River from Sidmouth Station	(Wilson, 1926)	Talc-carbonate zone in serpentine.
7. White's camp,	Koomoos Creek, along old railway grade southeast of Greenwood.	(Wilson, 1926)	Talc in serpentine.

and Slocan Group of Triassic age. The rocks are quartzite, phyllite, schist gneiss, and crystalline limestone.

Some map-units formerly included in the Windermere division are now considered to be of Lower Cambrian age and some of these formations have been highly metamorphosed, giving rise to garnet-andalusite-sillimanite-schist, and gneiss. Near Crawford Bay, large crystals of tremolite and wollastonite have developed in the Bradshaw Formation (Rice, 1941). Garnets occur in the schists at Woodbury Point, south of Kaslo.

Prince Rupert area

High-grade metamorphic rocks in the vicinity of Prince Rupert may yield staurolite (see Pl. XX), garnet and sillimanite. Hutchison (1967) has described the occurrence and provided the specimen for Plate XX.

ALTERED ROCKS

In contrast to metamorphic rocks, in which reconstitution takes place without any significant change in bulk chemical composition, altered rocks are those which have had some part of the original material removed and something added. In many cases the addition is that of silica, giving rise to the type of alteration call silicification.

SILICIFICATION

Silicified rocks are of interest to collectors, especially amateur lapidarians because the hardness allows a fine polish. The silica forms microscopic crystals of quartz which may be blue, brown, green, grey, as well as milky white. Most petrified wood is, in fact, silicified. In some places the silica is in the form of opal or agate. Silicification of serpentine rocks near Midway has become of wide interest to British Columbia collectors. This deposit consists of light blue to white quartz filling spaces around brown brecciated and carbonatized serpentine. Slices of this rock have yielded some fine 'seascapes' and the rock is commonly called Ocean Picture Rock. The deposit is held as a mineral claim by N. Berkly of Rock Creek.

Much of the petrified wood in British Columbia is of rather poor quality. Some is partly silicified and much is merely carbonized. Most petrified wood occurs in Tertiary sedimentary rocks usually associated with volcanic flows. Cretaceous sedimentary rocks may also yield petrified wood.

The petrified wood locality in White Lake basin in the Penticton area is on the east side of the road leading south from the radio-telescope site. The locality is about one mile south of White Lake at a point half way between two cattle gates, 0.6 miles apart which cross the road on either side of a dug slough. The wood which is poorly silicified may be dug out of a declivity in a shallow cliff.

Petrified wood has been reported (Sabina, 1964) from Deadman River area in a locality 13 miles north of Highway 1. Tertiary sediments along the north shore of Kamloops Lake may yield petrified wood although, to the writer's knowledge none has been reported.

Petrified wood is exposed in Tertiary sediments on private property about a mile upstream from Douglas Lake Cattle Company buildings east of Chapperon Lake. The locality is easily found and much float lies along the stream course. Some of the logs are 10 feet long and 18 inches in diameter Silicification has not been complete in all specimens and agate lies along cracks in the partly silicified wood. The author has not seen any polished material and cannot report on the quality.

Trunks of trees occur in sandstone interbedded with Tertiary flows on the hills behind Perry Ranch 5 miles east of Cache Creek. The sedimentary beds weather to a light sandy colour, readily spotted in the darker flows. Agate is abundant in the area and much may be picked up on the slopes leading up to the sedimentary beds.

A buried forest, now petrified and at least partly exhumed, occurs in the vicinity of McGlashan Lake, south of Bestwick, south of Barnhart Vale in the Kamloops area. The writer has not seen the occurrence and the precise location is unknown.

Opalized and agatized wood occurs along the banks of Barnes Creek, 7 1/2 miles due east of Ashcroft. Access is by way of dirt road which passes Barnes and Nesbitt Lakes. The location is described by Moldowin (1967) but has not been seen by the writer. Apparently collecting has reduced the amount of easily gatherable material and it is now necessary to dig using hammers and chisels, picks and shovels. The area is underlain by Tertiary rocks of the Kamloops Group. Presumably agate and opal could also be found in the vicinity.

Petrified wood occurs along the hills east of the road from Upper Hat Creek to Marble Canyon. One locality is on the side of the road 3.4 miles south of Highway 12.

Silicified wood has been found in a few places in the sedimentary rocks of the Kingsvale Group. Some good material was found during the stripping of the Kingsvale rocks overlying the orebody at the Craigmont mine. Sedimentary rocks close to agate-bearing volcanics are potential sources of silicified wood. Nicola River and its tributaries from Spences Bridge to Merritt drains such rocks and may yield both agates and petrified wood.

Cretaceous rocks similar to those in the Spences Bridge and Cache Creek groups occur in the Taseko Lakes map-area. Tipper (1963b) reported amygdaloidal volcanic rocks, Tertiary rocks, and possibly agate-bearing rocks, making the area attractive to collectors.

Petrified wood occurs associated with Cretaceous rocks on the west side of Chilko Lake (Fig. 9). Detailed information is given in Fry (1958). The locality is difficult to reach and involves a 37-mile boat trip from Chilko Lodge on the north end of Chilko Lake. A large boat is needed in the interest of safety as the lake may get very rough. Logs up to 2 feet in diameter are found in abundance but the material is inferior for the most part. Some local patches of black and white mottled agatized wood make attractive specimens. The logs are from conifers related to the cypress family.

Petrified wood is reported from the Lower Jurassic rocks in the Talkwa Range. The locality is 7 miles due south of the town of Telkwa in a rather inaccessible location between Webster and Goathorn creeks, at an elevation of about 6,000 feet (H.W. Tipper, pers. comm., 1972).

PROPYLITIZATION

Propylitization is the process of conversion of volcanic rocks into a mixture of chlorite, epidote, zoisite, sericite, quartz, and calcite. This is characteristic of many volcanic rocks such as those in the Nicola and Hazelton groups. Armstrong (1949) mentions epidote as being prominent in the rocks on Boo Mountain.

On Vancouver Island, epidote-rich rocks are abundant in the quarry along the Island Highway, west of Duncan Bay, 2 1/2 miles north of Campbell River.

Thulite, a pink variety of zoisite is found along the Pemberton Highway, 10 miles north of the Alice Lake road, north of Squamish. The collecting locality is about 500 feet south of a viewpoint overlooking Cheakamus Canyon. A number of white aplite dykes intrude the granitic rocks there. Thulite occurs on the east side of the road.

CARBONATIZATION

Carbonatization is the process of alteration to carbonate. Serpentine rocks are especially prone to this type of alteration developed by chemical action according to the following equation:

$$\underset{\text{serpentine}}{H_4Mg_3Si_2O_9} + 3CO_2 = \underset{\text{magnesite}}{3MgCO_3} + \underset{\text{quartz}}{2SiO_2} + 2H_2O$$

Magnesite is common in serpentine rocks and in the Yalakom River Valley northwest of Lillooet. Boulders of altered brecciated serpentine cut by magnesite veins are very common. This material called "Yalakomite" by local rockhounds takes a good polish and makes attractive slabs, book-ends, and penstands. Somewhat similar rocks occur around the Pinchi Lake mercury mine, and in fact are usually found in most serpentine belts.

Magnesite and chalcedony occur in altered serpentine north of Liza Lake about 3 miles west of Marshall Lake, in the Bridge River area. The deposit has not been seen by the writer but from the description given by McCann (1922) the material may have some interest for collectors.

STEATITIZATION

Steatitization is the process of hydrothermal alteration by which magnesium-rich rocks are converted into talc. In most cases the host is an ultramafic rock but dolomite may give rise to talc. Carbonate and chlorite are usually present and these impure talc-carbonate-chlorite rocks are commonly called soapstone. In most cases the carbonate is magnesite, especially so in the alteration of serpentine bodies. Soapstone has been a carving medium by the aborigines, and amateurs are increasingly aware of the value of the material for this purpose.

Talc

Talc and soapstone have a long list of industrial uses and some attempt to produce a marketable product has been tried in a few of the British Columbia localities but without any noteworthy success. Most of the small workings have long since been abandoned and may not be of much value as collecting localities. There may, however, be a small amount of material from the former operations to give collectors a few pieces for specimens.

Steatite is a massive, compact cryptocrystalline variety of talc.

Soapstone is a talcose rock which is soft and easily sawn. It may contain chlorite and carbonate minerals. The name is derived from the soapy feel imparted by the talc. Some talc localities are given in Table 9.

Pyrophyllite

Pyrophyllite is a hydrous aluminum silicate mineral similar to talc in many physical properties. The principal deposit of this mineral in Canada is close to tide water in Kyuquot Sound, Vancouver Island where it occurs with alunite. The locality is not easily reached except by boat. Description of the location and deposit is given by Clapp (1915). A second occurrence is described by McCammon (1952).

Pyrophyllite, coloured blue by presence of dumortierite occurs at Utah Construction's Island Copper mine near Port Hardy.

Kyuquot Sound locality

This locality is in the northwestern part of Kyuquot Sound in the vicinity of Easy Cove where the creek from Jansen Lake discharges. A sketch map and discussion of the occurrence is given by Spence (1940).

Semlin locality

Pyrophyllite occurs about 1,500 feet south of Semlin siding on the Canadian Pacific Railway 10 miles east of Ashcroft. The deposit has been investigated by Mountain Mineral Limited by a number of open cuts and small quarries. The pyrophyllite zone is marked by a light yellow stain.

ECONOMIC MINERALS

Some minerals are valued for the metal that can be extracted from them, e.g. lead from galena, iron from magnetite. Deposits containing these minerals are known as metalliferous deposits. Other minerals are valued because of some specific property, e.g. asbestos because of its insulating and heat resistant properties. These minerals are known as non-metalliferous or industrial minerals.

A metalliferous deposit is regarded as an ore deposit when the contained metal or metals may be extracted at a profit. Whether or not this can be done depends on several factors such as size, grade, market value of the metals, mining, milling, smelting cost, and location. Mineral deposits may become ore deposits with the construction of a railway or highway, with rising

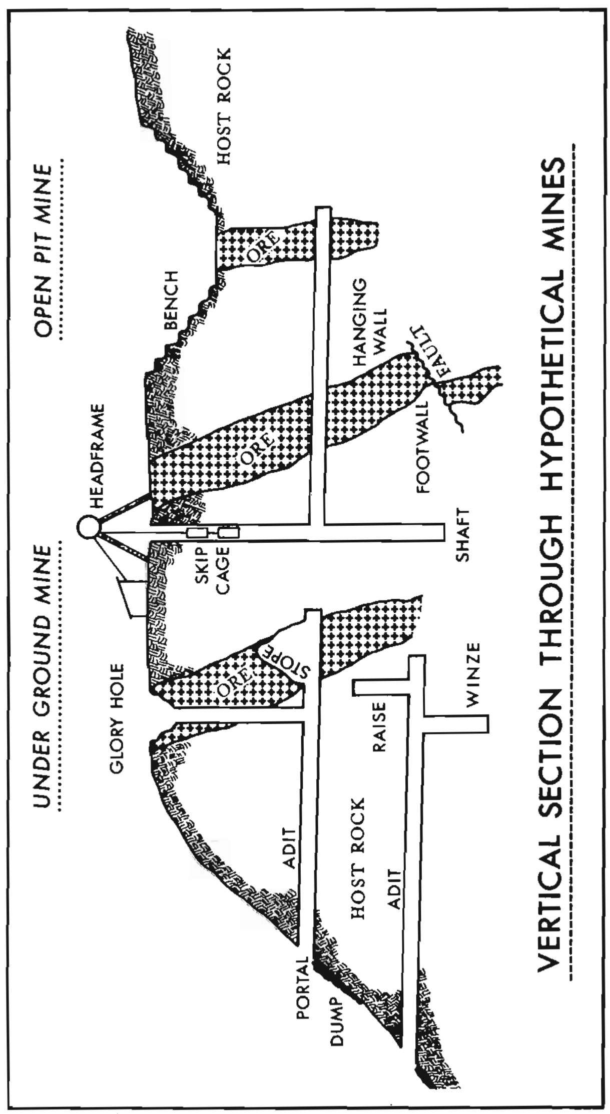
UNDER GROUND MINE
OPEN PIT MINE
HOST ROCK
ORE
BENCH
HANGING WALL
FAULT
FOOTWALL
ORE
HEADFRAME
SHAFT
SKIP
CAGE
GLORY HOLE
ORE
STOPE
WINZE
RAISE
ADIT
HOST ROCK
ADIT
PORTAL
DUMP
VERTICAL SECTION THROUGH HYPOTHETICAL MINES

Figure 28.

metal prices, or the development of new technology. They may cease to be economic with falling metal prices whether due to an economic slump, or the discovery of richer deposits in better locations.

Generally, the larger the deposit, the lower the grade need be, but in this case, economic production can only be effected by large scale operations. Underground mines must generally be richer than open-pit mines because of the higher mining costs.

Metalliferous deposits may contain one valuable metal but commonly two, three or more metals may be extracted from a single deposit. This is illustrated by the following mines in British Columbia:

Bethlehem Copper	Highland Valley	copper
Bralorne Pioneer*	Bralorne	gold
Endako Mines	Endako	molybdenum
Giant Mascot	Choate	nickel-copper
Utica Mines*	Keremeos	silver-gold
Phoenix Mine	Greenwood	copper-gold-silver
Jersey Mine	Salmo	lead-zinc
Bluebell Mine*	Riondel	silver-lead-zinc
Sullivan Mine	Kimberley	lead-zinc-silver (cadmium, tin, antimony)
Pinchi Mine	Pinchi Lake	mercury
Tasu Mine	Moresby Island	iron-copper
Lynx Mine	Buttle Lake	copper-zinc-lead
Britannia Mine	Britannia Beach	copper-zinc

Ore deposits consist of a mixture of ore minerals and valueless gangue which is commonly quartz, calcite or other carbonates, barite, feldspar etc. The assay values of the metals present is called the grade of the deposit. This may be quoted as a percentage figure as 1.5% copper or 0.50 ounces gold per ton, 2.5 pounds mercury per ton. The weight may often be omitted in which case a short ton of 2,000 pounds is implied.

Metalliferous minerals may occur in small, rich bodies which have to be mined by underground methods, or large low-grade bodies which can be mined from the surface using very large equipment to ensure minimum mining costs. A few terms used in mining are presented for the reader's information in Figure 28.

Metalliferous minerals are treated in alphabetical order. Some of these are really semi-metals from a strict chemical point of view and some are nonmetallic in lustre.

Some of the metallic minerals contain two or more elements, and might be considered an ore of either. Thus, bournonite (Cu, Pb, SbS_3) contains about 42% lead and 13% copper. It would normally be considered an ore of lead and it is in fact more frequently found in lead-zinc mines. However, the higher unit value for copper makes it almost as valuable for copper and it may be considered economically as an ore of copper. The reader will therefore find some duplication of minerals in classifying minerals by their metallic content. The justification is the needs of the collectors. The scheme would not be suitable for mineralogists. British Columbia ore minerals and their occurrences are given in the following section.

---

* Now closed

METALLIFEROUS DEPOSITS

Antimony Minerals

The main antimony mineral of commerce is stibnite, Sb_2S_3, which contains about 71 per cent antimony. The element is also found in the native state and in a number of other minerals which include: tetrahedrite, jamesonite, boulangerite, bournonite, meneghinite, berthierite, kermesite and andorite, all of which are reported from localities in British Columbia. There are no antimony mines in British Columbia but the element is recovered as a by-product of the smelting of lead-zinc ore at Trail.

At one time, the Alps-alturas property north of Sandon was mined for its antimony content.

Stibnite usually occurs in quartz veins, which may also contain pyrite, gold tellurides, and cinnabar.

Collecting areas for stibnite include the mine dumps in the Bridge River area (Fig. 18), including the Gray Rock Mine at the head of Trux Creek, the Old Reliance, Congress and Golden Claims, Dauntless and Minto Mines. Cairnes (1943) described the properties in some detail.

Stibnite, with galena, sphalerite, pyrrhotite, scheelite, jamesonite, boulangerite, pyrolusite, and molybdenite occurs in a quartz vein on the Mammoth Group (Cairnes, 1921). Berthierite is reported from the Rainbow claim southeast of the Mammoth group. These claims lie along the Sumallo River near the confluence with the Skagit River in Manning Provincial Park.

The Emancipation mine in Coquihalla valley opposite the mouth of Dewdney Creek contains stibnite, enargite and chalcopyrite as well as gold for which it was worked (Cairnes, op. cit.).

Stibnite with boulangerite, sphalerite, pyrite and ruby silver is reported from ore at Takla Silver Mines west of Germansen Landing. Andorite is reported (Warren, 1946) from the Kay Group which joins Takla Silver Mines on the west. In addition stibnite, freibergite, native silver, realgar, jamesonite, pyrite, arsenopyrite and sphalerite are also present in a crushed zone in argillite.

Stuart Lake antimony mine, 10 miles west of Fort St. James on the south side of Stuart Lake, has produced about 90 tons of antimony ore from quartz veins mineralized with stibnite, pyrite and a little gold.

Stibnite in high-grade float has been found 10 miles west of Big Bar Ferry crossing of the Fraser River north of Lillooet.

The Silver Bell prospect on the south shore of Horne Lake on Vancouver Island contains stibnite in quartz veins.

Kermesite (Sb_2S_2O) occurs as thin films on stibnite at the Alps-Alturas property at the head of Martin Creek, the west branch of Kane Creek, a tributary of Carpenter Creek which it joins near Sandon. Cairnes (1927) describes the property from which antimony ore was shipped in 1926.

Arsenic Minerals

Probably the commonest arsenic mineral is arsenopyrite (FeAsS). It is abundant in British Columbia, particularly in association with gold-bearing quartz veins. Native arsenic is known from two localities. Arsenic also occurs as safflorite, niccolite, realgar, orpiment, danaite, smaltite, cobaltite, proustite, tennantite, erytherite and arsenolite. The list could be extended but these include most of the arsenic-bearing minerals so far reported in British Columbia.

Hurst (1927) lists and described 34 occurrences in British Columbia.

Arsenopyrite is abundant on the dump at the Lucky Strike Mine in the Bridge River area (Fig. 18). It was a common sulphide in the ore at the Nickel Plate Mine at Hedley. On Silver Bell claim on the road west of Skeena River, about a half mile south of the mouth of Kispiox River, arsenopyrite is the main sulphide.

Arsenopyrite is common in many of the prospects in the Hazelton and Smithers area (Kindle, 1954).

Realgar (AsS) is found at the Mount Washington copper mine on Vancouver Island. The property is now inactive and collecting may be permissible. The mine is accessible from the gate at the southeast end of Wolf Lake via logging roads belonging to the Comox Logging Company. The locality may be of interest because of the presence of chalcopyrite, covellite, bornite, arsenopyrite, pyrite, chalcocite, molybdenite, and native arsenic. Native arsenic also occurs on the Grizzly claim near Alberni, and on Watson Bar Creek north of Lillooet.

Realgar is also found with stibnite at the Grey Rock property (p. 103).

Arsenolite (As_2O_3) is reported from the Watson Bar locality.

Beryllium Minerals

Beryl is the best known beryllium mineral although others may contain more beryllium. Beryl ($Be_3Al_2(5.0_2SiO_3)_6$ is typically associated with granite pegmatites. The gem variety, emerald, is one of the most highly priced gemstones and may exceed diamond in value. Aquamarine is a blue-green coloured beryl. Heliodor, a yellow variety, is also a valuable precious stone. Morganite is a rose-coloured variety of beryl. Beryl is not particularly common in British Columbia and none of the precious varieties are known.

Helvite-danalite (complex Be silicates) is reported from a skarn zone on Needle Point Mountain, McDame area (Mulligan, 1960).

Most beryllium occurrences in British Columbia consist of beryl in pegmatites. Table 10 gives additional details.

Bismuth Minerals

The principal bismuth minerals found in British Columbia are bismuthinite (Bi_2S_3), native-bismuth cosalite ($CuPb_7Bi_8S_{22}$), matildite ($AgBiS_2$). Cosalite and bismuthinite occupy drusy cavities in quartz veins within a porphyritic granite stock 2 miles north-northwest of Cassiar (Gabrielse, 1963b).

Native bismuth is reported from the Minto Mine, Bridge River area, but this is now inaccessible. Bismuthinite occurs in the Bluebell Mine at Riondell. Little (1960) reported the mineral in the Jumbo deposits at Rossland. It occurs in veins in the Burn Group east of Tabor Lake in the Prince George area.

Cosalite is found in the veins at Cariboo Gold Quartz Mine at Wells. The property is now closed. Possibly some of the mineral may be found around mine dumps, or surface pits in the general area.

TABLE 10

Some Beryl Localities in British Columbia

Locality	Location and Access	References
Cassiar Beryl,	Horseranch Range 45 miles south-southwest of Lower Post.	(Holland, 1956)
Butler Range,	5 to 10 miles south of Fort Grahamme.	(Dolmage, 1928)
Bonanza mine,	Tete Jaune Cache, Mica Mountain 7 miles south of Tete Jaune.	(Galloway, 1921)
Mt. Begbie,	southwest of Revelstoke, northeast side on edge of snow field.	(Jones, 1959)
Woolsey Creek,	Alberta Canyon.	(Gunning, 1929)
Midge Creek,	Kootenay Lake.	(Rice, 1941)
White Creek,	East Kootenay District.	(Ressor, 1958)
Skookumchuck Creek,	East Kootenay.	(Ressor, 1958)
Hell-Roaring Creek,	Cranbrook area.	(Leech, 1957)

TABLE 11

Some Chromite Localities in British Columbia

Locality	Access	Reference
Scottie Creek,	18 miles north on Highway 97, from Cache Creek turn up access road.	Duffell and McTaggart (1952)
Fergusson Creek,	18 miles on Highway 97 from Cache Creek – north side of highway	Duffell and McTaggart (1952)
Chrome-Vanadium Group	Headwater of Nicola River	Jones (1959)
Mastodon Claim,	Christina Lake off old Highway No. 3, three miles east of Christina Lake.	B.C. Ann. Rept., Min. Mines (1918)
Anarchist Chrome,	summit of Anarchist Mtn., , north side of Highway 3.	B.C. Ann. Rept., Min. Mines. (1957)
Bob Chromite,	Mitchell Mountain, north of Table Lake	Armstrong (1949)

Cosalite also occurs in veins on the Sunrise Group, and Lead King Group on Nine Mile Mountain (see Kindle, 1954).

Joseite (Bi_4TeS_2) and hedleyite ($Bi_5.Bi_2Te_3$) are reported from the Nickel Plate Mine at Hedley.

Tetradymite (Bi_2Te_2S) is said to occur in the White Elephant mine, on the west side of Okanagan Lake opposite Okanagan Landing. Access is via a forest access road running west from the Okanagan Lake road at a point about one mile north of Shorts Creek. The deposit is a large irregular quartz "vein" with masses of pyrrhotite, and minor pyrite, chalcopyrite, and gold.

Chromium Minerals

Chromite ($FeCr_2O_4$) is the principal chrome ore mineral. It is a common associate of ultramafic rocks such as serpentine. A few tons of chromite have been mined from British Columbia deposits but significant economic concentrations are rare.

Chromium is present in a few other minerals found in British Columbia. Chrome garnet is sometimes found in boulders and cobbles on the bars of the Fraser River. Chrome mica dispersed throughout quartz is also found on Fraser River bars and elsewhere in the province. Chrome diopside is a constituent of some jade rocks and gives a light green mottling to the material.

Potential collecting localities for chromite may be chosen from the following table.

Cobalt Minerals

Cobalt forms a number of minerals by combining with arsenic, sulphur, oxygen and water. The most common are:

Smaltite	$(Co, Ni)As_{3-x}$
Cobaltite	$CoAsS$
Safflorite	$(Co, Fe)As_2$
Danaite	$(Fe, Co)AsS$
Erythrite	$Co_3As_2O_8 \cdot 8H_2O$
Glaucodot	$(Co, Fe)AsS$

Cobalt minerals are not common in British Columbia.

The Gem property on Roxey Creek (Fig. 18) in the Tyaughton Lake area (Cairnes, 1943) contains danaite (cobaltian arsenopyrite) with cobalt bloom (erythrite) on the oxidized outcrops.

Cobalt is present at the Rocher Deboule mine at the head of Juniper Creek, about 8 miles northeast of Skeena Crossing. Cobalt bloom, cobaltite, glaucodot occur in veins along with uraninite, scheelite, and chalcopyrite (Little, 1959).

Copper Minerals

Principal copper deposits of British Columbia are shown on Figure 29.

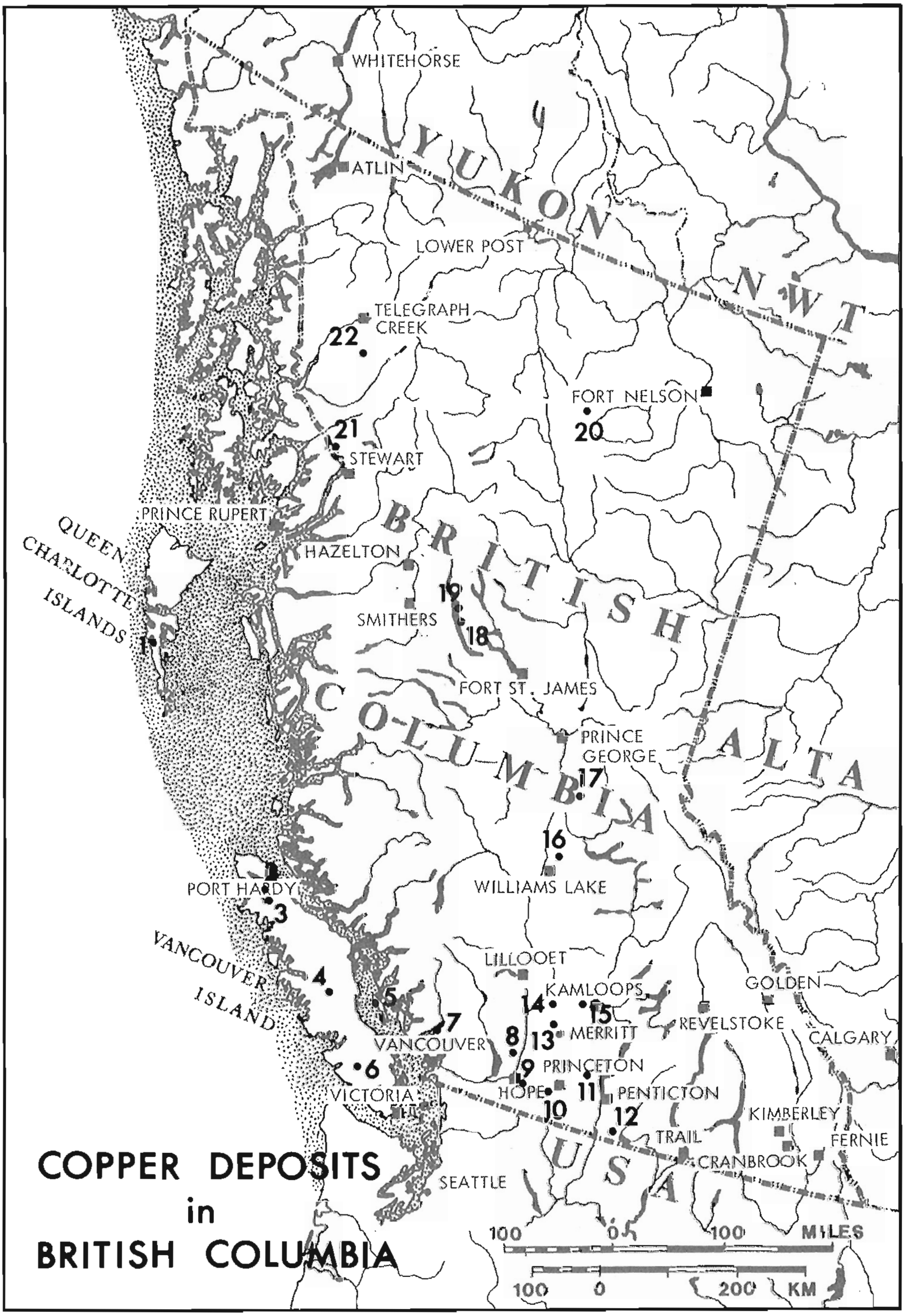
COPPER DEPOSITS
in
BRITISH COLUMBIA
WHITEHORSE
ATLIN
YUKON
LOWER POST
N.W.T.
TELEGRAPH
CREEK
22
FORT NELSON
20
21
STEWART
PRINCE RUPERT
QUEEN
CHARLOTTE
ISLANDS
1
HAZELTON
BRITISH
COLUMBIA
19
18
SMITHERS
FORT ST. JAMES
PRINCE
GEORGE
ALTA
17
16
WILLIAMS LAKE
PORT HARDY
3
VANCOUVER
ISLAND
4
5
7
LILLOOET
KAMLOOPS
14
15
13
MERRITT
8
9
PRINCETON
REVELSTOKE
GOLDEN
CALGARY
VANCOUVER
6
VICTORIA
HOPE
10
11
PENTICTON
12
TRAIL
KIMBERLEY
CRANBROOK
FERNIE
U.S.A.
SEATTLE
100
0
100
MILES
100
0
200
KM

Figure 29.

Figure 29 (opposite)

COPPER DEPOSITS IN BRITISH COLUMBIA

1. Tasu Mine - O/P
2. Island Copper - O/P
3. Coast Copper (Cominco) - U/G
4. Western Mines - O/P and U/G
5. Texada Mines Ltd. - U/G copper-iron
6. Cowichan Copper - U/G closed
7. Anaconda (Britannia mine) - U/G
8. Giant Mascot mine - U/G
9. Canaam Copper - prospect
10. Similkameen Mining (Ingerbell mine) - O/P
11. Brenda Mines Ltd. - O/P
12. Phoenix mine (Granby) - O/P
13. Craigmont Mines - U/G
14. Highland Valley Mines
    - Bethlehem Copper Corp. - O/P
    - Lornex Mines Ltd. - O/P
    - Valley Copper - prospect
    - Highmont Mines - prospect
    - Alwin Mining - prospect
15. Ironmask mine - closed
16. Gibraltar Mines Ltd. - O/P
17. Cariboo-Bell - prospect
18. Bell Copper (Noranda) - O/P
19. Granisle mine (Granby) - O/P
20. Churchill Copper - U/G closed
21. Granduc Mines Ltd. - U/G
22. Stikine Copper - prospect

* O/P open-pit mine
U/G underground mine

Chalcopyrite ($CuFeS_2$) is the commonest ore mineral of copper, in most mines; some bornite (Cu_5FeS_4) accompanies it. At the surface, weathering produces the blue and green secondary carbonate minerals, azurite and malachite.

Chalcocite (Cu_2S), and covellite (CuS) are less common copper minerals. Cuprite (Cu_2O) and tenorite (CuO) are rare in British Columbia.

Tetrahedrite $(Cu, Fe, Ag, Zn)_{12} Sb_4S_{13}$ is a copper mineral but is more common in vein deposits worked for silver, lead and zinc. A silver-bearing variety called freibergite is reported from the Slocan and Vernon areas. The Highland-Bell mine at Carmi contains freibergite. Native copper is somewhat uncommon because copper readily forms compounds with other elements. In strongly reducing environments, however, native copper is produced. The Craigmont mine has yielded fine specimens but it is not a collecting area. The old Aberdeen mine, near Broom Creek about 10 miles north of the Craigmont mine, yielded native copper and chalcocite.

The Maxine mine, on the north shore of Kamloops Lake at Frederick Siding on the C.N.R., contained chalcopyrite, bornite, chalcocite, augite, malachite, and some native copper. The mine, which was never much more than a prospect, is now inaccessible, but some specimens may be found on the dumps.

Two properties in the Aspen Grove Camp north of Princeton contain native copper. Rice (1947) stated that on the Golden Sovereign Group, "Native copper is common.... and lumps weighing as much as 100 pounds are said to have been encountered".

Native copper is one of the principal minerals in the Afton deposit 10 miles west of Kamloops. It is also present in the Gibraltar mine 38 miles north of Williams Lake.

Cuprite is rare in British Columbia. It is present at Gibraltar and Traill (1970) reported small transparent crystals at King Solomon Mine, Copper Creek in the Greenwood area.

Chalcocite

Chalcocite occurs in interlava sedimentary rocks west of Menzies Bay on Vancouver Island. The locality, also noted for the occurrence of volborthite ($Cu_3(VO_4)_2 . 3H_2O$) is easily accessible from a rough road running south from the Island Highway at a point 11.8 miles north of Campbell River bridge on the north side of the town. The road is marked by a sign stating that the road is not recommended for highway vehicles. There are two collecting localities on each side of the road. One is visible from the road at a point 0.8 miles from the highway. The other is a few hundred feet up the hill in a westerly direction from the first. Chalcocite is the main copper mineral in the upper part of Gibraltar mine.

Several veins in the Smithers area contain chalcocite. The reader is referred to the Annual Report of the Minister of Mines and Petroleum Resources for British Columbia for 1968 for further details.

Copper minerals may or may not be collectable from the following mines depending on the policy of the company.

Anaconda	Britannia Beach
Bethlehem	Highland Valley
Phoenix	east of Greenwood
Craigmont	west of Merritt
Giant Mascot	north of Hope
Coast Copper	Benson Lake
Granisle	Babine Lake
Gibraltar	north of Williams Lake

In general, inactive prospects and former mines in the Princeton-Merritt-Kamloops area make good collecting areas (see Fig. 30).

Tetrahedrite is more common in silver-lead-zinc mines than in copper mines. The many prospects, small mines, and abandoned mines in the Nelson-Slocan area are good collecting areas (see Little, 1960). Four localities are summarized in Table 12.

TABLE 12

Some Tetrahedrite Localities in British Columbia

Property	Location and Access	Minerals
Midnight	2 miles from Silverton by branch road from Merritt mine	Sphalerite-galena-tetrahedrite
Ottawa	6 miles east of Slocan on north side of Springer Creek	Tetrahedrite, native silver, argentite, galena, sphalerite pyrite
Little Tim	Head of Tim Creek, 2.7 miles from Ottawa mine	Galena, sphalerite, tetrahedrite, chalcopyrite
Enterprise	south side of Enterprise Creek 7 miles from Slocan	Tetrahedrite, sphalerite

Gold Minerals

Native gold is the main ore mineral of gold. A few gold tellurides are known although they are uncommon in British Columbia.

Collecting specimens of gold will not be very rewarding. Good specimens are rare and valuable and any places where these are likely to be available will be held as mineral claims. Most good specimens, such as those on display in museums, come mainly from rich gold mines as gifts or purchases. About the best an amateur collector could expect would be to have a vial of black sand containing a little native gold from one of the many placer streams in British Columbia.

Placer mining has declined greatly from its hey-day in the early part of the century. The collector should have no problem finding a suitable place

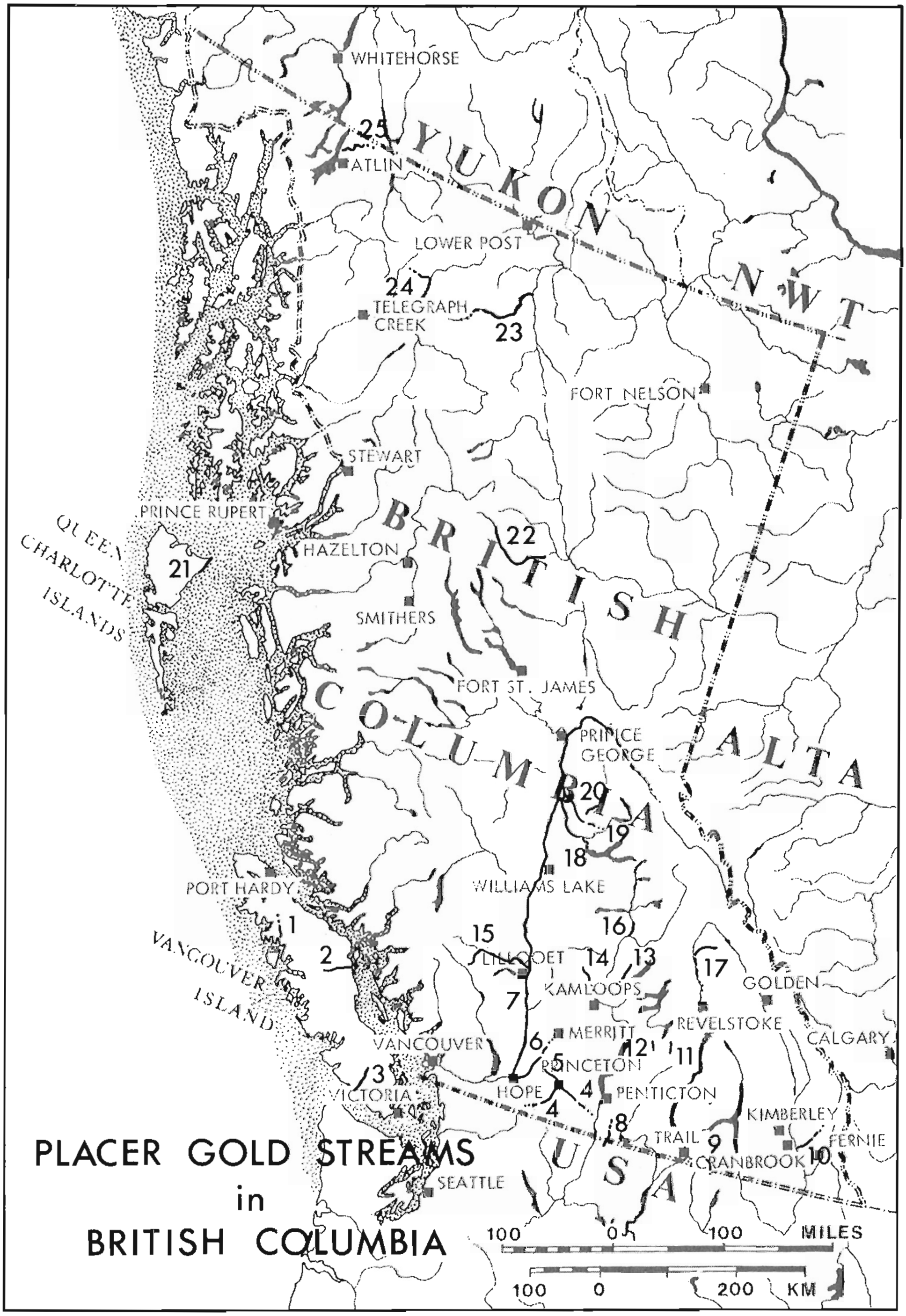
PLACER GOLD STREAMS
in
BRITISH COLUMBIA
WHITEHORSE
ATLIN
YUKON
LOWER POST
TELEGRAPH CREEK
N.W.T.
FORT NELSON
STEWART
PRINCE RUPERT
QUEEN CHARLOTTE ISLANDS
HAZELTON
SMITHERS
BRITISH
COLUMBIA
FORT ST. JAMES
PRINCE GEORGE
ALTA
WILLIAMS LAKE
PORT HARDY
VANCOUVER ISLAND
LILLOOET
KAMLOOPS
GOLDEN
REVELSTOKE
MERRITT
CALGARY
VANCOUVER
PRINCETON
HOPE
PENTICTON
VICTORIA
KIMBERLEY
TRAIL
FERNIE
CRANBROOK
SEATTLE
U.S.A.
100 0 100 MILES
100 0 200 KM
1
2
3
4
5
6
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Figure 30.

Figure 30 (opposite)

PLACER GOLD STREAMS IN BRITISH COLUMBIA

1. Zeballos River
2. Oyster River
3. Bedwell River
4. Similkameen River
5. Tulameen River
6. Coquihalla River
7. Fraser River - Maria Bar, Hills Bar, Sisco Flat, Boston Bar
8. Rock Creek
9. Pend d'Oreille
10. East Kootenay; Bull, Wild Horse, and Moyie Rivers, Bull, Perry and Findlay Creeks.
11. Barnes Creek
12. Okanagan - Harris Creek - Cherry Creek
13. Scotch Creek
14. Tranquille River
15. Bridge River
16. Clearwater River
17. Big Bend of Columbia River - French, McCulloch, Camp and Carnes Creeks.
18. Cariboo Area - Quesnel Forks, Keithley Creek
19. Williams Creek (Barkerville) Lightning Creek, Horsefly River.
20. Cottonwood
21. Queen Charlotte Island - Graham Island beach placers
22. Omineca area - Vital, Germansen, State, Silver Creeks, Manson River.
23. Turnagain River and Wheaton Creek.
24. Dease Lake
25. Atlin area - Pine, Spruce, Boulder, Rudy, McKee, Atler and Wright Creeks.

to pan gravel which ought to yield some colours in most of the streams shown on Figure 31. Reference to the bibliography will provide further details. One of the most useful references to placer mining is Bulletin 21 "Notes on Placer Mining in British Columbia", Department of Mines and Petroleum Resources, Victoria.

Many of the bars on the Fraser River have yielded gold. The most famous perhaps and richest was Hills bar about 1 1/2 miles below the village of Yale but on the east side of the Fraser. From Hope to Prince George and probably beyond, gold has been found on the bars. There is no doubt that many sources or "mother lodes" were involved. Plate XXI shows a bar at the horse bend on the Fraser 10 miles north of Quesnel. Fine flow gold was shown to the author by placer miners testing this bar. Plate XXII shows a section of the Cottonwood River, a tributary of the Fraser north of Quesnel wher placer gold may be found. Plate XXIII shows a section of Bridge River just down stream from the confluence with Yalakom River. This is also potential placer gold ground. Jade has been taken from this claim in early part of the 1960's.

Lode mining of gold has suffered from the general rise in cost of supplies and wages in the face of a fixed value for the product, which has, in effect, lowered the grade of gold deposits so they are no longer ore deposits. The Bralorne-Pioneer mine the last producing gold mine in British Columbia closed in 1971. Cooke (1946) listed 46 mines, potential mines, and mines in which gold was an important by-product. A few of these latter are still producing, but the great decline in gold mining is evident.

There exists the possibility of finding gold specimens around some of the ore dumps and surface pits of some of these former producers and abandoned prospects, but the collector should not really expect to be so fortunate. He may of course be able to collect specimens of gold ore, that is rock which on assay would yield values of say 0.3 oz. or more without any gold being visible. The gold may be associated with sulphides, especially arsenopyrite in quartz veins, or intimately associated with mixed sulphides in replacement deposits.

Gold tellurides are reported from the Engineer mine near Atlin, Windpass mine near Barriere, Vidette Gold Mines north of Savona, Bralorne mine at Bralorne.

Iron Minerals

The main iron ore mineral in British Columbia is magnetite (Fe_3O_4). There are producing mines on Vancouver, Texada, and Moresby Islands where the mineral occurs mainly with chalcopyrite in skarn zones.

Hematite (Fe_2O_3) is the main iron ore mineral in eastern Canada. A few deposits occur in British Columbia but they are not worked for iron. One of the largest deposits lies east of Kitchener about 10 miles from McConnell (Kitchener P.O.). Hematite occurs in masses and narrow veins with quartz, as disseminations in quartzite, and as breccia-filling. Hematite occurs on Fenwick Mountain along to Bull River.

Siderite ($FeCO_3$) is used as an iron ore in a few places in eastern Canada but there are no substantial deposits in British Columbia. It occurs as a gangue mineral in some vein deposits in the lead-zinc ores of the Slocan and Hazelton areas, and is associated with copper ores in the Boundary district at Greenwood.

The following table gives some details of collecting localities for iron ore mineral in British Columbia. Further information may be found in a report by Young and Uglow (1926).

TABLE 13

Some Iron Ore Deposits in British Columbia

Locality	Location and Access	Iron Mineral	Remarks
Texada mine	Texada Island.	Magnetite	producing mine
Brynnor mine,	Kennedy Lake via Alberni Tofino road	Magnetite	mine now closed.
King Iron,	Alta Lake, 1/2 mile west of north end on Pemberton Highway	Limonite	bog iron.
Iron Mountain	summit of Iron Mountain southeast of Merritt, road to Microwave tower.	Hematite	
Glen deposit	south shore Kamloops Lake, 1/2 mile east of Cherry Creek Station on C.P.R. and 400 feet above lake.	Magnetite	apatite abundant.
Lodestone Mountain	7 miles southwest of Tulameen	Magnetite	mainly disseminated
Kitchener Iron	Iron Range Mountain road north from Kitchener	Hematite	veins and replacements mainly in quartzite.
Bull River iron deposits	north side of Fenwick Mountain east of Bull River village.	Hematite	

Pyrite ($FeS2$) and pyrrhotite ($Fe_{1-x}S$) are iron minerals but are not usually used as an ore of iron except in a few places where iron is recovered as a by-product of lead-zinc or nickel mining. Both are common in lode deposits usually mixed with other sulphides. Pyrite crystals are not uncommon and when formed in openings in rocks may occur in beautiful groups embedded in quartz or calcite or both. Pyrrhotite is usually massive but crystals are found in the Bluebell mine at Riondel.

Knebelite $(FeMn)_2SiO_4$, a rare iron manganese silicate of the olivine family, occurs in a few places in British Columbia. It is not an iron ore mineral, but is included here as an iron-bearing mineral.

Arsenopyrite (FeAsS) is a common accessory mineral especially in gold-quartz veins. It has already been treated under the heading of arsenic minerals.

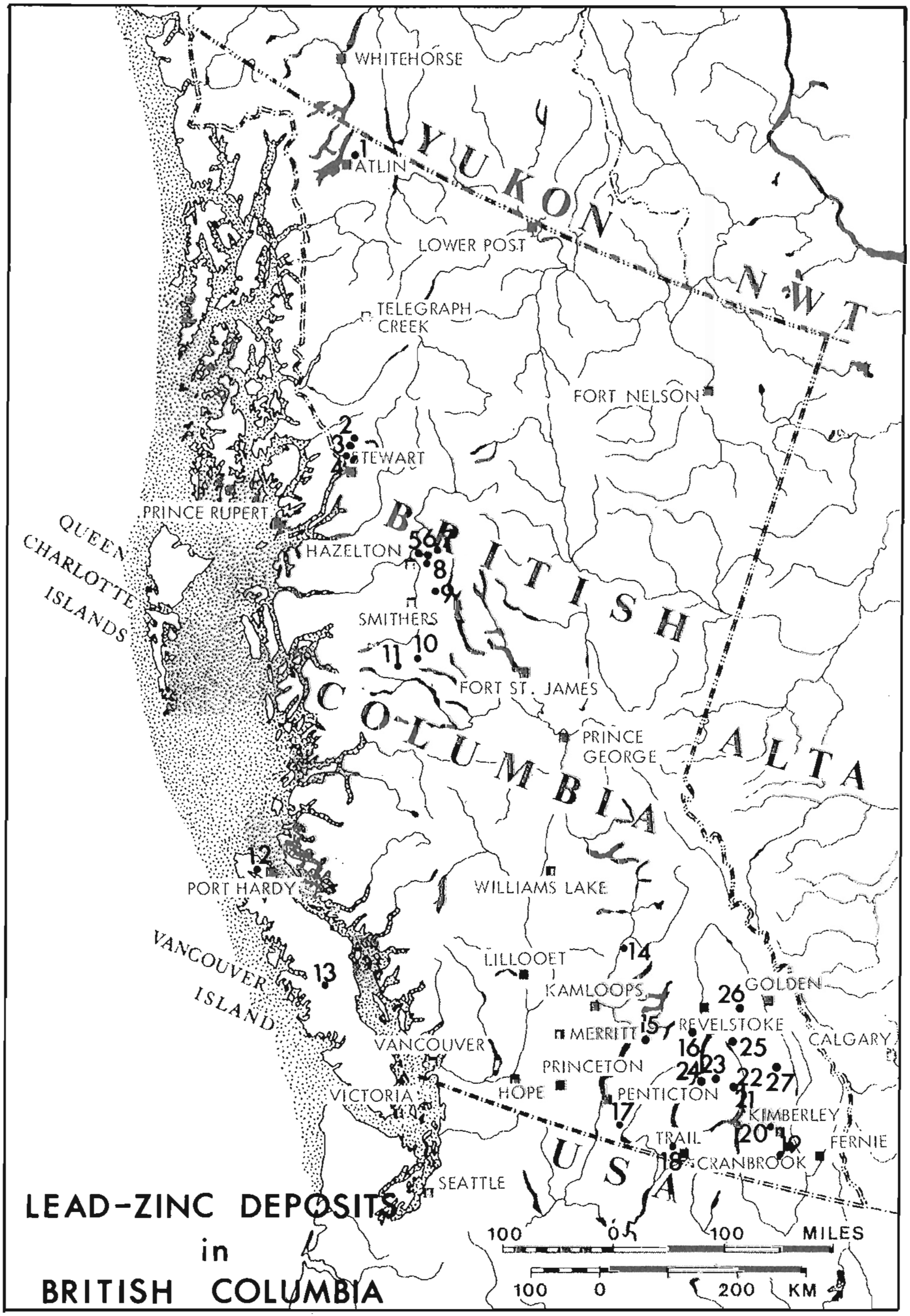
LEAD-ZINC DEPOSITS
in
BRITISH COLUMBIA
YUKON
N.W.T.
BRITISH COLUMBIA
ALTA
USA
QUEEN CHARLOTTE ISLANDS
VANCOUVER ISLAND
WHITEHORSE
ATLIN
LOWER POST
TELEGRAPH CREEK
FORT NELSON
STEWART
PRINCE RUPERT
HAZELTON
SMITHERS
FORT ST. JAMES
PRINCE GEORGE
PORT HARDY
WILLIAMS LAKE
LILLOOET
KAMLOOPS
GOLDEN
REVELSTOKE
CALGARY
MERRITT
VANCOUVER
PRINCETON
HOPE
PENTICTON
VICTORIA
KIMBERLEY
TRAIL
CRANBROOK
FERNIE
SEATTLE
100 0 100 MILES
100 0 200 KM

Figure 31.

Figure 31 (opposite)

LEAD-ZINC DEPOSITS

	Name	Minerals	Reference
1.	Atlin-Ruffner mine (idle)	Galena, sphalerite, arsenopyrite	Aitken (1959)
2.	Big Missouri (El Paso Mining)	Gold, galena, sphalerite, chalcopyrite and pyrite	Alcock (1930)
3.	Silbak Premier (Granby operating)	Galena, sphalerite, tetrahedrite, argentite, native silve, pyrite, chalcopyrite	Alcock (1930)
4.	Porter-Idaho	Galena, sphalerite, tetrahedrite	Alcock (1930)
5.	Silver Standard mine (operator-Northwest Midland Development Limited)	Galena, sphalerite, tetrahedrite, arsenopyrite and pyrite	Kindle (1954)
6.	Sunrise	Silver, galena, sphalerite, tetrahedrite, stibnite	Kindle (1954)
7.	American Boy (operator Northwest Midland)	Silver, galena, sphalerite, tetrahedrite, chalcopyrite, jamesonite	Kindle (1954)
8.	Mohawk	Jamesonite, boulangerite, galena, sphalerite, tetrahedrite	Kindle (1954)
9.	Cronin-Babine mine	Galena, sphalerite, tetrahedrite	
10.	Nadina (Silver Queen)	Sphalerite, galena, chalcopyrite, tennantite, pyrite	Church (1970)
11.	Emeral Glacier mine	Galena, sphalerite, chalcopyrite, pyrite	Duffell (1959)
12.	H.P.H. Group - Nahwitti Lake	Galena, sphalerite, pyrite, pyrrhotite, chalcopyrite, knebelite	Gunning (1932)
13.	Western Mines	Galena, sphalerite, chalcopyrite, bornite, tennantite, covellite	Jeffrey (1965)
14.	Queen Bess	Sphalerite, galena, tetrahedrite, cerargyrite	Alcock (1930)
15.	F.K. Exploration	Galena, sphalerite	
16.	Stannex	Galena, sphalerite	Alcock (1930)
17.	Highland Bell mine	Galena, sphalerite, ruby, silver	Reinecke (1915)
18.	Midnight Claim (Toil Mines Limited)	Galena, sphalerite, gold, chalcopyrite	Little (1960)
19.	Society Girl	Galena, pyromorphite, sphalerite, cerussite	Alcock (1930)
20.	Sullivan mine	Galena, boulangerite, sphalerite, pyrrhotite	Alcock (1930)
21.	Scranton mine	Pyrite, galena, sphalerite	Cairnes (1935)
22.	Reeves MacDonald		Little (1960)
23.	Arlington Silver mine		Little (1960)
24.	Silmonac	Galena, sphalerite	
25.	True Fissure		Fyles and Eastwood (1962)
26.	Ruth Vermont (Columbia River Mines)	Galena, sphalerite	Alcock (1930)
27.	Mineral King (Toby Creek)	Galena, sphalerite, bournonite, meneghenite	mine closed

TABLE 14

Some Non-Economic Iron Mineral Localities in British Columbia

Locality	Location and Access	Mineral	Reference
White Elephant,	west side of Okanagan Lake 1 mile north of Shorts Creek	pyrrhotite	Cairnes (1931b)
Nickel Plate mine	Hedley.	arsenopyrite	
MPH Group	east end Nahwitti Lake	knebelite	Gunning (1932)
Bluebell mine	Riondel	knebelite	Gunning (1939)
Lucky Strike mine	Taylor Basin, west of Tyaughton Lake	arsenopyrite	Cairnes (1942)
Nadira Mines	7 miles northwest of Nitinat Lake.	ilvaite	

Lead Minerals

Galena (PbS) is by far the most abundant lead mineral. It is usually associated with sphalerite and may be silver-bearing. Lead is also found in the following minerals found in British Columbia.

Anglesite	$PbSO_4$
Boulangerite	$Pb_5Sb_4S_{11}$
Bournonite	$CuPbSbS_3$
Cerussite	$PbCO_3$
Cosalite	$CuPb_7Bi_8S_{22}$
Jamesonite	$4PbS.FeS.3Sb_2S_3$
Kobellite	$Pb_6FeBi_4Sb_2S_{16}$
Meneghinite	$Cu_2S.26PbS.7Sb_2S_3$
Pyromorphite	$Pb_5(PO_4,AsO_4)_3Cl$
Wulfenite	$PbMoO_4$

Galena, with some of the lead minerals noted above, sphalerite, pyrite, and silver minerals, or some combination of these occur in quartz veins or replacement deposits, under a great variety of geological conditions. Probably the best collecting area in British Columbia is the Nelson area, particularly in the Slocan district where there are many small deposits, not shown on Figure 32 (see Little, 1960). Ore dumps and open cuts are potential collecting sites. It is not wise, however, to venture into underground working without full knowledge of conditions to be encountered.

Mercury Minerals

Although mercury is present in about fifteen minerals, only cinnabar (HgS) is common. Native mercury is found rarely in cinnabar deposits.

Mercury is being produced at the Pinchi Lake mine north of Fort St. James. The Silverquick mine, north of Tyaughton Lake in the Bridge River area has constructed a mill and expect to be in production soon.

Cinnabar is found in three general areas of British Columbia: (1) along the Pinchi Fault zone north of Fort St. James, (2) in the Tyaughton Lake area of Bridge River district, and (3) in the Kamloops area.

Owing to the current high price of mercury, most if not all known showings are held as mineral claims, hence collecting may not be permitted in the best localities.

Fort St. James map-area

According to Armstrong (1949) the principal cinnabar deposits are found in brecciated fault zones in Cache Creek limestone, as veinlets and blebs in pre-existing openings, and minor replacements along minute fractures. Cinnabar is also deposited in serpentinized rock which has been brecciated. All the mercury deposits lie within the Pinchi Fault zone which provided the channelways for the mineralizing solutions.

In the Fort St. James map-area the following snyopsis may help the collector. For further details, the reader is referred to Armstrong (1949).

TABLE 15

Some Mercury Deposits in Fort St. James area

Property	Access	Remarks
Snell	junction of Silver and Kenny Creeks, 10 miles north of Bralorne Takla mine.	cinnabar with minor stibnite occurs in cherty limestone and in boulders in the overburden.
Bralorne Takla mine	accessible by road leading west of Germansen Lake.	most of the ore came from underground and collecting here unlikely to be rewarding.
L. 1 Group	adjoining Bralorne Takla on the north	orginally discovered pit may yield some specimens.
Bion Group	between west fork of Kwanika Creek and Bralorne Takla mine	cinnabar is exposed in a 16-foot-wide zone on west fork of Kwanika Creek.
Dan Group	south of the west fork of Kwanika Creek	3-inch band of high-grade cinnabar in a 3-foot mineralized zone.
Kwanika Group	west side of Kwanika Creek, 3 miles from Tsayta Lake.	stringers of cinnabar with realgar, pyrite, and native arsenic.
Indata Lake Showing	east side of Indata Lake a mile from south end.	cinnabar in scattered grains in cherty fragments in serpentine dyke or fault breccia.
Indata Group	east of Indata Lake showing	minor cinnabar in carbonatized and brecciated zones.
Pinchi Lake mine	north shore of Pinchi Lake	cinnabar, minor stibnite and pyrite in limestone

Bridge River area

A number of mercury deposits are known in the Bridge River area. Only the Silverquick property has reached production stage. The mill was more or less finished in the fall of 1969. A number of other showings are being developed but those which fail to become mines will be good collecting sites in the future.

Most mercury deposits lie in sheared, fractured and dolomitized volcanic rocks of the Fergusson Group of late Paleozoic to mid-Triassic age. However the deposit of Silverquick mine lies in conglomerate beds of the Taylor Group (Jurassic age). Cinnabar is also found in carbonatized serpentine rocks.

The synopsis of known showings below may be of help to collectors.

Cinnabar and minor stibnite occur in sedimentary rocks in Yalakom valley 28 miles from Lillooet. The property, being developed by Condor Mines Limited lies on the northeast side of Yalakom River above the mouth of Shulaps Creek.

TABLE 16

Some Mercury Deposits in Bridge River area

Locality	Access	Remarks and References
Silverquick mine	good road marked by signs from Bridge River area.	to begin production in 1970.
Lillomer	road from south end of Tyaughton Lake leading northwest to elevation 6,700 feet.	cinnabar and native mercury in veins, in sheared and faulted sedimentary and volcanic rocks Cairnes (1943).
Cinnabar King	north side Mercury Creek a mile southeast of Empire Mercury (Manitou).	cinnabar in conglomerate Cairnes (1943).
Phillips Cinnabar	on side of main road from Tyaughton Lake just south of Noaxe Creek.	Veinlets of cinnabar in sheared Ferguson greenstone.
Manitou mine (Empire Mercury)	at Mire Creek near confluence with Taughton Creek.	cinnabar mainly in volcanic rocks of Ferguson group, along sheared contact with ribbon chert, Cairnes (1943).

Kamloops area

Cinnabar occurs in the Kamloops area in a belt running from Tunkwa Lake to Criss Creek. Most of the deposits lie in carbonate zones in volcanic rocks. The showings as described by Cockfield (1948) are poor collecting sites as no cinnabar was seen in many of them. Unless recent development work has opened up these showings, collectors may have more luck elsewhere. The most important deposits include the Mercury Group at Tunkwa Lake from which about 100 pounds of mercury was produced, and the Cinnabar claims at Cyprus Creek on the north side of Kamloops Lake from which 100 or more flasks (76 pounds) of mercury were produced.

Manganese Minerals

Manganese ore minerals including pyrolusite (MnO_2) manganite (MnO(OH), braunite ($Mn^{++}Mn_6{}^{+++}SiO_{12}$) neotocite (hydrated iron manganese silicate) psilomelane ((Ba, $H_2O)_2Mn_5O_{10}$), rhodonite ($MnSiO_3$) and rhodochrosite ($MnCO_3$) occur in British Columbia.

Manganese is no longer mined in British Columbia, although a small amount was produced under war time conditions from oxides derived from rhodonite at Hill 60 near Duncan, Vancouver Island and from oxides from the Manganese Group near Zwicky.

Rhodonite is discussed in the section on Sedimentary Rocks.

The British Columbia occurrences are tabulated in Table 17 for quick reference. Details are available in Hanson (1932).

TABLE 17

Some Manganese Mineral Deposits in British Columbia

Locality	Location and access	Mineral
Sproat Mountain	6 miles north of Arrowhead	rhodochrosite
Kaslo Creek	lower eastern slope of Kaslo, 2.2 miles Zwicky	wad braunite
Clinton	10 miles northeast of Clinton	psilomelane manganite pyrolusite
Hill 60 claim	east of Cowichan Lake	psilomelane on rhodonite
Hollings claim	Saltspring Island	rhodonite neotocite

Molybdenum Minerals

Molybdenite (MoS_2) is the main ore of molybdenum. A few molybdenum minerals of secondary origin are found, but are rare in British Columbia. Ferrimolybdite ($Fe_2(MoO_4)_3 . 8H_2$) may be expected on weathered outcrops containing molybdenite.

Molybdenite is very common in British Columbia. The reader is referred to the British Columbia Minister of Mines Annual Reports and Vokes (1963) for further information.

Molybdenite occurs principally in (1) disseminations in granitic rocks, (2) mineralized quartz veins, (3) mineralized skarn zones. It is also found in pegmatite dykes and replacement deposits.

The following table summarizes some of the more important molybdenum deposits in British Columbia. Further details may be found by referring to Vokes (1963).

TABLE 18

Some Molybdenum Deposits in British Columbia

Locality	Location and access	Remarks
Endako Mines	north of Highway 16 at Endako village	producing mine (open pit)
Boss Mountain	50 miles east of 100 Mile House via mine road	producing mine (underground)
Red Mountain mine	north of Rossland	producing mine
Brenda	northeast of Peachland via mine road	producing mine (copper and molybdenum)
B.C. Molybdenum mine	5 miles south of Alice Arm P.O.	producing
Hardy prospect	Glacier Gulch on Hudson Bay Mountain 5 miles northwest of Smithers	other sulphides also present
Golconda mine	1 mile west of Olalla on Highway 3, and 1,000 feet above road	molybdenum is very fine grained; chalcopyrite present
Molly mine	Host Creek, east of Salmo	molybdenum, pyrite

Nickel Minerals

The principal nickel ore mineral is pentlandite $(FeNi)_9S_8$. Several other nickel minerals are not uncommon. These include:

nickeliferous pyrrhotite	$(Fe, Ni)S$
millerite	NiS
niccolite	$NiAs$
chloanthite	$(Ni, Co)As_{3-x}$
heazlewoodite	Ni_3S_2
garnierite	$H_2(Ni, Mg)SiO_4.nH_2O$
annabergite (nickel bloom)	$Ni_3(AsO_4)_2.8H_2O$
violarite	Ni_2FeS_4

Only one mine produces nickel concentrates from deposits in British Columbia. This is the Giant Mascot mine north of Hope on the west side of Fraser Canyon.

Occurrences of nickel associated with serpentine may be of economic interest but they are generally submarginal in grade.

TABLE 19

Some Nickel Deposits in British Columbia

Locality, location and access	N.T.S. and reference	Minerals
Univex Mining, Heazlewood Creek, west of head of Blue River.	104P (Wolfe, 1965)	heazlewoodite in dunite
Turnagain River (Falconbridge) Turnagain River, east of Flat Creek.	104I	pyrrhotite, chalcopyrite, pentlandite.
(E and L Group), Head of Snippaker Creek, a tributary of Inskut River.	104B (Jeffery, 1967)	pyrrhotite, pentlandite, chalcopyrite, magnetite, pyrite.
Ni Group, south of east end of Williams Lake	93B; Ann. Rept. B.C. Min. Mines 1956, p. 34	millerite.
JC, JB Group, Yalakon River 40 miles from Lillooet.	92J (Waterland, 1967)	nickel silicate in serpentine.
Sun-west Minerals, head of Tofino Inlet 18 miles by boat from Tofino	92F; Ann. Rept. B.C. Min. Mines 1967, p. 149	nickeliferous pyrrhotite
Dalex Mines Limited, west side of Fraser 20 miles south of Lillooet and 6 miles along logging road to property.	92I; Ann. Rept. B.C. Min. Mines 1967, p. 149	copper, molybdenum, silver, nickel minerals.
Giant Mascot, Mine road from Highway No. 1 at Choate 10 miles north of Hope	92H (Horwood, 1936)	pentlandite, pyrrhotite, chalcopyrite in hornblendite; also chromite, magnetite, sphalerite pyrite, violarite.
Mammoth claim, No. 3 Highway 20 miles east of Hope	92H; Ann. Rept. B.C. Min. Mines 1965, p. 43.	nickeliferous pyrrhotite, stibnite, galena.
Johnstone Creek, 3 miles north of Jonstone Creek Park.	82E	nickeliferous pyrrhotite in dunite.
Old Nick (Nickel Ridge Mines), south of Rock Creek.	83E; Ann. Rept. B.C. Min. Mines (Eastwood, 1968).	nickeliferous pyrrhotite in dunite; chalcopyrite, nickel hydroxide.
Chromex Nickel Mines Limited, old Maston claim east Christina Lake on old Highway No. 3.	82E	chromite, nickel in serpentine.
Barriere Exploration Limited John Creek east of East Barriere Lake 22 miles from Barriere.	82M; Ann. Rept. B.C. Min. Mines 1968.	copper nickel minerals, unspecified in report.

TABLE 20

Some Silver Mineral Deposits in British Columbia

Location and access	N.T.S. map no.	Minerals
Premier Gold Mines, Portland Canal.	103P	native silver, argentite freibergite, pyrargyrite.
Queen Bess, Blackpool, North Thompson Valley.	92P	cerargyrite.
Utica Mines Limited, Keremeos (Horn Silver .	82E	native silver.
Highland Bell mine, Carmi.	82E	freibergite, acanthite, polybasite, native silver pyrargyrite.
Waterloo Claim, Lightning Peak, south of Highway No. 6 east of Vernon.	82L	native silver, ruby silver, argentite.
Lead King, 8 miles north-east of Hazelton.	93M	argentite in quartz veins, with jamesonite, sphalerite, galena, arsenopyrite cosalite, tetrahedrite, pyrite.
Sunrise Group, north slope Nine Mile Mountain, 4 miles northeast of Hazelton.	93M	quartz veins carrying jamesonite, galena, sphalerite, cosalite, pyrite, arsenopyrite, argentite, tetrahedrite.
Silver King, on northeast side of Toad Mountain 3 miles south-west of Nelson.	82F	quartz veins with pyrite, chalcopyrite, bornite, tetrahedrite, malachite, galena, stromeyerite.
Arlington mine, north side Springer Creek 6 miles east of Slocan.	82F	galena, tetrahedrite, sphalerite, silver.

Silver Minerals

Silver may be found as the native element but most silver in British Columbia is produced as a by-product of lead-zinc mining. Silver is nearly always present in native gold in amounts from 10 to 20 per cent as a natural gold-silver alloy. It is usually present in lead-zinc ore associated with the galena or as distinct silver minerals. Silver readily combines with other elements to form many minerals. Of those found in British Columbia the following are listed:

arquerite	(HsAg)
argentite, acanthite	(Ag_2S)

hessite	(Ag_2Te)
petzite	$(Ag, Au)_2Te$
cerargyrite	AgCl
freibergite	(argentiferous tetrahedrite)
proustite	Ag_3AsS_3
pyrargyrite	Ag_3SbS_3
polybasite	$(Ag, Cu)_{16}(Sb, As)_2S_{11}$
andorite	$PbAgSB_3S_6$
stromeyerite	$(Ag, Cu)_2S$
stephanite	$(5Ag_2S. Sb_2S_3)$

Collecting silver minerals will not be easy. Most promising places, where rich ore is known, will be private property.

Tungsten Minerals

Scheelite ($CaWO_4$) is the principal ore mineral of tungsten. Three others are of major importance:

wolframite	$(Fe, Mn)WO_4$
ferberite	$FeWO_4$
huebnerite	$MnWO_4$

A few other tungsten minerals are reported from mines and prospects in British Columbia, these include:

powellite	$CaMoO_4$
stolzite	$PbWO_4$
tungstite	$WO_3.H_2O$
meymacite	$WO_3.2H_2O$

Tungsten minerals occur principally in quartz veins and skarn zones, but may also be found as disseminations in igneous rocks, concentrations in pegmatite dykes, and in placer deposits.

Collecting areas are very numerous in British Columbia. Some of the most important and convenient localities are shown in Table 21 taken from Little (1959).

Scheelite is rather difficult to recognize in hand specimens in which high specific gravity is not apparent. The ultraviolet light is almost essential in prospecting for scheelite. The characteristic fluorescence is bluish-white, but the presence of molybdenum gives a yellowish hue.

Scheelite has been produced at the Emerald Mine near Salmo, and the Red Rose Mine near Hazelton.

No tungsten is being produced in British Columbia now (May, 1973).

Zinc Minerals

The main zinc ore mineral is sphalerite (ZnS). Many uncommon zinc minerals are mentioned in mineralogy textbooks, but are rare in British Columbia.

Hemimorphite ($Zn_2H_2SiO_5$) and smithsonite ($ZnCO_3$) have been reported (Alcock, 1930) but they are rare.

Sphalerite and galena generally occur together in most important deposits and are rarely found separately. For collecting purposes the reader is referred to the section dealing with lead minerals.

TABLE 21. Some Tungsten Deposits in British Columbia

Locality and access	N.T.S. map no.	Minerals
Black Diamond claim, Boulder Creek, 12 miles northeast of Atlin.	104N	wolframite
Louise and Dot claims, 4 1/2 miles north of Stewart.	104A	scheelite
Molly B Claim, east of Bear River opposite Stewart.	103P	scheelite
Esperanza claim, 1 miles north of Alice Arm.	103P	scheelite, arsenopyrite, galena, sphalerite, tetrahedrite, ruby and native silver.
Ptarmigan Group, 6 1/2 miles southeast of Terrace.	103I	scheelite, gold, pyrite, galena, chalcopyrite, barite.
Rocher Deboule mine, 8 miles northeast of Skeena Crossing.	93M	scheelite, galena, sphalerite, tetrahedrite, pyrite, chalcopyrite, arsenopyrite, cobaltite, smaltite-chloanthite, uraninite.
Red Rose mine, 8 miles northeast of Skeena Crossing.	93M	scheelite, ferberite.
Black Prince claim, 6 miles south of New Hazelton.	93M	scheelite, wolframite, ferberite, molybdenite, pyrite, chalcopyrite.
Blue Lake Group, 7 miles south of New Hazelton.	93M	scheelite, molybdenite, chalcopyrite, tungstite, meymacite, tetrahedrite.
Deerhorn Mines, Whitesail Lake.	93F	scheelite.
Hardscrabble Creek 5 miles northeast of Wells.	93H	scheelite, pyrite, galena, chalcopyrite, gold in quartz.
Rand Group, headwaters of Cunningham Creek, south of Barkerville.	93H	scheelite, tetrahedrite, sphalerite, galena.
Gold Coin Claim, head of Little Snoeshoe Creek, south of Barkerville.	93A	scheelite, tungstite, stolzite.
Tungsten Queen claim, east side of Tyaughton Creek, w.4 miles north of Noake Creek.	92O	scheelite, stibnite.
Bralorne mine, Bralorne.	92J	gold, pyrite, arsenopyrite, tetrahedrite, scheelite.
Chalco Group, at confluence of Piebiter and Cadwallader Creeks.	92J	scheelite, chalcopyrite, molybdenite, pyrrhotite.

TABLE 21. (cont'd)

Locality and access	N.T.S. map no.	Minerals
Mammoth Group, Hope-Princeton Highway at confluence of Sumallo Creek and Skagit River, 23 miles east of Hope.	92H	scheelite, pyrrhotite, sphalerite, stibnite, boulangerite, galena, pyrite.
Last Chance Group (Swakum Mountain), 13 miles north of Nicola.	92I	scheelite, pyrrhotite, pyrite, skarn.
Consolidated Nicola Gold Fields mine, east shore of Stump Lake	92I	scheelite, galena, sphalerite, chalcopyrite, tetrahedrite, bornite, gold, arsenopyrite.
Jupiter Group, 3 miles northwest of Hedley.	92H	scheelite, molybdenite, pyrite, chalcopyrite, arsenopyrite, pyrrhotite.
White Elephant mine, 2 miles west and 17 miles south of north end of Okanagan Lake.	82L	gold, tetrahedrite, pyrrhotite, chalcopyrite, scheelite.
Snowflake and Regal Silver claims, 5 miles south of Albert Canyon. (Columbia lead and zinc mines)	82N	scheelite, stannite.
Lucky Boy Group, 3 miles west of Trent Lake.	82K	galena, tetrahedrite, sphalerite, pyrite, chalcopyrite, native silver, scheelite.
Meteor Group, divide between Lemon and Springer Creeks.	82F	sphalerite, galena, tetrahedrite, stephanite, argentite, native silver.
St. Elmo claim, a mile north of Rossland.	82F	chalcopyrite, galena, sphalerite, molybdenite, scheelite.
Blue Moon claim, 3 1/2 miles north of Rossland.	82F	scheelite crystlas, pyrite.
Molly Group, 3 1/2 miles up Lost Creek from Nelson-Nelway Highway.	82F	scheelite, molybdenite.
Emerald Mine, Sheep Creek, east of Nelson-Nelway Highway.	82F	scheelite, pyrrhotite, molybdenite, chalcopyrite.
Kootenay Belle mine, Sheep Creek.	82F	scheelite, wolframite,
Bayonne mine, Bayonne Creek, tributary of Summit Creek.	82F	pyrite, galena, sphalerite, chalcopyrite, tetrahedrite, hessite, petzite, scheelite.
Leader Group (Estella Mines), Angus Creek, south of St. Mary River.	82G	galena, pyrite, chalcopyrite, sphalerite, scheelite, stolzite.
Victory Claim, San Juan River, 22 miles west of Shawnigan Lake.	92B	stibnite, scheelite, pyrite gold.

NON-METALLIFEROUS OR INDUSTRIAL MINERALS DEPOSITS

Most non-metalliferous deposits are fine grained massive beds or veins without much esthetic appeal but specimens should be included in any extensive collection. Crystalline varieties, however, may be found in a few occurrences.

Asbestos

The term asbestos is applied to fibrous varieties of various minerals, mainly serpentine and amphibole. The asbestos of commerce is chrysotile ($H_4Mg_3Si_2O9$) a variety of serpentine. Other asbestos minerals have brittle fibres and are of little economic value.

The sole producer of asbestos in British Columbia is Cassiar Asbestos Corporation Limited which produces fibre from a deposit on Mount McDame, 3 miles north of the village of Cassiar in northern British Columbia.

A large number of minor occurrences of asbestos are known in British Columbia and any of the ultramafic areas shown on Figure 15 may contain some small veins from which specimens may be collected. McCammon (1960b) refers briefly to 36 localities of minor importance, and gives some details on 9 others of more economic significance including the producing mine at Cassiar.

A few of the better and more accessible localities are listed in Table 22.

TABLE 22

Some Asbestos Deposits in British Columbia

Locality	Access	N.T.S. Map and Reference
Van Decar Creek, Mt. Sydney Williams.	via boar from Fort St. James	93K (Armstrong, 1949)
Cadwallader Mountains, south of Bralorne	trail up Noel Creek.	92J (McCann, 1922)
Hall Creek Canyon	5 miles north-northeast of Carnie.	82E (Reinecke, 1915)
Sproat Mountain.	2 miles northeast of Sidmouth (24 miles south of Revelstoke).	82K (McCammon, 1960b)
Letain Lake	50 miles east of south end of Letain Lake, 2 miles by trail northeast to property.	104I (McCammon, 1960b)

Barite

Barite ($BaSO_4$) is mined in a few places in the Columbia valley south of Golden for use as drilling mud in the petroleum industry.

Parson Barite (Mountain Minerals Limited)

The mine is 65 miles south of Parson via logging road. The mine is a group of 3 crown-granted mineral claims which are shown on topographic map 82 N/2 east half. The claims are L14351, L14352 and L1534. The deposits consist of barite veins in quartzite.

Brisco Barite (Mountain Minerals Limited)

This deposit is covered by crown-granted mineral claims L15044, 46 and 49 which lie west of Columbia River 3 miles west of Brisco. Access to these claims are shown on topographic map 82 K/16. The barite occurs in a breccia zone in dolomite.

Baroid of Canada

This company recovers barite from tailings at the old Silver Giant Mine, 8 miles by road northwest of Spillimacheen. The mine dumps may be interesting collecting sites. Location and access are shown on topographic map 82 K/16.

Barite occurs in crystalline form in the Rocky Candy mine north of Grand Forks (see under Fluorite).

Barite is a common gangue mineral in the Mineral King mine near the head of Toby Creek, west of Windermere. The mine is now closed but the mine dumps are potential collecting sites.

The Homestake mine, situated 18 miles along the road from Louis Creek in the Thompson River valley to Squam Bay on Adams Lake, contains veins and lenses of barite with various sulphides. The property has been worked in a small way and presumably barite could be found in the workings or on the dump.

Barite may be found in many silver-lead-zinc mines as a gangue material. It is reported from the Slocan district north of Nelson in the Ottawa, Enterprise and Highland Light claims.

In the Portland Canal area, barite occurs in the Premier mine. The Dolly Varden mine north of Alice Arm contains barite in the gangue.

Epsomite

Epsomite (Epsom salt, $MgSO_4 . 7H_2O$) is a saline residue which crystallizes from certain undrained lakes and ponds on evaporation of the water during the hot dry summers.

It is believed that the sulphate radical comes from the oxidation of pyrite in the surrounding drainage area. This sulphate combines the magnesium and/or calcium to form epsomite and/or gysum. In most deposits sodium sulphate also precipitates.

Many of the small undrained ponds in the interior dry belt are ringed by a white precipitate, and, under extreme conditions, a white crust forms over the whole pond. Some of the larger deposits have been worked on a commerical scale but none are now in operation.

Epsomite has been extracted from Spotted Lake which lies close to Highway 3A (Richter Pass) about 6 miles from Osoyoos. The lake is readily recognizable by the spotted appearance produced by circular bowls of crystalline material. Gypsum crystals are reported to occur in the mud associated with the deposit, but were not observed by the writer. The epsomite is coarsely crystalline and slabs of the outer crust comprise fragile orthorhombic crystals.

Deposits of epsomite are situated about a mile and a half north of Venables Lake in the Ashcroft area. The location is shown by a chain of crown-granted mineral claims on topographic map 92 I/11 west half, and also less accurately on Figure 8.

About 5,000 tons of crystals have been produced prior to 1942 from four ponds.

Epsomite also occurs in a small lake on the north side of Highway 97 about a mile south of Clinton. Reinecke (1920) reported prismatic crystals up to 4 inches in length. The crystals are clean and translucent when first exposed but soon become white and earthy, possibly due to loss of contained water and alteration to lower hydrates of magnesium sulphate.

Fluorite

Fluorite is known from a number of locations in British Columbia. Only one has had any production, this is the Rock Candy mine north of Grand Forks. Wilson (1929), described seven occurrences and mentioned three more. To these may be added the deposits on the west side of Okanagan Lake, and those on Quesnel Lake. A small amount of fluorite occurs at the silica quarry at Oliver. The following localities include the best collecting localities:

Rocky Candy Mine:

This property lies on the north bank of Kennedy Creek which flows into Granby River about 16 miles north of Grand Forks. Twelve miles north of the town, a logging road to the west of the public road leads to the property via Pass Creek and Rock Candy Creek. The location is shown on topographic maps 82 E/1W and 82 E/8W. The property was worked from two adits, and underground workings are extensive but probably inaccessible now. Collecting can be done around the old mill buildings where fluorite has spilled from ore bins. Some of the open stopes may be entered but caution is needed.

Whiteman Creek Fluorite:

This deposit lies 2 miles southest of the mouth of Whiteman Creek which empties into Okanagan Lake opposite Okanagan Landing. Most of the workings are on Lot 4323 which is shown on topographic map 82 L/3 west half. The deposit consists of veins and fracture fillings up to a foot or two wide. Extensive stripping of overburden and trenching on the vein has been done so that easy collecting is possible.

Eaglet Group:

Fluorite is found on the Eaglet claims on the east side of Quesnel Lake, half a mile north of the mouth of Wasko Creek. The area is accessible only by boat. Fluorite occurs as disseminated grains, veinlets and veins up to 6 inches thick, and irregular masses. (McCammon, 1966) reports that "minor amounts of calcite, some of which fluoresces bright reddish-orange, dickite, celestite, pyrite, galena, sphalerite, molybdenite and allanite also are found with the fluorite."

Rexspar Fluorite:

Deep purple fluorite occurs as an accessory mineral in the uranium zones at Rexspar property south of Birch Island in the North Thompson River valley about 90 miles north of Kamloops. A fluorite zone devoid of radio-colourless, and massive. Access to the property may be gained by following the old mine road south across the tracks near the east end of the village. The road, which is about 7 miles long, ends at the Old Mine Camp from which other roads lead to the workings a little farther south.

Liard River Hot Springs Fluorite:

Fluorite along with witherite, and minor barite occurs about 2 miles north of Liard River Hot Springs at Mile 497 Alaska Highway. The deposit has been known for 20 years. In 1954 a road was bulldozed from Mile 498 into the Gem No. 1 Mineral Claim which contains two mineralized areas about 1,000 feet apart. The occurrences lie in Middle Devonian limestones near the contact with Upper Devonian shales (Gabrielse, 1963a).

Plate I. Sawn natrolite nodule from Yellow Lake locality.

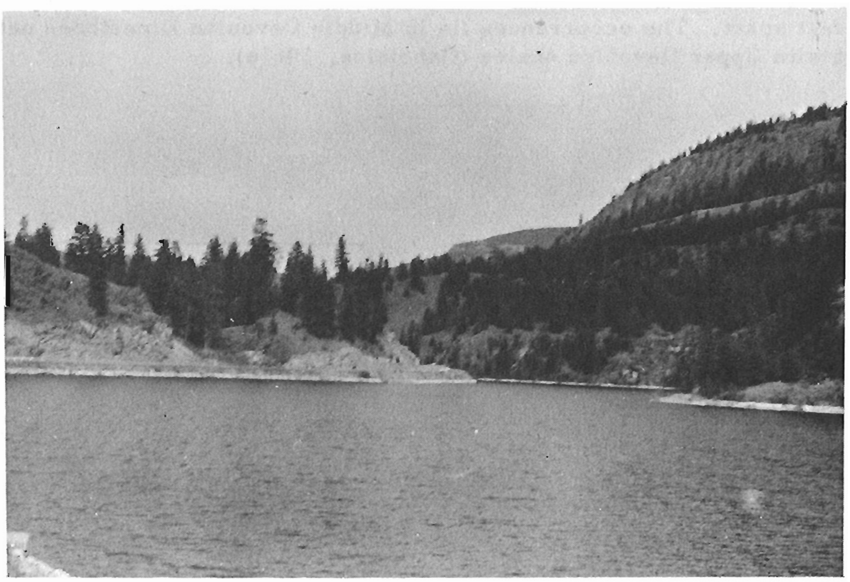

Plate II. (1-5-66). Zeolite locality in Tertiary lava flows. Yellow Lake, Highway No. 3, east of Olalla looking east.

Plate III. Ferrierite on agate. North Shore, Kamloops Lake.

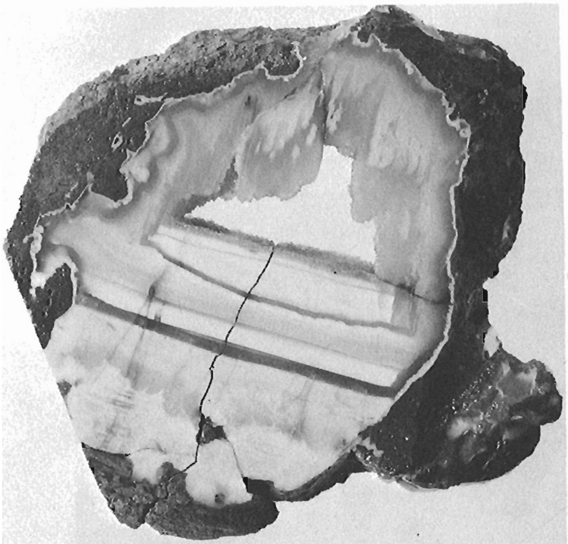

Plate IV.
Slab from geode from Mt. Savona. Specimen donated by Mr. N. Berkley.

Plate V. Zeolite and agate locality in Tertiary lava flows. Painted Chasm on Highway 97 north of Clinton, looking southeast.

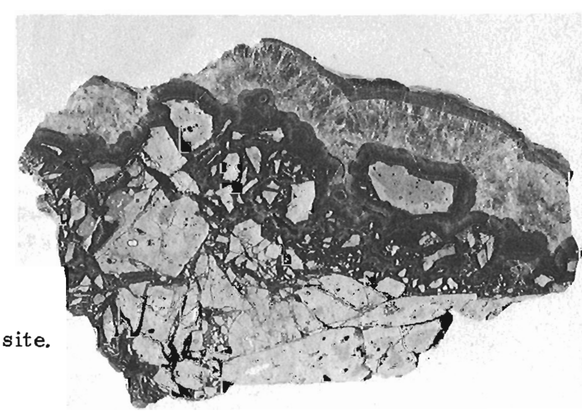

Plate VI.

Collinsite band on brecciated andesite.

Plate VII. "Dallasite", or pillow breccia from boulder found on Qualicum Beach, Vancouver Island.

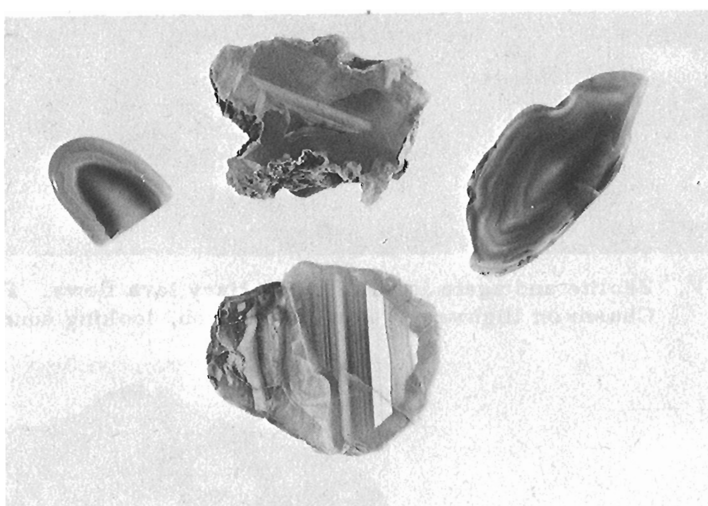

Plate VIII. Agates from Spences Bridge formation near Shaw Springs.

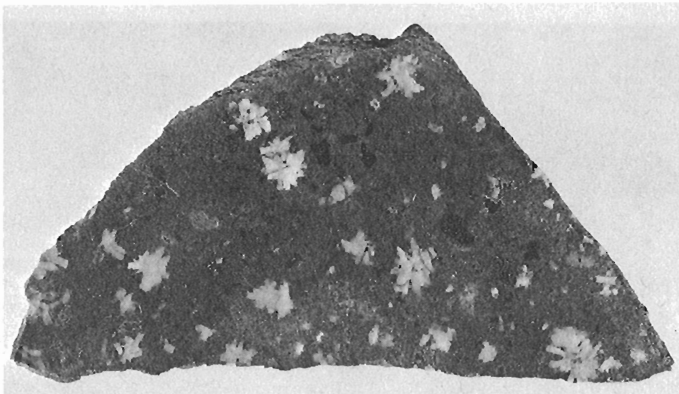

Plate IX. Snowflake porphyry from Salt Spring Island.

Plate X. Photomicrograph of jade from Hell Creek deposit of Birkenhead Jade Mines Ltd. Crossed nicols; x50

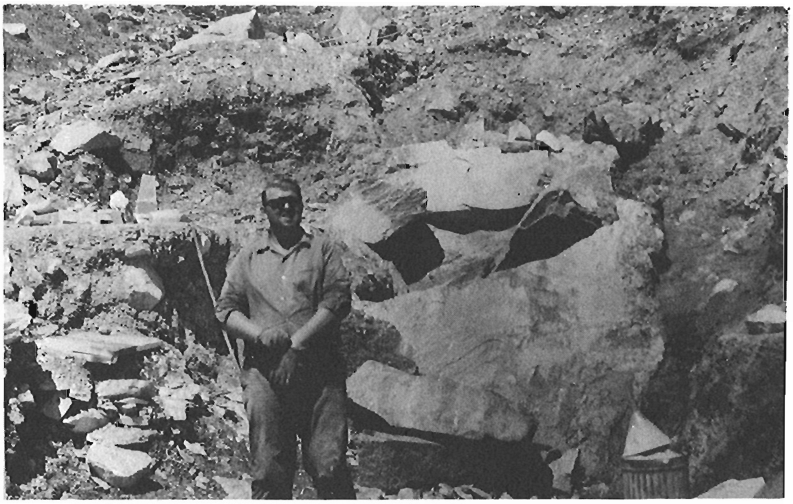

Plate XI. Eight-foot jade "vein". Hell Creek, Bridge River area.

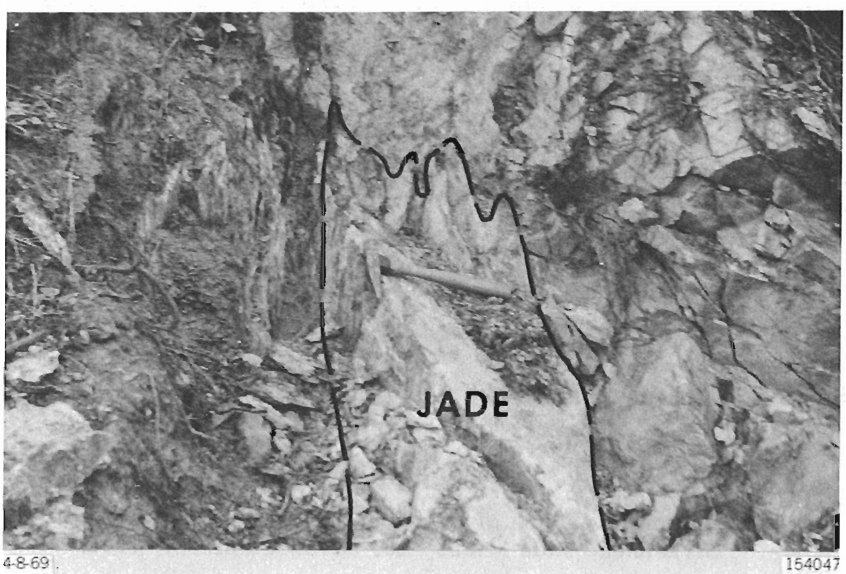

Plate XII. Small lens of jade in serpentine. D'Arcy, Pemberton area.

Plate XIII. Jade "vein". Noel Creek, Bridge River area.

Plate XIV. Charred and partly silicified wood, Sunday Summit.

125024

Plate XV. Rhodonite "vein". Hollings claim. Saltspring Island. Wall-rocks are Sicker Group sediments.

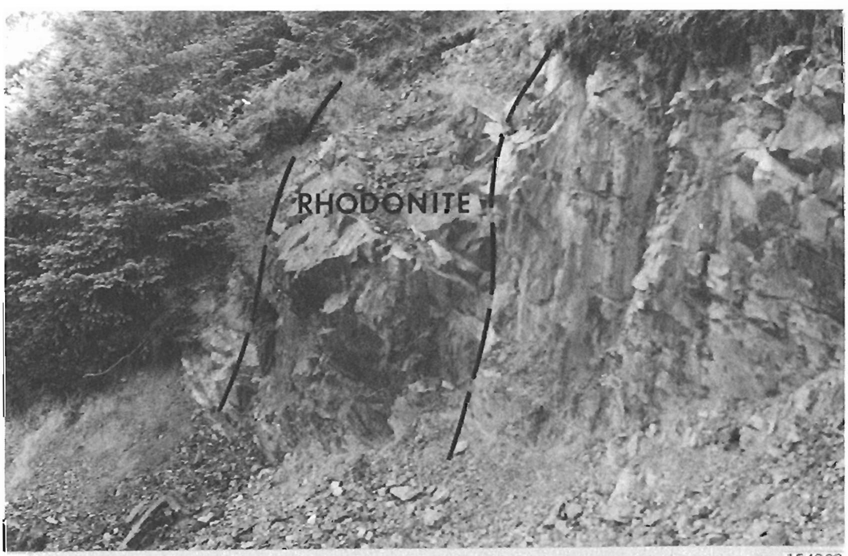

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Plate XVI. Rhodonite "vein". Hill 60, Cowichan Lake, Vancouver Island. Rock on right is chert of Sicker Group (Permian).

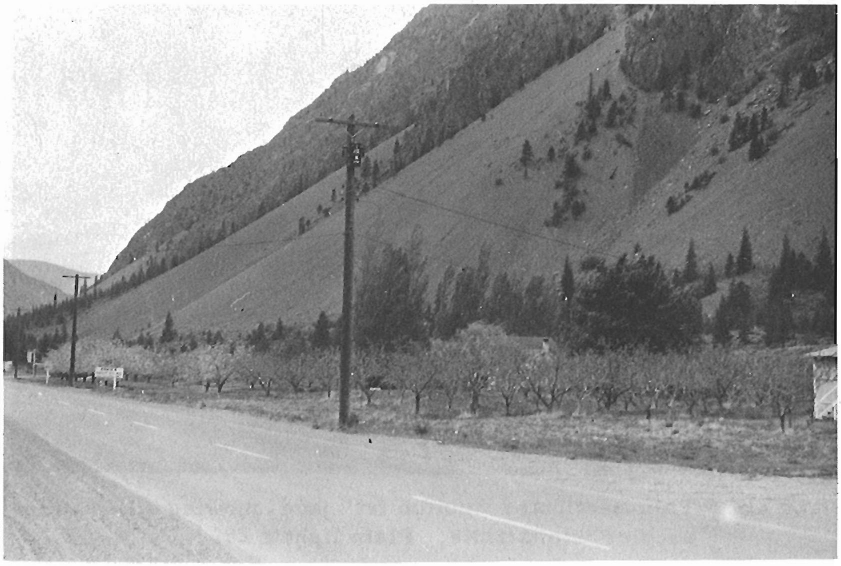

Plate XVII. Jasper-rhodonite locality. Slide at west side of Keremeos. Shoemaker Formation of Triassic age.

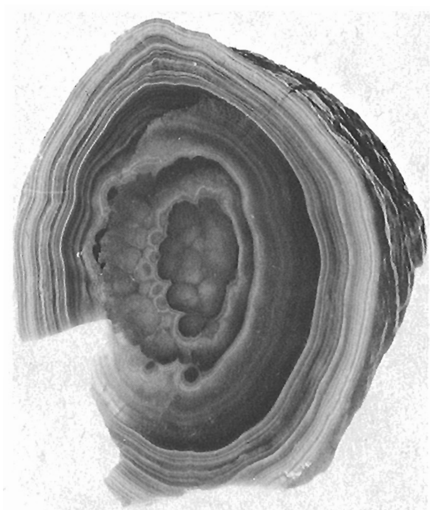

Plate XVIII. Travertine from Lillooet area.

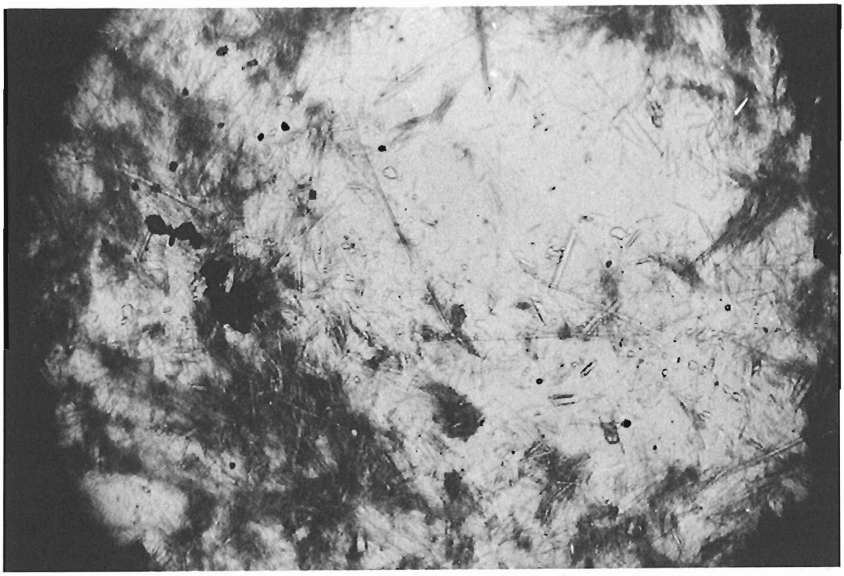

Plate XIX. Thin-section of "mutton fat" jade-showing sillimanite needles in quartzite. Plain light x 25.

Plate XX. Staurolite schist from Prince Rupert area.

Plate XXI. Fraser River bars at mouth of Big Slide 10 miles north of Quesnel.

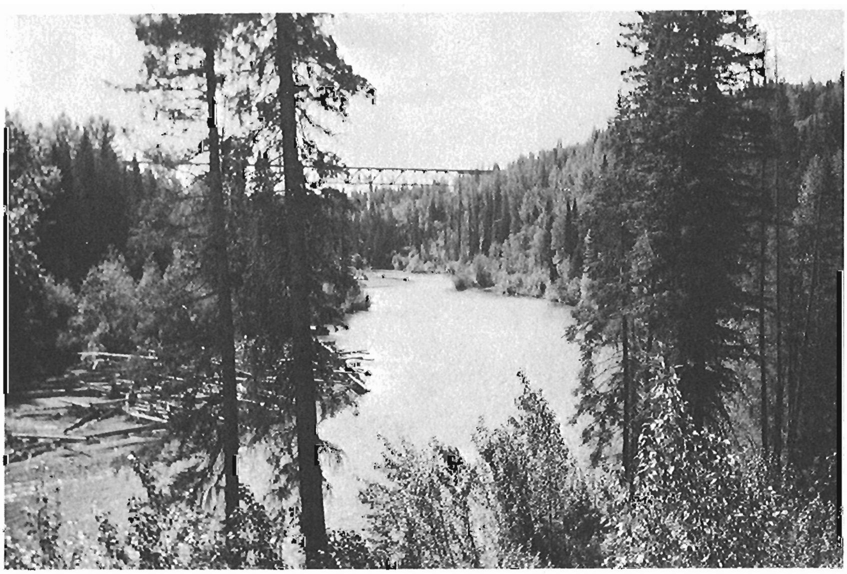

Plate XXII. Cottonwood River upstream from crossing on Highway 97, 10 miles north of Quesnel.

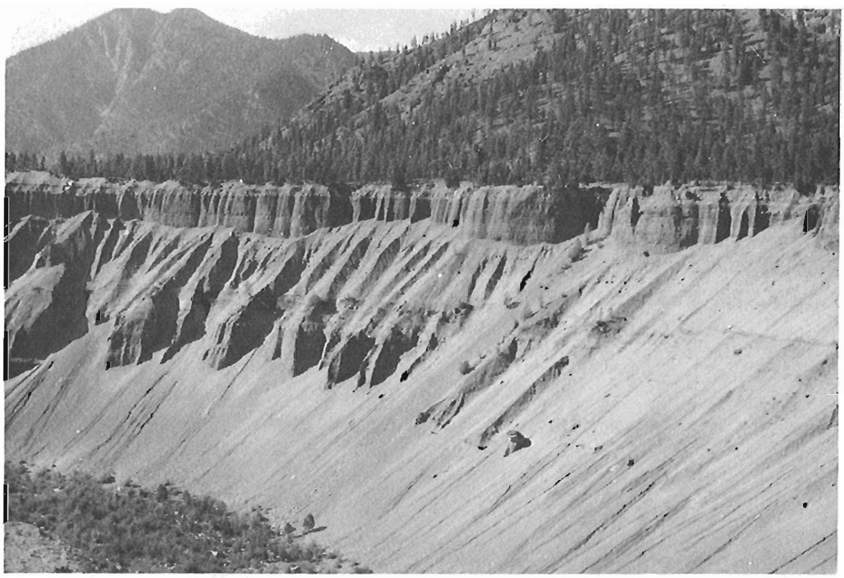

Plate XXIII. Bridge River horse shoe bend near confluence with Yalakom River.

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	Map 316A	Camp McKinney (W.E. Cockfield)
	Map 627A	Okanagan Falls (H.S. Bostock)
	Map 568A	Hedley (H.S. Bostock)
	Map 6-1957	East Kettle (H.W. Kettle)
	Map 539A	West Kettle (Mineral Localities)
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	Paper 69-22	Structure and Petrology of the Grand Forks Group, British Columbia (W.A. Preto)
	Geology, Exploration and Mining 1970	The Geology of the White Lake Basin (B.N. Church)
	Bull. 126	Feldspar and Quartz Phenocrysts in the Shingle Creek Porphyry (H.H. Bostock)
82F	Memoir 79	Ore Deposits of the Beaverdell map-area (L. Reinecke)
	Memoir 308	Nelson West (H.W. Little)
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	Memoir 292	Dewar Creek (J.E. Reesor)
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	Ann. Rept. M.M. 1967	The Geology of Red Mountain (J.T. Fyles)
	Memoir 184	Descriptions of Properties, Slocan Mining Camp, B.C. (C.E. Cairnes)
	Memoir 207	Cranbrook map-area (H.M.A. Rice)
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* Some of these publications are out-of-print and are no longer for sale. However most good reference libraries may have copies.

82J	Paper 54-7	Canal Flats (G.B. Leech)
	Map 24-1958	Canal Flats (G.B. Leech)
	Bull. 35	(B.C. Dept. Mines) Stanford Range (G.G.L. Henderson)
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82K	Memoir 161	Lardeau (Bancroft, Walker and Gunning)
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	Bull. 161	Nakusp (D.W. Hyndman)
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	Mineral Resources of Northern Okanagan Valley, B.C.	Sum. Rept. 1931, Pt. A. (C.E. Cairnes)
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	Ann. Rept. M.M. 1964	Giant Mascot Mine (G.E.P. Eastwood)
	Ann. Rept. M.M. 1967	Copper Mountain-Kennedy Mountain area (V.A.G. Preto)
	Memoir 139	Coquihalla (C.E. Cairnes)

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	Ann. Rept. M.M. 1967	Lornex
	Ann. Rept. M.M. 1967	Bethlehem Copper
	Ann. Rept. M.M. 1967	Craigmont Mine
	Bull. 56	(B.C. Dept. Mines) Guichon Batholith (K.E. Northcote)
	Canadian Rockhound	Barnes Creek Petrified Wood, W. Moldowin, August 1967
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	Memoir 130	Geology and Mineral deposits of the Bridge River area (W.C. McCann)
	Sum. Rept. 1288 Pt. A.	Gun Creek (V. Dolmage)
	Bull. 32	Shulaps Range (B.C. Dept. Mines) (G.B. Leech)
92L	Memoir 272	Zeballos-Nimpkish (J.W. Hoadley)
92N	Paper 68-33	Mt. Waddington (H.W. Tipper)
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	Ann. Rept. M.M. 1964	Silverquick Mines (J.W. McCammon)
	Quaterly Bulletin of the Lapidary and Mineral Society of British Columbia	A Trip to Empire Valley (Mary Sutherland)
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	Bull. 41	Kemano-Tahtsa (B.C. Dept. Mines) (R.A. Stuart)
93F	Memoir 324	Nechako (H.W. Tipper)
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	Ann. Rept. M.M. 1965	Granisle Mine (N.C. Carter)
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94O	Paper 68-12	Maxhamish Lake (Taylor and Stott)
103B, C, F, G, K, L.	Bull. 54	(B.C. Dept. Mines) Geology of Queen Charlotte Islands (A. Sutherland-Brown)
	Ann. Rept. M.M. 1963	Moresby Island (A. Sutherland-Brown)
103I	Memoir 329	Terrace (Duffell and Souther)
	Paper 66-33	Prince Rupert (W.W. Hutchison)
103J	Map 3-1965	Prince Rupert-Skeena (W.W. Hutchison _et al._)
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103K	Map 3-1965	Prince Rupert-Skeena (W.W. Hutchison _et al._)
103P	Ann. Rept. M.M. 1964	Geology of Line Creek area (N.C. Carter)
	Ann. Rept. M.M. 1967	Bell Molybdenum Mines Ltd. (N.C. Carter)
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	Memoir 246	Lower Stikine (F.A. Kerr)
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APPENDIX C

ADDRESSES FOR SERVICE

1. Topographic Maps

    (a) Geological Survey of Canada,
    6th Floor, 100 West Pender Street,
    Vancouver 3, B.C.

    (b) Map Distribution Office,
    Department of Lands, Forests and Water Resources,
    Parliament Buildings,
    Victoria, B.C.

    (c) Government Agent Office – in most towns and cities.

    (d) Institute of Sedimentary and Petroleum Geology,
    3303 – 33rd Street N.W.,
    Calgary, Alberta. T2L 2A7

    (e) Map Distribution Office,
    Surveys and Mapping Branch,
    615 Booth Street,
    Ottawa, Ontario. K1A 0E9

2. Geological Maps and Reports

    (a) Geological Survey of Canada,
    601 Booth Street,
    Ottawa, Ontario. K1A 0E8

    (b) Geological Survey of Canada,
    6th Floor, 100 West Pender Street,
    Vancouver 3, B.C.

    (c) Institute of Sedimentary and Petroleum Geology,
    3303 – 33rd Street N.W.,
    Calgary, Alberta. T2L 2A7

    (d) Information Canada Book Store,
    800 Granville Street,
    Vancouver, B.C.

3. Claims Maps and Free Miner's Certificates

    (a) Department of Mines and Petroleum Resources,
    Douglas Building,
    Victoria, B.C.

(b) Mining Recorder's office in each Mining Division viz.

Port Alberni	New Westminster
Atlin	Merritt
Quesnel	Smithers
Clinton	Pemberton
Cranbrook	Revelstoke
Golden	Princeton
Kamloops	Prince Rupert
Lillooet	Kaslo
Nanaimo	Rossland
Nelson	Vancouver
Vernon	Victoria

4. Amateur Publications

Canadian Rockhound,
941 Wavertree Road,
North Vancouver, B.C.

Subscriptions: 3.00 per year (6 issues)
3.50 U.S.A.