BRITISH COLUMBIA
DEPARTMENT OF MINES AND PETROLEUM RESOURCES
HON. W. K. KIERNAN, *Minister* P. J. MULCAHY, *Deputy Minister*

BULLETIN No. 45

Geology of the Ferguson Area

LARDEAU DISTRICT
BRITISH COLUMBIA

by

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1962

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Geology of the Ferguson Area, Lardeau District, British Columbia

SUMMARY

1. The Ferguson area is in southeastern British Columbia, about 40 miles southeast of Revelstoke and 80 miles north of Nelson.

2. The area is near the north end of the Kootenay arc, a curving belt of complexly deformed sedimentary, volcanic, and metamorphic rocks extending from Revelstoke southeast and south across the International Boundary.

3. This report is primarily a study of the structure and stratigraphy of part of the Kootenay arc and is one phase of a broader study of the arc that is continuing.

4. The area lies within the Selkirk Mountains. The highest summits have elevations just over 9,000 feet; the lowest point in the area, Trout Lake, has an elevation of 2,345 feet. The valleys of Gainer, Ferguson, Lardeau, and Wilkie (Trout) Creeks, which cut across the formational strike, provide good structural and stratigraphic cross-sections.

5. The area contains a thick sequence of highly deformed sedimentary and volcanic rocks intruded by small masses of diorite. Most of the rocks belong to the Hamill group, Badshot formation, and Lardeau and Milford groups. The Badshot is probably Lower Cambrian, though no fossils have been found in it. Rocks of the Milford group contain Mississippian fossils.

6. The oldest rocks are found in the northeastern part of the map-area. They strike northwest and are complexly folded into tight and isoclinal synclines and anticlines with low plunge. The folds produce a cumulative dip to the southwest, and regionally the stratigraphic top is to the southwest.

7. The stratigraphic succession as exposed northeast of Trout Lake is summarized in a table of formations on page 13. This report gives the first detailed account of the succession within the Lardeau group.

8. Little is known of the stratigraphy and correlation of rocks in the area southwest of Trout Lake. Most of the area contains a succession of grey argillites, phyllites, and grits which are complexly folded and contain no distinctive markers. Two distinctive units, a light-grey dolomite and a green volcanic rock, are exposed along the southwestern edge of the map-area.

9. The structure of the Ferguson area is dominated by complex folds. The folds are isoclinal in phyllitic rocks below the Ajax formation and are asymmetric or overturned in the overlying more competent formations.

10. Northeast of Trout Lake, fold axes plunge at low angles both to the northwest and southeast and axial planes dip steeply. Southwest of Trout Lake fold axes plunge 20 to 40 degrees to the northwest, axial planes are essentially vertical, and many of the folds are isoclinal.

11. The largest folds in the area are an anticline and complementary syncline known as the Silvercup anticline and Finkle Creek syncline. The anticline is southwest of the syncline and separated from it by a series of strike faults named the Cup Creek fault zone.

12. The Silvercup anticline and the Finkle Creek syncline, though complicated in detail, have a general cross-sectional shape looking northwest of a letter "N." Southwest of the anticline and northeast of the syncline the folds have the same general form and are smaller than the anticline and syncline.

13. The pattern of folding implies a relative movement of the southwest side upward and over the northeast.

14. The principal mineral deposits in the area contain silver, lead, and zinc. Most deposits were discovered before 1900, and a great deal of the exploration and mining was done before 1920. Total production amounts to 44,259 tons. Gross contents: Gold, 6,941 ounces; silver, 2,205,383 ounces; copper, 5,439 pounds; lead, 9,056,174 pounds; zinc, 435,033 pounds.

15. As early as 1903, it was recognized that the mineral deposits in the Lardeau district fall into three belts—the lime dyke belt, the central mineral belt, and the southwest mineral belt.

16. The most common deposits in the lime dyke belt contain galena in siderite which has replaced limestone. In this belt are the Molly Mac, Index, White Quail, and Silver Chief properties, which are in the Lade Peak limestone and limestones in the Index formation.

17. More than 85 per cent of the ore mined in the Ferguson area has come from the central mineral belt. The Silver Cup, Triune, Nettie L, and True Fissure mines account for most of the production. These deposits and others from which there has been little or no production are veins and lodes containing galena, argentiferous tetrahedrite, sphalerite, and locally chalcopyrite. They are southwest of the Cup Creek fault zone and near the crest of the Silvercup anticline.

18. Descriptions of many of the deposits within the area and their relationship to the regional structure and lithological types are given in Chapter IV.

CHAPTER I.—INTRODUCTION

The Ferguson area (*see* Fig. 1) includes about 85 square miles of mountainous country in southeastern British Columbia. It is part of the Lardeau district of the West Kootenay region, and is about 40 miles southeast of Revelstoke and 80 miles north of Nelson.

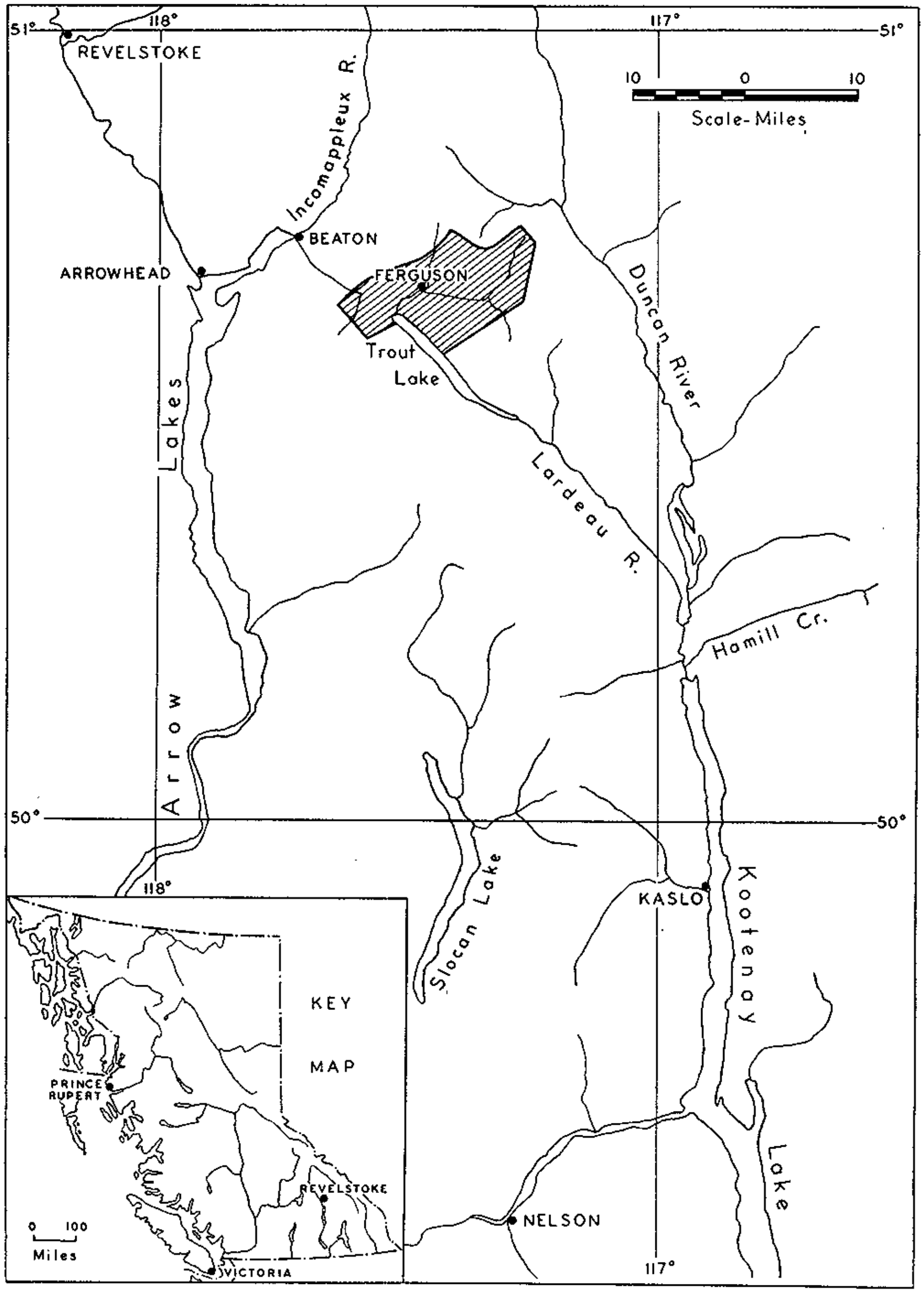

Figure 1. Index map showing the location of the Ferguson area.

Geologically, the map-area is near the northern end of a structural belt known as the Kootenay arc, which extends southeast from Revelstoke, south along Kootenay Lake, and southwest across the International Boundary. The Kootenay arc is a belt of highly deformed, heterogeneous, lime-bearing sedimentary rocks bowed around the eastern margin of a major batholithic area. It is bounded somewhat arbitrarily on the east by quartzites beneath a limestone formation known as the Badshot limestone, the type locality of which is within the Ferguson area. In the northern part of the arc, the batholithic rocks form the Kuskanax batholith and in the south the Nelson batholith. Along the arc are scores of mineral deposits containing dominantly lead and zinc but also containing gold, silver, copper, and tungsten. The search for ore has gone on for many years.

Regional geological maps and local detailed studies of mines and prospects have been made at many places within the arc. The rocks are highly deformed and more or less metamorphosed so that neither reconnaissance work nor detailed study has provided an adequate understanding of the internal structure and stratigraphy of the rocks and localization of the mineral deposits. The present work is a study of stratigraphic and structural detail over a relatively large area in a critical part of the arc. The study has brought to light many characteristics of the structure and stratigraphy, but solution of several remaining important problems must await additional study.

ACCESS AND TOPOGRAPHY

Ferguson and Trout Lake, the only communities in the area, are reached by road from Nelson via Kaslo, Lardeau, and Gerrard, and from Revelstoke by road and ferry via Arrowhead and Beaton or Galena Bay. The roads from Kaslo and Beaton or Galena Bay are gravel surfaced and relatively narrow. They meet near the mouth of Lardeau Creek at a point about half a mile northeast of Trout Lake (*see* Fig. 2). The road from Trout Lake to Ferguson follows Lardeau Creek for about 4 miles and continues 9.5 miles beyond Ferguson through deserted townsites at Fivemile and Tenmile into the valley of Gainer Creek.

The map-area lies within the Selkirk Mountains. Mount Templeman, just east of the map-area, has an elevation of 10,073 feet, Mount Jowett and Spine Mountain within the area are more than 9,000 feet, and several other peaks are more than 8,000 feet in elevation (*see* Plate I). Trout Lake, which at low water is 2,345 feet in elevation, is the lowest part of the area.

The valley containing Trout Lake (*see* Plate III), known as the Lardeau Valley, transects the southwest end of the map-area. It is a flat-floored, almost straight valley one-half to 1 mile wide which extends from near the head of Kootenay Lake almost to the head of the northeast arm of Upper Arrow Lake, a distance of about 50 miles. Trout Lake, about 15 miles long, drains to the southeast. This drainage is separated from the Arrow Lakes drainage by a low divide about 4 miles northwest of the head of Trout Lake.

Lardeau Creek and its tributaries, Ferguson and Gainer Creeks, are the largest streams in the map-area. They flow into Trout Lake and are in deep valleys between high peaks, some of which are drained also by streams flowing northeastward into the Westfall and Duncan Rivers. The heads of Marsh-Adams Creek and Track Creek on the Duncan drainage are within the map-area.

The topography of the map-area does not have a regular pattern. Trout Lake, Lardeau Creek, and Healy Creek beyond the map-area to the east virtually isolate a large upland area known as Silvercup ridge (*see* Plate IV). The southwest part of the summit area of the ridge is a rolling upland about 7,000 feet above sealevel. The northeast part is a series of arrêtes and horns, of which Triune and Silvercup Peaks lie within the map-area and higher peaks lie to the east. Northeast of Lardeau Creek is a high zigzag ridge forming the Lardeau-Duncan drainage divide. Summits along the divide include Redcliff Peak, Corner Hill, Mohican Mountain, Mount Gainer, Piton Peaks, Badshot Mountain, Lade Peak, Spine Mountain, and Mount Jowett. Northwest of Ferguson is a broad upland area known as Great Northern Mountain, which is partly isolated from Mount Thompson and a spur of Mount Pool, peaks west and northwest of the map-area, by the valleys of Mountaingoat and Glenn Creeks.

Mountains southwest of the Lardeau Valley are in a part of the Selkirks known as the Lardeau Mountains. Trout Mountain, immediately south of the map-area, is 8,819 feet in elevation. Wilkie (Trout*) Creek, which flows into Trout Lake, and Beaton Creek, which flows into Upper Arrow Lake, are the main streams in the southwestern part of the map-area.

A number of topographic features facilitate geological studies. Exposures in cliffs and above tree line enable fairly large structural features to be seen from one observation point. Although some extensive areas at lower elevations are covered by talus, glacial deposits, and alluvium, outcrops in a large proportion of the area are adequate for geological work. The narrow and deep valley of Gainer Creek cuts across formations and structures and gives an excellent cross-section of rocks in the northeastern part of the map-area. Another, less well-exposed cross-section is found along Ferguson and the lower part of Lardeau Creeks. Timberline is at about 7,000 feet, and near this elevation and above it in alpine meadows or rocky summits geological features on the whole are well exposed. Below this elevation, many steep slopes contain cliffs and bluffs, whereas others are thickly covered with trees or underbrush. Large parts of the southern and northwestern slopes of Nettie L Mountain and Mount Homer have been cleared of trees by forest fire. The Lardeau Valley and slopes southwest of it constitute the only large area where geological studies are hampered by poor rock exposure.

The area has a heavy snowfall. In Ferguson, at 3,000 feet elevation, the first fall is commonly in early October, and normally snow remains on the ground until the middle of May. The True Fissure mine camp, at 5,600 feet elevation, is snow-covered from about October to early or mid July.

Glacial ice of the Cordilleran sheet once covered the Ferguson area to elevations greater than 8,000 feet. Striæ and erratics have been found on open ridges to elevation of 8,200 feet, and a more careful search than was possible in the present work may find them higher. The striæ trend consistently about south 5 degrees east, and it is assumed the ice moved southward. Most valleys show evidence of erosion by valley glaciers. Cirques with spectacular headwalls are common. The Index and Triune basins and the heads of Finkle Creek and Gainer Creek are characteristic cirques. A cirque lake lies below and on the northwest side of Redcliff Peak. The valleys of Gainer and Ferguson Creeks are U-shaped in cross-section.

Moraines are the only well-defined depositional features of glacial origin. On the north side of Lardeau Creek east of Finkle Creek, more than a dozen lateral moraines form ridges, one above the other, along the hillside between elevations of 5,000 and 6,000 feet. On the average they slope gradually downward toward the west and are readily seen because the hillside has been burned clear of trees. Other more obscure moraines are present along the lower slopes of Lardeau Valley, particularly on the north side of Trout Lake. The highest morainal ridges rise 30 to 40 feet above the general slope of the hill. Small terraces, apparently related to the glacial history of the district, are found at Ferguson and near the mouth of Lardeau Creek. The terrace at Ferguson contains clay overlain by gravel and sand.

* The older unofficial name Trout Creek, which is used exclusively by local residents, is used in this report.

Glaciers occur on many of the higher peaks, mainly on slopes facing north or northeast; those on Spine Mountain and Mount Jowett are the largest. All the glaciers are receding remnants of more extensive ice-sheets which deposited debris in moraines or as outwash, much of which is not yet covered by vegetation. Extensive talus deposits are found beneath bluffs and cliffs. Some hillsides have been subject to landslides (*see* Fig. 2), which are marked by scars or show a characteristic crescentic form on air photographs. Old landslides which are covered with trees may be difficult to recognize on the ground because the slumped blocks are commonly more than 100 feet across. Landslides southeast of Lade Peak, part of the slide between Corner and Mohican Creeks, and a slumped area southwest of Nettie L Mountain appear to be active at present. Others shown on Figure 2 appear to be old slides, and still others, particularly the western end of the slide near Mohican Creek and an area on the north slope of Bunker Hill Creek, are heavily timbered and relatively obscure.

GEOLOGICAL WORK

The Lardeau district was mapped geologically by R. W. Brock in 1903, 1904, and 1907, by Bancroft in 1917, 1918, 1920, and 1921, and by Walker and Bancroft in 1926. The first geological map was published by the Geological Survey of Canada with Memoir 161 in 1929. The mineral deposits were described by N. W. Emmens (1914) and more comprehensively by H. C. Gunning (1929). Information on the properties appears in the Annual Reports of the British Columbia Department of Mines from 1890.

The present geological study was done by G. E. P. Eastwood during parts or all of the seasons of 1953 to 1958, inclusive, and by J. T. Fyles during the season of 1957 and part of the season of 1958. The base map used was prepared by the British Columbia Department of Lands in 1952, at a scale of 1,000 feet to the inch with a 50-foot contour interval. Geological features were located by barometric observations, compass resections, pace and compass traverses, and radial line plotting of selected points recognized on air photographs. Detailed mapping around mineral deposits and in certain other areas was carried out partly by planetable-stadia and partly by tape and compass surveys, assisted by any available company surveys. For underground mapping, company plans were available for the Silver Cup, Ajax, Nettie L, and True Fissure mines; other workings were mapped by tape and compass. Mapping of the Silver Cup mine was mainly by H. P. Trettin, senior assistant in 1956. Chapters II and III and Figure 2 in this report are largely the work of J. T. Fyles, and Chapter IV and accompanying maps are the work of G. E. P. Eastwood.

ACKNOWLEDGMENTS

The writers were assisted in the field by A. F. Gates and J. D. Geigerich in 1953; L. E. Armstrong and O. E. Fornasier in 1954; E. T. Kimura, D. A. Davidson, and T. E. Wynne in 1955; H. P. Trettin, I. B. Faulks, D. F. Irving, and J. J. Twiss in 1956; B. L. Barman and W. D. Groves in 1957; and R. V. Kirkham in 1958.

Base camp was made in Ferguson in the True Fissure office building, for the use of which the writers are indebted to Columbia Metals Corporation Limited and Yellowknife Bear Mines Limited. Accommodation was also obtained at the True Fissure, Nettie L, Silver Cup, and Molly Mac mining camps, through the courtesy of Trout Lake Mines Limited, Ferguson Mines Limited, and Mollie Mac Mines Limited. These companies, together with The Granby Consolidated Mining Smelting and Power Company Limited, kindly made underground plans and transit surveys available. Residents of the area and others assisted the work in various ways.

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MINING HISTORY

Prospecting in the Ferguson area began essentially in 1890, although it has been reported that Lardeau Creek was tested for placer gold some years earlier. In 1890 Walker, McDonald, Holden, and Downs boated down from Revelstoke to a point on the northeast arm of Upper Arrow Lake, cut out a trail to Trout Lake, and prospected the lower 2 miles of Lardeau Creek for placer gold. It was probably in this year also that they located the Great Northern and Silver Cup mineral claims. Intensive prospecting followed, and most of the principal showings in the area were found before 1900. The townsite of Ferguson, originally St. David, was pre-empted by the Ferguson brothers about 1895. A wagon-road was built from Thompson's Landing (renamed Beaton in 1903) to Trout Lake and Ferguson in 1897, and continued to Tenmile the following year. A 30-ton Vulcan furnace was erected in Ferguson in 1901, but is reported to have cracked during its trial run. The railway from Lardeau to Gerrard was completed in 1902, and steamer service was instituted on Trout Lake. By 1900 Ferguson and Trout Lake each had a population of about 1,000.

The pattern of mine development varied from property to property, but for the larger ones it consisted of some initial development by the locators, major development and mining by companies, followed by small-scale mining at irregular intervals by lessees. In 1896 and subsequently, the Lillooet, Fraser River, and Cariboo Gold Fields Co. Ltd., of London, England, controlled by the Horne-Payne Syndicate, gained control of the Broadview, Old Sonoma, Great Northern, and adjoining claims, and acquired the Silver Cup, Sunshine, and adjoining claims through its subsidiary, Sunshine Limited. This company's principal development work was on the Broadview and Silver Cup. In 1898 other companies entered the field, and W. B. Pool, of Nelson, formed Great Western Mines Limited to carry on development of the Pool Group, which included the Nettie L and Ajax properties. In 1901 control of the latter company was acquired by British investors, who formed Silver Cup Mines Limited in 1902 to purchase the Silver Cup. Ferguson Mines Limited bought out both the Great Western and Silver Cup companies in 1904, and completed installation of a concentrator at Fivemile, a combined stamp-mill and chloridizing and amalgamating plant. Ore from both the Silver Cup and Nettie L was carried by aerial trams to the plant. The milling process was unsuited to the ore, most of the tetrahedrite from the Silver Cup was lost in the tailings, and, after treating about 10,000 tons of ore, the plant was shut down in June, 1905. It was destroyed by fire in 1922. Ferguson Mines Limited was dissolved in 1914, but was restored in 1920 and continued to function as a holding company.

When mining ceased at the Silver Cup in 1914, other properties in the area received increased attention, the principal effort being made by the True Fissure Mining and Milling Company Limited, controlled by G. F. Park, of Cincinnati. The True Fissure and Blue Bell were slowly developed in the period from 1916 to 1939. In 1930 a 100-ton flotation mill was erected at the True Fissure and a hydro-electric plant was installed on Ferguson Creek. The mill produced 79 tons of concentrates in 1937. In 1936 and 1937 the Silver Cup Mining and Milling Company Limited erected a small flotation mill beside Cup Creek to treat low-grade ore from the Silver Cup dumps, and shipped 209 tons of concentrates. In 1941 lessees did some further milling of dump ore. The mill machinery was sold in 1952.

With increased metal prices after World War II, there was considerable exploration in the area, and a small boom was developing in 1952, when metal prices slumped. Trout Lake Mining Company, Limited, and its successor, Trout Lake Mines Limited, acquired control of the Nettie L and adjoining properties from Ferguson Mines Limited, reopened adits, and did some diamond drilling. The Granby Consolidated Mining Smelting and Power Company Limited (since March, 1959, The Granby Mining Company Limited) was engaged by Toronto interests to rehabilitate workings and conduct exploration on the True Fissure and Silver Cup. The Broadview, True Fissure, and other claims were purchased from the Park estate by Columbia Metals Corporation Limited, a subsidiary of Yellowknife Bear Mines Limited, but the Silver Cup was retained by Ferguson Mines Limited until sold to Jacques and LaFleur in 1960. Since 1952 exploration in the map-area has been sporadic and mostly in the Gainer Creek area. By 1959 the population of Trout Lake and Ferguson had dwindled to seven persons in each community. In 1951 to 1954 a road was built along Trout Lake, which provided a road connection between Trout Lake and Kaslo. In 1951 the Ferguson–Tenmile road was regraded and extended 3 miles up Gainer Creek.

CHAPTER II.—GENERAL GEOLOGY

The Ferguson area contains a thick sequence of highly deformed sedimentary and volcanic rocks intruded locally by small masses of diorite. The sedimentary and volcanic rocks were divided by Walker and Bancroft (1929) into the Hamill series, Badshot formation, Lardeau series, and Milford group. The Hamill series, the oldest, is dominantly quartzitic, the Badshot is limestone, and the Lardeau series includes phyllite, quartzite, grit, pyroclastic and flow rocks, and minor limestone. These three units were regarded as part of a thick conformable succession unconformably overlain by limestone, chert, and argillite of the Milford group.

The Hamill and Lardeau series, which are primarily lithological units, are called the Hamill and Lardeau groups in the present report. The groups have been subdivided into formations. Several formations are well-defined units with distinctive lithologies; others are poorly defined and contain thick and varied sequences not readily subdivided. Some formations, particularly those containing volcanic rocks, change facies rapidly. The formations have been named because they are useful map-units within the area, and several have been recognized well beyond the map-area. It is hoped they will be of value in geological studies of other sections of the Kootenay arc. The formations are given in the following table.

Table of Formations

Group	Formation	Lithology
Mafic intrusives.		Mainly diorite.
Milford.		Slate, argillite, chert, limestone, and pebble conglomerate.
Stratigraphic relationship not established within the map-area.		
Lardeau.	Broadview.	Grey and green grit and phyllite; minor pebble conglomerate and pyroclastic rocks.
	Jowett.	Mafic lavas, pyroclastic rocks, argillite, minor limestone.
	Sharon Creek.	Dark-grey to black siliceous argillite; slate, phyllite, and minor grit.
	Ajax.	Massive grey quartzite.
	Triune.	Grey to black siliceous argillite.
	Index.	Dark-grey and green phyllite; dark-grey argillite; minor limestone and volcanic rocks.
Probable conformity—relationship uncertain in map-area.		
	Badshot.	Grey limestone.
	(Lade Peak.)	(Grey limestone and argillaceous limestone.)
Apparent conformity—relationship uncertain in map-area.		
Hamill.	Mohican.	Dark-grey and green phyllite; minor limestone.
	Marsh-Adams.	Grey, brown, and white quartzite; micaceous quartzite; minor phyllite.
	Mount Gainer.	White to pinkish quartzite.
Base not exposed.		

The present study has been principally of the Lardeau group. Although the Lardeau group has been known for many years and is widely distributed in the Kootenay arc and to the north (*see* Reesor, 1957b; Rice, 1941; Okulitch, 1949), little is known of the internal stratigraphy of the group. Areas containing the Lardeau group are structurally complex, and the structural complexities have confused stratigraphic studies which heretofore have been mainly of a reconnaissance nature.

Within the present map-area, stratigraphy is difficult to determine because the rocks are highly deformed. At many places they have been greatly thickened or thinned by isoclinal folding, shearing, and flowage. The relationship between the observed thickness and the original thickness of formations is nowhere certain. Formations are commonly repeated several times by folds, the complexities of which must be determined before the stratigraphy can be understood. Stratigraphic studies are further complicated by a general lack of primary sedimentary structures which might indicate stratigraphic tops. Stratigraphy and structure must be worked out together. Much of the Ferguson area, because of its high relief and alpine exposures, is well suited to this sort of study. In this chapter, formations and groups of rocks are described as a stratigraphic succession, even though the original stratigraphy, properly speaking, no longer exists. The rocks constitute a highly deformed succession of lithologic types in which the grade of regional metamorphism in general is low.

Walker and Bancroft (1929) regarded all the rocks of the Ferguson area as belonging to the Hamill, Badshot, Lardeau, and Milford, but the present work has confirmed this only for rocks northeast of Trout Lake and Lardeau Valley. Close studies have shown that the Hamill group and Badshot formation are not present southwest of the Lardeau Valley and that the rocks in that area are of uncertain correlation.

SUMMARY

The oldest rocks are found in the northeastern part of the map-area. They strike northwest and are complexly folded into tight and isoclinal synclines and anticlines with low plunge. The folds produce a cumulative dip to the southwest and regionally the stratigraphic top is to the southwest. Rocks of the Hamill group, which outcrop at the head of Gainer Creek, include white quartzite overlain by micaceous quartzite and phyllite containing minor limestone in the upper part. The rocks above the white quartzite are divided into two formations which total more than 3,000 feet thick.

The Hamill group is overlain by massive grey limestone of the Badshot formation, which forms the prominent peaks of Badshot and Mohican Mountains. The limestone is several hundred feet thick.

The Badshot formation is succeeded by a thick sequence of phyllites containing a few beds of limestone. These rocks make up the Index formation, the oldest in the Lardeau group. Parts of the Index formation are repeated several times by isoclinal folds in a belt about 2½ miles wide, southwest of Badshot and Mohican Mountains. The rocks are greatly deformed, and correlation of rock units from one fold to the next is hampered by the deformation and by the fact that sedimentary facies appear to change across the strike. The exact stratigraphic relationship between the Index and the Badshot formations is not entirely certain, but the Index is the younger. Anticlines within the Index expose a limestone called the Lade Peak formation beneath the Index phyllites that probably is equivalent to the Badshot formation. Green phyllitic volcanic rock a few hundred feet thick forms the uppermost member of the Index formation and is conformably overlain by the Triune formation.

The Triune formation consists of dark-grey thin-bedded cherty slates and argillites. It is overlain by a lighter-grey, somewhat coarser-grained quartzite named the Ajax formation. The Ajax quartzite in turn is overlain by a dark-grey to black siliceous argillite and phyllite named the Sharon Creek formation. These three formations constitute a distinctive stratigraphic succession a few thousand feet thick. The Ajax quartzite is a particularly useful marker.

Volcanic rocks of the Jowett formation conformably overlie the Sharon Creek formation in the northeastern part of the map-area. The Jowett formation includes a few thousand feet of mafic volcanic rocks with a predominance of amygdaloids and pillow lavas near the base and pyroclastic rocks toward the top.

The Jowett formation is overlain by a thick succession of grey and green grits and phyllites known as the Broadview formation. The formation occurs between the Jowett formation and the Cup Creek fault zone (*see* p. 42) in the northeastern part of the area and between the Sharon Creek formation and Trout Lake on the southwestern limb of the Silvercup anticline. Very few distinctive lithologic units are found within the formation, and only a general stratigraphic sequence is recognized.

Between the Cup Creek fault and the Trout Lake-Lardeau Valley, the uppermost part of the Index formation and rocks stratigraphically above it are exposed. They lie on a major anticline, the Silvercup anticline, the axis of which is nearly parallel to the Cup Creek fault and no more than a few thousand feet southwest of it. The axial plane of the anticline dips steeply to the northeast and the axis plunges at a low angle to the northwest. The Triune formation and, near the southeast edge of the map-area, the underlying Index formation are exposed in the core of the anticline, and the Ajax, Sharon Creek, and Broadview formations are repeated on the limbs. The Jowett formation is not found on the Silvercup anticline.

The Broadview formation is overlain by the Milford group on the northeast side of the Lardeau Valley. It is uncertain from evidence within the Ferguson area whether the contact between the Broadview at the top of the Lardeau group and the Milford group is one of conformity or disconformity. The Milford group consists mainly of grey and black argillite and slate and grey, pink, or green chert. Argillaceous limestone near the base contains Mississippian fossils.

Little is known of the structure and stratigraphy of the southwestern part of the map-area because the structure is exceedingly complex and large areas contain only scattered outcrops. The Milford group is followed to the southwest by black slates and argillites with minor bands of carbonaceous limestone along the Lardeau Valley, and these rocks are succeeded to the southwest by monotonous grey and black grits and phyllites. White crystalline dolomite and limestone underlain by phyllitic green pillow lavas lie southwest of the grits and phyllites and constitute the only traceable markers in the southwestern part of the area. They are isoclinally folded about axes plunging 20 to 40 degrees to the northwest and are followed to the southwest by grey and black argillite. Rocks in the southwestern part of the map-area cannot be correlated directly with any rocks northeast of the Lardeau Valley. It is possible that some of them belong to the upper Lardeau or Milford groups, but it may be that they are younger than the Milford.

AGE AND CORRELATION

Carboniferous fossils were found by Walker and Bancroft (1929, p. 13) in limestones in the Milford group. Fossils were not found in any of the other rocks, and they were assigned to the late Precambrian Windermere system. Although fossils have not yet been found in these rocks in the northern part of the Kootenay arc, studies at the southern end of the arc in the Salmo area and northeastern Washington since 1938 have led to the conclusion that the Badshot formation and at least part of the underlying Hamill group are Lower Cambrian. The age of the Lardeau group, which overlies the Badshot and underlies the Milford, is not known.

The correlation of the Badshot formation and Hamill group in the Ferguson area with rocks in the Salmo area is based on lithology. The areas are many miles apart, but the general lithologic succession and the detailed lithologies of the quartzites are strikingly similar in the two areas. Rocks in the Salmo area that were originally regarded as Windermere (*see* Walker, 1934, p. 3) are now known to contain Cambrian fossils (*see* Park and Cannon, 1943, p. 15; Little, 1960, p. 34). Regional geological maps (Little, Map 1090A; Rice, 1943; Walker and Bancroft, 1929) have essentially linked the Badshot formation with a Lower Cambrian limestone member of the Laib formation in the Salmo area known as the Reeves limestone (*see* Fyles and Hewlett, 1959, pp. 17 and 32). Although tracing of the Badshot formation near Kootenay Lake is made difficult by structural complexities and intense metamorphism, the correlation of the Badshot with the Reeves limestone has been generally accepted (*see* Reesor, 1957a, pp. 158 and 164; 1957b). A final test of the validity of the correlation must await critical study in the field.

HAMILL GROUP

The Hamill group was named by Walker and Bancroft from Hamill Creek, a westerly flowing tributary of the lower Duncan River near the north end of Kootenay Lake. The group comprises a thick sequence of quartzitic rocks beneath the Badshot formation (*see* Walker and Bancroft, 1929, p. 9) that outcrops widely in the Lardeau area and the Purcell Range to the east (*see* Reesor, 1957b). In the Ferguson area, rocks of the Hamill group form cliffs and jagged ridges on either side and at the head of Gainer Creek. The oldest rocks of the group in the map-area are white quartzites on Mount Gainer. They are overlain by the Marsh-Adams formation of quartzite, micaceous quartzite, and phyllite, which, in turn, is overlain by the Mohican formation of phyllite and minor limestone.

Quartzite on Mount Gainer, referred to as the Mount Gainer formation, is white to flesh coloured, uniformly fine grained, and is composed almost entirely of quartz. It is blocky, with massive beds a few feet to a few tens of feet thick. Joints parallel and perpendicular to the bedding cause it to break into cubic talus blocks.

The Marsh-Adams formation outcrops principally in two bands crossing the head of Gainer Creek. The first band, immediately southwest of Mount Gainer, is homoclinal; the second, about a mile southwest of the first, is anticlinal. In the first band the Mount Gainer quartzite grades upward into grey and white quartzite with micaceous interbeds. The base of the Marsh-Adams formation is not well defined; the mapped contact with the Mount Gainer quartzite is a horizon below which little or no micaceous quartzite occurs for at least 1,000 feet. A sequence of interbedded white quartzite, grey quartzite, and phyllitic grey quartzite several hundred feet thick lies immediately southwest of this contact and forms the lower part of the Marsh-Adams formation. The upper part of the formation consists of interbedded grey and brown quartzite, rusty weathering argillaceous quartzite, and grey or black phyllite. Beds range from a few inches to a few feet thick, and coarser-grained quartzites show vague cross-bedding. A few feet of green to grey phyllite occurs at the top of the formation, underlying a white limestone at the base of the Mohican formation. The apparent thickness of the Marsh-Adams formation immediately southwest of Mount Gainer is 1,500 to 2,000 feet.

Only the upper part of the Marsh-Adams formation is exposed in the second band in the core of a tight anticline, the Marsh-Adams anticline. Here the formation is dominantly thin-bedded grey and greyish-brown quartzite and minor grey phyllite. Vague cross-bedding is present locally, and disseminated magnetite is seen in some beds. In places, particularly on the southwest limb of the anticline, the uppermost few hundred feet of the formation consists of rusty weathering brown argillaceous quartzite overlain by 50 to 100 feet of grey quartzite with lenses containing quartz grains as much as one-eighth of an inch in diameter in a limy cement. The limy quartzite is locally cross-bedded and is overlain by a few feet of green and grey phyllite immediately below the Mohican formation.

The Mohican formation consists of phyllite and limestone lying between the Badshot and the Marsh-Adams formations. The formation is named from Mohican Mountain, on which it forms conspicuous rusty cliffs. The Mohican formation is exposed on the Marsh-Adams anticline and in a complementary syncline, the Mount Templeman syncline, to the northeast. In general the Mohican formation has a distinctive limestone member at the base overlain by grey and green phyllite, black argillite, and grey to black argillaceous limestone. The basal limestone, which normally is no more than a few tens of feet thick, is finely crystalline, white to light grey, and weathers grey or buff. Rocks above the limestone show considerable variation from place to place. The cause of the variation is uncertain because details of the internal structure of the Mohican formation are unknown.

On the southwest limb of the Marsh-Adams anticline, along the ridge southeast of Gainer Creek and on Mohican Mountain, the rock above the basal limestone is greyish-green phyllite with narrow lenses of buff limestone and streaks of rusty carbonate at intervals throughout. The phyllite is overlain directly by the Badshot formation. On the same limb of the anticline, north of Gainer Creek, and at the base of the cliffs south of Gainer Creek, the Mohican formation is a uniform dark-grey phyllite and grey argillite with 100 to 200 feet of soft green phyllite at the top against the Badshot formation. The change along strike from dominantly grey phyllite along Gainer Creek to dominantly green phyllite on the crest of the ridge to the southeast, 2,500 feet above, takes place along a series of cliffs and was not studied. On the northeast limb of the Marsh-Adams anticline the basal limestone is overlain by several tens of feet of dark-grey phyllite, argillite, and argillaceous limestone, overlain in turn by a succession of green and grey phyllite in alternating bands a few hundred feet thick. Southeast of Gainer Creek, green phyllite underlies the Badshot formation on the southwest limb of the Mount Templeman syncline (*see* Fig. 3), but dark-grey argillite, limy argillite, and argillaceous limestone underlie the Badshot on the northeast limb of the syncline. The dark-grey argillite and argillaceous limestone are a few hundred feet thick and are underlain by a thick succession of dark-grey phyllite with interbands of green phyllite; these phyllites overlie the basal limestone.

On the southwest limb of the Marsh-Adams anticline and on the northeast limb of the Mount Templeman syncline, the apparent thickness of the Mohican formation is 1,500 to 2,000 feet; on the southwest limb of the syncline, it is less than 1,000 feet.

BADSHOT FORMATION

The Badshot formation, which overlies the Mohican formation at the top of the Hamill group, was named by Walker and Bancroft (1929, p. 10) from Badshot Mountain (*see* Plate V) on the northwest side of the upper part of Gainer Creek. It was originally known as the " lime dyke " from the fact that it weathers to a series of high wedge-shaped peaks extending for many miles along the formational strike. A steeply dipping homoclinal occurrence of the Badshot formation forms Badshot and Mohican Mountains, and synclinal remnants in the trough of the Mount Templeman syncline form a prominent peak south of Mount Gainer and castellated towers on Piton Peaks northwest of Track Creek.

The Badshot formation is light-grey, thick-bedded to massive, finely crystalline limestone. Bands several feet wide and small lenses of white- to cream-coloured marble, with grains a few millimeters across, commonly occur within the limestone or along the contacts of the formation. The marble commonly contains black argillaceous material in irregular patches and partings which bear no obvious relation to bedding. The marble probably represents recrystallized limestone, and the black argillaceous material may represent impurities segregated during recrystallization.

Much of the limestone contains irregular dark-grey or white siliceous lenses and bands. Small light-grey spots on some weathered surfaces resemble fossils. Specimens of this type of rock were studied by V. J. Okulitch, who reports that the small spots probably are algal pellets. No other fossils were found, though an intense search was made.

The stratigraphic relationships of the Badshot formation to the overlying and underlying rocks are obscured by structural complexities. The base of the Badshot formation is well defined and from place to place is in contact with various rocks at the top of the underlying Mohican formation. On the northeast limb of the Mount Templeman syncline the Badshot is underlain by dark-grey limy argillite, on the southwest limb it is underlain by green phyllite, and on the southwest limb of the Marsh-Adams anticline it is underlain by green phyllite which is probably higher in the Mohican formation than that in the synclinal section. These relationships are thought to be caused by extreme structural lensing (*see* p. 48).

The upper contact of the Badshot formation, found only on the southwest limb of the Marsh-Adams anticline, is largely covered by talus below the cliffs of Badshot and Mohican Mountains. Where exposed the limestone is in sharply defined contact with black argillite of the Index group. The contact is strongly sheared and the stratigraphic relationships are not entirely certain.

The apparent thickness of the Badshot formation on the northwest side of Gainer Creek is almost 1,000 feet. On Mohican Mountain it is about 700 feet.

Lade Peak Formation

Prominent limestones exposed southwest of Badshot and Mohican Mountains are tentatively correlated with the Badshot formation, but they are referred to as the Lade Peak formation because correlation with the Badshot is not completely certain. The formation is exposed in the cores of five isoclinal anticlines (*see* Figs. 2 and 3). In one, the Lade Peak anticline, the limestone forms the summit and southeast ridge of Lade Peak; in three others, close together and known as the Silver Chief anticlines, the limestone is exposed on the Silver Chief ridge and for several miles to the northwest and southeast. In the fifth anticline the limestone occurs only on Gainer Creek, between the Lade Peak and Silver Chief anticlines (*see* Plate VIII). Overlying green and grey phyllites of the Index formation are repeated on the limbs of the anticlines and occupy the troughs of the intervening synclines.

The Lade Peak formation consists of limestone, argillaceous limestone, and limy phyllite. The base is not exposed, but the lowest beds are black limy phyllite interbedded with grey limestone. Many of the limestone beds are a few inches thick and are separated by thinner dark-grey phyllitic partings (Plate IX). These rocks, a few hundred feet of which are exposed in the cores of several of the anticlines just described, are overlain by fine-grained light-grey limestone 100 to 200 feet thick. The limestone has poorly defined narrow light- and dark-grey bands which are parallel to joints and are spaced from a few inches to about a foot apart. Lenses of white limestone, more coarsely crystalline than the grey, are found locally. At a few places, notably near Corner Hill, an abnormally high proportion of grey phyllite and locally small lenses of green phyllite are present in the formation. Pods of siderite, some of which contain sulphides, occur in the limestone on the Silver Chief anticlines and on the anticline on Gainer Creek between the Silver Chief and Lade Peak anticlines.

Correlation of the Lade Peak formation with the Badshot limestone is suggested by the structure but is not wholly substantiated by the stratigraphy. The non-argillaceous part of the Lade Peak formation is very similar to, though much thinner than, the Badshot limestone. The Lade Peak and the Badshot limestones occur northeast of the Lade Peak anticline on the limbs of a complex syncline containing dark-grey and black phyllites without distinctive markers or structural features by which the form of the syncline can be readily determined. On the southwest limb of the syncline the Lade Peak limestone is overlain by a few hundred feet of green phyllite with a thin bed of limestone and another of quartzite near the top (*see* p. 20). These distinctive rocks are not found on the northeast limb of the syncline adjacent to the Badshot limestone. The contact of the Badshot limestone with the dark-grey phyllites to the southwest is strongly sheared and may represent a fault with considerable displacement. Despite these uncertainties the Lade Peak limestone is tentatively considered to be the equivalent of the Badshot. Alternatively, the Lade Peak limestone may be a relatively great distance stratigraphically above the Badshot and not repeated northeast of Lade Peak.

LARDEAU GROUP

The Lardeau group was defined by Walker and Bancroft (1929, p. 11) from the Lardeau district in which it is widely exposed. It includes a great thickness of sedimentary and volcanic rocks between the Badshot formation and the Milford group. The Lardeau group continues beyond the Lardeau area and has been mapped along Kootenay Lake (*see* Rice, 1943; Reesor, 1957a). Everywhere it is highly deformed and locally it is intensely metamorphosed. Details of the structure and stratigraphy of the Lardeau group as a whole had not been studied before the present work in the Ferguson area. In this work the Lardeau group has been subdivided into formations (*see* Table of Formations) which have been traced for several miles along strike within the map-area and are found in both the northeastern part of the area and on the Silvercup anticline. Parts of some formations change facies within the map-area, both parallel to and across the formational strike. Although it is uncertain how far details of the stratigraphy extend, the Lardeau group as a whole and a few distinctive formations within it are recognized in other places in the Kootenay arc.

INDEX FORMATION

The oldest rocks in the Lardeau group are members of the Index formation, named from exposures in the basin of Index Creek, a northwesterly flowing tributary of Gainer Creek. The Index formation consists of a thick sequence of grey and green phyllite and dark-grey argillite together with thin bands of limestone, argillaceous limestone, and volcanic rocks. The formation outcrops in a folded belt more than 2 miles wide southwest of Badshot and Mohican Mountains, and the upper part is exposed in the basin of Triune Creek in the core of the Silvercup anticline.

The formation is best known from exposures in the folded belt southwest of Badshot and Mohican Mountains. It consists of green phyllite, overlain by grey phyllite and dark-grey argillite. Thin lenses of limestone are found near the base and at the top of the grey phyllite. The uppermost limestone is overlain by phyllitic green volcanic rocks, the highest member in the Index formation. The volcanic rocks are overlain conformably by the Triune formation.

The Index formation is isoclinally folded about northwesterly trending axes with low plunge. Individual members are repeated several times across the belt between Badshot and Mohican Mountains and the valleys of Bunker Hill and Index Creeks. The Lade Peak limestone occupies the cores of five isoclinal anticlines (*see* Fig. 3), and the Index formation, which overlies the limestone, is contained in the intervening synclines and forms a more or less homoclinal succession only southwest of the Silver Chief anticlines.

Green phyllite, the basal member of the Index formation, overlies the Lade Peak limestone. The contact is well defined and commonly sheared or tightly folded. The green phyllite occurs on both limbs of the Lade Peak anticline, where it is a few hundred feet thick, and outcrops widely to the southwest as far as Index and Bunker Hill Creeks. It appears to thicken toward the southwest and has not been found adjacent to the Badshot limestone on Badshot and Mohican Mountains. The green phyllite has a strong but somewhat irregular cleavage. Beds are not commonly visible, but where seen they are a fraction of an inch thick and tightly crenulated. Study of thin-sections shows the principal minerals to be quartz, muscovite, and chlorite. Narrow lenticular bands of grey and greenish-grey phyllite, which lack chlorite, are fairly abundant.

The green phyllite is overlain by grey and dark-grey phyllite and argillite. The grey phyllite and argillite occupies most of a synclinal trough between the Lade Peak anticline and Badshot and Mohican Mountains. Northwest of Gainer Creek it is repeated in another synclinal trough southwest of the Lade Peak anticline, but it does not continue on strike southeast of the creek. The grey phyllite is repeated again in the upper part of Bunker Hill Creek and on the ridge between Bunker Hill and Gainer Creeks (*see* Fig. 2). The rocks immediately southwest of Badshot and Mohican Mountains are dark-grey to black phyllites and argillites with lenses and beds of limy argillite and platy limestone a few tens of feet thick. The argillite is commonly silty, and characteristically contains clear quartz grains which are visible with the aid of a hand-lens. Southwest of the Lade Peak anticline the grey phyllites are similar to those just described, but in general they are lighter grey, fined grained, and contain essentially no limy beds. In the upper part of Bunker Hill Creek, grey to black phyllite is several hundred feet thick and on the southwest is interbedded and infolded with green phyllite. To the southeast along Index Creek it grades into green phyllite. Thin-sections reveal that the grey phyllite differs from the green only in the content of carbonaceous material.

The contact of the grey phyllite with the underlying green phyllite is not well defined, but locally a bed of grey limestone and another of brownish quartzite occur near the contact. The limestone and quartzite are well exposed on the northeast limb of the Lade Peak anticline. The limestone averages a few tens of feet thick, but north of Lade Peak it is more than 100 feet thick, near Gainer Creek it pinches out, and to the southeast of Gainer Creek it occurs only as lenses. The limestone is grey and dark grey and contains narrow interbeds of grey and locally green phyllite. It is overlain by about 100 feet of grey and green phyllite which in places contains lenses of brownish quartzite and grades up into a few tens of feet of this quartzite. The quartzite is mainly composed of rounded grains of quartz that are commonly 1 to 2 millimetres in diameter and, in the coarser varieties, as much as 4 millimetres in diameter. Visible grains of feldspar give the rock a porphyritic appearance. Minor amounts of muscovite, iron oxides, and carbonates are present. The quartzite occurs in lenticular beds a few feet thick that change rapidly in thickness and grain size along strike.

Neither the quartzite nor the underlying limestone is found on the southwest limb of the Lade Peak anticline, but the limestone and thin lenses of fine-grained brownish quartzites are repeated about 3,000 feet southwest of Lade Peak. The limestone pinches out near Gainer Creek and has not been found to the southeast. Farther to the southwest a lens of quartzite near the contact of the green and the grey phyllite is exposed on the ridge between Bunker Hill and Marsh-Adams Creeks. It weathers white, is brownish on fresh surfaces, and contains many quartz veinlets. The lens is 15 to 20 feet thick and extends for about 1,000 feet along strike on the top and down both sides of the ridge.

Another thin bed of limestone in the Index formation crosses the Molly Mac property on the ridge between Bunker Hill and Gainer Creeks and is referred to as the Molly Mac limestone. It overlies the grey phyllite just described and is several hundred feet stratigraphically above the limestone and quartzite near the base of the grey phyllite. Southeast of the Molly Mac property the limestone outcrops intermittently as far as the Index basin; at the head of the basin and to the southeast it forms discontinuous lenses in complexly folded phyllite. Northwest of the Molly Mac property the limestone continues to an area of little or no outcrop southwest of the lower part of Bunker Hill Creek and does not occur to the northwest near the head of the creek.

The Molly Mac limestone on the Molly Mac property ranges from about 40 to more than 100 feet thick. It is thinly banded grey and dark-grey limestone with dark-grey argillaceous partings in the lower part. The contacts are well defined; it is underlain by several feet of green phyllite followed downward by a thick section of grey phyllite, and is overlain by olive-green phyllitic volcanic rocks containing lenses of grey phyllite near the limestone. In the Index basin near the Index workings the limestone is 50 to 60 feet thick, weathers cream coloured, and is more coarsely crystalline than at the Molly Mac. Lenses of siderite containing disseminated pyrite and locally galena and sphalerite are found at many places in the limestone.

Olive-green phyllitic volcanic rocks which overlie the Molly Mac limestone constitute the uppermost member of the Index formation. Near the limestone the volcanic rocks contain lenses of green or dark-grey phyllite a few feet thick and up to a few hundred feet long. Most of the volcanic rocks are sheared, and many are more or less replaced by rusty-weathering carbonates. Locally, in particular in the basin of Bunker Hill Creek and southeast of the Index basin just beyond the map-area, the volcanic rocks are fairly blocky and contain pillow structures. The pillows have narrow dark-green rims, and spaces between them are filled with buff to white crystalline limestone. In cross-section the pillows are oval, as much as 18 inches long and about 6 inches thick. The longest dimension is parellel to the plunge of fold axes. Pillows are not seen in the sheared and altered volcanic rocks, but small irregular lenses of whitish limestone like those between pillows in the more blocky rocks are common. It is suggested that much of the volcanic sequence above the Molly Mac limestone originally had a pillow structure. Microscopic study of the more blocky volcanic rocks shows that they are composed of very fine-grained amphibole, albite, chlorite, quartz, and somewhat coarser-grained carbonate. The original texture and composition are completely changed. Near the Molly Mac property the volcanic rocks are 500 to 800 feet thick. On the southwest side of the Bunker Hill basin they are about 400 feet thick, and in the Index basin they are very much thinner.

The total apparent thickness of the Index formation ranges from about 1,500 feet in the Index basin to about 2,500 feet in the upper part of Bunker Hill Creek.

The uppermost part of the Index formation is exposed in the core of the Silvercup anticline in the basin at the head of Triune Creek and at the Silver Cup mine. The rocks are well exposed in the Triune basin, but they are altered to carbonates, intruded by diorite, and complexly folded, and the stratigraphic relationships are uncertain. Probably the oldest rocks of the Index formation in the Triune basin are green and grey phyllites occurring immediately southwest of a strike fault on the northeast limb of the Silvercup anticline. They occur on both sides of the basin and contain a bed of buff-weathering fine-grained grey massive dolomite 50 to 100 feet thick. The dolomite lenses out on the northwest side of the basin and continues southeast beyond the map-area. Altered rocks lying southwest of the green and grey phyllites comprise the youngest member of the Index formation in this part of the area. They are dominantly green phyllites containing sheared and angular fragments commonly up to half an inch across. Thin-sections show that the fragments are mainly of volcanic rock including mafic amygdaloids and porphyries. The main constituents are chlorite, actinolite, epidote, and albite. These rocks are overlain by the Triune formation.

Triune Formation

The Triune formation, overlying the Index formation, occurs in the northeastern part of the map-area and on the Silvercup anticline. The formation, named from Triune Peak, is the principal rock in the core of the Silvercup anticline and is extensively exposed between Triune Peak and Five Mile Creek. In the northeastern part of the map-area it forms a more or less continuous band along the southwest side of the valleys of Bunker Hill and Index Creeks.

The formation is characteristically blocky grey to black siliceous argillite. Where sheared it is siliceous slate or phyllite. Very siliceous rocks resembling grey cherts are found in the formation at a number of places on the Silvercup anticline.

In the northeastern part of of the area the Triune formation is composed mainly of dark-grey to black siliceous argillite. Fresh surfaces are commonly coated with rust from the weathering of disseminated pyrite, and below the glacier on the southwest side of Bunker Hill Creek the Triune formation forms impressive rusty cliffs. Locally, areas a few inches across are coated with a blue copper stain. Vague beds, parallel to joints, range from about one-half to 2 inches thick and are commonly obscured by cleavage. Near the top of the formation in the northeastern part of the area is a soft, grey to purplish-brown silty argillite with well-marked beds a fraction of an inch to as much as a foot thick. Southwest of Bunker Hill Creek a 10-foot bed of conglomerate containing angular fragments of argillite in a sandy and silty matrix is interbedded with the soft argillite. Soft argillite is found also in the Ajax mine near the crest of the Silvercup anticline, but it has not been recognized elsewhere in the area.

The Triune formation varies greatly in thickness in the northeastern part of the area. On the northwest side of Gainer Creek it is more than 1,000 feet thick but thins rapidly to the southeast, pinching out entirely in the cliffs north of Redcliff Peak and thickening again to a few tens of feet at the southeast edge of the map-area. Northwest of Gainer Creek it is a few hundred feet thick. The upper soft argillite is as much as 75 feet thick below the glacier southwest of Bunker Hill Creek and thins markedly to the northwest and southeast. Southeast of Gainer Creek it is found only locally.

On the Silvercup anticline the Triune formation consists of grey and dark-grey siliceous rocks ranging from argillite to slate and phyllite; in places it includes very siliceous grey cherty rocks. Most of the formation on the anticline has a more or less well-defined cleavage. Slate and phyllite are common near the Silver Cup mine and in the Triune basin. Thin-sections of phyllite from near the Silver Cup mine reveal extremely fine-grained quartz and small amounts of sericite and carbonaceous matter. Rusty siderite metacrysts are common near the mine, and to the southeast the phyllite is almost entirely altered to a rusty mass of siderite, muscovite, and chromian mica. Very siliceous grey cherty rocks occur in the Triune formation on the northeast limb of the Silvercup anticline on both sides of the Triune basin and near the crest of the anticline near Five Mile Creek. The cherty rocks have irregular beds marked by poorly defined joints 1 to 2 inches apart.

Apparently complete sections of the Triune formation on the Silvercup anticline are found only on the southwest limb between the Silver Cup mine and Triune Peak. In this locality the formation is somewhat more than 1,000 feet thick.

Ajax Formation

The Ajax formation is a distinctive grey quartzite named from exposures near the Ajax mine northeast of Ferguson. Although it has been named only during the present work, the quartzite was recognized as a distinctive rock type by Walker and Bancroft (1929, p. 12) and was known as the Cromwell dyke in the early days of prospecting. At the Ajax mine the quartzite is near the crest of the Silvercup anticline, and to the southeast it outcrops as two divergent bands on the limbs of the anticline. In the northeastern part of the area the quartzite forms a band of variable width southwest of the Triune formation and has been traced from the head of Marsh-Adams Creek to the head of Stevens Creek southeast of the map-area.

Typically, the Ajax formation is massive grey quartzite with beds ranging from a few inches to several tens of feet thick. Locally the quartzite has interbeds of dark-grey to black argillite a few inches to several feet thick. The quartzite is commonly cut by irregular branching white quartz veins. In general the base of the Ajax quartzite is well defined, but in the northeastern part of the area a few beds of quartzite are found in the uppermost part of the Triune formation.

In the northeastern part of the area the quartzite is mainly massive and blocky, but in some sections several feet of thin-bedded quartzite with dark-grey argillaceous partings are present. Thin-bedded rocks have a poorly developed cleavage, dipping steeply to the southwest, and most of the quartzite has joints parallel to bedding planes. Blocky quartzites in places contain rounded limy concretionary masses composed of grey to brownish quartzite with a limy cement. In some localities these are 1 to 3 inches in diameter; in others, 8 to 10 inches in diameter. On the northwest side of Marsh-Adams Creek conglomerate a few feet thick containing rounded cobbles a few inches across occurs in the Ajax quartzite. The quartzite is more than 2,000 feet thick along Gainer Creek, but has been thickened by folds and obscure strike faults. It thins rapidly upward to a few feet in exposures in upper Bunker Hill Creek, and pinches out entirely to the southeast in cliffs north of Redcliff Peak.

On the southwest limb of the Silvercup anticline the Ajax quartzite has a lower part as much as 200 feet thick in which beds are a few feet thick and argillaceous interbeds are common. It is overlain by massive quartzite, becoming flaggy toward the top. Very few argillaceous beds occur in the quartzite on the northeast limb. The Ajax quartzite is commonly about 600 feet thick on the southwest limb of the Silvercup anticline and less than 200 feet thick on the northeast limb. Near Five Mile Creek and southeast of Triune Creek it pinches out entirely.

Sharon Creek Formation

The Sharon Creek formation, named from exposures near the head of Sharon Creek, conformably overlies the Ajax quartzite. It occurs on the Silvercup anticline and is well exposed on the southwest limb along the Tenmile road near Six Mile Creek. In the northeastern part of the area it has been traced from the northeast slopes of Mount Jowett southeastward around the northeast slopes of Spine Mountain and Redcliff Peak to the head of Stevens Creek beyond the map-area. On the Silvercup anticline the Sharon Creek formation is overlain by the Broadview formation and in the northeastern part of the area by the Jowett formation.

The Sharon Creek formation is dominantly dark-grey to black siliceous argillite, argillite, slate, and phyllite. Locally it contains lenses of argillaceous limestone and beds of grey quartzite and pebble conglomerate. In general the Sharon Creek closely resembles the Triune formation, and beds of grey quartzite are very similar to parts of the Broadview group.

In the northeastern part of the area the Sharon Creek formation is mainly dark-grey to black siliceous argillite. It commonly resembles bedded chert and has more or less well-defined bedding planes one-half to 2 inches apart, in places marked by thin phyllitic partings. The uppermost part of the formation consists of black argillite, which is less siliceous, poorly bedded, and commonly is strongly cleaved. Where bedding and cleavage are both present, the argillite has a pronounced lineation and breaks into rod-like fragments. On the northern slopes of Redcliff Peak, lenses of grey limestone a few inches thick and about a foot long, and less commonly beds of limestone 2 to 3 feet thick, occur in siliceous argillite of the Sharon Creek formation. On the northwest side of the upper part of Marsh-Adams Creek a 6-foot bed of conglomerate is interbedded with argillite in the upper part of the formation. The formation ranges from about 200 feet to a little more than 1,000 feet thick in the northeastern part of the area.

The Sharon Creek formation is well displayed on the southwest limb of the Silvercup anticline. As in the northeastern part of the area, the lower part, somewhat more than half the total thickness, is dominantly siliceous dark-grey to black argillite, and the upper part is less siliceous. The siliceous argillite is commonly phyllitic and grades up into slaty argillite with interbeds of grey grit up to several feet thick. The grit contains rounded black quartz grains about 1 millimetre in diameter. Between Five Mile and Six Mile Creeks a few beds of conglomerate are found. They contain rounded and angular tabular fragments up to one-half inch thick and 2 inches long, mainly of grey siliceous argillite and less commonly of green phyllite.

On the northeast limb of the Silvercup anticline, the Sharon Creek formation is discontinuous and sliced by strike faults. It is mainly black siliceous argillite and commonly is strongly sheared and crushed.

On the southwest limb of the Silvercup anticline through most of the map-area the Sharon Creek formation is about 800 feet thick. Northwest of Five Mile Creek it appears to thin rapidly and to pinch out entirely on the slopes of Ferguson Creek northwest of the Nettie L mine.

JOWETT FORMATION

The Jowett formation occurs only in the northeastern part of the map-area. The formation is composed mainly of volcanic rocks, which form many of the highest peaks in the district. Within the map-area the Jowett formation occurs on the summits and upper southwest slopes of Mount Jowett, Spine Mountain, and Redcliff Peak; beyond the map-area it forms the upper parts of Mount Pool to the northwest and Mount Wagner to the southeast. Between Ferguson Creek and Gainer Creek the formation has three distinct members—a lower member composed of flow rocks, a middle member of mixed sedimentary rocks, and an upper member of volcanic breccia. Southeast of Gainer Creek the three members are not readily distinguished.

On Mount Jowett the lower member is composed of green commonly amygdaloidal volcanic rock overlain by and grading upward into volcanic breccia. The rocks are blocky and form spectacular cliffs on the northwest, northeast, and southeast sides of Mount Jowett. A poor stratification seen in the cliffs from a distance, although difficult to see at close range, apparently represents individual flows 10 to 20 feet thick, with vague flow banding and scoriaceous margins. In outcrops, vague wavy epidote-rich layers are seen to be somewhat parallel to purplish, discontinuous, highly amygdaloidal layers. The blocky flow rocks are at least 1,000 feet thick and grade upward into somewhat sheared pillow lavas and fragmental volcanic rocks. On Mount Jowett, rocks of the lower member lie conformably on black argillite of the Sharon Creek formation and are in fault contact with the middle member.

Southeast of Mount Jowett, on Spine Mountain and the northwest slope of Gainer Creek, the lower member of the Jowett formation is composed mainly of pillow lavas and fragmental volcanic rocks. The pillow lavas are well displayed near the head of Glacier Creek, a creek flowing southeast into Gainer Creek about 1¾ miles northeast of Tenmile. The pillows are ellipsoidal and commonly are 6 inches to 1 foot thick and 1 to 2 feet long, but some are as much as 2 feet thick and 4 feet long (*see* Plate XIII). They are marked by a fine-grained dark-green margin and concentric bands of amygdules extending into the centre of the pillows. Interpillow spaces are filled with white to buff crystalline limestone. Pillows are displayed best where the rocks are not strongly sheared. On Spine Mountain most of the lower member of the Jowett formation is green phyllite that contains small irregular lenses of whitish to buff limestone. The phyllite is regarded as sheared pillow lava and locally contains recognizable pillow structures. Fragmental volcanic rocks are interlayered with the pillow lavas. Most commonly they are phyllitic, with vague angular light-green fragments up to 2 inches across in a somewhat darker-green matrix. Rocks containing well-defined, rounded, commonly amygdaloidal fragments a few inches across are found locally and are usually less sheared (Plate VIII). Such rocks are well displayed in outcrops in the glacier on the northeast slope of Spine Mountain.

Southeast of Gainer Creek the lower member of the Jowett formation contains phyllitic fragmental volcanic rocks and green phyllites with limy lenses, and in general is similar to the lower Jowett northwest of the creek. It is in sharp and apparently conformable contact with the underlying Sharon Creek formation and grades upward into the middle member of the Jowett formation. On Redcliff Peak the lower Jowett is relatively blocky green fragmental volcanic rock; no pillow lavas were found in the part of the formation mapped.

Thin-sections of the lower member of the Jowett formation show that the rocks are completely recrystallized. Epidote, chlorite, actinolite, and plagioclase are the principal constituents; carbonates and quartz are present locally. Very fine-grained epidote predominates in the more blocky rocks; actinolite and chlorite are abundant in the phyllitic rocks. Plagioclase identified as oligoclase is mostly very fine-grained and rarely occurs as poorly formed porphyroblasts. Actinolite is in fine needles and locally forms pseudomorphs after pyroxene and is itself altered to chlorite. Amygdules are mainly epidote and chlorite and less commonly quartz and calcite.

The middle member of the Jowett formation is a mixed assemblage of sedimentary rocks of both volcanic and non-volcanic derivation. The member contains occasional thin lenses of limestone and comprises mainly brownish, greyish, and locally greenish tuff, lapilli-tuff, argillite, and volcanic breccia with some fragments of limestone and some limy cementing material. The thickness and lithology vary considerably along strike.

On the southeast side of Ferguson Creek and the southwest slopes of Mount Jowett the middle member of the Jowett formation is composed of lenses of buff-weathering grey limestone and green, somewhat limy phyllite. It is strongly sheared and tightly folded and has a wide rusty fault zone on the northeast side. At the head of Finkle Creek the middle member appears to be more than 1,000 feet thick and contains a variety of rock types. Discontinuous lenses of buff-weathering limestone a few tens of feet thick at the top of the member are underlain by grey to brown argillite, tuffaceous argillite, and breccia. Lower in the section a striking bed of conglomerate and breccia a few hundred feet thick contains rounded and angular fragments, some of which are very large, scattered in a grey argillaceous matrix. Rounded fragments a few inches to a foot across are of dark-grey argillite, limy argillite, and buff-weathering siliceous limestone. Fragments of banded light-grey limestone occur as angular blocks several feet across, and one such block, well exposed in the basin southwest of the summit of Spine Mountain, is about 8 feet thick and 75 feet long. The conglomerate and breccia are underlain by grey argillite containing thin beds of dark-grey limestone. Rocks of the type exposed in the Finkle Creek basin continue to the southeast as far as the head of Glacier Creek where they grade into dominantly green and grey phyllites which cross the valley of Gainer Creek. The green phyllites commonly are fragmental, and lenses of buff limestone and amygdaloidal fragmental rocks are interbedded with them on the southeast side of Gainer Creek and extend southeast to the limit of mapping.

The upper member of the Jowett formation is a distinctive green agglomerate or volcanic breccia. Typically the breccia is green to dark green, locally purplish, and is made up of vague rounded fragments an inch to a few inches across. Thin-sections reveal that the matrix is also fragmental and composed of rounded and angular fragments of volcanic rock, commonly with interstitial carbonate. The principal minerals are very fine-grained epidote, actinolite, and chlorite and minor plagioclase. Fragments and matrix are of about the same colour, but fragments usually stand out in relief on weathered surfaces. Although it is somewhat phyllitic, the upper member is resistant to erosion and tends to make continuous ridges and prominent bluffs. The rocks show no bedding or banding but commonly have a poor cleavage. The base of the upper member is sharply defined, except in the valley of Gainer Creek, where it is gradational with green fragmental rocks of the middle member. The top of the upper member is a conformable contact with basal argillite of the Broadview formation. The upper member ranges from about 200 to about 800 feet thick.

The total thickness of the Jowett formation is difficult to estimate accurately. On Gainer Creek, the thinnest section in the map-area, it is 1,500 to 2,000 feet; on Mount Jowett it appears to be double that thickness.

The Jowett formation is not found on the Silvercup anticline, where the Sharon Creek formation is overlain by the Broadview formation (*see* p. 29). The lower division of the Broadview formation on the Silvercup anticline contains two pyroclastic members; one at the base is 50 to 100 feet thick, and one 1,000 to 1,500 feet above the base is about 400 feet thick. In the northeastern part of the area a thick sequence of grits without significant volcanic material overlies the Jowett formation and is regarded as part of the Broadview formation. Close studies along formational contacts suggest that the sequence in both the northeastern part of the area and on the Silvercup anticline is a conformable one. It is concluded that only part, if any, of the Jowett formation was deposited in the vicinity of the anticline. Whether or not the lower division of the Broadview formation on the anticline is equivalent to part of the Jowett formation is a matter for speculation. Similarities between the pyroclastic member of the lower Broadview and the upper member of the Jowett formation suggest a possible correlation of these two members. Lithologic changes within the Jowett formation along strike have been described in the foregoing paragraphs. In general the formation appears to thin toward the southeast.

Broadview Formation

The uppermost part of the Lardeau group in the Ferguson area is the Broadview formation, named for exposures along Broadview Creek and near the Broadview mine. It is exposed in two broad belts—one in the northeast part of the map-area and the other on the southwest flank of the Silvercup anticline. The formation comprises a very thick sequence of grey and green unsorted quartzites or grits* and phyllites, with very minor interbedded pyroclastics. The rocks show all gradations from grit to phyllite and from green to grey or black, and the various types are closely interbedded and change in relatively short distances both across and along the strike. Stratigraphic subdivisions can be discerned, but in general they can be traced only relatively short distances. In particular, a succession determined on Mount Homer and Nettie L Mountain in the northeast belt cannot be matched with a succession determined on Silvercup ridge (*see* table, p. 28). On Silvercup ridge and for a short distance up the south and east slopes of Great Northern Mountain three divisions of the formation are recognizable, but on the summit of Great Northern Mountain facies changes make it impossible to distinguish between the middle and upper divisions. Rocks of the Broadview formation probably are exposed widely beyond the limits of the map-area.

Much of the Broadview formation is composed of blocky grey grit, dark-grey and green micaceous grit, and phyllite. Thick sequences of interbedded blocky and micaceous grits with more or less well-defined bedding planes are common. Blocky beds generally weather light grey and contain readily visible dark-grey to black rounded quartz grains. The quartz grains are not sorted; coarse grains locally as much as 1 centimetre across are scattered through a matrix of much smaller grains with a wide range of sizes. Quartz, muscovite, and chlorite are the main constituents seen in thin-section, and minor plagioclase, biotite, epidote, hornblende, and varying amounts of carbonaceous matter are also present. Grits composed mainly of quartz are blocky; micaceous and carbonaceous varieties are phyllitic. In green grits visible quartz grains are whitish. Thin-sections show that the green rocks contain the same minerals as the grey rocks, and differ from them only in the content of carbonaceous material.

Deformation has caused extreme changes locally in the apparent thicknesses and stratigraphic succession within the Broadview formation. Blocky grits interbedded with phyllitic grits tend to pinch out abruptly and phyllitic beds may be greatly thickened, or tightly squeezed and sheared (*see* Fig. 4). Detailed stratigraphy can be determined only by closely following individual beds relatively great distances. Primary sedimentary features that might be useful in determining stratigraphic tops of beds have not been found in the Broadview, and secondary structures such as bedding-cleavage relationships and dragfolds are complex and difficult to interpret.

Two generalized sections of the Broadview formation are given in the following table. The succession on Mount Homer is well exposed and is recognized at many places in the northeastern belt between Ferguson and Gainer Creeks. The succession on Silvercup ridge is not as well exposed as that on Mount Homer but is known at several localities and can be recognized at many places along the southwest side of the Silvercup anticline. The two sections are lithologically similar but cannot be correlated in detail. Differences in the stratigraphy are considered to be the result of sedimentary facies changes. In the northeastern part of the area the Broadview overlies the Jowett formation, but on the Silvercup anticline where the Jowett forma-

* The term "grit" is used in this report for poorly sorted clastic sedimentary rocks with rounded and angular grains, mainly of quartz, up to several millimetres in diameter. The term is descriptive, and is not restricted, as in the classic usage, to rocks with angular grains.

tion is missing (*see* p. 26) the Broadview formation overlies the Sharon Creek formation. Sedimentary facies changes are found on the Silvercup anticline, particularly between Silvercup ridge and Great Northern Mountain.

Generalized Sections of the Broadview Formation

MOUNT HOMER AND NETTIE L MOUNTAIN

Approximate Thickness (Ft.)	Lithology
	Top not found within the map-area.
700	Grey to greenish-grey grit with dark-grey phyllitic partings, beds 6 inches to 1 foot thick.
300–500	Dark-grey to black phyllite and phyllitic grit.
500–1,000	Blocky light-grey grit, beds up to 6 feet thick, few phyllitic or thin-bedded rocks.
100	Greenish grit with buff-weathering limy beds less than 1 foot thick.
1,000–1,500	Green and grey grit in beds up to 1 foot thick with greenish-grey phyllitic interbeds.
50	Dark-grey to black argillite.
	Jowett formation.

SILVERCUP RIDGE

	Approximate Thickness (Ft.)	Map Unit	Lithology
			Milford group.
Upper Division	Several thousand.	10d	Light-green and light greenish-grey grit, greenish phyllitic grit, minor grey grit and dark-grey phyllite.
Middle Division	Several thousand.	10c	Dark-grey to black phyllite and phyllitic grit with relatively few interbeds of blocky grey grit.
	500–1,000		Grey and greenish-grey grit with phyllitic interbeds; beds a few inches thick.
Lower Division	400	10b	Pyroclastic member. Green phyllitic tuff, lapilli-tuff, agglomerate, and breccia.
	1,000–1,500	10a	Green and grey grits with interbeds of dark-grey phyllite and phyllitic grit.
	50		Green to dark-green somewhat limy phyllite.
			Sharon Creek formation.

The section on Mount Homer was measured on the southeast side where the rocks are well exposed, and individual beds can be seen from a distance and traced through a series of complex folds (*see* Fig. 3). Overlying the Jowett formation is dark-grey to black argillite which has been followed along strike to the limits of the map-area. It ranges from a few feet to 200 feet thick and locally is complexly infolded with the overlying grits. The grits immediately overlying the argillite are characteristically thin bedded with light-grey blocky beds separated by dark greenish-grey phyllitic beds. These rocks are a few hundred feet thick and grade up into a sequence of grits and phyllites, without distinctive markers, which in turn are overlain by greenish grit containing buff-weathering limy beds. The limy beds, though not mapped, have been recognized at a number of places between Gainer and Ferguson Creeks. They include buff-weathering interbeds of limestone a few inches thick in grit and greenish phyllite, coarse grits with a limy cement (Plate XII), and locally lenses of limestone a few feet thick. On Mount Homer the limy beds are overlain by very blocky light-grey grit, but to the southeast grits overlying the limy beds contain dark-grey phyllitic partings. The highest member of the Broadview formation shown in the table is exposed on the crest of the ridge about midway between Mount Homer and the summit of Nettie L Mountain. Probably stratigraphically higher rocks occur lower on the slopes southwest of Nettie L Mountain (*see* Fig. 3), but they are broken by faults and their exact relationship to the section described is uncertain.

Grits and phyllites in a belt one-half to 1 mile wide along the northeast side of the Cup Creek fault zone belong to the Broadview formation but have not been correlated with the section on Mount Homer, either because they are highly sheared and broken by faults or because they have no structural continuity with the Mount Homer section. Northwest of Triune Creek the rocks are mainly blocky grey grit with dark-grey phyllitic interbeds. Locally a bed of green phyllite, probably of volcanic origin, is found. One such bed a few hundred feet thick is exposed in Cup Creek near Lardeau Creek, and another occurs on the northwest side of Triune Creek near the Cup Creek fault zone. Attempts to trace and correlate these green phyllites were not successful. Between Finkle Creek and the ridge southwest of Nettie L Mountain the rocks are highly sheared dark-grey to black phyllitic grits.

Southwest of the Silvercup anticline on Silvercup ridge three more or less well-defined divisions of the Broadview formation are recognized. The lower division, roughly 2,000 feet thick, is mainly grey and green grit with a distinctive green limy phyllite at the base and a pyroclastic member at the top. The middle division, several thousand feet thick, contains a few hundred feet of thin-bedded grit in the lower part but is predominantly soft black phyllite and phyllitic grit. The upper division is light-green or grey grit, locally very coarse grained.

The basal member of the lower division, which is a soft, somewhat limy green phyllite, lies directly on the Sharon Creek formation. It is generally a few tens of feet thick and locally is as much as 200 feet thick. Study of thin-sections indicates that the green phyllite is an altered limy argillaceous rock composed of actinolite, chlorite, and plagioclase and containing clastic quartz grains and crystal and rock fragments probably of volcanic origin. The green phyllite is overlain by a thick sequence of green and grey grit and phyllitic grit without distinctive characteristics or marker beds. The basal green phyllite and part of the overlying sequence of grits are repeated across the Silvercup anticline, but the upper part of the grit sequence and the overlying rocks are not exposed on the northeast limb of the anticline because they are transected by the Cup Creek fault zone.

The green and grey grits are overlain by a striking pyroclastic member about 400 feet thick, which is taken as the top of the lower division and has been traced from the southwest slopes of Triune Peak to Broadview Creek, where it is transected by the Broadview fault. The member is phyllitic and is composed of green agglomerate and breccia and phyllitic green crystal tuff. The agglomerate and breccia are composed of vague, rounded and angular fragments of green volcanic rock scattered in a somewhat darker-green tuffaceous matrix. Relatively scarce beds a few feet thick are crowded with well-defined rounded fragments up to about 2 inches in diameter, many of which are amygdaloidal. The fragmental rocks are interbedded with green fine-grained clastic rocks, some of which have prominent white beds a fraction of an inch thick and others contain scattered well-formed crystals of augite up to a few millimetres across. The crystals and rock fragments are broken and are probably of volcanic origin. Study of thin-sections shows rocks of this member to be composed mainly of a very fine-grained aggregate of epidote, chlorite, actinolite, and plagioclase. Whitish beds contain feldspar crystals and detrital quartz grains.

The volcanic member is overlain by the middle division of the formation, which comprises several hundred feet of relatively thin-bedded grey and greenish-grey grits grading upward into a thick sequence of dark-grey to black phyllite and phyllitic grit. These rocks are strongly sheared, contorted, and crushed. They contain disseminated pyrite which commonly, in alpine basins, gives rise to large rusty " iron caps." The middle division has been traced from Silvercup ridge, where it is most easily recognized, northwest across Lardeau Creek and is well exposed in the lower part of Alpha Creek.

The upper division of the Broadview formation on Silvercup ridge is mainly light-coloured, relatively blocky grit. It is dominantly green but contains light-grey members. Dark-grey phyllitic grits are present locally. The contact with the underlying middle division is gradational, and its location on Figure 2 is approximate. The uppermost part of the upper division is characteristically coarse grained and contains several massive beds of green grit which form prominent bluffs in the lower part of Silvercup ridge and along Lardeau Creek.

Few of the rock types in the Broadview formation recognized on Silvercup ridge have been traced up onto Great Northern Mountain. The lower division is not exposed north of Broadview Creek. Grey and greenish-grey grits at the base of the middle division at the True Fissure mine are overlain by interbedded dark-grey grits and black phyllites. These rocks are succeeded to the southwest, and apparently overlain, by soft, black, gritty, micaceous argillite and phyllite, in which occur scattered thick beds of blocky, coarse-grained grey grit. These rocks are in turn overlain by greenish-grey phyllitic grits which exhibit lustrous, wavy cleavage surfaces. These greenish, lustrous rocks outcrop on the summit of Great Northern Mountain and another peak 3,000 feet to the east, and occur extensively around the head of Mountaingoat Creek. To the southwest on the Lardeau Valley slope they become greener and less phyllitic, grading to light-coloured blocky grit typical of the upper division. The relationship of the greenish phyllitic rocks to the middle and upper divisions is not understood.

MILFORD GROUP

The Milford group is named from Milford Peak (*see* Bancroft, 1919, p. 43), on the west side of Kootenay Lake about 6 miles north of Kaslo (*see* Fig. 1). The stratigraphy and structure of the group near Milford Peak are described in detail by Cairnes (1934, pp. 38–43). Near the type locality the group is a few thousand feet thick and is mainly black argillite and slate with interbeds of limestone and chert. Fossils from the lower part of the group are late Palæozoic, those from the upper part are Triassic, and the sequence is apparently conformable. The group was throught to overlie the Lardeau group with unconformity even though the lower contact is concordant with the Lardeau group.

The Milford group was traced northwest from Milford Peak and into the Lardeau map-area (*see* Walker and Bancroft, 1929, Map 235A) to the southwest side of Trout Lake, a little more than 10 miles south of Ferguson. Farther to the northwest Carboniferous fossils were found in limestone near the mouth of Lardeau Creek, on Mount Thompson between 4 and 8 miles northwest of Lardeau Creek, and northwest of the northeast arm of Upper Arrow Lake. The rocks in which the limestone occurs are lithologically similar to those of the Milford group to the southeast and were regarded as small masses of Milford infolded with the Lardeau group. Pebble conglomerate a few feet below the fossiliferous limestone was taken as the base of the Milford and the top was not defined. No Triassic fossils were found in the Lardeau map-area.

The present work has shown that, within the Ferguson area and to the northwest, rocks of the Milford group are more extensive than indicated on Map 235A, and also that rocks mapped as Milford at the mouth of Laughton (Eight Mile) Creek are actually part of the Broadview formation. A belt of Milford rocks, about a mile wide, can be traced from near the mouth of Lardeau Creek northwestward, across the southwest slopes of Mount Thompson beyond the Ferguson map-area, to the northeast arm of Upper Arrow Lake. The northeast limit of the belt is the upper part of the Broadview formation, which underlies the Milford, and the southwest limit is poorly defined. The southwest limit or top of the Milford has been taken as a distinctive chert member, but rocks southwest of the chert member may also belong to the Milford group.

The Milford group in the Ferguson area includes chert, olive-grey and jet-black slate, fissile grey shale, limestone and calcareous rocks, and pebble conglomerate. The rocks are sheared and contorted, but appear to be less strongly metamorphosed than the underlying formations. Many of the rock types are characteristic of the Milford and serve to define it. Chert is a particularly distinctive rock type. Because outcrops are scattered and the structure is uncertain, only the following generalized sequence can be given:—

Varicoloured chert (uppermost member).
Black slate, argillite, limestone, succession uncertain.
Lower chert member.
Fissile grey shale.
Calcareous member.
Conglomerate member.

Though complexly folded, the rocks in general dip and appear to face to the southwest. The whole group is exposed best along Glenn Creek and the adjoining logging-road, but even in this locality outcrops are scattered. The lower members are generally better exposed than the rest of the group and have been studied in detail along the Ferguson road and Lardeau Creek.

Near Lardeau Creek the basal conglomerate contains rounded and angular pebbles commonly about an inch and locally as much as 2 inches across in a matrix of green argillite. In order of abundance the pebbles consist of white quartz, grey chert, green argillite, green grit, and grey phyllitic grit. They are either scattered through the matrix or clustered in discontinuous lenses.

The base of the conglomerate member is not well defined. On Lardeau Creek the conglomerate grades downward into green argillite, which overlies greenish grit in the upper part of the Broadview formation. The green argillite appears to be about 100 feet thick, but outcrops are not continuous and the base is not exposed. The conglomerate is probably that described by Walker and Bancroft (1929, p. 12) as the basal conglomerate of the Milford group. In the Ferguson area it is not known whether the relation between the conglomerate and rocks clearly belonging to the Broadview formation is one of conformity or disconformity. A possible disconformity is exposed at one point at the top of the conglomerate member.

The upper part of the conglomerate member in places contains lenses of pebbles and in others it contains scattered pebbles. The member in general is several tens of feet thick and along Lardeau Creek is as much as 100 feet thick. It is overlain by a calcareous member 200 to 300 feet thick consisting of calcareous argillite, limestone, and calcareous sandstone and conglomerate. The contact between the calcareous member and the conglomerate member was seen just north of the road to Ferguson, where small blocks of green argillite 2 to 3 inches across are incorporated in dark-grey calcareous argillite. The dark grey argillite which forms the base of the calcareous member penetrates the green argillite along fractures. The grey argillite grades upward to light-grey or cream-coloured limestone, which in turn grades to cream-coloured calcareous sandstone or quartzite. The limestone weathers light grey to cream or light brown. In the brown-weathering limestone, bedding is indistinct and intersecting narrow quartz veinlets are common. Lenses of pebble conglomerate and grey grit a few feet thick and 100 or 200 feet long are scattered through all three calcareous rock types and consist of angular and sub-rounded pebbles of milky quartz in a calcareous and argillaceous matrix. These rocks have a dark-grey matrix and are rusty weathering.

Fossils, mainly corals and brachiopods, are found at a number of places in the grey limestone. Poorly preserved cup corals from the southeast bank of Lardeau Creek have been identified by V. J. Okulitch, of the University of British Columbia, as either of the genus *Neozaphrentis* or the genus *Hapsiphyllum*. Fossils collected about 1,000 feet southeast of Lardeau Creek, also identified by Okulitch, include an incomplete brachiopod specimen, possibly *Punctospirifer*, and several specimens of the coral *Turbophyllum*, most probably *Turbophyllum multiconem* Parks. The fossils confirm the late Mississippian age of the limestone determined previously (*see* Walker and Bancroft, 1929, p. 13). Fossils have also been found about 4,500 feet southeast of Lardeau Creek in calcareous pebble conglomerate and in Glenn Creek. At the Glenn Creek locality a zone containing mostly cup corals lies beneath one containing mainly colonial forms.

Along the Ferguson road the calcareous member grades upward to fissile, grey silty shales, which are exposed only in the road cut and have an apparent width of 150 feet. Beds of cream to brownish-grey sandstone or quartzite, commonly a few inches thick, are intercalated in the lower half of this unit and decrease upward in number and thickness. Some of the sandstone is slightly calcareous.

The shales in the road cut are succeeded to the southwest, and presumably upward, by the lower chert member, which is 100 to 300 feet wide and outcrops sporadically from a mile east of Lardeau Creek to Glenn Creek. The contacts of this chert member with other units are not exposed. The lower part, which is medium-grey to light-brown chert, grades upward to dark-grey cherty slate.

Only scattered outcrops of rocks between the lower chert member and the uppermost member of the Milford group are found, and no stratigraphic succession has been established. Jet-black and olive-grey slates and fissile shales like those in the Ferguson road cut are exposed along a logging-road beside Glenn Creek. In a small exposure at the mouth of Lardeau Creek thin-bedded grey limestone is interbedded with olive-brown and black slate and black argillite. Olive-brown and black slates also outcrop sporadically along the Gerrard road from Lardeau Creek to Christie Point, where they separate exposures of the lower chert member from exposures of similar chert on the point.

The uppermost member of the group, exposed between Glenn and Adams Creeks, consists of about 1,000 feet of fine-grained grey quartzite overlain by 100 to 200 feet of varicoloured chert. The quartzite appears to pinch out to the northwest, but the varicoloured chert continues beyond the map-area to the ridge between Beaton and Thompson Creeks and is exposed in the lower part of Beaton Creek near the settlement of Beaton. This uppermost chert of the Milford group is pale green, pink, white, medium grey, and light brown; some beds of pink and white chert are argillaceous. The lower contact is exposed near Glenn Creek, where grey chert grades in 2 or 3 feet to the underlying quartzite. The upper contact, seen only along Adams Creek, is gradational. About 60 feet of pale-green and white chert is overlain by a few inches of black cherty slate which grades upward into a fissile black slate or phyllite characteristic of a sequence of black phyllites found to the southwest of the Milford group. Although the varicoloured chert is taken as the top of the Milford, other rocks to the southwest may also belong to the Milford.

ROCKS IN THE SOUTHWESTERN PART OF THE MAP-AREA

Rocks in the southwestern part of the map-area were mapped by Walker and Bancroft (1929, Map 235A) as part of the Lardeau series, Badshot formation, and Hamill series on the basis of lithology. A prominent white crystalline limestone and dolomite was correlated with the Badshot formation; rocks southwest of the limestone were mapped as Hamill series, and those to the northeast as Lardeau series. These correlations have not been confirmed in the present more detailed study. The stratigraphic succession, though still poorly understood, is unlike any in the rest of the Ferguson map-area and is in no way similar to the succession close to the Badshot formation in the northeast part of the map-area (*see* p. 17). The structure is so complex that detailed mapping of an area larger than that now studied will be necessary to establish the stratigraphic succession with any certainty. As now known, the rocks in the southwestern part of the map-area and for some distance to the southeast and northwest must be regarded as of uncertain correlation.

Little is known of the stratigraphy of the southwestern part of the area because many of the rocks are poorly exposed, the structure is very complex, and the sequence contains very few distinctive markers. The subdivisions, A, B, C, and D, of Figure 2, sheet B, show the distribution of lithologic units, of which only A, the dolomite member, and B, the volcanic member, are well defined. Because of complexities of the structure, the stratigraphic relationships between A and B are uncertain, and little is known of either the local correlation or stratigraphy of the other units. The Badshot formation as shown on Map 235A (*see* Walker, 1929) coincides in general with the dolomite member between Beaton and Trout Creeks, but southeast of Trout Creek the Badshot as mapped coincides with dark-grey argillaceous limestone which is probably stratigraphically below the dolomite.

Dark-grey to black slate and phyllite outcrop along the Lardeau Valley southwest of the uppermost chert member of the Milford group. The rocks are well exposed along the Beaton road, but are very poorly exposed elsewhere. Along the road, about 150 feet of highly cleaved silty black slate lies southwest of the chert and is followed by a few feet of soft black calcareous argillite. Southwest of the calcareous argillite are two beds of distinctive pebble conglomerate totalling a few tens of feet thick. The conglomerate contains squeezed and broken pebbles of white quartz and light-grey chert in a matrix of black argillite. The rock is intensely deformed; the matrix is crushed and many of the pebbles are so contorted that they resemble lenticular quartz veinlets. Southwest of the conglomerate the outcrops along the road are all of black slate and phyllite with a few calcareous lenses. The rocks are intensely sheared, and distinct crushed zones resembling bedding faults are seen in a few places.

Rocks immediately southwest of the uppermost chert member of the Milford group are also exposed in Adams Creek a few miles to the northwest. The sequence is essentially the same as that on the Beaton road. Scattered outcrops of similar rocks occur between these two localities, but individual members cannot be mapped. To the southwest in the Lardeau Valley, the exposed rocks are mainly black phyllite, slate, and argillite with minor interbeds of black calcareous argillite and limestone and rare interbeds of dark-grey slaty chert. Rocks along the Beaton road and in the Lardeau Valley are lithologically similar to parts of the Milford group, but because of a lack of structural and stratigraphic data they have not been mapped with the Milford.

On the southwest side of the Lardeau Valley, black phyllite, slate, and argillite of the unit just described grade into dark-grey and green phyllite, southwest of which is a thick sequence of grey phyllitic grits. These latter rocks are well exposed in the canyon of Trout Creek and in Humphries Creek. They are mainly fine grained, thin bedded, and phyllitic, but locally contain thick beds of blocky grit with rounded black quartz grains a few millimetres in diameter. The blocky and phyllitic grits closely resemble rocks in the middle part of the Broadview formation (*see* p. 29).

Southwest of the grits, and possibly underlying them stratigraphically (*see* Fig. 5), is a prominent band of grey- to buff-weathering dolomite and limestone, referred to as the dolomite member. It forms spectacular bluffs on the northwest side of Trout Creek and on both sides of Beaton Creek and is exposed intermittently from the Lucky Boy mine to the northwest side of Humphries Creek. Fine- to medium-grained white dolomite is the principal rock type. The dolomite grades into limestone, and the two rocks are difficult to distinguish without the use of acid. Both dolomite and limestone are generally massive, but locally grey carbonaceous bands or elongate wisps are present, and in places small lenticular white quartz veinlets are found. The dolomite member has an outcrop width of about 2,000 feet on Beaton Creek, where it is complexly thickened by folding, but thins rapidly to the southeast. Between the Lucky Boy mine and Humphries Creek it has an apparent thickness of as much as 500 feet.

The dolomite member is closely infolded with and probably underlain by green volcanic rocks, here referred to as the volcanic member. They form a well-exposed band, as much as 1,000 feet wide, which has been traced from the high ridges southeast of Trout Creek to the northwest side of Beaton Creek. The volcanic rocks are commonly phyllitic, especially near the dolomite member, but the foliation is indistinct. In places the rocks are massive, in some they contain small irregular lenses of carbonate, and in others they show more or less well-defined pillow structure. The pillows are oval in cross-section and as much as 1 foot wide and 2 feet long. The principal constituents of the rocks seen in thin-section are hornblende, epidote, and plagioclase. Between the Lucky Boy mine and Humphries Creek, the volcanic member is not found below the dolomite member. Instead, several hundred feet of grey grit and quartzite follow the southwest side of and apparently underlie the dolomite member.

Dark-grey to black argillite, limy argillite, and limestone are exposed southwest of the volcanic member and extend beyond the southwestern limit of the map-area. Similar rocks occur northeast of the volcanic member on both sides of Trout Creek and southeast to the southeast limit of mapping. They are highly contorted and more or less well cleaved. Bedding is indistinct in the non-calcareous varieties, but well formed in calcareous types. Strongly folded calcareous beds a few inches thick with phyllitic and slaty argillaceous partings are common. On the ridge and slopes southeast of Trout Creek and northeast of the volcanic member, calcareous beds are altered to garnet diopside skarn (*see* p. 61) and are lighter coloured than elsewhere. Farther to the south on the ridges between Trout and Humphries Creeks, the rocks are intensely silicified.

Intrusive Rocks

Small stocks, dykes, or intrusive sheets of dark-coloured rocks are found here and there in the Ferguson area. The largest masses of these rocks are in the Triune basin and on Corner Hill (*see* Fig. 2). Other moderately large masses are found on Mount Jowett and in the saddle between it and Spine Mountain. Isolated small intrusives are found in the Index basin, east of the Molly Mac mine, 1½ miles northeast of Tenmile, and in the road cut between Five Mile and Six Mile Creeks. The rocks are generally massive, medium to coarse grained, and light to dark green or greenish-grey in colour. They vary in their relations to the country rock and in their texture and mineralogy, and it is not clear whether they belong to one or several suites.

Between Mohican Creek and Corner Hill a swarm of small sheets of light- to medium-green pyroxene diorite intrudes the Lade Peak limestone and phyllites of the Index formation on the Lade Peak anticline. They are generally a few hundred feet long and a few feet or tens of feet wide. The majority are within 1,000 feet northeast of the northeast crest of the anticline. Several occur along the contact between phyllites and limestone, or between phyllite and calcareous phyllite where the limestone has been squeezed out. A curious relationship between limestone and diorite is shown in a small cliff a few hundred feet southeast of the landslide between Mohican Creek and Corner Hill (*see* Fig. 2). The rock at the base of the cliff is clean white limestone which gradually becomes green and passes upward in a distance of 8 feet to a fine-grained calcareous diorite. In the northeast corner of the slide a band of dense green calcareous rock occurs immediately northeast of a calcareous phyllite and is in sharp contact on the northeast with a sheet of medium-grained diorite.

The principal minerals are andesine feldspar, green amphibole or chlorite, pale-brown pyroxene, sphene, and calcite. In thin-section the calcite appears to replace the other minerals, but field relationships suggest that the diorite has replaced the limestone or has assimilated masses of limestone.

Three small dioritic bodies were found on the southwest side of the Index basin. Two are sills in gently dipping siliceous phyllites of the Sharon Creek formation half a mile northwest of Redcliff Peak. The third body forms a small outcrop in an unstable talus slope between outcrops of Ajax quartzite and volcanic rocks 1,200 feet north of the peak. The sills are massive and fine grained, and are light green on fresh surface but weather rusty. In thin-section the rock is a mat of fine-grained feldspar and stellate amphibole, overprinted with masses of chlorite and carbonate. The body in the talus slope is coarse grained, dark green, and has a fibrous appearance. In thin-section it consists largely of plagioclase, hornblende, and chlorite, some biotite, and replacing carbonates and quartz. The plagioclase was not determined, but the mineralogy suggests that the rocks probably are diorites.

Two thin dykes of fine-grained greenish-grey rock intrude Lade Peak limestones and adjacent Index phyllites on the central and southwest Silver Chief anticlines and in the intervening syncline east of the Molly Mac mine. The dykes are 4 feet thick, strike more or less with bedding, but dip gently northeast, crosscutting the beds in dip. A similar thin dyke cuts the upper, pyroclastic member of the Jowett formation a mile southwest of the Molly Mac mine and 600 feet above the Gainer Creek road. It strikes north 30 degrees east and dips 20 degrees northwest.

The intrusive bodies on and near Mount Jowett are massive, medium to coarse grained, and medium green in colour, resembling rocks in the Triune basin. On the summit of the mountain irregular masses a few hundred feet across intrude the lower member of the Jowett formation. To the southeast, in the saddle between Mount Jowett and Spine Mountain, irregular sill-like bodies as much as 100 feet wide trend northwest in slaty argillites of the middle member of the Jowett formation.

In the Triune basin irregular bodies of massive rock intrude volcanics and phyllites of the Index formation in the core of the Silvercup anticline. They have not been found northwest of the basin, but from property descriptions by Emmens it is clear that they are found as far southeast as Brown Creek. Where the rocks are least altered, the massive, medium- to coarse-grained intrusive is readily distinguished from the foliated, fine-grained volcanics and phyllites, but for the most part the volcanics, and to a lesser extent the phyllites, are rather thoroughly replaced by siderite, which is generally massive and coarse grained. The alteration of the intrusive is less than that of the Index rocks, but is sufficient to make the contacts difficult to follow and even in places to mask them entirely. Because of this and because of the talus cover in the Triune basin, the boundary of the intrusives shown on Figure 2 represents the outline of an area in which intrusive rock is found rather than the contact of a single body. The intrusive rocks are medium to dark green in colour where fresh, but are rusty weathering where partly carbonatized. One thin-section consists predominantly of coarse pale-brown pyroxene crystals and of masses of clinozoisite altered from feldspar; a little chlorite and relict feldspar and biotite are present. Another thin-section contains roughly equal amounts of hornblende, feldspar, chlorite, and clinozoisite, with accessory sphene and replacing carbonate. Although alteration precludes precise naming, the rocks are probably diorites.

Along the Tenmile road, 1,400 feet west of Six Mile Creek, a small body of massive dark brownish-grey rock has been intruded along the lower contact of the pyroclastic member of the Broadview formation. The body narrows downward toward Lardeau Creek, and probably pinches out within 200 feet of the road. In the road cut it is 50 feet wide, and it is not exposed to the northwest above the road. The interior is medium grained and massive, but the margins are very fine grained and show banding. In thin-section the rock is a mosaic of albite feldspar, overprinted with isolated thorns and feathery aggregates of biotite; sphene, a black opaque mineral probably magnetite, white mica, chlorite, and quartz are accessory. The rock is a dark syenite.

Acidic intrusive rocks have not been found in the Ferguson area, although dykes and small stocks occur to the northwest on both sides of the Lardeau Valley, and the Kuskanax batholith lies to the southwest. The relative ages of acidic and dark intrusives are not known.

METAMORPHISM AND ALTERATION

Specific studies of metamorphism and alteration have not been made in the present work. Only the most noticeable effects recognized in the field and in a study of representative thin-sections are summarized in the following paragraphs. Although they are strongly deformed and highly sheared, essentially all rocks in the area are in a low grade of regional metamorphism. The non-calcareous rocks contain principally muscovite, chlorite, and quartz. Sedimentary grains are clearly visible in both hand specimen and thin-section. Biotite, apparently related to the composition of the rock rather than to metamorphic grade, is present in tuffaceous rocks of the Jowett formation. Lavas and mafic fragmental rocks in the Jowett and upper part of the Index formation contain epidote, actinolite, chlorite, and minor oligoclase. Pillow structures, amygdules, and breccia fragments are preserved at many places, although these rocks have been completely recrystallized.

On the southeast side of Trout Creek the grade of metamorphism is higher than elsewhere in the map-area. The grade decreases gradually to the north and northwest. Grey grits and quartzitic rocks contain biotite and muscovite in addition to quartz. Disseminated pyrrhotite, partly derived from pyrite, weathers readily and causes many outcrops to be rusty. Calcareous argillites are more or less converted to skarns, the most common of which contain diopside, epidote, and garnet in addition to quartz and calcite. The dolomite member (*see* p. 34) is mainly dolomite and does not change noticeably in appearance in passing northwestward out of the zone of relatively high metamorphic grade. The dolomite probably formed by dolomitization of limestone, because irregular masses of apparently unreplaced limestone occur in the dolomite. Whether dolomitization accompanied metamorphism or is related to some other process is uncertain. The volcanic member (*see* p. 34) between Beaton and Trout Creeks is composed of anhedral epidote and plagioclase and feathered grains of hornblende. Southeast of Trout Creek, on the ridge northwest of Trout Mountain, the volcanic member has the same composition but has been more completely recrystallized; many of the grains are subhedral, and hornblende is in well-formed crystals. Metamorphism southeast of Trout Creek appears to have been dominantly a thermal process involving recrystallization without appreciable deformation. Probably it followed the major period of deformation and may have been associated with intrusion of the Kuskanax batholith. No batholithic rocks are exposed within the map-area, and the main mass of the Kuskanax batholith is several miles to the south.

Silicified rocks and rocks containing vein-like bodies of quartz are found at many places in the map-area. The Badshot limestone on Badshot and Mohican Mountains contains irregular siliceous lenses with a shadowy breccia-like appearance that have probably developed by silicification. Quartz veins are found in limestones in the Milford group and locally in limestones of the Index formation, but replacement of these limestones by silica is uncommon.

Silicification of quartzose rocks is difficult to recognize with assurance. Some beds, notably those in the upper part of the Triune formation, vary in silica content from place to place and may have been partly silicified. Much of the Triune formation is a thin-bedded dark-grey siliceous rock in which detrital quartz grains are distinguishable in thin-section. Near Five Mile Creek and on the eastern side of the Triune basin the formation is a hard, dark bluish-grey rock resembling chert and may have formed in part by silicification. Along some veins, particularly in the Nettie L mine, a form of silicification has taken place. Folia from 1 to 3 inches thick resemble beds of normal grit or argillite on foliation and joint surfaces, but are found to contain lenses of massive grey quartz. Vein-like bodies and masses of white quartz, called formation quartz by prospectors, are common in the Broadview and parts of the Index formations, and are abundant in the Ajax quartzite. Whether this quartz is to be regarded as a product of silicification will depend on how broadly the term is defined. It is thought likely that much of the quartz is derived from the formation in which it occurs, either by recrystallization with expulsion of impurities or in a more mobile form, such as a vein-forming fluid.

Bleaching has affected field recognition of some carbonaceous rocks. Limestones in the Index formation, where highly sheared, as along contacts with phyllitic rocks, are bleached and recrystallized to white marble. Banding in the limestones has probably been accentuated by bleaching during deformation. Variations in the apparent stratigraphy of the Index formation may be caused in part by bleaching of dark-grey phyllites to light-grey or green phyllites.

Siderite has replaced rocks of the Index formation extensively and parts of the Triune and Jowett formations locally. The rusty-weathering characteristic of the siderite makes sideritized rocks show up in the distance and has attracted the attention of prospectors. In the Index formation the uppermost volcanic member has been extensively altered, producing rusty cliffs on the south sides of the Index and Bunker Hill basins. The altered rocks contain principally chlorite and siderite, and primary structures are largely obscured. The Lade Peak limestone contains lenses of massive siderite, some of which contain pods of galena. Lenses at the Molly

Mac and Index properties are described in Chapter IV. Other lenses of siderite, some of which contain galena, are found in limestones in the Silver Chief anticlines and in the anticline to the northeast on the northwest side of Gainer Creek. Siderite is also found as scattered rhombohedral grains in a brown quartzite of the Index formation east of Lade Peak. In the Triune basin, volcanic rocks at the top of the Index formation as well as adjacent parts of the overlying Triune formation and underlying green phyllite (*see* p. 76) are altered to a chlorite-siderite rock containing a brilliant green chromian mica. In the northwest wall of the basin where the alteration is intense, the formations cannot be recognized. To the northwest, alteration becomes less intense. The volcanic rocks show a steady gradation from brown massive siderite rock to fine-grained green fragmental volcanics. Massive siderite rock in the Triune formation feathers out to the northwest as streaks and lenses in a spotted phyllite consisting of rhombs and irregular grains of siderite scattered through black phyllite. Farther to the northwest, spotted phyllite passes into unaltered black phyllite.

CHAPTER III.—STRUCTURE

The Ferguson map-area is near the northern end of the Kootenay arc, a belt of highly deformed sedimentary and volcanic rocks extending southeast from Revelstoke, south along Kootenay Lake, and southwest across the International Boundary (*see* Fig. 1). The area is in a part of the arc in which the rocks strike uniformly northwest—a strike which persists from near the north end of Kootenay Lake to the northeast arm of Upper Arrow Lake and the Incomappleux River, a distance of almost 50 miles. The structure of the Ferguson area is characteristic of this northwesterly trending part of the arc.

The rocks are strongly sheared and folded. In Chapter II they are described as a normal sedimentary and volcanic sequence, but formations and members cannot be regarded as stratigraphic units in the ordinary sense. Complexities of the structure are such that the original stratigraphy no longer exists. Apparently homoclinal successions commonly contain lenticular units which have been sheared by obscure strike faults or have been squeezed and have flowed. Members that are prominent at one locality may not be present a short distance away. Some units are repeated several times within themselves by isoclinal folding. Competent units in an incompetent sequence tend to be broken into series of lenses or have been intruded along cleavage planes by adjacent parts of incompetent, commonly micaceous units. Observed thicknesses give little indication of original thicknesses. Conclusions about the normal sedimentary succession are built up from many observations over relatively large areas.

The structure of the Ferguson area is dominated by complex folds. The folds are isoclinal in phyllitic rocks below the Ajax formation and are asymmetric or overturned in the more competent formations, particularly the Broadview. Tight folds in the competent rocks have extremely complex shapes. Northeast of Trout Lake and Lardeau Valley, fold axes plunge at low angles both to the northwest and to the southeast and axial planes dip steeply. In the southwestern part of the area, fold axes plunge 20 to 40 degrees to the northwest, axial planes are essentially vertical, and many of the folds are isoclinal.

Essentially all significant folds in the Ferguson area are composite. They are aggregates of folds of varying size and importance. The largest are an anticline and a complementary syncline known as the Silvercup anticline and Finkle Creek syncline. The anticline is southwest of the syncline and separated from it by a series of strike faults named the Cup Creek fault zone. Though complicated by faults and by many small folds, the syncline and anticline together have a general cross-sectional shape looking to the northwest of a letter " N." To the northeast, and to the southwest as far as the Trout Lake-Lardeau Valley, the major folds are smaller than the Silvercup anticline and Finkle Creek syncline but have the same general cross-sectional shape. Regionally they produce a cumulative dip to the southwest. The pattern of folding indicates a relative movement of the southwest side upward and over the northeast.

Most of the rocks in the southwestern part of the area lie southwest of a major shear zone along the southwest side of the Lardeau Valley. The importance of the shear zone is uncertain, and the relationships between rocks on either side are not known.

The cross-sections of Figure 3 show the structure of the Ferguson area. Because of the high topographic relief and the narrow and deep valley of Gainer Creek, it has been possible to draw relatively accurate cross-sections. At a number of places, however, they are diagrammatic, based on known fold patterns.

Few details of the structure of the Lardeau area are given by Walker and Bancroft (1929, p. 16). They concluded that a major synclinorium trends northwest across the area. The Badshot formation passing through Badshot Mountain was considered to be on the northeast limb of the synclinorium and to be repeated on the southwest limb about 15 miles to the southwest. Repetition of the Badshot formation was the key to the structure. The present work has been a much more detailed study of rocks between the two bands of limestone, and the presence of a major synclinorium has not been confirmed. In fact, the limestone (the dolomite member) southwest of Trout Lake cannot be correlated with the Badshot (*see* p. 33).

The largest structures in the map-area—the Silvercup anticline, Cup Creek fault zone, and Finkle Creek syncline—are treated first in the following descriptions. Relatively small folds to the northeast and southwest which are not closely related to the Silvercup anticline and Finkle Creek syncline are described next, and the less well-known structure of the southwestern part of the area is described last.

SILVERCUP ANTICLINE

The Silvercup anticline is named from Silvercup ridge. The axis crosses the ridge near Triune Peak and strikes to the northwest, crossing Lardeau Creek near the mouth of Finkle Creek, and Five Mile Creek about a mile from Lardeau Creek. The anticline can be recognized as far as the west side of Ferguson Creek. Northwest of Five Mile Creek it is broken by faults, and beyond Ferguson Creek it is truncated by the Cup Creek fault zone. Between Triune Peak and Five Mile Creek the anticline is overturned, with axial plane dipping about 60 degrees to the northeast and axis plunging 15 to 20 degrees to the northwest. Northwest of Five Mile Creek the plunge continues to be to the northwest, but is irregular and in general steeper than it is to the southeast.

The anticline is outlined by the Ajax quartzite (*see* p. 23) between Triune Peak and Five Mile Creek. Southwest of the axis the quartzite dips uniformly to the northeast at angles of 60 degrees and more. Near Six Mile Creek the quartzite is involved in a series of complex minor folds which together comprise a large dragfold on the southwest limb of the anticline. Northwest of the dragfold and closer to the anticlinal crest, the quartzite thins and pinches out. Near the crest of the anticline northwest of Five Mile Creek, it appears again, and to the east, around the head of Five Mile Creek on the northeast limb of the anticline, it dips gently to the northeast. Southeast along the strike and down from the crest the dip steepens until locally the quartzite on the northeast side of the axis dips nearly as steeply as the quartzite on the southwest side of the axis. In the Triune basin, the only place where local relief is abrupt enough to give a good cross-section, the quartzite northeast of the axis contains relatively open step-like folds which give it an average dip of 45 to 50 degrees to the northeast. In the Triune basin, and probably also to the northwest, strike faults transect the quartzite northeast of the axis of the Silvercup anticline. In general they dip to the northeast more steeply than the beds, which are downthrown on the northeast. One fault truncates the quartzite southeast of Triune Creek, and similar faults cause remarkable thinning of the quartzite elsewhere.

Northwest of Five Mile Creek the anticline is offset to the right by a fault known as the Brow fault, beyond which several other faults complicate the structure (*see* p. 69). Only the crestal part of the Silvercup anticline is outlined by the Ajax quartzite northwest of the Brow fault. The anticline plunges about 25 degrees to the northwest, and the quartzite plunges beneath the surface on the northwest bank of Ferguson Creek.

Little is known of the internal structure of the Silvercup anticline in rocks stratigraphically below the Ajax quartzite, except in the Triune basin and near the

Silver Cup mine. In this area three subsidiary anticlines, broken by faults, are outlined by rocks of the Triune and Index formations. The folds are not seen, but judging from attitudes of formational contacts they are essentially isoclinal. Cleavage dips steeply to the northeast and strikes more to the west than the axial planes of the folds as defined by formational contacts. Faults which are essentially strike faults, but which strike more to the west and dip more steeply than the beds, lie along the northeast limbs of two of the anticlines (*see* p. 42).

In rocks above the Ajax quartzite the Silvercup anticline is obscure. Northeast of the axis the anticline is truncated by the Cup Creek fault zone. The Sharon Creek and the lower part of the Broadview formations are tightly folded northeast of the anticlinal axis. The structure is known with certainty only in the Triune basin, where a series of tight infolds of the Broadview formation in the Sharon Creek formation have the form of dragfolds on the northeast limb of the Silvercup anticline. They have the same pattern of form as step-like folds in the underlying quartzite, but are much tighter and more attenuated (*see* Fig. 3).

Through most of the length of the Silvercup anticline, rocks forming the southwest limb of the anticline dip uniformly to the northeast and contain only small dragfolds. Near the top of Silvercup ridge, at the southeast edge of the map-area, the dip of the Sharon Creek formation and of the lower part of the Broadview formation gradually flattens to as little as 25 degrees to the northeast. The extent to which this relatively low dip affects rocks southeast of the map-area is unknown. Extreme overturning is represented, the structural significance of which is uncertain.

Northwest of Ferguson Creek an anticline and complementary syncline are outlined by the pyroclastic member of the Broadview formation. These folds are southwest of the axis of the Silvercup anticline and together take the form of a large dragfold on the southwest limb. The amplitude of the dragfold at the base of the pyroclastic member is about 1,500 feet, and the distance between the crest of the anticline and the trough of the syncline at the same horizon is about 2,000 feet. The axis of the anticline plunges 10 to 15 degrees to the northwest, and the axis of the syncline (which lies to the northeast) plunges about 30 degrees in the same direction. The folds are truncated along Broadview Creek by a fault known as the Broadview fault. Farther to the northwest the folds are again truncated by a fault, known as the Great Northern fault, which contains the True Fissure vein (*see* p. 80).

The Silvercup anticline is poorly defined northwest of the Broadview fault. Details of the structure near the True Fissure mine are given in Chapter IV, pages 80 to 82. A large anticline crosses the ridge between Fissure Creek and the head of Broadview Creek. The axis, which plunges 30 to 40 degrees to the northwest, is 2,000 to 3,000 feet southwest of Fissure Creek (*see* Fig. 2) and probably is southwest of the main axis of the Silvercup anticline. The subsidiary anticline is truncated on the southeast by the Broadview fault and on the northwest by the Great Northern fault. Southwest of the anticline the rocks dip steeply and in general face to the southwest and are highly contorted.

Another anticline, essentially on strike from that just described, is recognized northwest of the Great Northern fault. It is poorly defined, not well exposed, and is truncated acutely on the north by the Cup Creek fault zone. Like the first anticline, this fold is probably subsidiary to and southwest of the Silvercup anticline. Northwest of Ferguson Creek the Cup Creek fault zone gradually transects the Silvercup anticline and, before the northwest edge of the map-area is reached, crosses the axis.

The limits of the Silvercup anticline are difficult to define. The Cup Creek fault zone forms a natural limit on the northeast, but no limit can be set on the southwest (*see* p. 48) where, between the anticlinal axis and the Trout Lake-Lardeau

Valley, the rocks in general dip steeply and face to the southwest. Although the size of the Silvercup anticline and the complementary Finkle Creek syncline cannot be determined with accuracy, it is clear that the amplitudes and the distance between the axial planes of the folds are to be measured in miles.

CUP CREEK FAULT ZONE

The Cup Creek fault zone separates the Silvercup anticline from the Finkle Creek syncline (*see* p. 43). Many faults occur within the zone, but between Triune and Ferguson Creeks one main fault is recognized which strikes parallel to and is a short distance northeast of the Ajax quartzite on the northeast limb of the Silvercup anticline. The main fault is exposed at a number of places and has been named from exposures in the lower part of Cup Creek. Faults of the Cup Creek fault zone dip steeply and appear to represent a downthrow on the northeast.

The main fault is well exposed on the northwest side of Triune Creek in a steep gully, the bottom of which is about 600 feet northeast of the lowest switchback on the Triune road. The fault is marked by a zone of highly crushed and contorted black slaty argillite 50 to 100 feet wide and dipping 75 to 80 degrees to the northeast. Bands of breccia 1 to 4 feet thick occur along the margins of the slaty argillite and locally also within it. Steeply dipping grits lie on either side of the zone. Blocky and phyllitic grey grit on the southwest faces northeast, and greenish-grey grit on the northeast faces southwest. Grits on the northeast are stratigraphically well above those on the southwest. At the bottom of the gully, a short distance above the Triune road, the black slaty argillite is continuous with a mass of black argillite of the Sharon Creek formation (*see* p. 24 and Fig. 2), which to the southwest is isoclinally folded. The black slaty argillite appears to have been dragged into the fault zone and may have had the form of a tight anticline before faulting.

Southeast of Triune Creek the main fault splits. The southwestern branch dips less steeply than the northeastern and follows a contact between the Sharon Creek and Broadview formations and probably dies out near the southeast edge of the map-area. The northeastern branch probably continues to the southeast beyond the map-area. It is marked by a poorly defined zone of crushed and phyllitic grit.

Several subsidiary faults of the Cup Creek fault zone are exposed in the Triune basin and on the ridge to the northwest. One is along the southwest contact of the Ajax quartzite, and another is sub-parallel to it and a few hundred feet to the southwest. The faults are well exposed in places, and can be seen best at a distance, from the southeast side of the basin. The faults dip about 70 degrees to the northeast. The southwestern one flattens in dip toward the crest of the ridge. They slice beds in the Triune and Ajax formations, which dip 40 to 60 degrees to the northeast. The southwestern fault near the crest of the ridge is marked by a 2- to 3-foot zone of gouge containing broken fragments of white quartz. Drag in beds on the hangingwall side suggests downthrow on the northeast. Although both faults are essentially parallel to the formational strike, the northeastern fault truncates the Ajax quartzite on the southeast side of Triune Creek. Two other faults of the same type are recognized in the Triune basin. One is northeast of the Ajax quartzite, and the other is about 1,000 feet southwest of the quartzite. Both faults are marked by a few feet of gouge and appear to die out down the dip.

The main fault of the Cup Creek fault zone is exposed for several hundred feet along the lower part of Cup Creek. It separates green, somewhat limy phyllite and grey phyllitic grit of the lower Broadview on the southwest from greenish-grey grit which occurs much higher in the Broadview formation on the northeast. Rocks exposed in the creek are strongly sheared and are cut by several faults. One fault is followed by the creek for a few hundred feet. It dips 70 to 80 degrees to the northeast and is marked by 1 to 2 feet of crushed carbonaceous argillite. The Cup Creek fault zone near Cup Creek appears to be relatively narrow. No subsidiary faults are recognized.

Between Finkle and Ferguson Creeks the Cup Creek fault zone lies along the southwest side of a broad belt of sheared rocks. Rocks in this belt, mainly dark-grey to black grits, are strongly cleaved, shattered, and contorted, and only locally show bedding. Many of the rocks break down into fine black rubble. Springs are common along the belt, especially near the heads of Five Mile and Six Mile Creeks. Several have conspicuous cappings of limonite, some of which are several feet thick.

Subsidiary faults are recognized in and near this belt of sheared rocks. One which is vertical and strikes almost due east crosses the lower part of Finkle Creek. Another, also vertical and striking about north 60 degrees west, crosses the ridge south of Nettie L Mountain at an elevation of about 6,800 feet. This fault is along the northeastern side of the belt of sheared grits and is marked by a zone of intense crushing and shearing 50 to 100 feet wide. Both these subsidiary faults die out to the east.

A series of faults lie close to the Cup Creek fault zone between Five Mile and Ferguson Creeks. A northerly trending fault about 1,500 feet west of Five Mile Creek, known as the Brow fault, offsets the Cup Creek fault zone but does not offset the subsidiary fault on the northeast side of the belt of sheared grits.

Northwest of Ferguson Creek a number of faults are recognized in the Cup Creek fault zone, although continuity of the zone as a whole is not well established. Several of the faults near the True Fissure mine are described in Chapter IV. What is probably the main fault of the Cup Creek zone extends along the northeast side of the upper part of Fissure Creek and is exposed on the south slope of the ridge north of the basin at the head of the creek. It is marked by a wide zone of shearing with a well-defined fault plane on the southwest which strikes north 70 degrees west and is essentially vertical. Somewhat shattered grey grit lies on the southwest side and highly sheared dark-grey grit on the northeast. Beds dip toward the fault plane, and dragfolds suggest that they face toward it. The fault has been traced for about a mile to the southeast but cannot be closely located farther to the southeast. What is probably a branch fault runs northwest to the saddle above the head of Fissure Creek, and a parallel subsidiary fault is recognized about 1,000 feet north of the main fault and northeast of the True Fissure mine.

The Broadview fault along the upper part of Broadview Creek is a branch of the Cup Creek fault zone. Where exposed in the lower part of Broadview Creek, the fault strikes almost due west, dips 70 degrees to the north, and is marked by several feet of highly sheared dark-grey grit. The fault truncates an anticline and complementary syncline (*see* p. 41) outlined by the pyroclastic member of the Broadview formation. The pyroclastic member is not exposed on the north side of the fault, and it is inferred that the rocks are downthrown on the north.

No measure of displacement on the Cup Creek fault zone has been obtained. The zone is known to be downthrown on the northeast because the Sharon Creek and underlying formations on the Silvercup anticline southwest of the fault zone are deeply buried on the northeast side. Diagrammatic reconstruction of the Finkle Creek syncline suggests a dip-slip of a least a few thousand feet, but no estimate of the strike-slip can be made. Faulting on the Cup Creek fault zone obviously was later than folding because both large and small folds are disrupted. The faults comprising the zone appear to be normal faults.

FINKLE CREEK SYNCLINE

The Finkle Creek syncline is immediately northeast of the Cup Creek fault zone. The syncline involves rocks at least as low in the succession as the upper part of the Index formation. The Cup Creek fault zone truncates the syncline in such a way that only the trough and northeastern limb of the syncline are exposed. Rocks of the Broadview formation are mainly in the trough, and those of the underlying formations are exposed on the northeast limb. No markers outline the syncline, and no northeastern limit to the fold can be set. The general form is known only from the integration of many relatively small folds. Folds near the trough are asymmetrical, with axial planes dipping steeply to the northeast and axes plunging about 15 degrees northwest. The axial planes steepen to the northeast and in the Index formation dip steeply to the southwest. Step-like folds, N-shaped in cross-section looking northwest, are found on the northeast limb of the syncline and continue to the northeastern limit of mapping.

For descriptive convenience, only the structure of formations overlying the Index formation is considered in the following discussion of the Finkle Creek syncline. The most complete section of the Finkle Creek syncline is exposed on the southeast slopes of Mount Jowett, Mount Homer, and Nettie L Mountain, and is shown in Section E-F of Figure 3. Within half a mile of the Cup Creek fault zone, although details of folding are obscured by a strong cleavage, several overturned folds with axial planes dipping to the northeast at 60 to 70 degrees are recognized. Farther to the northeast on Nettie L Mountain and Mount Homer, large asymmetric folds with axial planes dipping steeply to the northeast can be seen in the distance from the southeast side of Finkle Creek. They are oulined by blocky members of the Broadview formation. Phyllitic members with which the blocky ones are interbedded are somewhat squeezed and thickened and in detail are highly contorted and sheared. To the northeast the uppermost member of the Jowett formation outlines a large anticline well exposed on the ridge south of Mount Jowett (*see* Plate V). The axial plane of the anticline is essentially vertical, and the northeast limb is contorted by a series of irregular folds. It is truncated on the northeast by a steeply dipping strike fault. The rocks are downthrown on the southwest, and the structure of the volcanic rocks to the northeast is poorly known. Probably the anticline is accompanied by a complementary syncline which is cut out by the fault and in any event is obscure in the volcanic rocks.

Similar sections across the Finkle Creek syncline are found to the northwest and southeast, and a few individual folds have been followed for several miles along strike. The anticline just described continues northwest to Ferguson Creek and southeast to Spine Mountain. Farther to the southeast the anticline appears to decrease in amplitude and the fault northeast of it dies out. On Gainer Creek no anticline is recognized and the Jowett formation forms a series of relatively small step-like folds with anticlines followed closely to the northeast by synclines.

A section of the Finkle Creek syncline immediately northeast of the Cup Creek fault zone is well displayed on the northwest side of Triune Creek (*see* Fig. 3, Section A-B). Rocks of the Broadview formation northeast of the main fault of the Cup Creek zone dip steeply to the northeast and are overturned. They are on the southwest limb of an anticline whose axis is 2,000 to 3,000 feet northeast of the fault. The northeast limb of the anticline dips gently to the northeast as far as the lower slopes of the valley of Lardeau Creek, where there are few or no outcrops. Probably the same overturned anticline within the Finkle Creek syncline lies along the northeast side of the Cup Creek fault zone as far as Finkle Creek and is gradually transected by the fault zone along strike to the northwest. Northwest of Finkle Creek the rocks are strongly sheared and folds are obscure.

Structure within the Sharon Creek, Ajax, and Triune formations on the northeast limb of the Finkle Creek syncline is known mainly from exposures along the steep walls of the valley of Gainer Creek between 1½ and 2½ miles northeast of Tenmile. All three formations are highly squeezed and thickened. Several tight to relatively open step-like folds, with amplitudes and distances between axial planes of a few hundred to about 1,000 feet, are outlined by formational contacts. The axial planes of the folds are either vertical or dip steeply to the northeast. In contrast to this northeasterly dip, the axial planes of folds immediately to the northeast in rocks of the Index formation dip steeply to the southwest. Northwest of Gainer Creek, fold axes plunge about 10 degrees to the northwest; southeast of Gainer Creek they plunge about 15 degrees to the southeast.

The Ajax quartzite is remarkably thickened near Gainer Creek and to the northwest and southeast; a few thousand feet up the formational dip from the creek level it is sqeezed out entirely. The internal structure of the Ajax formation is not well known, but the thickening is in part caused by a series of overriding folds in a step-like pattern in which the southwest side has moved upward in relation to the northeast side. Argillaceous layers in thickly bedded blocky quartzites have facilitated interbed slippage and near the crests of folds, particularly anticlinal folds, are thickened many times and are highly contorted and sheared. On southwesterly dipping limbs of folds the shearing in argillaceous beds produces bedding faults which commonly steepen upward into the overlying quartzite as steeply dipping reverse faults which themselves are commonly folded.

Folds within the Ajax formation are relatively open, with well-rounded crests and troughs. Folds outlined by the contact of the Ajax with the overlying Sharon Creek formation are similar to those within the Ajax. The contact between the Ajax and the underlying Triune formation is not folded and probably represents a slip plane, although no well-defined fault has been recognized along it. At the elevation of Gainer Creek the Sharon Creek formation is abnormally thin and the Ajax is abnormally thick. A few thousand feet up the dip the Sharon Creek formation is abnormally thick and the Ajax is correspondingly thin.

STRUCTURE IN THE UPPER PART OF GAINER CREEK

Structure in the upper part of Gainer Creek is characterized by isoclinal folding and strong shearing. The nature of folding is such as to indicate a relative movement of the southwest side upward in relation to the northeast. The pattern is the same as it is to the southwest, but individual folds are much more highly attenuated and shearing and flowage are more pronounced. Axial planes of the folds dip 75 to 80 degrees to the southwest and axes plunge away from Gainer Creek, to the northwest at 5 to 10 degrees and to the southeast at 10 to 15 degrees.

Phyllites and calcareous rocks forming the Index and Lade Peak formations have a pronounced foliation dipping steeply and relatively uniformly to the southwest. Bedding is rarely seen in the phyllites and is well defined only in argillaceous limestones. Casual observations suggest that the rocks form a homoclinal succession, but isoclinal anticlines, spectacularly displayed locally by the Lade Peak limestones, indicate that the whole succession is isoclinally folded, and close studies show that parts of the succession are repeated many times. The structure is displayed best on the northwest side of Gainer Creek. Five anticlines are exposed, each with Lade Peak limestone in the core. The structure of the intervening phyllites in general is synclinal, but structural details within the phyllites are uncertain and the synclines appear to be complex.

Three closely spaced anticlines known as the Silver Chief anticlines cross Gainer and the lower part of Bunker Hill Creeks between 3 and 3½ miles northeast of Tenmile. The southwesternmost anticline is well displayed in smooth cliffs of limestone and argillaceous limestone on the northwest side of Gainer Creek and can be seen from a distance (*see* Plate VIII). Beds are repeated more or less symmetrically across the axial plane of the anticline, although in detail they are complexly contorted, sheared, and locally broken. Dragfolds have opposing shapes on either side of the axial plane, and, near the axis, beds on either limb diverge by several degrees in dip. The two anticlines to the northeast are broken on the northeast limb by strike faults. Where exposed, the faults are marked by a relatively inconspicuous zone of shearing, and the presence of the faults is indicated only by dragfolds and by stratigraphic relationships that show the anticlines to be incomplete. Dragfolds at the lowest elevations show that the faults are southwest of the axial planes of the anticlines; at higher elevations the faults transect the northeast limbs and are thought to pass upward into the overlying phyllites. At low elevations the upper, non-argillaceous part of the Lade Peak limestone is cut out by the faults, but up the dip the non-argillaceous limestone is present on the northeast limbs and passes over the crests of the anticlines. These relationships are deduced from a number of observations at various places along the formational strike. The topography and attenuation of the folds is such that the limestone at the core of the northeasternmost anticline plunges beneath the overlying phyllites on Silver Chief ridge and the limestone in the central anticline plunges beneath the phyllite northwest of Bunker Hill Creek. The limestone at the core of the southwestern anticline plunges beneath the phyllite in the Index basin and on the northwest side of Bunker Hill Creek. Hence limestone in the core of the northeastern anticline continues beyond the map-area to the northwest, whereas limestone in the core of the central anticline continues beyond the map-area to the southeast. The faults on the northeastern and central anticlines cannot be recognized in the phyllites. The small synclines between the three anticlines of limestone contain mainly green phyllite and appear to be more highly attenuated than the anticlines. Within the phyllites, bedding is rarely seen and the detailed shapes of the folds are uncertain.

A fourth anticline in which the Lade Peak limestone is exposed lies about 2,000 feet northeast of the northeasternmost of the Silver Chief anticlines. The anticline is clearly outlined on the northwest slope of Gainer Creek by the contact between the limestone and the overlying green phyllite. On the lower slopes, dragfolds in the argillaceous limestone and repetition of the non-argillaceous limestone indicate the presence of the anticline, and on the upper slopes the actual crest at the limestone-green phyllite contact is exposed. Near the crest the limestone tapers rapidly upward, forming a thin wedge in the phyllite. One small subsidiary tight dragfold is present on the northeast side of the main anticline. Cleavage in the phyllite is parallel to the limestone-phyllite contacts but is complexly contorted for several feet above the wedge-shaped mass of limestone. Limestone in this anticline is poorly exposed on the southeast side of Gainer Creek. About 500 feet southwest of Corner Creek it forms a narrow interband in green phyllite that outcrops intermittently below about 6,000 feet elevation.

The Lade Peak limestone forms the core of another anticline which crosses the summit and follows the southeast ridge of Lade Peak and is called the Lade Peak anticline. It is known best from exposures northwest of Gainer Creek, although the limestone continues southeast of Gainer Creek beyond the southeast edge of the map-area. The anticline is clearly indicated in cliffs on the northwest side of the creek by dragfolds and by repetition of parts of the Lade Peak limestone and overlying phyllite. The contact between the limestone and the phyllite is tightly infolded. Argillaceous limestone which occurs in the core of the anticline near Gainer Creek wedges out higher in the anticline into the overlying non-argillaceous limestone on the summit of Lade Peak.

From the summit of Lade Peak the limestone in the anticline can be seen crossing several ridges to the northwest, beyond the map-area, and in the distance on the south spur of a high peak the limestone forms a slender light-coloured wedge in darker-coloured rocks which are probably phyllites overlying the limestone.

Southeast of Gainer Creek the limestone in the Lade Peak anticline is poorly exposed below about 5,500 feet elevation. The limestone occurs as a series of bands and lenses with interbands of green and locally grey phyllite. The relationships suggest that southeast of Gainer Creek the anticline is broken into several smaller folds and that, as a result of extreme attenuation, lenses of limestone have been isolated from the main mass of limestone.

The structure of the phyllitic rocks of the Index formation is known in only a general way. Cleavage dips steeply and fairly uniformly to the southwest. Beds are rarely seen and the structure is deduced from knowledge of the structure of the Lade Peak limestone, as well as from stratigraphic relationships, but the stratigraphic relationships are complicated and imperfectly known. Despite uncertainties caused by deformation, it appears that the green phyllite overlying the Lake Peak limestone thins toward the northeast, and the overlying grey phyllite thickens and becomes more carbonaceous in that direction (*see* p. 20). Probably grey phyllites grade into green ones toward the southeast because much less grey phyllite is found southeast of Gainer Creek than northwest of it. Thin beds of limestone and quartzite near the contact between the green and grey phyllite, that might form useful markers, are discontinuous and are of value in outlining only the general structure.

The phyllites and the Molly Mac limestone between the Triune formation and the Silver Chief anticlines in general dip and face to the southwest. They are tightly folded in a series of attenuated step-like folds rising to the northeast. Grey and green phyllites between the Molly Mac and the Lade Peak limestones are repeated several times, the grey phyllite occurring in synclinal troughs. In the syncline immediately northeast of the Silver Chief anticlines, very little grey phyllite is exposed.

The synclinal trough southwest of the Lade Peak anticline contains considerable grey and dark-grey phyllite which is repeated northeast of the anticline. The structure of the rocks between the Lade Peak anticline and Badshot Mountain in general is synclinal. The green phyllite above the Lade Peak limestone is not repeated to the northeast, and it is concluded that the northeastern limb of the syncline is sheared and faulted. This shearing and faulting, however, is not considered to represent a major strike fault. The possibility that the Lade Peak and Badshot limestones are correlatives and that the green phyllite above the Lade Peak limestone thins or pinches out stratigraphically to the northeast has been discussed (*see* p. 17).

The Badshot, Mohican, and Marsh-Adams formations are folded into the Marsh-Adams anticline and the complementary Mount Templeman syncline to the northeast. The folds are essentially isoclinal. The axial planes dip more than 80 degrees to the southwest and are 2,000 to 3,000 feet apart. Southeast of Gainer Creek the fold axes plunge about 10 degrees to the southeast, and northwest of the creek they plunge about 5 degrees to the northwest.

The Marsh-Adams formation in the core clearly outlines the shape of the anticline. The configuration of the top of the formation, which can be closely followed on the southeast side of Gainer Creek, shows the northeast limb to be nearly vertical; the southwest limb to dip 70 to 80 degrees to the southwest, and the crest to consist of a series of fairly open folds locally broken by small faults (*see* Fig. 3). The anticline at this horizon has a broad crest. Lower in the Marsh-Adams formation the anticline has a sharp crest. It is well displayed on the northwest side of Gainer Creek. Blocky beds of quartzite southwest of the axial plane dipping steeply to the southwest meet beds northeast of the axial plane dipping less steeply to the northeast in the form of a blunt wedge.

The Marsh-Adams anticline has a subsidiary syncline and anticline on its northeastern flank. These subsidiary folds are isoclinal and are spectacularly attenuated. Quartzitic rocks in the core of the anticline are strongly cleaved, and limestone at the base of the Mohican formation is pinched out on the limbs and squeezed into crests of the main folds and of dragfolds on the flanks.

The Mount Templeman syncline is named from Mount Templeman, a high peak east of the map-area on which the syncline is well exposed. Within the map-area the syncline is outlined by the Badshot limestone on Piton Peaks and on a sharp peak southeast of Gainer Creek.

As seen in the distance on the southeast face of the summit of Piton Peaks, the syncline is essentially isoclinal, with a nearly vertical axial plane. Bedding in the Badshot limestone curves gradually around the trough of the fold. Southeast of Gainer Creek the syncline is more complicated. The trough is split by a sharp-crested highly sheared anticline, and the southwest side is broken along the base of the Badshot limestone by a bedding fault. Rocks beneath the Badshot formation are not repeated symmetrically across the axial plane of the fold. Dark-grey argillite and argillaceous limestone which underlies the Badshot on the northeast limb of the syncline does not occur in the sharp-crested anticline or on the southwest side of the syncline, and is probably thickened on the northeast and eliminated by squeezing or shearing on the anticline and southwest side of the syncline. The Mohican formation occurs on the limbs of the syncline on Piton Peaks and southeast of Gainer Creek and is found in the trough between these two localities. The form of the syncline is not clearly shown in the Mohican formation, and details of the structure are not well known. Many complex folds and bedding or strike faults are seen along the cliffs on either side of Gainer Creek. Dragfolds are more or less symmetrical across the axial plane of the syncline.

STRUCTURE BETWEEN THE SILVERCUP ANTICLINE AND THE LARDEAU VALLEY

The structure southwest of the Cup Creek fault zone is dominated by the Silvercup anticline, which is described on pages 40 and 41. No major fold of comparable size is found farther to the southwest. All the rocks between the anticlinal axis and the Trout Lake-Lardeau Valley may be regarded as lying on the southwestern limb of the anticline. These rocks form a steeply dipping, complexly folded and sheared sequence which in general faces to the southwest. Folds within the sequence vary greatly in size and shape but have a uniform cross-sectional pattern and a low plunge to the northwest. The folds are N-shaped in section looking northwest, a shape that implies a relative movement of the southwestern side upward in relation to the northeastern.

The folds vary widely in size and in detail of form. The largest known have more than 1,000 feet between adjacent axial planes. The larger folds are aggregates of smaller ones. Some of the folds are relatively open flexures; many are strongly overlapping or complex. Commonly the rocks are broken or strongly sheared. Blocky, hard grit beds end abruptly, and phyllitic interbeds have been sheared and have flowed to accommodate themselves to local vagaries of the deformation. Several complex folds are illustrated in Figure 4.

One of the largest folds recognized is well exposed northeast of the lower part of Halfway Creek. It is a step-like fold with an anticline on the southwest and a complementary syncline on the northeast, the axial planes of which dip to the northeast and are about 1,000 feet apart. The folds are relatively open, and the rocks between them dip gently to the northeast. In detail the beds are highly contorted and some are strongly cleaved.

A somewhat similar fold is well exposed on the southeast side of the crest of the ridge a few thousand feet southeast of the summit of Great Northern Mountain. The fold is more open than the one just described, and is downthrown several hundred feet on the northeast by a northwesterly striking fault.

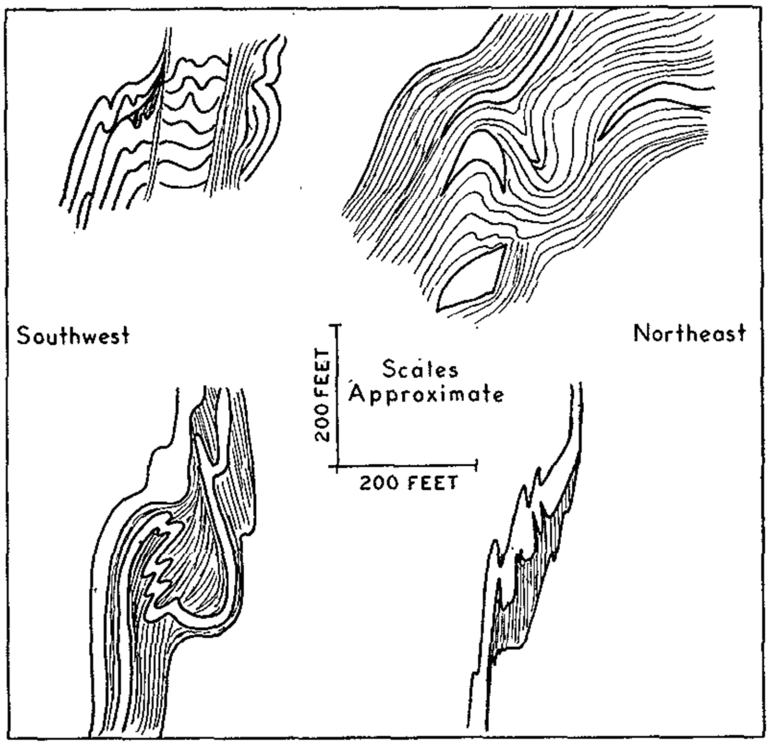

Figure 4. Cross-sectional shapes of typical folds in grits and phyllites of the Broadview formation. Phyllites shaded to show general form of cleavage.

Extensive zones of phyllitic black rocks with which are associated rusty springs, swamps, and iron caps are common in the Broadview formation. Although they are zones of strong shearing on which there has been more or less movement, they are not considered to represent major faults. Bedding outlined by blocky grits is seen locally in the black phyllitic zones, and dragfolds indicate that the relative movement has been of the southwestern side upward. Cleavage is prominent and, though irregular, is generally steeply dipping. In the middle division of the Broadview formation, a few thousand feet southwest of the outcrop of the pyroclastic member (*see* p. 28), these shear zones appear to be localized in incompetent strata containing few blocky grit beds.

The plunge of the folds between the Silvercup anticline and the Lardeau Valley is to the northwest at variable angles. In general on the Silvercup ridge near the anticline, the plunge is less than 20 degrees. The plunge decreases northwest of Lardeau Creek and is less than 5 degrees over wide areas on the upper southern slopes of Great Northern Mountain. Toward Trout Lake, on the southwestern slope of Silvercup ridge, the plunge steepens to 25 and 30 degrees. Folds are obscure on the southwestern slope of Silvercup ridge, but lineation, probably parallel to fold axes, is pronounced. The cause of the abnormally steep plunge of the lineation is uncertain. It is significant that southwest of the Lardeau Valley folds plunge as much as 40 degrees to the northwest.

STRUCTURE OF THE SOUTHWESTERN PART OF THE MAP-AREA

Rocks in the southwestern part of the area are tightly folded and strongly sheared. The structure is known best along the southwestern edge of the map-area in the volcanic and dolomite members (*see* p. 33), which have been traced from the ridge southeast of Trout Creek to Beaton Creek (*see* Fig. 2, sheet B). Northeast of these members the structure is not well understood, distinctive rocks are lacking, and the only good exposures are in the canyons of Beaton, Trout, and Humphries Creeks and along the Trout Lake–Beaton road. Rocks along the Lardeau Valley are especially sheared.

The volcanic and dolomite members are isoclinally folded and are remarkably squeezed and thickened by flowage due to folding. The structure has been determined by tracing contacts of the members and by studying dragfolds in adjacent argillites. Figure 5 is a diagrammatic structural cross-section northwest of Trout Creek showing two isoclinal anticlines and an intervening syncline. The lower part of the section is outlined clearly on the steep northwest slope of Trout Creek, where the relief is nearly 3,000 feet. The upper part is deduced from exposures on both sides of Beaton Creek. The two parts are placed in their approximate relative positions on the section by projection along the plunge of the folds. Other interpretations of the structure are possible, but the one shown in Figure 5 appears to best fit the known facts.

The axial planes of the folds strike north 35 to 40 degrees west and are essentially vertical. The axes plunge between 20 and 40 degrees to the northwest, the plunges being higher near Beaton Creek than they are to the southeast. The plunge has been determined from dragfolds, which are common in the argillaceous rocks near the dolomite and volcanic members, and from the crests and troughs of larger folds wherever possible. Two complex anticlines and an intervening syncline are outlined by the dolomite and volcanic member between Trout and Beaton Creeks.

The southwesternmost of the two anticlines has the main band of the volcanic member in the core and the dolomite member on the northeast limb. The southwest limb appears to be sliced by a strike shear, and only lens-shaped remnants of the dolomite member have been found along it. One of the largest lenses known, on the north slope of Trout Creek between 5,000 and 6,000 feet elevation, is probably the synclinal part of an isoclinal dragfold on the southwestern limb of the anticline.

This anticline is followed on the northeast by an isoclinal syncline well exposed on the steep slope north of Trout Creek. The syncline contains the dolomite member and is underlain by a thin tail of the volcanic member which wraps around the trough of dolomite and is pinched out on the northeast limb of the syncline. The syncline is followed on the northeast by a second anticline, on the crest of which, near Beaton Creek, the dolomite member is markedly thickened and the volcanic member occurs as isolated lenses. The dolomite member on the crest of the anticline plunges beneath the surface about three-quarters of a mile northwest of Beaton

Creek and appears to be truncated on the southwest side by the same strike shear that has sheared the dolomite member along the southwest side of the first anticline described (*see* Fig. 5). Reconnaissance to the northwest has not found other occurrences of the dolomite member. To the southeast the dolomite appears to pinch out on the northeastern limb of the second anticline.

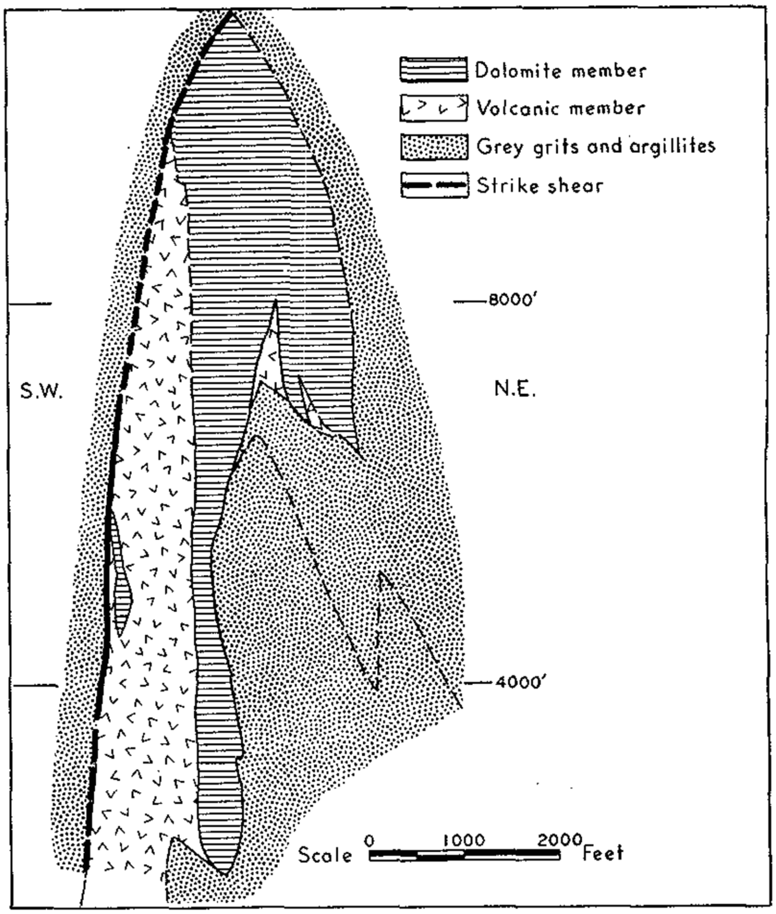

Figure 5. Diagrammatic section showing folds outlined by the dolomite and volcanic members. Looking northwest. Vertical and horizontal scales equal.

The structure of the rocks which lie immediately northeast of the complex folds outlined by the dolomite and volcanic members is known mainly from exposures in the canyon of Trout Creek. In the creek, for more than half a mile downstream from a point below the Lucky Boy mine, grey grits dip 50 to 75 degrees to the northeast and contain many dragfolds plunging 20 to 30 degrees to the northwest. The dragfolds have the shape of a reversed letter " N " seen looking down the plunge, and it may be concluded that the grits are on the northeast limb of an anticline, possibly the second anticline just described (*see* Fig. 5). Southeast of Trout Creek the dolomite member dips to the northeast, the dip gradually decreasing to the southeast. It also appears to be on the northeast limb of an anticline.

In the lower part of Trout Creek, for about 2,000 feet upstream from the point where it enters the Lardeau Valley, the rocks are strongly cleaved and highly contorted. Opposing dragfolds plunging to the northwest suggest that several large isoclinal folds, possibly broken by strike faults, are present. Rocks in the Lardeau Valley to the northeast are strongly cleaved and contorted. Although outcrops are scattered, relationships similar to those found in Trout Creek are found at other places along the southwest side of the Lardeau Valley. The valley cuts obliquely across the formational strike. It appears to follow a zone of strongly sheared and contorted rocks, but whether the sheared zone represents a major fault or whether it is a relatively local feature cannot be determined within the map-area.

PATTERN OF FOLDING

Folds in the Ferguson area in general have a uniform pattern of form, which is clearly defined northeast of Trout Lake and Lardeau Valley and is inferred in much of the southwestern part of the area. This pattern is thought to be characteristic of the northwesterly trending part of the Kootenay arc. The origin of this pattern is not clear, and more extensive studies in the Kootenay arc and in rocks to the northeast and southwest will be necessary before the structure of the map-area can be placed in its true perspective.

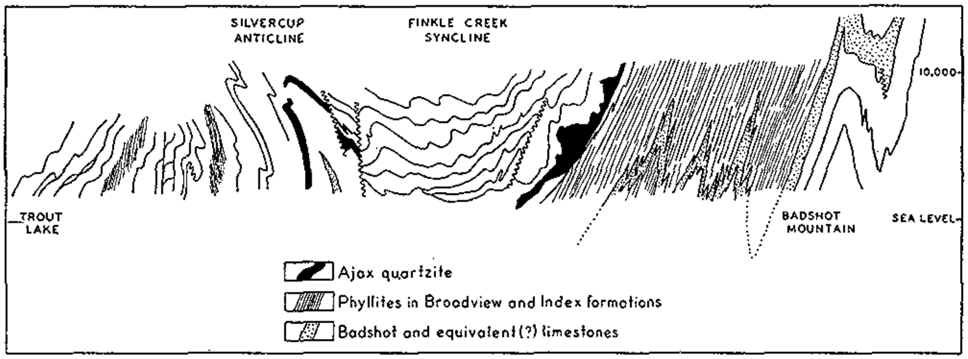

Figure 6. Generalized cross-section between Trout Lake and Badshot Mountain.

Essentially all the important folds in the Ferguson area are N-shaped in section looking northwest (*see* Fig. 6). Ideally they consist of pairs of folds made up of an anticline southwest of a syncline in which the southwest limb of the anticline and northeast limb of the syncline are relatively long and steeply dipping. They vary widely in size and shape. Many are step-like and relatively open; others are highly attenuated or isoclinal. This pattern may be complicated or difficult to see from place to place in the field because some large N-shaped folds have dragfolds the shape of a reversed " N " on their short limbs. Many folds are broken or complexly distorted. Despite local complexities, all the major folds have the N-shaped pattern, implying a relative movement of the southwest side upward and over the northeast. They have been caused by stresses that affected an area larger than the map-area. It is possible that they represent dragfolds on the northeast limb of a huge synclinorium, but it is more probable that they result from a regional thrusting of southwest over northeast.

The physical characteristics of the rocks have greatly affected the form of the folds. Thin-bedded phyllitic rocks and limestones of the Index formation have been folded and sheared, and have flowed essentially as a unit. Axial planes of the folds dip uniformly at 70 to 80 degrees to the southwest; the folds are isoclinal, and all folds have similar shapes throughout the formation. The rocks are moderately well cleaved. The cleavage dips fairly uniformly to the southwest parallel to the axial planes of the folds, and, because the folds are isoclinal, it is commonly parallel to the bedding. Locally, cleavage and axial planes of folds are gently folded. Beds and members are pinched out acutely or sliced at a long angle by strike faults. The Index formation is a relatively weak unit lying between stronger ones and is a zone in which regional thrusting or strike faulting may be localized.

In the more competent heterogeneous succession overlying the Index, relatively strong beds have transmitted stresses and have reacted more or less independently. The folds are irregular and complex. Commonly axial planes dip to the northeast and folds are asymmetric or overturned. Although complicated or obscure in detail, the pattern of N-shaped folds is found throughout the heterogeneous succession. Quartzitic beds and members, which are more competent than micaceous ones, at places are thickened in a series of rounded bulging folds, and at others are pinched out abruptly. Micaceous beds tend to conform to shapes determined by the quartzitic beds. Cleavage in the interbedded phyllitic rocks is commonly complexly distorted, and may be parallel to or at an angle to the beds. In the quartzitic rocks, cleavage in general is not parallel to the beds. In places quartzitic beds intrude masses of phyllitic rock near crests or troughs of folds, and phyllitic partings follow cleavage or other shear planes within quartzitic rocks.

The plunge of the folds in the northeastern part of the map-area and along most of the Silvercup anticline is at a low angle to the northwest. Southeast of Gainer Creek it is to the southeast, and the valley of the creek follows an axis of culmination. The change in plunge across this axis is fairly rapid, and the axis is curved and is followed closely by the valley of Gainer Creek. South and southwest of Tenmile all the folds plunge to the northwest, and if the axis of culmination along Gainer Creek continues to the south, it must pass southeast of the map-area. Near the northwest edge of the map-area, particularly on Great Northern Mountain, the plunge in general is lower than elsewhere. Reconnaissance to the northwest indicates that a poorly defined axis of depression lies a short distance to the northwest. In the southwestern part of the map-area, folds plunge to the northwest at angles of 20 to 40 degrees. These plunges, which are abnormally high, are found over a sufficiently large area to be considered of regional significance. Whether the relative steepness of the plunge is related to regional shear in the Lardeau Valley, to intrusion of granitic rocks to the south (*see* Walker and Bancroft, 1929, map), or to some other cause is uncertain. Locally, folds plunge more or less steeply than the general regional plunge. Pronounced and complex variations in plunge are found near the True Fissure mine in an area of complex faulting, in which folds in adjoining fault blocks have different plunges.

CHAPTER IV.—MINERAL DEPOSITS

INTRODUCTION

The principal mineral deposits in the Ferguson map-area contain silver, lead, and zinc. Small amounts of copper are found, and several properties have been explored for gold and one for tungsten. Most of the deposits were discovered before 1900, and a great deal of the exploration and mining took place before 1920. Total recorded production from mines within the map-area amounts to 44,259 tons. Gross contents: Gold, 6,941 ounces; silver, 2,205,383 ounces; copper, 5,439 pounds; lead, 9,056,174 pounds; zinc, 435,033 pounds. Zinc was not produced before 1917. Copper and gold are largely by-products of lead-zinc production, but two properties, the Ophir-Lade and Winslow, produced mainly gold. The following table lists the recorded production and shows the main periods in which shipments were made.

Total Production from Mines in the Ferguson Map-area

Mine	Year	Tons	Gold	Silver	Copper	Lead	Zinc
			Oz.	Oz.	Lb.	Lb.	Lb.
Badshot	1904	28	—	3,859	—	24,200	—
Black Prince	1904	30	—	4,643	—	8,532	—
Mohican	1903	9	1	459	—	4,894	—
Ophir-Lade	1932	13	13	—	—	—	—
Broadview	1900–1906	238	19	8,668	1,145	169,042	—
True Fissure	1908–1918, 1937–1944	5,076	198	42,148	—	533,019	286,570
St. Elmo	1899	6	1	624	—	2,420	—
Ajax	1912–1914	539	13	18,901	—	552,696	—
Nettie L.	1899–1904, 1912–1922	12,820	781	459,253	—	1,309,868	28,239
Silver Cup	1895–1921, 1937–1941	22,544	4,978	1,419,339	—	5,684,204	110,447
Towser	1917	25	5	1,400	—	20,117	—
Triune	1900–1905, 1916–1918	653	335	144,928	—	494,867	9,749
Winslow	1934–1941	1,788	596	312	—	477	28
Copper Chief	1905, 1917	14	—	1,936	—	2,672	—
Lucky Boy (including Horseshoe)	1902–1906	467	1	97,467	4,294	247,481	—
Ruffled Grouse	1901–1902	9	—	1,446	—	1,685	—
Totals	—	44,259	6,941	2,205,383	5,439	9,056,174	435,033

The mineral deposits in the Lardeau district were described by Newton W. Emmens soon after the early stage of mining activity (*see* Emmens, 1914) and by Gunning in 1926 (*see* Gunning, 1929). These writers describe the early history of mining, and Annual Reports of the Minister of Mines give detailed accounts of mining progress from the earliest recorded discoveries to the present. Little or no work has been done on many of the properties since 1926, and little can be added to the descriptions by Emmens and Gunning. In the present study the setting of the deposits and the relation of mineralization to regional and local structure has been emphasized. A summary of mining activity is given in Chapter I.

As early as 1903 it was recognized that mineral deposits in the Lardeau district in general fall into three belts. These are shown on maps by Brock (1903, p. 56) and Emmens (1914) as the lime dyke mineral belt, the central mineral belt, and the southwest mineral belt. They trend more or less parallel to the regional strike of the formations. Between the belts no ore mineralization has been found. Within the Ferguson map-area most of the deposits are in the central and lime dyke mineral belts; only one group of deposits, including the Lucky Boy and Copper Chief properties, is in the southwest belt. Therefore, generalizations can be made only about deposits in the central and lime dyke mineral belts. Many deposits within the map-area are similar to others in the same belts outside the area, and it is thought that many of the following generalizations apply beyond the Ferguson map-area. In the table of production the mines are grouped by belts. The first four are in the lime dyke mineral belt, the following nine are in the central mineral belt, and the last three are in the southwest mineral belt.

The most common deposits in the lime dyke mineral belt contain galena in siderite which has replaced limestone. More than a dozen of these deposits are known, of which the best known are on the Molly Mac, Index, White Quail, and Silver Chief properties. The deposits are in the Lade Peak and Molly Mac limestones and in other limestones in the Index formation; they are not restricted to one horizon. Commonly they consist of lenses of siderite which have replaced the limestone along crests of folds or in sheared zones, and which contain massive pods or poorly defined disseminations of galena. Locally as on the Silver Chief property, galena is found in limestone without siderite as small veinlets or replacements along beds, folds, or fractures. Masses of siderite are conspicuous because they weather to a rusty brown colour; they may be more than 100 feet long and several tens of feet thick. Masses of galena are much smaller than those of siderite. Although the dimensions of none of the deposits are completely known, the longest dimension is thought to be parallel to the plunge of the folds in the enclosing rocks. The plunge is low—about 5 degrees to the northwest on the northwest side of Gainer Creek and 10 to 15 degrees to the southeast, southeast of Gainer Creek. Some of the most common masses of galena are no more than a few feet high and a few feet thick, and continue several tens of feet along the plunge. Galena and pyrite are the principal sulphides, and sphalerite is present in minor amounts. Samples containing 15 to 25 per cent lead can be obtained from many of the lenses. The silver content is relatively low, and in samples taken by the writers amounts to about 1 ounce per ton for every 5 per cent lead. In the samples taken this ratio is uniform, but too few assays are available to be certain that the silver-lead ratio is constant.

Mineralization has been controlled by folding and related shearing. The formation of siderite preceded mineralization by galena. Sideritization at many places is clearly controlled by isoclinal folds, commonly by anticlinal parts of N-shaped dragfolds. Galena has formed in sheared, folded, or fractured parts of the siderite and nearby limestones.

Other mineralized zones in the lime dyke belt include silver-lead veins in the Badshot limestone and quartz veins in green and grey phyllites of the Index formation. Only two small silver-lead veins in the Badshot limestone—one at the Badshot mine on Badshot Mountain and the other at the Black Prince on Mohican Mountain—are known. Quartz veins in phyllites of the Index formation are found on the Mohican and Ophir-Lade properties. A zone of quartz stringers containing minor galena occurs on the southeast side of upper Gainer Creek in the Marsh-Adams formation (*see* Fig. 2).

More than 85 per cent of the ore mined in the Ferguson area has come from the central mineral belt. The Silver Cup, Triune, Nettie L, and True Fissure mines account for most of the production. These deposits, and others from which there has been little or no production, are veins and lodes containing galena, argentiferous tetrahedrite, sphalerite, and locally chalcopyrite. Some of the properties were developed early in the exploration of the district because of their high silver content. Early shipments of ore from the Silver Cup and Triune mines are reported to have contained more than 150 ounces of silver to the ton and more than 30 per cent lead.

The veins and lodes in the central mineral belt are southwest of the Cup Creek fault zone and near the crest of the Silvercup anticline. They are relatively crowded along the anticline and become widely scattered to the southwest. The Cup Creek fault zone sharply bounds the central mineral belt to the northeast, although there is no evidence that any individual vein is truncated by the fault zone. Mineralization dies away to the southwest and has not been found in the upper half of the Broadview formation. The veins and lodes are in relatively brittle rocks of the Lardeau group, in zones of faulting and fracturing in or adjacent to competent members. The True Fissure and adjoining properties are located on a large complex vein which follows an east-dipping fault. The fault strikes northward, transecting northwest-trending folds at a small angle. The small St. Elmo vein lies in the footwall of the main vein. The Nettie L and adjoining properties are located on a group of veins which form a zone half a mile long, essentially along the crest of the Silvercup anticline. Some of the veins follow north-striking, steeply east-dipping faults which have transected the anticline at small angles; other veins follow fractures which vary in attitude and are very local. The Silver Cup and Triune orebodies, three-quarters of a mile apart, are in bedded shears in a thin brittle member on the southwest limb of the Silvercup anticline near the crest. Between these major properties there are small showings scattered along the anticline, half of them fracture-veins and veinlets in the brittle Ajax quartzite and immediately adjacent beds of siliceous argillite.

None of the lodes is continuously mineralized. At the Silver Cup, mineralization is concentrated in three orebodies within two longer parallel shear zones, and within the orebodies mineralization is further concentrated in oreshoots, being relatively sparse between the shoots. The Silver Cup orebodies are restricted along strike and extensive down-dip, the largest being about 300 feet long, 1,200 feet deep, and about 5 feet thick. Smaller orebodies near the Silver Cup appear to have the same general shape. On the Nettie L and adjacent properties the relatively extensive north-striking fault veins are only sparsely and sporadically mineralized, and most of the ore has been mined from a small fracture-vein, known as the Cross vein, which warps toward the main vein down-dip and disintegrates. This Cross vein has been mined out, but the stope suggests that it was 120 feet long, 200 feet deep, and 3 to 6 feet thick. Mineralization at the True Fissure contrasts with that at the Silver Cup in being restricted down-dip and possibly extensive along strike, and contrasts with that at the Nettie L in being mostly in the main fault vein, rather than in a subsidiary fracture. Present limited exposures indicate an orebody about 350 feet long and as much as 360 feet on the dip on the True Fissure claim, and a mineralized zone about 500 feet long and as much as 450 feet on the dip on the Blue Bell. The 500-foot interval between them is probably barren, but it is likely that the bodies were continuous at a higher level, before erosion. The width varies from a few inches to as much as 14 feet. Additional shoots and lenses of ore are present in probable extensions of the lode on the Great Northern and Broadview claims.

Quartz is the main gangue mineral in all the veins. Iron-bearing carbonates are also present. Pyrite, galena, and sphalerite are the main sulphides. Argentiferous tetrahedrite is common in the Triune, Silver Cup, and nearby mineralized zones, and is scarce in the orebodies on and near the Nettie L and True Fissure properties. Chalcopyrite is found in places, particularly at the Broadview property. The veins are commonly weathered for a depth of several feet, and oxidation of the pyrite and iron carbonates produces a red or brown stain or crust. A large stripped area of the True Fissure vein presents a spectacular stained surface. However, " iron caps " are not reliable guides to ore. Several have been formed along the

Cup Creek fault zone and other shear zones by deposition from seepage water. Northwest of the True Fissure, in a draw on the Mountaingoat Creek slope, an adit was driven into blood-red hematite on the former Woods property (*see* Fig. 2), encountering barren black phyllite at a depth of 2 or 3 feet. It is suggested that the iron is derived from pyrite sparsely disseminated through sheared rock in the Cup Creek fault zone.

The mineral belts in the Lardeau district were originally recognized because of the geographical distribution of the properties. The belts are well defined; the central and lime dyke mineral belts are separated by 4 miles of folded rocks in which no significant sulphide deposits are known, and properties in the central mineral belt are at least 3 miles from those in the southwest mineral belt. The belts are clearly controlled by the geology, and probably the most important geological factors are the structure and the physical characteristics of the deformed rocks. The central mineral belt is along the Silvercup anticline and close to the Cup Creek fault zone. Although the role of these two structures in controlling mineralization is not clear, probably the regional localization of the mineralized zones in this belt depends on one or both of these structures. Local sites for mineralization were formed by faults, fractures, and crushed zones in the heterogeneous rock sequence near the large structures. The local structures developed later than the Silvercup anticline, as did the Cup Creek fault zone (*see* p. 43). It is possible that a regionally favourable zone for mineralization developed where the Cup Creek fault zone came close to the crest of the Silvercup anticline.

In the lime dyke mineral belt no well-defined regional structural control of mineralization is obvious. Rocks in which the deposits are found comprise a relatively incompetent unit which has folded isoclinally, sheared, and flowed as a single mass. Mineral deposits are scattered through this mass, mainly in limestone, and many are clearly related to local structures within it.

The source of the mineralization is not known. Early workers concluded that the mineral-bearing solutions originated from the final stages of consolidation of granitic rocks, principally the Kuskanax batholith which lies several miles southwest of the map-area (*see* Gunning, 1929, p. 31). Direct evidence of this relationship has not been found. The exposed granitic masses are many miles from the central and lime dyke mineral belts in the Ferguson area, and there is no indication that granitic rocks lie beneath the deposits at any reasonable depth. In exploration, structure and lithology are of much more significance than the relationship of the deposits to granitic rocks.

The three mineral belts contain a large number of mineral occurrences, which vary greatly in size and in the amount of work done on them. Those that have produced ore are listed in the table at the beginning of this chapter. Several others have not produced, but have attracted recurrent exploration and are generally well known. Other mineral occurrences have been opened by trenches, open-cuts, and short adits at some time during the past seventy years, but most of the covering claims have been allowed to lapse. A few others do not appear to have had any work done on them. Finally, there are several dozen trenches, open-cuts, shafts, and short adits which have either sloughed in or show no mineralization; these workings can rarely be identified with a claim name and are generally ignored on the areal map and in the following descriptions. The map shows all the mineral deposits seen during the present mapping or described by Emmens or Gunning; it omits some properties mentioned in Annual Reports.

As noted above, many of the mineral deposits have been described repeatedly; therefore, descriptions are given in the following pages generally only for those deposits on which additional information has been gained during the present work.

Those deposits on which there is no additional information are listed with references in a table at the end of the chapter. The deposits described fall into two general groups—those that have produced ore or attracted recurrent exploration, and those on which the covering claims have lapsed. Deposits in the first group are indicated by name on the areal map, and most of them have received some study in the present mapping. Deposits in the second group were examined only briefly, and are described because no previous description has been published or because recent exploration has elaborated the picture. These deposits and the deposits listed in the table are shown on the areal map by key number. In the following descriptions the deposits shown by name are treated alphabetically, the others in numerical order. A few mineral occurrences for which no name is known are shown on the map by a symbol.

Broadview

The Broadview mine is on an outlying ridge of Great Northern Mountain, south of Broadview Creek. The Broadview, Old Sonoma, and adjoining Crown-granted mineral claims are owned by Columbia Metals Corporation Limited, owner of the True Fissure (*see* p. 79). A jeep-road leads up the north side of Broadview Creek from the True Fissure road to a point opposite the lowest workings.

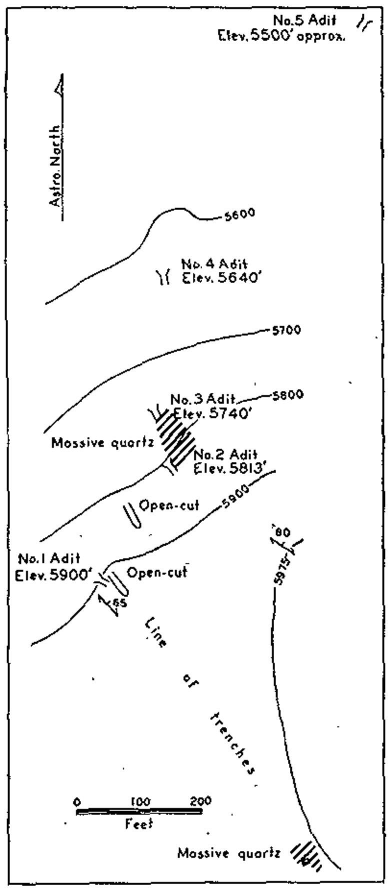

Figure 7. Sketch-map showing surface workings, Broadview mine.

The Broadview workings are shown on Figure 7. The Broadview shaft is sunk in a saddle in the ridge; to the east the ridge rises to a low hill, then drops away in the general slope to Ferguson Creek. The Broadview adits are driven into the moderate north slope of the ridge, No. 5 being just above Broadview Creek. The remains of an old camp are about 300 feet up along the south side of the creek from No. 5. On the Old Sonoma claim a shallow shaft has been sunk and an adit driven in the gentle south slope of the ridge a short distance southeast of the Broadview shaft.

Work on the property was done between 1895 and 1907 by the Lillooet, Fraser River, and Cariboo Gold Fields Co. Ltd. and by Ohio Mines Development Co. Ltd. Sorted ore shipped is listed in the table on page 54. In 1955 Columbia Metals Corporation diamond drilled three holes from surface.

The country rocks are poorly exposed grits and phyllites of the middle division of the Broadview formation (*see* p. 28). In the adits they are broken by numerous shears, which strike in varied directions, and are extensively injected by lenses and veins of quartz and minor ankerite. Some of the veins are sheared. Diamond-drill cores show abundant quartz over a width of 400 feet, with greatest concentration in the middle of that interval. Massive gangue, consisting of quartz and minor ankerite, is exposed at the shafts, between Nos. 2 and 3 portals, and in the outer part of No. 4 level, and may form a more or less continuous vein.

There does not, however, appear to be the continuity of gouge or shear zone and of vein that is found in the True Fissure mine. Instead, the exposures suggest a broad zone of recurrent fracturing in which quartz and minor sulphides have been injected, striking northward and dipping east.

The Broadview shaft was sunk 120 feet on a shoot of rather coarse-grained galena-sphalerite-chalcopyrite-pyrite ore which appears to follow the footwall of a tight fissure near the middle of the vein, striking north 20 degrees west and dipping 70 degrees east. The shoot rakes 45 degrees north and is 18 feet long and 5 feet wide on the 60-foot level. It has been largely mined out between this level and surface, and partly mined below. The galena-rich portion was hand-sorted for shipment, and several hundred tons of chalcopyrite-sphalerite ore accumulated on the dump.

The open-cut beside No. 1 adit exposes quartz stringers and about 1 foot of sphalerite, chalcopyrite, and galena in silicified green phyllite. The adit, 80 feet long, traverses sheared and brecciated dark phyllites to the ragged footwall of a quartz-carbonate vein which strikes about north 60 degrees west and dips steeply northeast. From the adit a 15-foot winze has been sunk, 60 feet east-southeast of the open-cut, on some sulphides in the footwall part of the vein. This mineralization, together with mineralization formerly exposed in some of the trenches toward the shaft, has been referred to as the " Copper " vein by Emmens and others.

No. 2 adit, 220 feet long, toward its face followed a galena-sphalerite oreshoot 33 feet long and 1½ to 2 feet wide. A sample across 20 inches of the best-looking part of the shoot assayed: Gold, 0.01 ounce per ton; silver, 7.4 ounces per ton; copper, 4.09 per cent; lead, 5.83 per cent; zinc, 4.5 per cent. The shoot follows the footwall of a tight fissure or indistinct shear striking north 9 degrees west and dipping 70 degrees east. It is interrupted or cut off at the south end by a shear zone striking north 63 degrees west, which may be a downward continuation of the " Copper " vein. In the face just beyond the shear zone, sparse galena and sphalerite follow a faint south-striking fissure. At the north end the shoot ends at an east-striking shear which dips 30 degrees north across most of the adit but appears to flatten near the floor. Some 25 feet north of the waist-height trace of this cross-shear a veinlet of sphalerite and siderite follows the footwall of a diffuse, east-dipping shear. No. 3 adit is 25 feet long; no mineralization was seen in it.

Additional pockets or shoots of ore are reported to occur on Nos. 4 and 5 levels, but were not seen by the writers, as No. 4 was flooded 170 feet from the portal and the portal of No. 5 was caved. The " Oxide " shoot, reported to be a few feet from No. 4 portal, was not found.

The Old Sonoma shaft was caved in 1957–58. It is reported that a 60-foot drift from it traversed a low-grade oreshoot 25 feet long and 2 feet wide. The Old Sonoma adit is reported to be driven entirely in black phyllite.

[References: Emmens, 1914, pp. 38–40; Gunning, 1929, pp. 75–76; *Minister of Mines, B.C.,* Ann. Rept., 1900, pp. 817–820.]

Copper Chief and Lucky Boy

The Copper Chief and Lucky Boy properties are on the ridge and steep slope east of Trout Creek between 1 and 2 miles south of the Lardeau Valley. The properties adjoin each other and include a group of seven Crown-granted claims owned by Esther Brandon, of Gerrard, and Alice M. Hillman, of Ottawa, and one located claim owned by Archie Oakey, of Beaton. Several of the Crown-granted claims, including the Lucky Boy, Horseshoe, Copper Chief, Willow Grouse, Ruffled Grouse, and Molybdenum, are briefly mentioned in Annual Reports of the Minister of Mines between 1898 and 1943. They were originally located on narrow, flat-

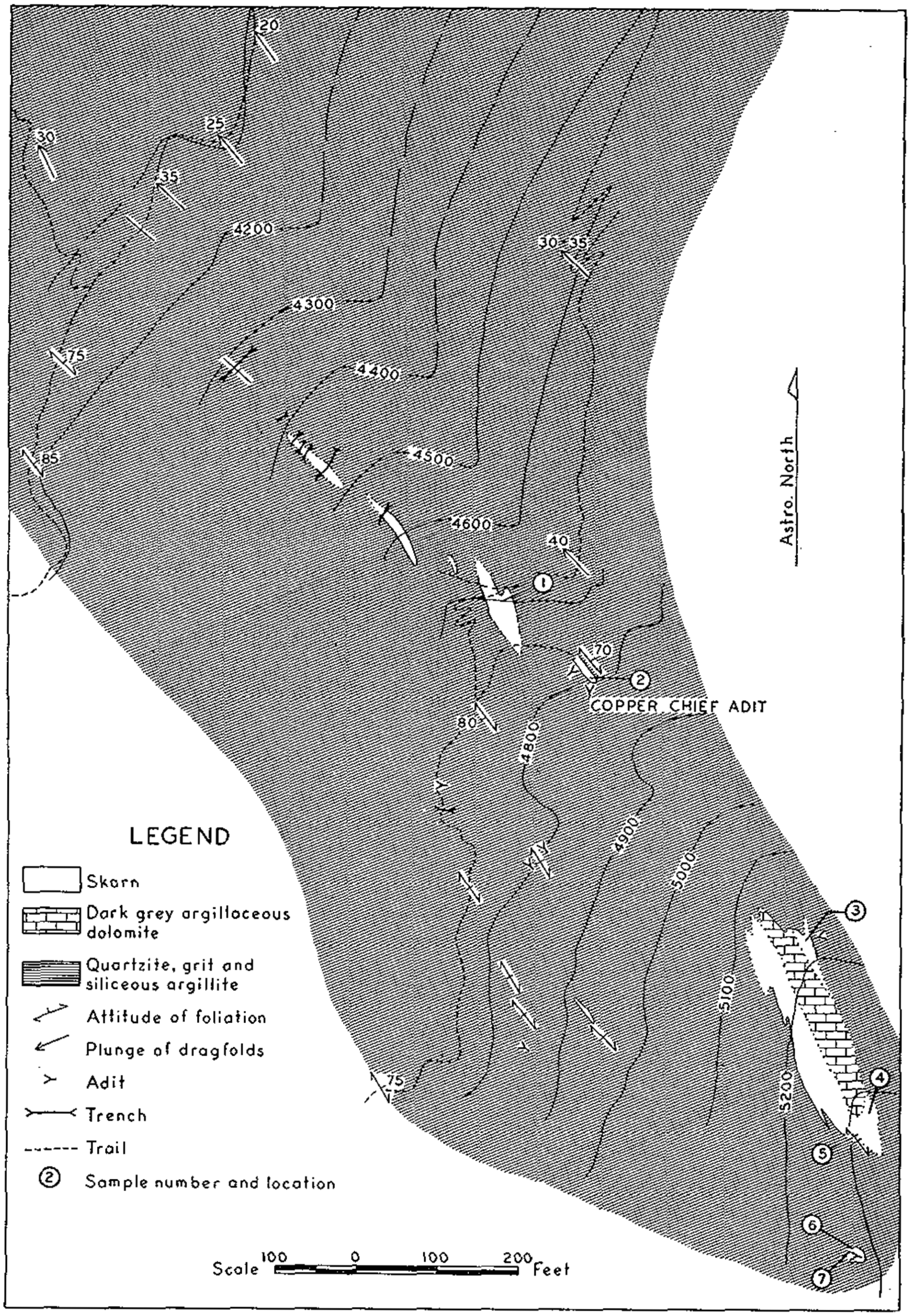

Figure 8. Geological map of the main showings on the Copper Chief property.

lying quartz veins, from which small shipments of high-grade silver-lead ore were made. Recorded production is given in the table on page 54.

During 1942 and 1943 the Lucky Boy and adjoining claims attracted some attention because of the occurrence of scheelite in the quartz vein on the Lucky Boy and in skarn bands on the Copper Chief. No scheelite was mined at the Lucky Boy, but in 1942, 23 tons sorted from the old dump and shipped to Ottawa for treatment produced 650 pounds of concentrates assaying 69 per cent tungstic oxide. No further work was done on the properties until they were optioned in 1951 by Major Explorations Limited. This company, in 1952, made a camp at the Lucky Boy mine, built about 3 miles of narrow road from Trout Lake to the camp, and explored showings of scheelite-bearing skarn on the Copper Chief.

Most of the outcrops on the property are on the steep slope east of Trout Creek; very few are found east of this slope on the relatively gentle slope facing the Lardeau Valley. Geological studies are hampered by the rusty surface of many of the quartzitic rocks, which is produced by weathering of disseminated pyrrhotite and pyrite. Figure 8, based on a compass and tape survey made in September, 1958, shows the main skarn zones and workings on the Copper Chief.

Although detailed geological studies have been made near the showings in addition to regional mapping, the stratigraphy and structure on the property are imperfectly known. Light-grey to white dolomite is exposed near the Lucky Boy mine and is encountered underground. It forms a band a few hundred feet wide which dips steeply to the northeast and is exposed only on the crest of the ridge southeast of Trout Creek. It probably continues to the southeast and pinches out to the northwest a few hundred feet below the mine. The dolomite is correlated with the dolomite member (*see* p. 34) of the southwestern part of the map-area, which outcrops extensively northwest of Trout Creek. Grey phyllite is exposed in the mine and in scattered outcrops immediately northeast of the dolomite.

To the southwest are quartzites, grits, and siliceous and silicated argillites containing calcareous lenses more or less altered to skarn. They form poorly defined bands several hundred feet wide on the steep Trout Creek slope, extending from the crest of the ridge east of Trout Creek to the level of the creek. The rocks have a poor cleavage, and bedding is rarely visible. Rounded grey quartz grains are seen in some specimens. Argillites containing skarn lie southwest of the quartzites and grits. They are grey to light grey, rusty weathering, and grade into dark-grey argillites with limy interbeds. Probably most of the siliceous argillite and some of the quartzites are formed by bleaching and silicification of grey argillite. The skarn consists of a fine-grained aggregate of quartz, carbonate, epidote or zoisite, diopside, and garnet. It is commonly heavily mineralized with pyrrhotite and locally contains chalcopyrite and scheelite. Skarn rich in diopside and epidote is dark green; that containing a high proportion of garnet and carbonate is brown or cream coloured.

The rocks are complexly folded. Cleavage is vertical or dips steeply to the northeast. Poorly defined lineations and dragfolds plunge 20 to 40 degrees to the northwest essentially parallel to the steep eastern slope of Trout Creek. No major fold or pattern of dragfolds is recognized near the showings. Dragfolds in calcareous skarn southwest of the main Copper Chief showings are N-shaped in section looking down the plunge. Near the main showings calcareous beds have been squeezed into lenses on the crests and troughs of folds which plunge parallel to the slope of the hill. These lenses contain the skarn and scheelite.

Exposures of skarn on the Copper Chief property lie on the southwest side of a steep gully, known as the Copper Chief draw, that extends from the old Copper Chief adit at an elevation of 4,830 feet to the level of Trout Creek more than 1,500 feet below. Light-grey to white dolomite, with lenses of skarn along contacts with greyish quartzitic rock, occurs in the draw at about 3,500 feet elevation 500 feet northwest of the area of Figure 8. All the other known occurrences of skarn are above about 4,000 feet in elevation southwest of the draw (*see* Fig. 8). They are mainly lenses of green skarn containing pyrrhotite and disseminated fine-grained scheelite. Because of its fine grain, the scheelite is almost impossible to see with the unaided eye, and use of an ultraviolet light is necessary. Lenses of skarn are discontinuous, and the distribution of scheelite within them is difficult to determine. What appears to be the largest and most continuously mineralized skarn lens is 400 to 600 feet southeast of the Copper Chief adit near the crest of the ridge east of Trout Creek. Most scheelite in this showing is in green skarn which grades into buff to brownish skarn containing little scheelite. The skarn is in a lens of dark-grey dolomite that appears to dip to the southwest, forming a slab parallel to the slope of the hill. Assays of three samples (Nos. 3, 4, and 5) taken in this locality are given in the following table, and the location of the samples is shown on Figure 8. A few hundred feet to the south is a lens of green siliceous skarn rich in pyrrhotite. It appears to lie on the crest of an anticline plunging to the northwest, less steeply than the slope of the hill. Assays of two samples (Nos. 6 and 7) taken in a short adit in the skarn are shown in the table.

At the portal of the Copper Chief adit at 4,840 feet elevation, another skarn body is 2 to 4 feet wide and encloses several lenses of unaltered grey limestone. Both skarn and limestone are mineralized with scheelite, and a sample across 4 feet assayed 1.06 per cent tungstic oxide. Several hundred feet of underground work was done at the Copper Chief adit, which was driven on a narrow quartz vein dipping 10 degrees northeast. Underground the vein is cut off by a strong fault striking north 30 degrees west and dipping 85 degrees northeast, and most of the underground work was in search of the faulted segment of the vein. The fault cuts off the skarn band whose extension on the east side of the fault is not visible. The Copper Chief quartz vein and other narrow, flat-lying veins nearby are rather sparsely mineralized with scheelite. A lens of dark-green skarn between 50 and 100 feet below the adit is well mineralized with pyrrhotite but contains only small amounts of scheelite; an assay of a sample of the highest-grade scheelite-bearing skarn is given in the table (No. 1).

Copper Chief Assays

Sample No.	Width (Ft.)	WO_3 (Per Cent)
1	8	0.20
2	4	1.06
3	6	0.50
4	4	0.11
5	8	0.04
6	4	1.62
7	4.5	1.02

Between 1,000 and 1,500 feet to the south of the Copper Chief adit, at an elevation of about 4,800 feet, south of the area of Figure 8, are three adits along a gently dipping quartz vein. The vein which ranges from 6 inches to 1 foot thick contains minor amounts of sphalerite and galena and in places is copper stained. Bluffs above the adits are composed of limestone and dolomite interbedded with rusty-grey argillite. The rocks are tightly folded in a series of N-shaped folds plunging to the northwest almost parallel to the slope of the hill. Lenses of skarn, mainly light brown in colour, are found in the calcareous rocks, particularly near limestone-argillite contacts. One or two narrow, gently dipping quartz veins which cut the skarn contain scattered grains of scheelite. Some of the darkest-coloured skarns also contain small amounts of scheelite.

The Lucky Boy workings are on the slope facing the Lardeau Valley about 2,000 feet north of the Copper Chief adit. They include an inclined shaft on the Lucky Boy claim near the northeast corner of the Horseshoe claim. This shaft and several short adits and open pits are on a quartz vein which strikes slightly north of east and dips 20 to 30 degrees to the south. The vein is exposed on both the Lucky Boy and Horseshoe claims. Workings on the Horseshoe, which are reported to include two shafts west of the Lucky Boy shaft, were inaccessible in 1958. The vein is in a reverse fault which transects light-grey dolomite of the dolomite member (*see* p. 34) and has offset the northeastern contact about 20 feet. The vein ranges from 6 inches to 6 feet thick and probably averages 1 to 2 feet. It contains white drusy quartz, galena, tetrahedrite, sphalerite, chalcopyrite, and pyrite. Native silver is reported to be present. Scheelite occurs in the quartz in small grains and masses up to several inches across.

The vein has been traced on surface for about 500 feet by open-cuts and adits, most of which are badly caved. The shaft is inclined at 17 degrees and runs south 20 degrees east a slope distance of 190 feet.

The shaft follows the vein and passes downward through grey phyllite into light-grey dolomite. From the shaft three drifts have been driven on the vein at distances of 65, 85, and 155 feet respectively from the collar of the shaft. They are described by Holland (1943) as follows:—

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

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

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

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

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

"The distribution of the scheelite mineralization falls within the limits of a shoot raking eastward from the surface exposure on the *Horseshoe* through the raise on the west end of No. 2 level to the area between No. 2 and No. 3 levels.

The exposure of scheelite on the east side at the intersection of the shaft and No. 3 level appears to be separated by a barren section suggesting that it is the apex of another shoot. No faulting was observed that would displace the vein were it part of the same shoot.

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

The scheelite content of the vein drops off rapidly as the vein passes out of the dolomite. Although locally scheelite occurs with sulphides, scheelite mineralization in general is independent of the sulphides. The sulphides appear to have an erratic distribution not obviously related to the wallrocks.

[References: *B.C. Dept. of Mines,* Bull. No. 10 (Revised, 1943), p. 131; *Geol. Surv., Canada,* Sum. Rept., 1903, Pt. A, pp. 71–72; Gunning, 1929, pp. 83–84; *Minister of Mines, B.C.,* Ann. Repts., 1952, pp. 183–187; 1953, pp. 144–145.]

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The Index claim was owned in 1960 by G. C. Short, of Calgary. It is reached by about 1½ miles of jeep-road and trail from Gainer Creek. It is one of a line of Crown-granted mineral claims following the Molly Mac limestone (*see* p. 21) along the southwest side of Index basin, from Redcliff Peak almost to Gainer Creek. In order from southeast to northwest these claims are the Red Cliff, Index, Royal R., Hidden Treasure, President, and White Quail. The Star Fraction recorded claim lies between the President and White Quail.

Early work on the Index was done before 1914. In 1956 Northern Inland Resources Ltd. had a small crew stripping on the Index and White Quail. A tractor-road was built from the head of the Index basin jeep-road, and some diamond drilling was done that autumn and the following summer.

Workings on the Index claim include a short adit and small inclined shaft driven into opposite sides of a band of the Molly Mac limestone, extensive stripping for 600 feet southeast of the adit, and a caved prospect shaft and two pits 1,200 feet southeast of the adit. On the Hidden Treasure claim a long adit is reported to have been driven in unmineralized rock.

On the Index claim the Molly Mac limestone is in two parallel bands, both dipping steeply southwest. The southwest band forms the core of a small anticline and passes beneath phyllite to the southeast. The northeast band is believed to be a repetition of the limestone on the ascending limb of a dragfold. It is from 50 to 90 feet wide on the Index claim. It is pinched out just southeast of the Index claim, but structural lenses of the limestone occur more or less on strike with it higher in the basin. The limestone is exposed in only two places between the Index and White Quail. Both bands are offset about 50 feet to the left on a fault striking north 75 degrees east and dipping 80 degrees south, 650 feet southeast of the adit. Mineralization has been found only in the northeast band.

The Index showings comprise galena disseminated in siderite which has partly replaced two segments of the northeast band of limestone. One segment extends 1,000 feet from the cross-fault northwest to the end of the outcrop. The second mineralized segment is poorly exposed around the prospect shaft, 400 to 550 feet southeast of the fault. Exposures of limestone immediately southeast of the fault and southeast of the prospect shaft are unaltered and unmineralized. About a foot of galena-bearing quartz has been injected along the fault where it traverses the northeast band. Recent exploration was confined to the larger mineralized segment of the limestone.

Within the larger segment siderite replacement is largely in three ragged parallel zones, 3 to 10 feet wide. One zone, 10 feet or more in width, follows the footwall of the limestone for 650 feet northwest from the fault; galena is irregularly disseminated in it and locally forms lenses or veinlets a few inches long and fractions of an inch wide. The other two zones, along the hangingwall and in the middle of the limestone band, are 450 and 150 feet long, respectively, and contain sparsely disseminated galena.

Molly Mac The Molly Mac group of four Crown-granted mineral claims is owned by Mollie Mac Mines Limited; company office, 850 West Hastings Street, Vancouver. The property straddles Gainer Creek about 2½ miles upstream from Tenmile. A short switchback road leads from the Gainer Creek road up to the vicinity of the lower showings. The Milner Fraction lies immediately southeast of Gainer Creek, and the Molly Mac Nos. 1 to 3 adjoin in succession to the northwest, covering galena-pyrite mineralization in the Molly Mac limestone (*see* p. 21).

The showings are on the steep northwestern slope of Gainer Creek and extend across the crest of the ridge between Gainer and Bunker Hill Creeks. The rocks and showings are well exposed in precipitous bluffs on the upper part of the Gainer Creek slope, but are poorly exposed on the lower slopes.

The Molly Mac claims were first located before 1895. A short adit was driven at 4,450 feet elevation in barren limestone prior to 1925, and a small amount of work was done on the showings in the bluffs from time to time before 1951. In that year and the following, the present company built the road from Tenmile and diamond drilled about 2,000 feet of short holes. In 1954 a second adit, 285 feet long, was driven at 4,560 feet elevation. The work since 1951 has been directed to testing the extent of mineralization below the base of good bluff exposures at 5,000 feet elevation. Mineralization discovered in this part of the hillside is referred to as the lower showings, that in the bluffs above as the upper showings. Figure 9 is a geological map of the upper showings. A caved shaft on the north brow of the ridge is about 200 feet to the northwest beyond the area of Figure 9, and an adit is reported to have been driven farther to the northwest and lower down the slope toward Bunker Hill Creek.

The Molly Mac limestone is fine grained, grey to dark grey, with many dark-grey argillaceous partings in the lower part. Locally, especially toward the upper contact, it is recrystallized to white marble. The limestone is underlain on the northeast by a few feet of green phyllite followed by a thick sequence of grey phyllites. It is overlain by olive-green phyllitic volcanic rocks containing lenses of green, greyish-green, or grey phyllite near the limestone.

The rocks dip steeply to the southwest and, on the whole, also face southwest. They are tightly dragfolded. Relatively small dragfolds which are readily seen in argillaceous parts of the limestone plunge 5 to 10 degrees to the northwest and are N-shaped in section looking down the plunge. Large dragfolds of the same general shape are outlined by the upper contact of the Molly Mac limestone and are well displayed in the bluffs. The lowest fold, which appears near the bottom of the bluffs, is highly attenuated and truncated by a steeply dipping fault in such a way that an anticlinal tail of limestone in green phyllite is the only part of the fold exposed (*see* Fig. 9). The anticline is irregularly warped and sheared.

A more complex larger fold of the same type involves the main band of limestone and causes it to be offset to the right near the top of the bluffs. As outlined by the upper contact of the limestone, the dragfold consists of two or three anticlines with rounded crests separated by synclines with sharp troughs. On the lower contact of the limestone, only one relatively small N-shaped dragfold con-

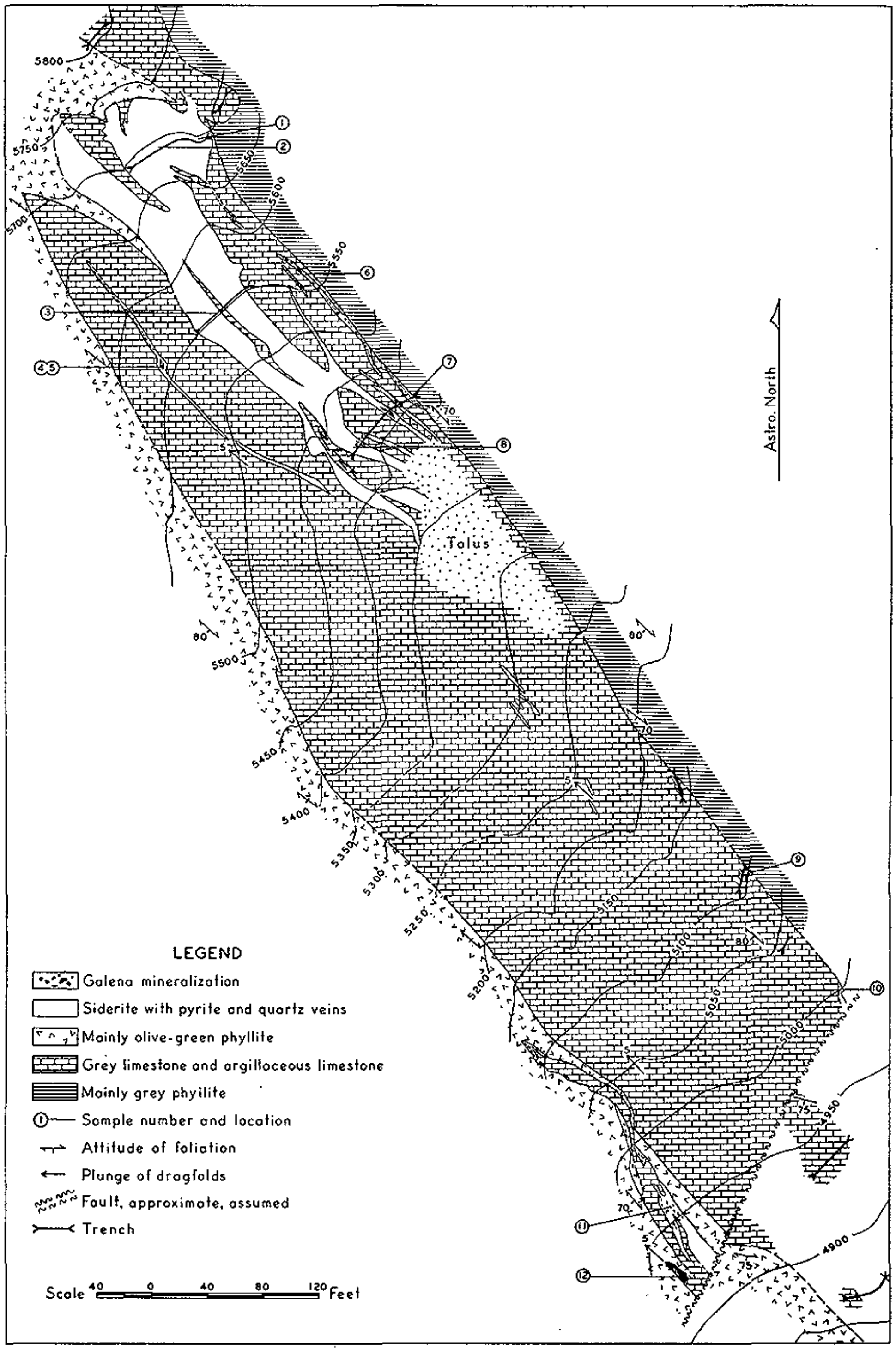

Figure 9. Map of the upper showings, Molly Mac property.

sisting of a sharp-crested anticline and a syncline with a curved trough is exposed. Apparently in folding there has been considerable flowage of limestone toward the crests of the round-crested anticlines and shearing along the base of the limestone.

Lenses and irregular masses of siderite replace the limestone in the two large dragfolds and locally elsewhere. The principal bodies on the Gainer Creek slope are shown on Figure 9. Additional bodies occur on the crest and upper north slope of the ridge, and much siderite rubble was found on the lower north slopes. Although the form of the siderite bodies is incompletely known, they appear to be pipe-like in form, to plunge with the dragfolds, and to be irregular in cross-section. The siderite is buff-coloured to light brownish-grey on fresh surfaces, but weathers dark brown and forms impressive rusty zones in the cliffs. It is fine to medium grained and massive, though criss-crossed with small tight fractures and veinlets of white quartz. Pyrite is disseminated in it irregularly, and lenses of fine-grained galena are present locally.

Galena is essentially the only ore mineral, though minor amounts of sphalerite have been found. The distribution of the largest masses of galena is shown on Figure 9, together with locations of samples, the assays of which are given in the following table. Most of the galena occurs in siderite, as massive fine-grained lenses or less commonly as poorly defined disseminations. Locally galena is found in limestone as small veinlets or replacements along beds, folds, or fractures. The largest pods of galena probably plunge gently to the northwest parallel to the axes of the dragfolds. Some are obviously related to flexures in the siderite, of the same general form but more open than the dragfolds. Other masses of galena are along discontinuous shear zones within masses of siderite or near their margins. The lenses of galena are a few feet wide and extend a few feet to a few tens of feet up the slope. Mostly they are well defined, and siderite away from the galena-bearing lenses is barren.

Twelve of the following samples were taken on surface, in bluff and trench exposures. No. 13 was taken in the upper adit, across a lens of siderite containing pockets of massive or thickly disseminated galena along and near small fractures.

Sample No.	Width	Gold	Silver	Lead
	Ft.	Oz. per Ton	Oz. per Ton	Per Cent
1	8	*Nil*	*Nil*	(1)
2	10	Trace	*Nil*	(1)
3	7	*Nil*	0.5	0.65[2]
4	4½	*Nil*	*Nil*	(1)
5	2	*Nil*	3.7	22.09
6	4	Trace	0.1	0.93[2]
7	2½	*Nil*	1.8	10.89[2]
8	9	*Nil*	0.3	1.81
9	4	*Nil*	*Nil*	0.27
10	3½	*Nil*	*Nil*	2.06
11	9	*Nil*	0.7	3.96
12	5½	Trace	0.4	7.85
13	13	Trace	1.0	5.5

[1] Semi-quantitative spectographic analyses show a few one-hundredths of 1 per cent lead.
[2] Semi-quantitative spectographic analyses show a few one-hundredths of 1 per cent zinc.

[References: *Minister of Mines, B.C.,* Ann. Repts., 1952, p. 190; 1954, p. 143.]

Nettie L, etc. The Nettie L, Nettie L Fraction, Ajax, May Bee, Good Luck, Lula Belle Fraction, Copper Reef, and No. 1 Fraction Crown-granted claims are owned, and the G.Y.P. Fraction and G.Y.P. No. 2 claims are held by record, by Alexander Gillespie, of Calgary.

The Nettie L mine area includes the Nettie L and Ajax mines and the G.Y.P. and May Bee upper workings. It is a strip extending northwest along the crest of an outlying spur of Nettie L Mountain. At the southeast end of the mine area the ridge crest turns east and rises toward the mountain, across the head of a large basin. The ridge slopes west and northwest into Ferguson Creek and northeast into the basin. From Fivemile a road climbs along the Ferguson Creek slope to the camp at 4,500 feet elevation. A narrow, locally steep road continues up around the nose of the ridge to the lower Nettie L adit at 4,850 feet elevation and recrosses the ridge to the upper Nettie L adit at 5,085 feet elevation. From it two roads lead south along the Ferguson Creek slope toward the Ajax workings. Bedrock is moderately well exposed along the crest of the ridge but is largely covered on the slopes. The northeast slope has been largely burned over, but most of the southwest slope is covered with scrub timber.

The Pool group, including the Nettie L, May Bee, and Ajax claims, was located in 1892 by W. B. Pool, of Nelson, who later formed Great Western Mines Limited to continue development. British investors acquired control of this company in 1901 and bought the Silver Cup mine in 1902, thereafter using the same management for both. In 1904 the properties were bought by Ferguson Mines Limited. Most of the development and mining on the Nettie L was done between 1898 and 1905, the higher-grade ore being largely mined out by 1903. An aerial tram-line was built to Fivemile and an unsuccessful attempt was made to mill lower-grade ore. After 1905 the Nettie L mine was worked occasionally by lessees. Development on the G.Y.P. and May Bee was done between 1896 and 1901, and on the Ajax in 1901 and 1912–14. In 1950 Trout Lake Mining Company Limited was organized to develop the G.Y.P., Nettie L, and Ajax, control subsequently passing to its successor, Trout Lake Mines Limited. The camp was built and the road repaired. The Nettie L mine was rehabilitated, and a new short adit was driven into the nose of the ridge at 5,106 feet elevation. On the G.Y.P. the existing adit was enlarged, and a new one was driven lower on the nose of the ridge. Diamond drilling totalled 2,000 feet. No work has been done since November, 1952. The total production of the Nettie L and Ajax mines is listed on page 54, and a yearly breakdown is given in the Annual Report for 1952.

Part of the mine area was geologically mapped by S. S. Holland in 1952. Underground and additional plane-table mapping was done by Eastwood in 1957 and 1958.

The country rocks of the mine area belong to the Triune, Ajax, Sharon Creek, and lower part of the Broadview formations. Basically, the Triune and Sharon Creek rocks are siliceous argillites, the Ajax is massive grey quartzite which weathers white, and the Broadview rocks are interbedded grey grits and black phyllites. The rocks have been more or less sheared along the veins, and the various argillites and phyllites are indistinguishable underground. Even on surface and away from the veins, Triune and Sharon Creek argillites are difficult to distinguish. The Ajax quartzite is the key to the structure. It commonly contains stockworks of white quartz, and portions of it 20 to 30 feet wide are completely replaced by or converted to white quartz, but normally enough of the original quartzite remains to identify the formation. At the Ajax mine, however, recognition of the quartzite in some exposures is uncertain, and the lithological and structural pattern there is partly tentative.

The mine area is bounded on the northeast by the Cup Creek fault zone (*see* Fig. 10a), and on the southeast by the Brow fault. The southwest boundary of the mine area is somewhat arbitrarily placed at the northeast contact of the Broadview formation, which in part is probably a fault contact. The resulting area is 3,200 feet long and 700 to 800 feet wide.

The Cup Creek fault zone is in part traversed by the outer part of Nettie L No. 4 adit, which exposes crumbly black phyllites containing scattered lenses of grey grit. Additional exposures of these rocks occur along the road to the upper Nettie L workings and to the north of the workings.

The contact of lower Broadview rocks with the Sharon Creek formation is exposed only in the road cut near the west corner of the area where it is evidently a fault. In the road cut it is marked by a wide breccia zone, containing some quartz, and the Sharon Creek formation is abnormally thin. Southeastward to the Ajax workings this contact cannot be closely located, but south of No. 5 adit it is defined by outcrops too small to show on Figure 10. The rock sequences here on either side of the contact, and the width of the Sharon Creek formation northeast of it, suggest that the section is essentially complete and that the contact is not here faulted.

The mine area covers a segment of the core of the Silvercup anticline (Fig. 10a), disrupted by three relatively large north-northwest-striking faults and by numerous subsidiary faults and shears. The anticline dips isoclinally northeast, and in the mine area plunges northwest at an angle of about 25 degrees. Southeast of the Brow fault the anticline is outlined by the Ajax quartzite, which plunges into a south-facing hillside. On part of the southwest limb of the anticline the quartzite is squeezed or sheared out. Sharon Creek siliceous argillite is similarly squeezed or sheared out on most of the northeast limb. The anticline is upthrown and offset to the northeast by the Brow fault. The position of the anticlinal crest at the Ajax and Nettie L mines is a matter of some doubt, but at the northwest end of the area the crest is again outlined by the Ajax quartzite. The hillslope is there steeper than the plunge of the anticline, and the quartzite bands on the limbs diverge downslope to the northwest. Triune siliceous argillite is exposed in the core. The quartzite is overlain on the southwest by a narrow band of Sharon Creek siliceous argillite, which is apparently in fault contact with lower Broadview greenish grits to the southwest. To the east the anticline is offset on the north-northwest-striking Gyp fault, and the northeast limb is much disturbed. Near the road, folding and faulting have produced alternating narrow bands of Ajax quartzite and Sharon Creek black phyllite. To the southeast the Sharon Creek formation is not present on the northeast limb, and lower Broadview grey grit is directly in contact with Ajax quartzite.

The principal faults in the mine area are here termed the Gyp, Netax, and East faults. They dip east, for the most part steeply. The Gyp and East faults strike north 20 degrees west. The Netax fault for most of its length strikes north 30 degrees west, but at the Ajax mine it appears to swing sharply to due north. It dips between 60 and 86 degrees east in the Nettie L mine and dips 65 degrees and less in the Ajax mine. For most of its length it is mineralized with quartz and can be traced on surface by exposures of vein quartz in trenches and a few natural outcrops. The Gyp fault is exposed in a crosscut off the G.Y.P. adit as a breccia zone 50 feet wide. Its extension southward is inferred from offset of the Ajax quartzite. The East fault is inferred from offset of contacts and from drag in contacts and bedding, and has been rather doubtfully identified near the face of Ajax No. 4 adit.

The Gyp fault appears to offset the Ajax quartzite and Silvercup anticline to the left, with a nearly horizontal net slip of about 800 feet. Between the Gyp and Netax faults, only one band of Ajax quartzite has been found, and Triune rocks have not been identified. It is concluded that the quartzite here forms the core of the anticline. It is flanked on the northeast by lower Broadview grey grit and on the southwest by Sharon Creek siliceous slate and phyllite.

About 100 feet to the west of the Gyp fault is a narrower shear zone which is followed by the inner part of the G.Y.P. adit. It strikes more westerly than the Gyp fault and appears to join it to the south. It dips about 80 degrees east.

The Netax fault appears to displace the Silvercup anticline at least 1,200 feet to the right, measured along the fault, and to throw it up more than 100 feet on the east. This interpretation is based on identification as Triune of the intervening rock between two bands of Ajax quartzite, east of the fault at and south of the Ajax mine. A little siliceous grey phyllite and argillite exposed on the outer flanks of the quartzite is inferred to belong to the Sharon Creek formation. Lower Broadview grey grit and black phyllite are exposed on the northeast limb.

The East fault apparently offsets the northeast contact of the Ajax quartzite to the right, with a horizontal separation parallel to the fault of 75 feet, although contacts and bedding are dragged to the left. Bearing in mind that the beds dip to the north here, it is concluded that they have been displaced to the left but have also been downthrown on the east. The narrow band of Sharon Creek siliceous argillite west of the fault is not present east of it, and it is concluded that this formation has been squeezed or sheared out along the upper part of the fold limb.

The known mineralization is in a shear zone west of the Gyp fault zone, in the Netax fault zone, in a shear near the Netax fault that is known as the Cross vein, and in several other shears or fractures associated with the Netax fault. The Cross vein has been by far the largest producer.

Nettie L Mine.—The Nettie L mine includes two adit levels, three internal levels, and a number of stopes. The lowest, or No. 4, level is shown on Figure 10. It crosscuts from the basin slope at 4,850 feet elevation and follows the Netax fault southeastward. A higher, or No. 1, level crosscuts from the Ferguson Creek slope of the ridge at 5,085 feet elevation and follows the Netax fault both northwest and southeast. Raises connect these adit levels through No. 3 level and two short levels, here termed No. 2 and No. 1½. A third short adit has been driven into the nose of the ridge at 5,106 feet elevation, 200 feet north of No. 1; it does not reach the Netax fault and is not connected with the other levels.

The Cross vein has been stoped from No. 3 level to surface. At surface the stope strikes north 32 degrees east, dips 75 degrees southeast, and exposes Sharon Creek phyllites dragged to the right. Downward, the vein swings to a strike of north 5 degrees west and a dip of 64 degrees east on No. 3 level. Remnants of the vein exposed on No. 3 level and on three sublevels up to 40 feet above it consist of quartz, carbonates, and minor sulphides along a shear. The ore has been mined out, and its occurrence has largely to be inferred from stope outlines. For the most part, it appears to have been along the hangingwall of the shear, but in No. 3 level drift a streak of sphalerite and galena follows the shear footwall for 40 feet. The footwall rock is partly black phyllite, partly vein quartz and carbonate. On No. 3 level the Cross vein shear splits at each end of the oreshoot, the principal branches curving left into the phyllite foliation. On the sublevels above No. 3 level a similar branching pattern is evident at the north end. On No. 4 level, at and near the projection of the Cross vein, the rock is broken by a network of small shears, no one of which can be identified as the main Cross vein shear. Small lenses of sphalerite and galena occur along some of these shears. Sphalerite and galena occur on No. 4 level also in the footwall of this broken area, and on No. 3 in the footwall of the Cross vein, without obvious relationship to any shear, in small veins and pockets of quartz and as veinlets directly in phyllite. The main Cross vein structure in its general relations with the Netax fault suggests a tension fracture. But it is warped and passes locally into the cleavage of the phyllite, so the origin may be complex.

The Netax fault zone in the Nettie L mine contains quartz and is known as the Main vein. Parts of it are rather sparingly mineralized with sphalerite and galena, and some stoping has been done. The dip of the vein is uniformly 85 degrees northeast on No. 1 level, but decreases downward and northward. It is 75 degrees on most of No. 4 level, but drops to 60 degrees at the adit crosscut. North of the Cross vein on Nos. 3 and 4 levels the vein splits into three branches, which are as much as 20 feet apart. The east branch continues up through No. 1 level and is the main branch; on No. 3 level and above only it is mineralized. On No. 4 level, however, the middle branch appears to have contained most of the mineralization. The middle and west branches seem to die out upward; they have not been found on No. 1 level.

Through most of the mine the Main vein consists of a hangingwall zone of gouge and breccia, from 3 to 6 feet wide, and a footwall zone of quartz and carbonate, separated by a slick, planar fault surface. In the upper part of the north end of the mine a second slick surface, nearly parallel to the first, defines the hangingwall of the breccia zone; elsewhere the breccia zone grades to sheared but unbroken hangingwall rock. Quartz and carbonates occur in the hangingwall rock and in the breccia zone, rather sparingly on upper levels, and in greater amount on Nos. 3 and 4 levels. The breccia zone contains most of the ore. The footwall zone varies in width and character. On Nos. 1 and 1½ levels it is 7 feet of massive quartz and carbonate. On No. 2 level and the north parts of Nos. 3 and 4 levels the whole interval between the slick surface and the middle branch of the vein is thickly injected by anastomosing quartz veins. On the south parts of Nos. 3 and 4 levels the quartz-carbonate footwall zone tends to be thin and discontinuous.

The occurrence of the ore and its probable grade must be largely inferred from indirect evidence, because visible mineralization has been almost completely stripped by lessees. A report written when mining was in progress (Ann. Rept., 1903) states that values were "spotty." This observation agrees with the scattering and small size of the stopes. In the north part of the mine a small stope has been opened on each of the five levels, but only two such stopes are connected. Three additional small stopes have been opened south of the Cross vein. At the north end, backs of stopes and drifts expose scattered pockets and lenses of galena, sphalerite, and pyrite, with minor chalcopyrite in quartz-carbonate veins in the breccia zone, rarely directly in the crushed rock. On the upper levels these veins tend to be small and broken or crushed; on No. 3 level they are larger and coherent. The largest of the stopes south of the Cross vein is on No. 3 level, is 80 feet long, and exposes lenses of galena and sphalerite in the immediate footwall of the slick surface. The greatest length thus mineralized is 120 feet, on No. 1 level. Veins of massive pyrite, as much as 10 inches thick, occur both in the breccia zone and in the footwall quartz and carbonate, but contain no ore minerals. The following assays illustrate the grade of two of the better-mineralized exposures and of a lens of massive pyrite:—

Width Samples	Gold	Silver	Copper	Lead	Zinc
	Oz. per Ton	Oz. per Ton	Per Cent	Per Cent	Per Cent
3.0 ft.	0.04	20.5	0.38	1.39	3.5
4.0 ft.	0.03	5.1	(1)	1.46	2.5
2.7 ft.	0.01	1.4	......	......	.....

[1] Present.

Mineralization along the middle branch of the vein on No. 4 level has been stoped over a length of 110 feet. This stope is inaccessible, and where the shear is exposed in the drift back, no ore minerals were seen along it. The country rock is extensively injected by quartz and carbonates. An 18-foot winze, now flooded, has been sunk on this vein, reportedly exposing 30 inches of ore. The top of the winze is approximately at the junction of the middle and west branches of the vein, and all three branches should meet close to the foot of the winze.

On No. 4 level, at the junction of the drift and adit crosscut, galena and sphalerite are sparingly disseminated in a phyllitic band in Ajax quartzite in the hangingwall of the west branch of the vein.

The highest Nettie L adit at 5,106 feet elevation has been driven 85 feet in Ajax quartzite west of the Netax fault. The outer part of the adit follows the northeast contact of a 20-foot band of grey phyllite in the quartzite, but the inner part swings left into the quartzite. Along this contact the quartzite has been liberally and irregularly injected by vein quartz, which contains a few scattered gobs of pyrite and sphalerite.

Ajax Mine.—Four Ajax adits—Nos. 2, 3, 4, and 5—have been driven into the ridge from the Ferguson Creek slope, between elevations of 5,263 and 5,095 feet. Nos. 2 and 3 levels, 38 feet apart vertically, are connected through two short sublevels at 5,260 and 5,275 feet elevation, and No. 3 level connects with an inclined shaft. A third sublevel has been driven above No. 2 at 5,290 feet elevation. Two open-cuts have been made at 5,350 feet elevation.

In the Ajax mine, ore mineralization has been found not along the main break of the Netax fault, but along smaller shears or fractures from 60 to 200 feet in its hangingwall. In No. 3 adit the fault is represented by an open break, smeared with pyrite but bearing no ore minerals, along the hangingwall of an 8-foot zone of softened phyllite, which is flanked on either side by 15 feet of barren quartz. Farther south in the mine the fault is represented by several shears and gouge bands, along which quartz has been extensively injected.

The only sphalerite and galena of consequence seen in the Ajax mine are exposed on a sublevel 50 feet above No. 3, where, with less chalcopyrite, they form a small orebody on which minor stoping has been done. The dimensions of this orebody are not fully known, but the total length along the sublevel is about 140 feet. The orebody appears to plunge north and may continue down through an inaccessible sublevel, but it is not present on No. 3 level. On surface, 75 feet vertically above the middle sublevel, a 60-foot-long open-cut, now caved, with a fairly large dump may be on a continuation of the oreshoot. The width varies greatly, and no average figure can be given. The gangue varies, in some parts being largely phyllite, in others largely quartz and carbonates. At the south end of the sublevel a sample across 3.5 feet of vein assayed: Gold, 0.08 ounce per ton; silver, 2.7 ounces per ton; copper, 1.33 per cent; lead, 2.99 per cent; zinc, 8.3 per cent.

A great deal of crosscutting and drifting has been done on lower levels without finding additional ore. On No. 4 level three small mineral occurrences were found between 140 and 200 feet east of the Netax fault. One consists of galena and sphalerite sparsely disseminated through about a cubic yard in the hangingwall part of a 25-foot quartz-carbonate vein. The second occurrence comprises five vertical fracture veinlets of sphalerite, galena, and pyrite, from one-quarter to one-half inch thick, in Ajax quartzite, forming a zone 3 to 4 feet wide and 12 feet long. The third occurrence on No. 4 level consists of small pockets of pyrite, sphalerite, and galena in quartz in the hangingwall of a shear dipping gently southeast. On No. 5 level minor galena and sphalerite occur in small quartz lenses 40 and 60 feet west of the drift.

G.Y.P. — Two adits have been driven and a shaft has been sunk along the boundary between the G.Y.P. Fraction (formerly I.X.L. Fraction) and May Bee claims. The workings are not connected. The main adit is at road level just southwest of the nose of the ridge and extends 470 feet southeast. The shaft collar is 200 feet southeast of the portal and 150 feet higher; the shaft is reported to be 100 feet deep. The second adit was started on the nose of the ridge, 150 feet lower than the main adit and 400 feet north, and was driven 280 feet southeast; it is not shown on Figure 10.

The main adit follows the main northeast contact of Ajax quartzite southeast for 130 feet, then continues south-southeast along a shear zone just west of the Gyp fault. A 3-foot quartz vein follows the footwall of the shear zone for most of its length. It is reported* that a narrow streak of galena and sphalerite extended along the footwall of the vein for about 100 feet, in places swelling to form small lenses of ore. Little mineralization can now be seen.

The shaft is now inaccessible, and no mineralization can be seen there.

Two open-cuts 150 feet north of the main adit expose vein quartz mineralized with galena. They are approximately on the strike of the shear zone in the adit, but this zone was not recognized; instead, the rocks are broken by a number of small faults and shears with divergent attitudes.

The lower adit exposes, 180 feet from the face, a small lens of galena-bearing quartz along one of many contacts between quartzite and phyllite.

Copper Reef and No. 1 Fraction.—One open-cut on each of these claims has been made into the Brow fault zone, here 2 to 3 feet wide. The hangingwall rock at both cuts is lower Broadview grit. At the Copper Reef cut the footwall rock is Triune argillite, which has been largely replaced by quartz. In part the quartz has been brecciated and recemented with siderite. In the cut the quartz contains scattered pyrite and a trace of chalcopyrite. At the No. 1 Fraction cut a 7-foot quartz vein lies immediately in the footwall of the fault and has Ajax quartzite in its footwall. It contains a little pyrite. Samples from both cuts assayed: Gold, *nil;* silver, *nil.*

[References: Brock, 1903, p. 64; Emmens, 1914, pp. 41–42; Gunning, 1929, pp. 68–70; *Minister of Mines, B.C.,* Ann. Repts., since 1894, especially 1900, 1903, 1924, 1952.]

Silver Chief

This property is on the north side of the Index basin southeast of Gainer Creek. The original name is retained, although the ground is at present covered by the May No. 1 to No. 6 claims, owned by L. B. York and Loyd York, of Vancouver. The showings are reached by about 2 miles of jeep-road and trail from Gainer Creek.

The Silver Chief property is first mentioned in 1897, and by the following year an adit had been driven 80 feet, but very little further work was done for over half a century. In 1953 Samson Mining Corporation built a jeep-road into the Index basin and did some test-pitting on the Silver Chief. The claims lapsed during a dispute over ownership in 1955, and in 1957 R. Zielinski located the present claims. In 1958 ownership passed briefly to Foundation Mines Ltd., then to the present owners. Since 1957 some road and trail work and some stripping and prospecting had been done.

The showings are at timberline on the northeast slope of the Index basin, at elevations ranging from 6,700 to 7,400 feet. Several are in or close to Silver Chief draw, a shallow but marked gully approximately bisecting this slope; others are to the northwest. Bedrock is well exposed, and overburden is generally less than 2 feet deep.

Workings include three adits, a small cut in bedrock, and a dozen or more small pits and trenches. The upper adit, now caved, was driven into the centre of the draw at 7,000 feet elevation, and the cut is about 20 feet to the east of it. A second adit is in the draw at 6,730 feet elevation. A third adit is reported to have been driven about 75 feet lower down the draw. Most of the pits and trenches are northwest of the upper adit.

The showings are in Lade Peak limestone, and all but one are in the northeast Silver Chief anticlinal band. The exception is galena sparsely disseminated in rusty

* *Minister of Mines, B.C.,* Ann. Rept., 1924, p. 209.

phyllitic limestone of the middle band near its faulted northeast contact. For convenience in reference and description, the showings have been numbered in sequence downhill from the crest of Silver Chief ridge:—

1. A line of pits and trenches angling across the crest of the ridge between 7,300 and 7,325 feet elevation exposes a zone, 1 to 3 feet wide, of siderite replacing limestone near its northeast contact and containing sparsely disseminated galena. The total indicated length of the zone is 300 feet, but not enough pits have been opened on it to prove continuity. It is offset on at least one small cross-fault and may be shifted to the right as a result of dragfolding of replaced limestone beds. A small trench exposes a 3-inch bedded vein or lens of massive galena in unaltered limestone at about 7,290 feet elevation, halfway between zones 1 and 2.

2. Pits and trenches along a 100-foot line at 7,250 feet elevation expose galena sparsely disseminated in limestone over a width of about 2 feet. The zone appears to be bedded.

3. Close pitting and trenching over a length of 400 feet at 7,200 feet elevation has exposed as many as three nearly parallel bands of massive galena, 3 to 4 inches thick, in unaltered limestone. For most of this length, only one band is exposed, but 50 feet from the southeast end of trenching a second band appears 4 feet southwest of the first and toward the southeast diverges to a separation of 10 feet. The third band is exposed for a few feet at the southeast end, 6 feet southwest of the second. All three bands strike nearly parallel to bedding and dip almost vertically.

4. Pits and trenches over a length of 30 feet at 7,150 feet elevation expose about 6 inches of nearly massive galena in limestone. The galena appears to pinch in the end pits and is probably a lens. A sample across 15 inches of galena and barren limestone assayed: Gold, *nil;* silver, 4.9 oz. per ton; lead, 26.29 per cent; zinc, not detected.

5. The small cut east of the upper adit exposes highly contorted limestone seemingly interbedded with green phyllite at the northeast contact of the northeast band of Lade Peak limestone. Galena, quartz, and some siderite have replaced the limestone beds rather raggedly, more intensely in the cores of the folds. The mineralization does not extend to the top of the cut and cannot be traced to the southeast. The most concentrated galena was noted in a band 10 inches thick passing through the trough of a syncline. A little chalcopyrite and sphalerite were noted on the northeast limb of a small anticline appearing on the northeast. A sample across 40 inches of the largest section of galena mineralization assayed: Gold, *nil;* silver, 2.8 ounces per ton; lead, 16.16 per cent; zinc, 0.02 per cent. The mineralization is evidently controlled by dragfolds at the northeast contact of the limestone, plunging 15 degrees southeast. The adit just below is at least 100 feet long but was accessible only for 25 feet. It follows a shear 1 to 2½ feet wide, believed to be a continuation of a fault in Silver Chief draw, which strikes north 50 degrees east and dips 70 degrees northwest. Much coarse-grained calcite appears on the footwall of the fault, but no galena was seen; any continuation of the ore seen in the cut probably lies beyond the accessible part of the adit.

6. The second adit, at an elevation of 6,730 feet, is in the centre of the draw and has been driven northeast about 10 feet. It is in limestone near a contact with green phyllite on the southwest limb of the northeasternmost Silver Chief anticline. A lens of siderite on the northwest wall of the adit contains clusters of galena. The Silver Chief fault, which is 10 to 15 feet northwest of the draw, strikes north 75 to 80 degrees east, dips 70 degrees to the north, and offsets the limestone-phyllite contact 20 feet to the left. Northwest of the fault a lens of siderite well mineralized with pyrite and galena lies along the contact. As exposed in trenches, it is as much as 2 feet thick and 20 to 30 feet long.

7. On a small bench at 6,700 feet elevation south of Silver Chief draw, galena is sparsely disseminated through about 10 feet of rusty phyllitic limestone at the faulted northeast contact of the middle band of Lade Peak limestone. This mineralization was not seen to continue to the southeast.

Silver Cup

The Silver Cup, Sunshine, Free Coinage, and adjoining Crown-granted mineral claims are owned by H. E. Jacques and J. E. La Fleur, of Vancouver. The Towser Crown-granted mineral claim is owned by W. D. Morse, of Chelan, Washington, and the estate of the late T. Porter Cutler. The Silver Cup orebodies were discovered about 1890 and mined almost continuously from 1895 to 1914, producing nearly two-thirds of the metal shipped from the Ferguson area to date. Near them, and in similar geological settings, are smaller mineral occurrences on the Sunshine, Towser, and Free Coinage claims. The narrow strip of country that includes these four properties is here termed the Silver Cup mine area.

This area runs obliquely up the slope east of Cup Creek, from near the creek to the ridge separating the basins of Cup and Triune Creeks. The slope is generally moderate, and outcrops are scattered. Small timber grows thickly on the lower part, but thins out on the upper part as timberline is approached.

The mine area may be reached from Eightmile on the Tenmile road via a bridge over Lardeau Creek and a road up to the camp on the Towser claim. In 1956 the lower part of this road was deeply gullied and impassable for wheeled vehicles. The camp is at 5,200 feet elevation on the east side of Cup Creek. The Towser workings are just east of it, and the Sunshine, Silver Cup, and Free Coinage are successively up the slope to the southeast. A jeep-road switchbacks up to No. 7 adit, the main haulage level of the Silver Cup, at 6,312 feet elevation. A trail continues on up to the other workings.

From northwest to southeast the mine workings include: a shallow shaft and short adit on the Towser; four adit levels, nine internal levels, and connecting shafts and raises on the Sunshine and Silver Cup; and an adit on the Free Coinage. The adit levels are shown in whole or in part on Figure 11. No. 7 traverses both the Sunshine and Silver Cup ore structures and is connected with No. 4 level by a raise. From No. 7 an internal shaft descends five more levels to a point 1,200 feet below the outcrop of the Silver Cup orebody. No. 8 is not connected with any other workings.

The Silver Cup was developed and mined steadily from 1893 to 1913, after which it was leased intermittently until 1921. The ore above No. 7 level has been largely mined out. High-grade ore was sorted and carried by aerial tram to Ninemile on the Tenmile road, whence it was shipped by wagon, lake steamer, and railway to the smelter. In 1904–05 an unsuccessful attempt was made to mill some of the lower-grade ore at Fivemile. In 1937 a small flotation mill was built at the Towser camp, and some of the lower-grade ore on the dumps was milled in 1937 and 1941. In 1952 The Granby Consolidated Mining Smelting and Power Company Limited (since March, 1959, The Granby Mining Company Limited), under terms of an agreement with Yellowknife Bear Mines Limited which had optioned the Silver Cup and Sunshine from Ferguson Mines Limited, rehabilitated No. 7 level, unwatered the shaft briefly to No. 10 level, and diamond drilled ten holes from No. 7 level. The option was dropped.

The other properties have had briefer histories. The Sunshine orebody was developed intermittently from 1897 to 1909 in conjunction with mining on the Silver Cup. The Towser shaft and adit were sunk and driven in 1897–1901, and some ore was mined in 1917–18. The Free Coinage adit was driven between 1897 and 1900.

The Silver Cup mine area was geologically mapped by H. P. Trettin, senior assistant in 1956, and the following account is based largely on his work. The raise from No. 7 to No. 4 was in a hazardous condition, and the shaft from No. 7 was flooded. Nos. 3 and 4 adits were reopened, but one-quarter of the total drift length was inaccessible. The Towser adit was partly flooded, and examined only briefly. The Free Coinage was likewise examined only briefly. Plans of workings were made available by Ferguson Mines Limited.

The geology of the mine area is outlined on Figure 11. The mineral deposits are almost all in a thin basal member of the Triune formation and lie close to one of several crests of the Silvercup anticline. The following sequence of members was mapped in the mine area:—

Triune formation—

6c—Grey siliceous slate	1,000 feet
6b—Black phyllite	200 to 400 feet
6a—Grey siliceous slate	0 to 150 feet

Index formation—

5—Green phyllitic lapilli tuff	50 feet
5—Green phyllitic tuff	50 feet
5—Interbedded black and green phyllites	100+feet

The Index formation is not subdivided on Figure 11. The sedimentary rocks are strongly cleaved, and cleavage surfaces in the siliceous rocks are generally smeared with carbon. The contact between Triune phyllite and basal slate appears to be gradational. The phyllites and tuffs are extensively replaced by siderite and green chromian mica, the degree of alteration increasing from northwest to southeast. The siliceous slates are nowhere noticeably altered. There is little apparent relation between alteration and mineralization, although the one vein in tuff, the Sunshine cross-vein, is flanked by several feet of carbonate rock in a part of the mine area where the tuff is generally little altered. On the wall of the Triune basin, both phyllites and tuffs have been converted to massive siderite rock, and only shadows of lapilli on certain weathered surfaces give any clue to the original rock.

The Index and Triune rocks are involved in several tight crests of the northwest-plunging Silvercup anticline. Two crests in Index rocks, separated by a wedge of basal Triune, are indicated by the trace of contacts on Figure 11. Axial planes and contacts appear to be parallel to the cleavage, which dips mostly between 60 and 75 degrees northeast. The Silver Cup mine and the Free Coinage workings are about 200 feet southwest of the southwesterly crest, in the thin basal member of the Triune formation. The Towser showing is in basal Triune on the southwest flank of the second crest. Southeast of the Towser the basal Triune pinches out up-plunge in the syncline between the two anticlinal crests. The Silver Cup band of the basal Triune thins to the southeast due to squeezing and pinches out on the Triune basin slope. At the Silver Cup mine the foliation is warped, and the Index-Triune contact is thrown into a shallow roll plunging steeply northwest (*see* Fig. 11a). This warping does not appear to be related to the principal folding, but suggests compression parallel to the axial planes.

No large strike faults have been identified in the mine area, although several occur to the northeast. A few small strike faults are present in different parts of the mines, and the orebodies lie in zones of shearing and crumpling. Many small cross-faults were seen; one of them, near No. 7 portal, is mineralized.

The Silver Cup mine has developed four orebodies, known as the Silver Cup, Blind, Sunshine, and Sunshine cross-lead. The Silver Cup and Sunshine orebodies lie in a shear zone that either follows bedding or traverses it at a very slight angle to the right. It dips northeast at an average angle of 65 degrees. Between the orebodies it is rather indistinct. Along the orebodies it widens, and the rock on either side is considerably crumpled. The Blind orebody lies in a similar shear zone about 50 feet in the footwall of the first. The Silver Cup and Blind orebodies are side by side, and the Sunshine orebody is 1,200 feet northwest of them. The Sunshine cross-orebody is just northwest of the Sunshine orebody, restricted to tuff in the hangingwall of the slate, and is essentially a fissure vein striking north and dipping about 70 degrees east. The Silver Cup and Blind orebodies have contributed an overwhelming part of the ore.

The Silver Cup and Blind orebodies are short, narrow, and deep, raking steeply northwest. The exact dimensions are not known. The stoped length of both above No. 7 level is about 250 feet (*see* Fig. 11b). Ore does not seem to have occurred uniformly over this length, but rather to have been concentrated in a number of parallel ore-shoots which raked steeply northwest. The shoots ranged in thickness from a few inches to 5 or 10 feet. The probable depth of the orebodies is suggested by indirect evidence. The Silver Cup orebody was found in outcrop, but is reported to have been very narrow there. The Blind orebody did not outcrop, though it has in part been stoped to surface and was found in crosscutting to the other body. A composite level plan shows equal drifting on the two bodies on No. 9 level, comparable with that on levels above No. 7, but only a short drift on the Blind orebody on No. 10 and none on it on Nos. 11 and 12 levels. It seems probable, therefore, that the Blind orebody may be said to terminate above No. 10 level. Drifts on the Silver Cup orebody are shorter on Nos. 11 and 12 than on other levels, but some stoping was done on No. 12. The Silver Cup orebody therefore appears to have been at least 1,200 feet deep, possibly with a barren section at No. 11 level, and the Blind orebody about 1,000 feet deep.

The occurrence of two short, deep orebodies side by side, at least one lying in a shear zone more extensive than itself, suggests some structural control. The only anomalous feature found around the outcrop of the orebodies is a gentle roll in the hangingwall contact of the siliceous slate and an irregular warping of foliation in the slate (*see* Fig. 11a). The roll plunges steeply northwest, more or less parallel to the orebodies and oreshoots. Underground exposures of the contact are not sufficient to outline the roll or indicate the plunge accurately. The few exposures of the footwall contact of the siliceous slate do not indicate whether it is straight or warped beside the orebodies. In detail the orebodies are slightly sinuous, and they are not strictly parallel to each other nor to the warped foliation in the slate. The orebodies occur in a section of the slates where they are warped, but are not related to the warping in any simple, obvious way. For a few feet into both walls of both orebodies, the slate is strongly crumpled, but the majority of the crumples are not obviously related to known structural directions.

Many cross-fissure veinlets of quartz, some well mineralized, occur on both sides of both orebodies. Level plans, from No. 6 to No. 10 levels, show workings either between or outside the drifts on the Silver Cup and Blind orebodies and trending about 20 degrees to the right of them. It is not clear whether these workings followed cross-fissure veins or branches of the main structures.

The orebodies consist of rock fragments, quartz, pyrite, sphalerite, galena, less tetrahedrite, and minor chalcopyrite and carbonates. Ruby silver is said to have been found in the upper workings. Quartz and carbonates are much less abundant than in most veins in the central mineral belt.

The Sunshine orebody is reported to have comprised two oreshoots, 10 and 25 feet long, extending from surface to No. 7 level, a distance of about 200 feet. Little of this mineralization can now be seen.

The Sunshine cross-orebody is unique in the Silver Cup mine area in striking north and being confined to the tuff. It is exposed in an open-cut above No. 7 portal and in No. 7 adit about 250 feet from the portal, dipping about 50 degrees east. A few tons of ore were mined from it by lessees.

The Towser shaft and drift follow a drusy mineralized quartz-carbonate vein that strikes north 17 degrees west and dips about 70 degrees east, cutting across the beds at a small angle to the right. The vein is in the basal siliceous slate of the Triune formation, close to its contact with the Triune phyllite. The vein has been exposed over a length of 175 feet and a depth of 50 feet; it varies greatly in width, averaging perhaps 5 feet. It contains bunches and streaks of pyrite, sphalerite, and galena, with which are associated some tetrahedrite and chalcopyrite. Minor amounts of sulphides occur with quartz in both the footwall and hangingwall of the vein.

The Free Coinage adit followed quartz-bearing fissures, mainly in Triune black phyllite. A crosscut to the northeast crossed the Triune basal slate and entered tuff. A tight fissure was found in the slate and might be an extension of the Silver Cup or Blind shear zone, but no sulphides were found in it. The fissures in the phyllite are accentuations of the schistosity and are in part occupied by narrow quartz veins. A few small bunches of sulphides are scattered along them. The workings also expose northwest-dipping tension fractures, commonly occupied by quartz seams one-tenth of an inch thick, and irregular pockets of quartz in crumpled rock. Neither the fracture veinlets nor the pockets contain appreciable sulphides.

[References: Brock, 1903, p. 67; Emmens, 1914, pp. 43–44; Gunning, 1929, pp. 61–66; *Minister of Mines, B.C.,* Ann. Repts., 1893–1914, 1917, 1918, 1920, 1921, 1924, 1926–28, 1936, 1937, 1941, 1951, 1952.]

Triune

The Triune mine includes four adits in the southeast wall of the Triune basin. It was owned in 1960 by Richrock Mines Ltd., of Vancouver. It is reached by 3 miles of jeep-road from Tenmile. The lowest, or No. 4 adit is at 7,200 feet elevation, and the highest is at 7,550 feet. The orebody is exposed 100 feet higher on the bluff face, and a raise, with sublevels, was driven to it from No. 3 through Nos. 2 and 1 levels. The remains of an old cabin is anchored to the bluff at No. 4 portal. In the present mapping, only No. 4 and the outer 200 feet of No. 2 adit were accessible. The orebody was discovered in 1900 and developed and mined in the periods 1900–05 and 1916–18. Several tons of sorted ore was sacked and left at No. 2 adit.

The general geology is similar to that at the Silver Cup mine. The host to the ore is a narrow band of siliceous dark-grey slate that dips steeply northeast and is on strike with the band that is host to Silver Cup ore. This band is only 15 to 20 feet wide at the mine but thickens considerably up toward Triune Peak. It is flanked to the northeast by relatively massive greenstone, which resembles the tuff in the Silver Cup mine area, and green and grey Index phyllites. Both the greenstone and the phyllites are partly carbonatized. The slate is flanked to the southwest by greyish-green biotitic phyllite, and this in turn by carbonatized black phyllite. This black phyllite extends up onto Triune Peak and appears to line up with the Triune black phyllite southwest of the Silver Cup mine, although it is covered across the head of the Triune basin. The biotitic phyllite is about 50 feet wide near No. 4 portal, but narrows up the bluff face and pinches out near the ore outcrop.

The orebody is indicated by published descriptions to lie in a shear zone in the siliceous slate. Its dimensions are not given, and it was not seen in the present mapping. The outer 200 feet of No. 2 adit exposes an irregular network of small quartz veins, with associated pyrite and carbonate, in strongly cleaved siliceous slate. No definite shear is apparent here. No. 4 adit, 675 feet long, crosscuts the hangingwall greenstone and follows a northeast-dipping shear in the siliceous slate. The shear has several branches and numerous horsetails, principally in its footwall. Lenses of quartz are scattered along the shear; some contain small amounts of sulphides. The inner part of the adit swings into the footwall phyllites.

[References: Brock, 1903, pp. 69–70; Emmens, 1914, pp. 44–45; Gunning, 1929, pp. 59–60; *Minister of Mines, B.C.*, Ann. Repts., 1900–06, 1916–19, 1940, 1952. A diagram of the workings is given with the report for 1919 opposite page 144.]

True Fissure

The True Fissure mine area is on the east end of Great Northern mountain. It includes the True Fissure, Blue Bell, Great Northern, and St. Elmo mines. The Broadview mine is to the south, across Broadview Creek. The Great Northern and adjoining Crown-granted mineral claims are owned by the estate of the late Donald McPherson, of Victoria. The True Fissure, Grace Fraction, St. Elmo, Yankee, Don Fraction, Blue Bell, and Park Fraction Crown-granted claims are owned by Columbia Metals Corporation Limited; D. J. Ongley, secretary; company office, c/o Yellowknife Bear Mines Limited, Suite 1002, 80 Richmond Street West, Toronto.

The mine area lies across the upper part of Fissure Creek and extends south over a spur of Great Northern Mountain. The creek heads in a swampy bench immediately west of the area. For the most part, slopes are moderate, and overburden is extensive. Timber is generally thin, but underbrush is thick. A 3½-mile road climbs from Ferguson to the True Fissure camp at 5,600 feet elevation, and a branch road leads to a lower level of the mine.

The Blue Bell workings consist of two adits and a connecting raise (*see* Fig. 12). The St. Elmo workings comprise two unconnected adits, a caved stope to surface, and, reportedly, a winze from the upper adit. The True Fissure mine includes four adit levels, two raises connecting Nos. 2 and 3 levels, and several open-cuts and pits. The Great Northern workings include six adits, caved in 1958. Additional short adits and open-cuts have been made along the east rim of the swampy bench and between the Blue Bell and St. Elmo workings.

The first showing is reported to have been found in 1890, on ground subsequently located as the Great Northern claim. Other discoveries soon followed, and the entire vein system was located before the turn of the century. Small-scale exploration and development was carried on by the locators and a number of bondholders. The St. Elmo vein was mined and the Blue Bell (then called Silver Queen) upper adit was driven in the period 1898–1901. Most of the work on the Great Northern was done before 1897; additional work in 1913, 1917, and 1928–30 was largely confined to No. 6 adit.

The True Fissure Mining and Milling Company Limited acquired the True Fissure, Blue Bell, St. Elmo, and four adjoining claims in 1907. In 1908 the Blue Bell was further developed, the St. Elmo vein was stoped to surface, and a little mining was done from open-cuts on the True Fissure. Further mining was done by lessees in 1908–09. Some development work was done in 1916–18, otherwise the properties lay idle until 1921, when David Morgan was placed in charge of further development. The True Fissure No. 3 adit was extended to 800 feet in 1921–22, and No. 4 adit was driven in 1923–24. On the Blue Bell the connecting raise was driven in 1925, the lower drift extended to its present length in 1925–28, and the north drift on True Fissure No. 4 level was driven under it in 1928. Most of the development funds had been supplied by G. F. Park, of Cincinnati, who died in 1930. Pursuant to the terms of his will a 100-ton flotation mill was installed at the mine and a small hydro-electric plant was installed on Ferguson Creek in that year. The company did no further work and went into voluntary liquidation in 1953.

The New True Fissure Mining and Milling Co. Ltd. was formed in 1937 and operated the True Fissure until 1939, when it was suspended from the Montreal curb market and ceased activity. The present camp was built and the mill started up, 79 tons of concentrates being shipped. The drift on True Fissure No. 3 level was extended to its present length, and the crosscuts on No. 4 level were driven. In 1940 three men scavenged zinc concentrates from the mill, and in 1943 Codan Lead and Zinc Co. worked thirteen men sorting and shipping zinc ore from the dumps. From 1945 to 1949 the True Fissure, Blue Bell, and St. Elmo were controlled by Comara Mining and Milling Co. Ltd., which did 2,200 feet of surface diamond drilling on the True Fissure and near the St. Elmo. In 1949 this company was transformed to Columbia Metals Corporation Ltd., in which Yellowknife Bear Mines Ltd. subsequently acquired an interest. In 1952–53 The Granby Consolidated Mining Smelting and Power Company Limited was engaged by these companies to map and sample the workings and superintend 3,000 feet of diamond drilling from True Fissure Nos. 2 and 3 levels. No work has been done since 1953.

General Geology.—The general geology and most of the workings are shown on Figure 12. Surface mapping was by plane-table and by tape and compass, at 40 and 100 feet to the inch, using mine co-ordinates and elevations. Underground mapping was plotted on copies of level plans prepared by the Granby company.

The country rocks are grits and phyllites of the Broadview formation. They form at least one medium-sized anticline and are closely dragfolded. Three major fault zones divide the eastern part of Great Northern Mountain into four structural blocks, as shown on Figure 13. The Cup Creek fault zone (*see* p. 43) is inferred from scattered exposures to pass just north of the mine area. The north block is downthrown on this fault, exposing rocks that are higher in the Broadview formation than rocks south of the fault. The Broadview fault essentially follows the valley of Broadview Creek, south of the True Fissure mine area but north of the Broadview mine. It also has downthrown the rocks on the north. The Great Northern fault dips east or northeast at 45 degrees; it strikes north 15 degrees west over

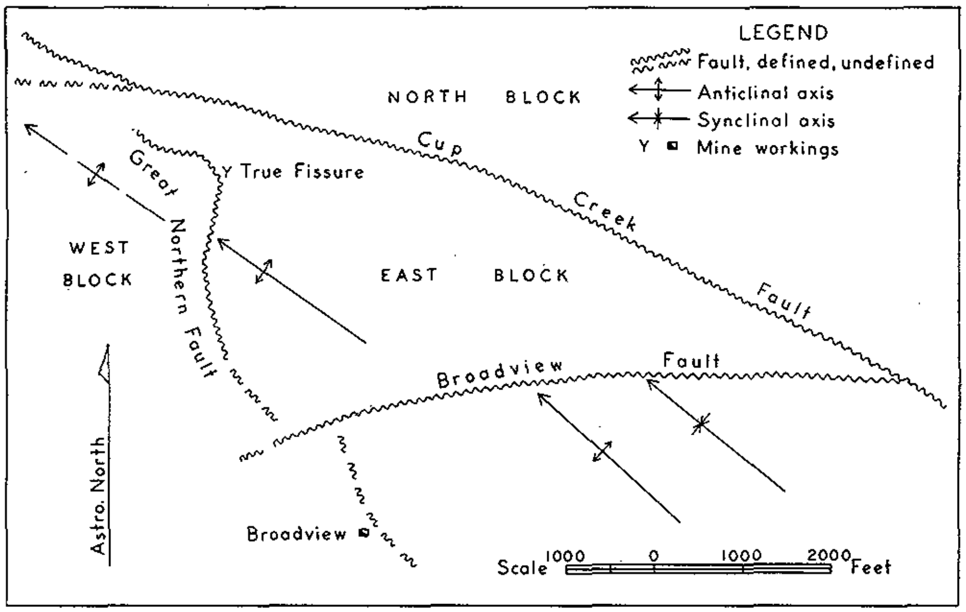

Figure 13. Sketch-map showing faults on the east end of Great Northern Mountain.

most of its length, but may swing to north 70 degrees west at its north end. The sinuous trace of the fault on Figures 12 and 13 is a result partly of topographic effect on a moderately dipping structure and partly of this swing. Evidence presented below suggests that it is a reverse fault. The principal mineralization occurs along the footwall of this fault. At the Broadview mine a broken mineralized zone may represent a continuation of the Great Northern fault.

The rocks of the mine area all belong to the middle division of the Broadview formation and rarely form well-defined members. In general, however, the following sequences can be recognized in the two blocks:—

West Block	*East Block*
Grey grit, lustrous grey phyllite, interbedded grey grit and black phyllite.	Black phyllite.
Light-brown to reddish-brown micaceous grit.	Dark-grey grit.
Black phyllite.	Light to medium greenish-grey grit.
Dark-grey grit.	

The thin brown micaceous grit affords the principal evidence for an anticline in the west block. It is exposed along the southwest edge of the swampy bench at the head of Fissure Creek and again just in front of the St. Elmo lower adit. Dragfolds in the two bands indicate that they face outward, and that an anticline lies between, under the swampy bench (*see* Fig. 13). The northeast limb dips less steeply than the Great Northern fault, and therefore is truncated by it. Black phyllites which outcrop sporadically along the bench in the core of the anticline occur in the footwall of the fault in the Blue Bell upper adit. Dark-grey grits occur in the footwall of the fault in True Fissure No. 4 adit and are inferred to underlie the black phyllites.

In that part of the east block included within the mine area, greenish-grey and dark-grey grits predominate. Abundant dragfolds indicate that they lie on an anticline, with the greenish-grey grits in the core and the dark-grey grits on the northeast limb. Black phyllites are exposed near True Fissure No. 4 portal and along the road to Ferguson, farther out on the northeast limb and evidently overlying the dark-grey grit. This sequence in the east block does not match any sequence in the west block above the brown grit, and therefore the black phyllite and dark-grey grit in the two sequences are tentatively correlated. The anticlines in the two blocks appear to be segments of the same structure. They are almost in line, and therefore movement on the Great Northern fault is predominantly dip-slip. Since older rocks are exposed in the east block it has moved up, and the fault is a thrust. A rough calculation suggests that the upthrow relative to the west block is 1,200 to 1,500 feet.

The anticline in the east and west blocks is believed to be not the Silvercup anticline but a large drag anticline on its southwest limb. South of the Broadview fault a large dragfold on the southwest limb of the Silvercup anticline is outlined by the pyroclastic member at the top of the lower Broadview and is indicated on Figure 13 by anticlinal and synclinal axes. In the east block east of the mine a few vague dragfolds suggest that there is a complementary syncline northeast of the anticline. In the west block, dragfolds indicate that the beds face southwest for many thousands of feet southwest of the swampy bench.

The Great Northern fault is represented by a gouge and breccia zone of variable width, along which a broad band of footwall rocks has been more or less injected by quartz and carbonates. The breccia zone is exposed on True Fissure Nos. 2, 3, and 4 levels and on Blue Bell No. 1 level. It is not exposed on surface, but its trace can be approximated from outcrops of quartz and carbonates. To the south, by the Great Northern workings, the trace of the fault zone is uncertain. The position of the trace is also uncertain in the north, above the Blue Bell workings. Just north of True Fissure No. 2 portal the fault zone curves to a more westerly strike, and its trace angles uphill to Fissure Creek. The trace does not pass through a large outcrop of grey grit above Blue Bell No. 1 adit, and therefore it presumably turns up beside Fissure Creek and follows a runnel to the swampy bench above. The geometrical relation of this trace to the topography and to the strike given by the direction of Blue Bell No. 1 drift indicates the dip is gentle near surface, although it is 45 degrees on the level. There is some doubt about the position of the fault on Blue Bell No. 2 level. A raise to No. 1 level evidently follows the fault zone. From the foot of the raise a shear extends northwest to the face of the drift and southeast to a point 120 feet from the adit crosscut, where it is truncated by another shear striking more westerly. No distinct shear is present in the Blue Bell No. 2 adit crosscut, and therefore the fault zone may be outside the portal. An open-cut 120 feet south of this adit exposes quartz and carbonates mineralized with sulphides, and as such vein material is found only in the footwall of the fault zone on the True Fissure it is possible that the open-cut and Blue Bell No. 2 portal may be in a window through the fault, though no window is shown on Figure 12. It is also possible that the fault splits north of the True Fissure workings, a branch passing east of the Blue Bell workings. Relatively wide quartz-carbonate veins, of the same general character as the main True Fissure-Blue Bell vein, occur just northeast of the Blue Bell No. 1 portal and at the north end of the area, and seem to follow a shear or shears.

The fault zone varies in character from place to place. On True Fissure No. 2 level and the north half of No. 3 it is a well-defined gouge zone 5 to 10 feet wide. Near the mid-point of No. 3 a wide shear zone branches from it into the hangingwall. Southward the fault zone narrows to a 3-inch mud seam flanked by a foot or two of sheared rock, then gradually widens to a 5-foot gouge zone at the south end of the level. On True Fissure No. 4 level a 25-foot zone of gouge and breccia at the adit crosscut appears to split repeatedly to the southeast. The most westerly branch forms the vein hangingwall but dies out near the south end of the drift, suggesting that the main branch of the fault zone may lie farther east. In the Blue Bell workings the fault is represented by a few inches of mud and sheared rock.

A lens-shaped vein of quartz and carbonates follows the footwall of the fault zone for 1,200 feet from Fissure Creek to True Fissure No. 1 adit and may continue south to the Great Northern workings. A branch vein extends from this adit for 900 feet northwest into the footwall. The southward continuation of the vein is indicated by an outcrop of mixed vein material and black phyllite, by vein rubble on the crest of the ridge, by vein material on the Great Northern dumps, and by one small outcrop of quartz and carbonate beside No. 5 adit. The hangingwall of the vein is generally sharply defined by the fault zone, only an insignificant amount of quartz having been injected into the hangingwall rocks. Locally on True Fissure No. 3 and Blue Bell No. 2 levels, vein material occurs along the hangingwall of the fault zone. The footwall of the vein is much less definite, and in most exposures has been placed arbitrarily where quartz and carbonates decrease to less than 50 per cent of the rock. Between the vein branches the rocks are closely laced with quartz, and in the inner part of True Fissure No. 4 adit the grit contains abundant pockets of quartz, from 3 inches to a foot across. Even in the footwall of the branch vein, quartz veins are more numerous than in the hangingwall of the fault. As thus defined, the main vein has a maximum width of 80 feet on True Fissure No. 4 level and a width exceeding 40 feet on True Fissure No. 3 level. The full width is not exposed on Nos. 2 and 3 levels, and on surface it is difficult to calculate because the vein curves in strike and dips only slightly more steeply than the hillside. Southward on Nos. 3 and 4 levels the vein narrows sharply, and only scattered small veins are present at the south end of No. 4. On No. 3 level the vein widens again to as much as 20 feet, but virtually pinches out 150 feet from the face. No. 1 adit traverses a preserved width of 27 feet, the hangingwall part of the vein having been eroded. Blue Bell No. 1 level exposes a 25-foot zone of quartz veins in phyllite in the footwall of the main shear. On Blue Bell No. 2 level, quartz-carbonate veins are discontinuous and are rarely more than 5 feet wide.

The gangue minerals of the veins are predominantly quartz and ankerite, and subordinately siderite and calcite. The ankerite was identified by X-ray diffraction; the siderite by spectrochemical analysis, which found almost no calcium. The ankerite is cream coloured, darkening somewhat on exposure. The siderite is buff to brown and weathers dark brown. The carbonates are generally coarsely crystalline, the quartz generally medium grained and massive. Vugs lined with quartz crystals occur but are not common. In places, as observed by Gunning, the quartz forms narrow prisms in the carbonates, producing a texture rather like graphic intergrowth. Possibly the bulk of the quartz is earlier than the carbonates, although convincing evidence is lacking. Quartz shows considerable crushing along some late slips, whereas carbonates in similar situations do not, but in view of the well-known self-healing properties of carbonates this does not provide conclusive evidence. Some quartz veinlets definitely traverse carbonates.

The sulphide minerals are pyrite, sphalerite, galena, chalcopyrite, argentiferous tetrahedrite (grey copper), and a greyish-white mineral which Gunning suggested might be bournonite. Their grain size varies considerably, and they are commonly closely intergrown. All appear to be later than the gangue.

True Fissure-Blue Bell Mineralization.—Surface and underground exposures indicate a mineralized zone in the hangingwall part of the vein with a maximum length, from True Fissure No. 1 adit to Blue Bell No. 1 drift, of about 1,300 feet, but extending to no great depth. Continuity of mineralization over this length cannot be proved, for there is a 400-foot gap between the True Fissure and Blue Bell surface exposures. No ore has been found on the main part of True Fissure No. 4 level, and the avoidance by later exploration of a flooded north drift on that level suggests that none was found there. The lower edge of the mineralized zone lies above No. 4 level. Exposures on True Fissure No. 3 and Blue Bell No. 2 levels suggest that this lower edge is lobate. A 270-foot mineralized section on No. 3 level pinches out northward, and the outer part of the adit is unmineralized. On Blue Bell No. 2 level there is a 180-foot mineralized section at the foot of the raise to No. 1 level and a 20-foot section 200 feet northwest of the raise. More or less continuous mineralization appears to have been found up the raise and is exposed along No. 1 drift. The outer part of True Fissure No. 2 adit is in the hangingwall of the vein, but the inner part follows ore for 290 feet to the face. True Fissure No. 1 adit appears to have been driven almost entirely in the footwall of the mineralized zone, but a 4-inch vein of pyrite, sphalerite, and galena occurs in quartz near the portal. The depth down dip therefore may range from zero, west of True Fissure No. 3 portal, to 360 feet near the south end of True Fissure No. 2 level and 450 feet at the Blue Bell raise.

The mineralized zone varies in width and character. On Blue Bell No. 2 level at the foot of the raise a lens of sphalerite with minor galena, 25 feet long and 2 feet wide, passes northwest and southeast to pockets of sphalerite along the shear footwall. Farther northwest a streak of sphalerite follows the shear hangingwall for 20 feet. On Blue Bell No. 1 level the north part of the drift exposes only scattered narrow stringers of sulphides, but the southeast 140 feet follows from 1 to 2 feet of galena and sphalerite along the shear footwall. Near the southeast face a crosscut into the footwall exposes a second sulphide band of about the same thickness in the quartz-carbonate vein; together with sparse sulphide mineralization between them, these bands form a zone about 6 feet thick. On surface above the Blue

Bell workings, galena and sphalerite along the hangingwall of the vein are sporadically exposed from the north bank of Fissure Creek for 170 feet southeast; the hangingwall shear zone is not exposed, and the full width of the mineralized zone is not known. A few feet farther up the south side of Fissure Creek a trench exposes large pockets of pyrite and a lens of galena and pyrite as much as 1 foot thick that strikes north 75 degrees west and dips 38 degrees north. This lens pinches out up dip and eastward and is covered to the west. It appears to lie in the footwall of the main mineralized zone. The pyrite is coated with hydrated ferrous sulphate. Farther up the creek, on its north side, the small dump of a caved adit contains considerable pyrite and a little ore. The open-cut 120 feet south of the Blue Bell No. 2 portal exposes about a foot of sulphides on the hangingwall of a small outcrop of quartz and carbonates.

On True Fissure No. 3 level the mineralized zone is more or less split into two parallel zones, one lying on the hangingwall surface of the vein, immediately beneath the gouge zone, the other within the vein and 5 to 12 feet from its hangingwall. The hangingwall zone consists of rather sparse galena and sphalerite in quartz and carbonate, is from 1 to 4 inches thick, and extends 35 feet south and 70 feet north of the north raise. Northward it pinches, and southward it becomes pyritic and also pinches. Between the zones there are scattered small pockets and veinlets of sulphides. The footwall zone extends from beneath the north raise to 70 feet south of the south raise, a length of 210 feet, ranging in thickness from a few inches to about 6 feet. It consists of closely spaced pockets, lenses, disseminations, and veinlets of sulphides in the quartz-carbonate gangue. Pyrite appears to predominate over sphalerite and galena in some sections. In part this mineralization is associated with tight, smooth-walled fissures in the gangue that dip almost parallel to the fault zone. The most extensive of these fissures is exposed for 90 feet along No. 3 level, forms the footwall of the south raise, and is exposed for 150 feet along No. 2 level. It appears to rake south. At its north end on No. 3 level it curves sharply left into the footwall. On No. 3 level it forms the footwall of the footwall orebody where both are present, but it continues south past the end of ore, and the orebody continues north beyond the fissure.

On True Fissure No. 2 level the mineralization forms a single variable zone, 6 to 14 feet thick, between the gouge zone in the hangingwall and the above-mentioned fissure in the footwall. At the south raise the fissure swings slightly into the footwall, and the mineralized zone narrows southward against the gouge zone. Galena, sphalerite, and pyrite occur as large and small lenses, pockets, veinlets, and disseminations in the gangue. A sample across 4.5 feet of better-looking ore assayed: Gold, 0.12 ounce per ton; silver, 9.1 ounces per ton; copper, 0.59 per cent; lead, 4.75 per cent; zinc, 6.3 per cent; tin, 0.05 per cent. The average grade across the whole zone would be somewhat lower. In a small stope on No. 2 level the gangue is broken by numerous slips and shears which generally dip steeply east or northeast. Ore occurs as three veins, 1 to 3 feet thick, which appear to be controlled by some of the fractures and disrupted by others. The mineralized zone here does not reach the hangingwall gouge zone, but extends farther into the footwall than on the level.

Above True Fissure No. 2 adit a considerable area of vein has been stripped of overburden, exposing remnants of massive sulphides on the hangingwall surface. Uphill and northward erosion has cut deeper into the vein and the exposed gangue is barren. Southward toward True Fissure No. 1 adit a series of pits and open-cuts exposes some ore on the gangue hangingwall.

Great Northern.—These workings were completely caved in 1958, and ore does not outcrop; therefore, the reader is referred to descriptions by Emmens and

O'Grady.* O'Grady's No. 4 adit is marked No. 6 on Figure 12. The dumps consist of quartz-carbonate gangue, finely comminuted black argillite or phyllite, and scattered pieces of massive pyrite.

St. Elmo.—This vein is in the footwall of the True Fissure-Blue Bell vein, in black silty phyllites. The upper adit and stopes on it which broke through to surface are completely caved, leaving a series of depressions on surface. The trend of these depressions is shown on Figure 12 and serves to indicate the strike of the vein. A few loose blocks of cavernous quartz occur along the depression wall. Bedrock is exposed at the northwest end of the depression, but consists of black phyllite without any vein material. The dump consists of comminuted black phyllite, less cavernous quartz, and some pyrite. A little massive sphalerite and galena has been piled beside the portal and also beside the depressions. To the southeast, along the bed of Fissure Creek, bedrock has been injected by scattered veins and pockets of quartz, but contain no sulphides. The lower adit evidently passed to the southeast of the main St. Elmo vein, encountering a different one striking north 70 degrees east and dipping 50 degrees north. This second vein lies on the hangingwall of a shear, is about 2 feet thick, and consists of quartz and a little pyrite.

[References: Emmens, 1914, pp. 36–38; Gunning, 1929, pp. 70–75; *Minister of Mines, B.C.,* Ann. Repts., since 1894, particularly 1899, pp. 682–683; 1921, pp. 161–163; 1924, p. 208; 1927, pp. 293–294; 1930, pp. 264–265.]

White Quail and Star Fraction

These claims are on the lower southeast slopes of Gainer Creek immediately southwest of the Index basin. In 1960 the White Quail was owned by L. Abrahamson, of Revelstoke. The showings are reached by an old trail which begins a short distance above the Molly Mac cabin and continues past the Hidden Treasure cabin. On the White Quail two adits, side by side and 120 feet apart, were driven southeastward into the hillside at 4,600 feet elevation, on the upper side of the trail. These adits were reopened in 1956, and it is reported that they join a short distance underground. On the Star Fraction the caved portal of an adit is just below the trail at 4,900 feet elevation.

The White Quail east adit and the Star Fraction adit were driven into limestone, which is probably the Molly Mac limestone. Exposures are very poor, and the adits were not entered. Dump material indicates that the limestone in both adits was more or less replaced by siderite, in which galena is rather sparingly disseminated.

Winslow

The Winslow property is at 6,400 feet elevation near the head of Burg Creek on the southwest slope of Silvercup ridge and is connected with the road along Trout Lake by a narrow road 4¾ miles long. The Winslow and adjoining Glad Hand Crown-granted mineral claims are variously owned. Seven adits, a mill building, and several camp buildings are on the north bank of Burg Creek. Development between 1904 and 1911 was resumed in the thirties. The camp and a 20-ton mill were built in 1938, and mining and milling were carried on intermittently until 1941. The property has since lain idle.

The veins are in phyllitic grey grits near the base of the middle Broadview, southwest of the Silvercup anticline. The rocks are sheared and warped, and a wide breccia zone passes a few hundred feet west of the mine. The adits were inaccessible when the property was visited. Published reports describe quartz veins with various attitudes containing pyrite and minor sphalerite, chalcopyrite, galena, and free gold.

[Reference: Emmens, 1914, pp. 50–51; Gunning, 1929, pp. 45–46; *Minister of Mines, B.C.,* Ann. Rept., 1939, p. 78.]

* *Minister of Mines, B.C.,* Ann. Rept., 1929, pp. 337–338.

LAPSED PROPERTIES

The following seven mineral occurrences are on ground that was open in 1960, but at least six were formerly covered by mineral claims. Some work has been done on them, but little mineralization can now be seen. Notes on these occurrences are included because descriptions have not previously been published and because three occurrences have had work done on them in recent years. Locations of the occurrences are shown by number on Figure 2.

1. *Maggie May*.—Southwest of the Lardeau Valley, on the lapsed Maggie May claim, an adit has been driven 10 feet into the southeast bank of Trout Creek 2,200 feet from the main valley. The adit follows two small irregular veins of galena-bearing quartz in coarse grey grit. Similar veins are sparsely scattered through the grit on either side, forming a weakly mineralized zone 35 feet wide.

2. Half a mile southeast of Staubert Lake, on the southwest side of Lardeau Valley, a logging-road cut has exposed a little galena and sphalerite in quartz stringers in carbonatized black phyllite.

3. *Tonowanda*.—Two adits were driven in about 1904 by P. Comerford at 4,250 feet elevation in a small draw 300 feet south of Fissure Creek, on the lapsed Tonowanda claim. One adit traverses for 50 feet barren grey grits of the middle Broadview outcropping along the south edge of the draw. A small dump indicates the position of the other adit in the middle of the draw, but the portal is completely hidden by gravel and clay. Only black phyllite and a little quartz can be seen on the dump, but some pieces of sulphide were found during unsuccessful attempts to reopen the adit in 1955. In 1956 R. Ernewin diamond drilled two short holes from bedrock on the south edge of the draw, entering a large mud seam in which a little pyrite and a few specks of chalcopyrite were encountered. In 1958 a jeep-road was built down to this adit from the True Fissure road.

4. *Baltimore*.—This ground has been held successively as the Baltimore, Revenue, and Katinka claims, and has now lapsed. It is 1½ miles from Ferguson up the Ferguson Creek trail. Most of the work appears to have been done before 1908. The workings include two adits just above the trail and an open-cut just below. The open-cut has been made on an 8-foot quartz vein that strikes north 70 degrees east and dips 55 degrees south and is crossed by numerous veinlets of sphalerite. The vein is in Ajax quartzite on or close to the crest of the Silvercup anticline. The adits are 100 feet apart. The south one was caved in 1955. The north adit crosscuts lower Broadview grits and a narrow band of Ajax quartzite, entering black phyllite. A drift follows a 4-foot quartz vein along the quartzite-phyllite contact for 55 feet northwest without encountering appreciable sulphides.

13. *Rambler*.—This lapsed claim straddled Lardeau Creek at Seven-and-a-half Mile Falls, where it is crossed by Ajax quartzite on the northeast limb of the Silvercup anticline. In 1905 an adit was driven from the canyon wall for 50 feet northwest along the northeast contact of the quartzite. A small shaft was sunk at a point 80 feet to the northwest. More recently W. Hladinec and A. Bobicki held a mineral claim and placer lease at the falls. In 1957 they drove a 42-foot diversion tunnel, which crossed the old adit, and then dammed the natural channel. A small open-cut was made just south of the portal of the old adit, in silicified Ajax quartzite near its northeast contact with Sharon Creek siliceous phyllites. The open-cut exposes galena stringers in the silicified quartzite, one-half to 2 inches thick and 1 to 2 feet apart, striking northwest and dipping steeply southwest. The owners reported encountering several similar stringers in the diversion tunnel, both in quartzite and in siliceous phyllite. A few scattered small stringers of galena were seen in quartzite in the walls of the plunge pool after it was pumped out. The work done was preparatory to testing sand and gravel in the plunge pool for gold.

Some mineralization has been found in or adjacent to Ajax quartzite on the northeast limb of the anticline on Cup and Sharon Creeks. On Cup Creek only some rusty vein quartz can now be seen in the quartzite, and at a falls on Sharon Creek an adit along the northeast contact of the quartzite is inaccessible. No mineralization is known in Ajax quartzite southeast of Cup Creek.

17. *California.*—An adit driven into the hill immediately west of the head of Sharon Creek is probably on the lapsed California claim. It was driven in the pyroclastic member of the lower Broadview. It was blocked by snow when visited, but dump material indicated that it followed a cavernous quartz-calcite vein containing pockets of massive galena.

Farther southeast on Silvercup ridge several pits have been blasted out of short, thick quartz veins in the pyroclastic member. Ore minerals were not seen.

21. *Muskateer Group.*—This group of lapsed mineral claims was located on disseminations and large pockets of massive pyrite and pyrrhotite in the middle member of the Jowett formation on the east bank of Ferguson Creek, 1,500 feet above the mouth of Mountaingoat Creek. James Furness, of Beaton, did some stripping in 1953 and had about 100 feet of diamond drilling done in 1954. A sample across 2 feet of massive pyrite assayed: Gold, trace; silver, *nil.* Spectrochemical analyses of the pyrite and pyrrhotite disclosed only traces of copper and nickel.

OTHER PROPERTIES

The following table lists properties which were not studied in the present mapping but which have been described in other publications as listed; they are indicated on Figure 2 by key number.

Properties Described in Other Publications

Original Name	1960 Title[1]	Owners, 1960	Workings	References[2]
5. Bruce			2 adits	M.M. 1898.
6. I.X.L.			1 adit	M.M. 1899.
7. Brow	C.G.	G. C. and W. H. Lembke	2 adits	M.M. 1900.
9. Florence	C.G.	G. D. Humphrey	2 adits	M.M. 1916, 1917.
10. Black Eagle	C.G.	Mrs. A. Ducie	1 adit	M.M. 1896, 1898.
12. Gold Bug			1 adit	M.M. 1900, 1919, 1933.
14. Canadian Boy[3]	Rec.	L. B. and Loyd York	1 shaft, 2 adits	Emmens, p. 42.
15. Parrsboro			1 shaft, 1 adit	M.M. 1919–21.
16. Davey			1 adit	M.M. 1898.
18. Copper Queen			1 adit	M.M. 1904, 1940.
19. U & I	C.G.	Richard Farrell		Gunning, p. 46.
20. Okanagan	C.G.	Trans Western Oils Ltd.	1 adit	Emmens, p. 51.
22. Lade Group (Ophir-Lade)	C.G.	H. W. Colgan	3 shafts, 1 adit	Gunning, pp. 49–50; M.M. 1898, 1922, 1924, 1925, 1932.
23. Mohecan	C.G.	Mrs. Eveline Daney	2 adits	Emmens, p. 55; Gunning, p. 82; M.M. 1902–05, 1925–28.
24. Badshot	C.G.	Mrs. Olive Lutley and Colin C. Loggie	1 shaft, 1 adit	Emmens, p. 54; Gunning, p. 108; M.M. 1894–1900, 1904.
25. Black Prince	C.G.	James Main	1 shaft, 2 adits	Emmens, p. 55; M.M. 1894–98, 1903–04.

[1] C.G.=Crown-granted; Rec.=held by record.
[2] M.M.=*Minister of Mines, B.C.*, Annual Report.
[3] The Canadian Boy has been relocated as the Old Silver Slipper.

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1962

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Plate I. The Ferguson area from the southwest looking across the Lardeau Valley and up the valley of Lardeau Creek.

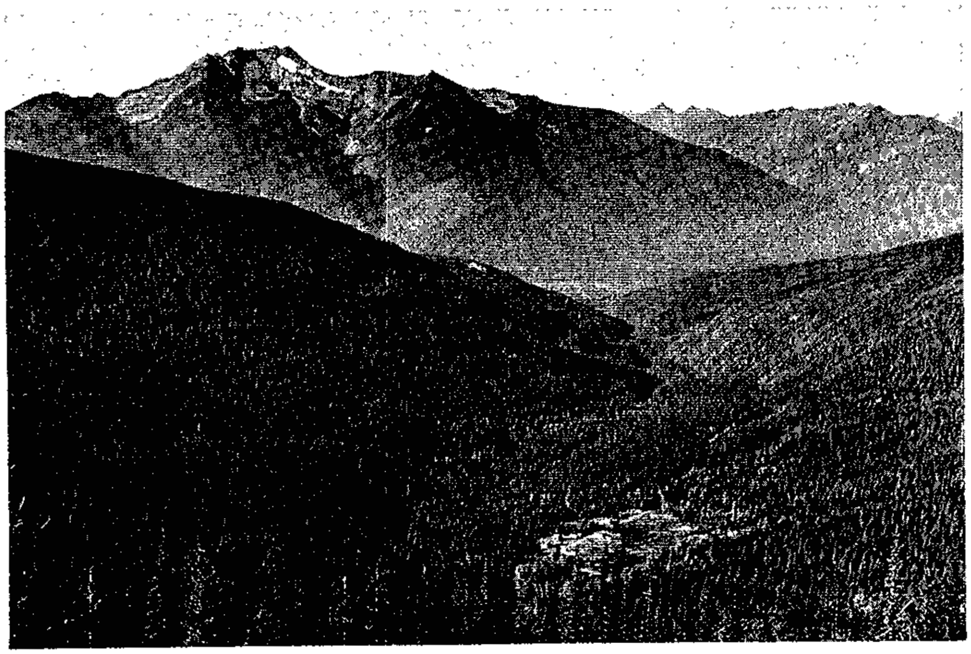

Plate II. The settlement of Ferguson and Trout Mountain looking southwest from the Nettie L mine.

Plate III. Trout Lake from the northwest end.

Plate IV. Looking north across the alpine meadows of Silvercup ridge and the valley of Lardeau Creek. Spine Mountain on the right, Mount Jowett on the left.

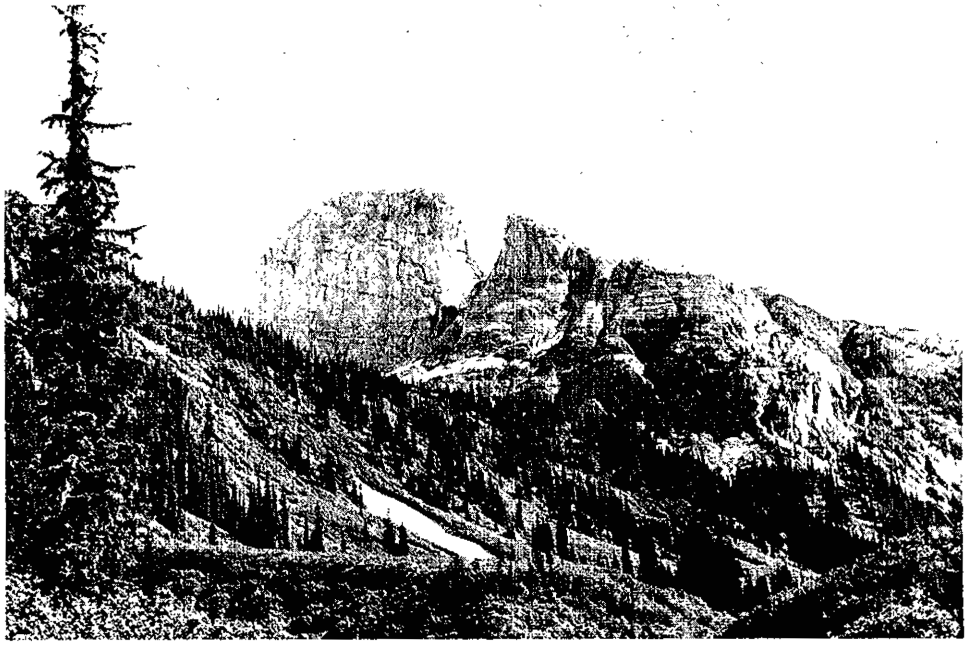

Plate V. Badshot Mountain from Gainer Creek.

Plate VI. Index basin from the west. Redcliff Peak on the right.

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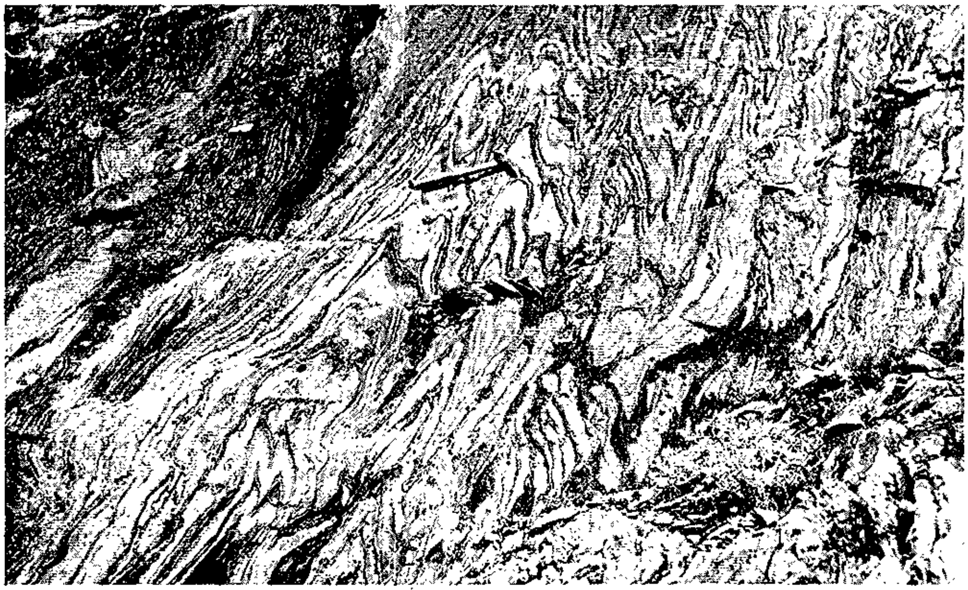
Plate VIII. Upper Gainer Creek looking north from the Index basin. Badshot Mountain on the right, Lade Peak right centre. One of the Silver Chief anticlines can be seen in the bluff on the lower left.



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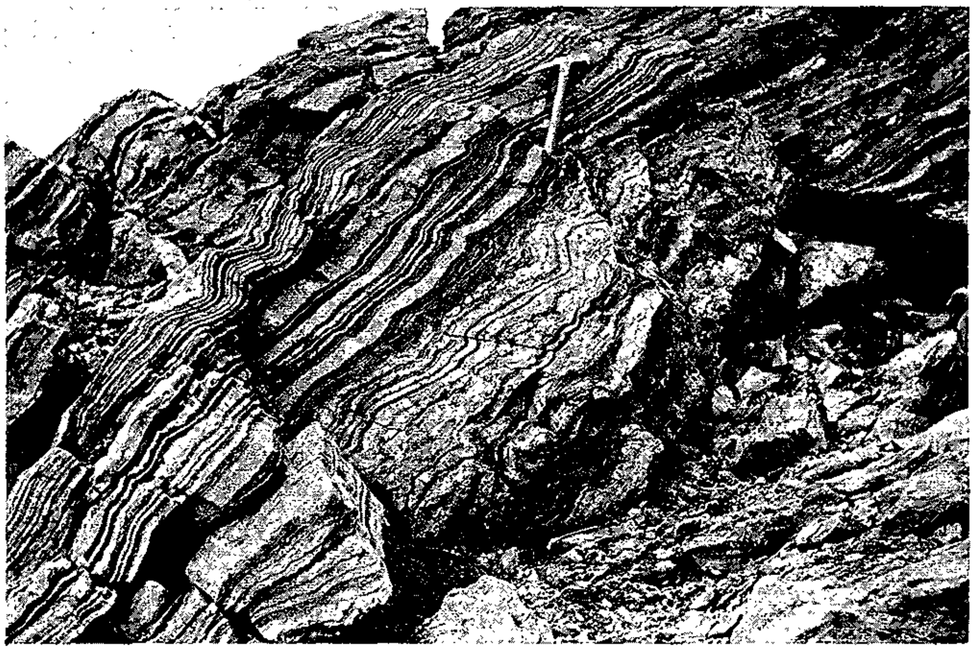

Plate XII. Calcareous grits in lower part of the Broadview formation on the south slope of Spine Mountain.

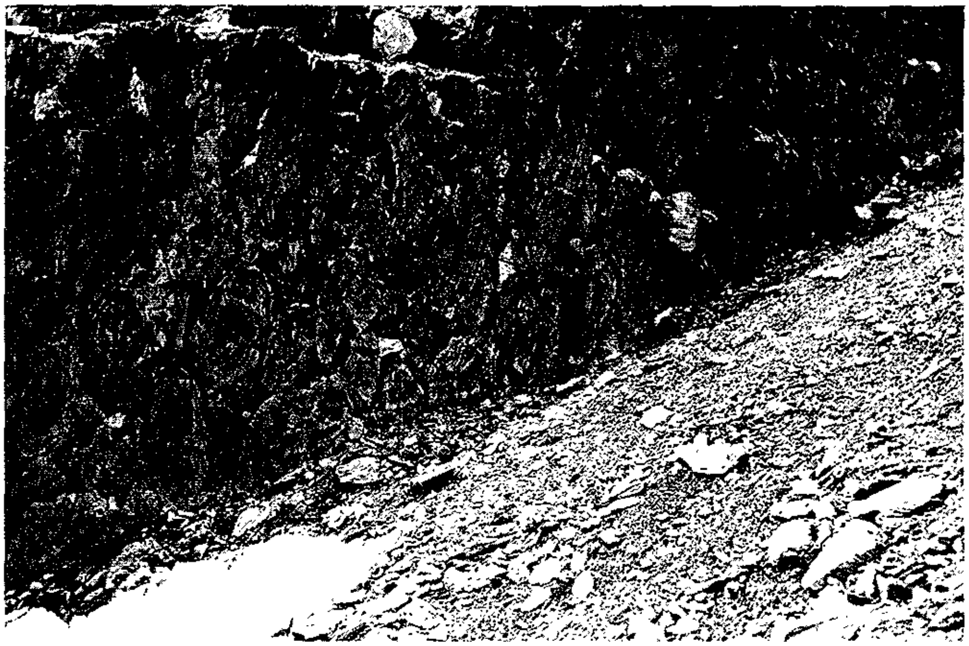

Plate XIII. Pillow structure in volcanic rocks of the Jowett formation.
Hammer on the left is 12 inches long.

Plate XIV. Fragmental volcanic rocks in the Jowett formation, Spíne Mountain.

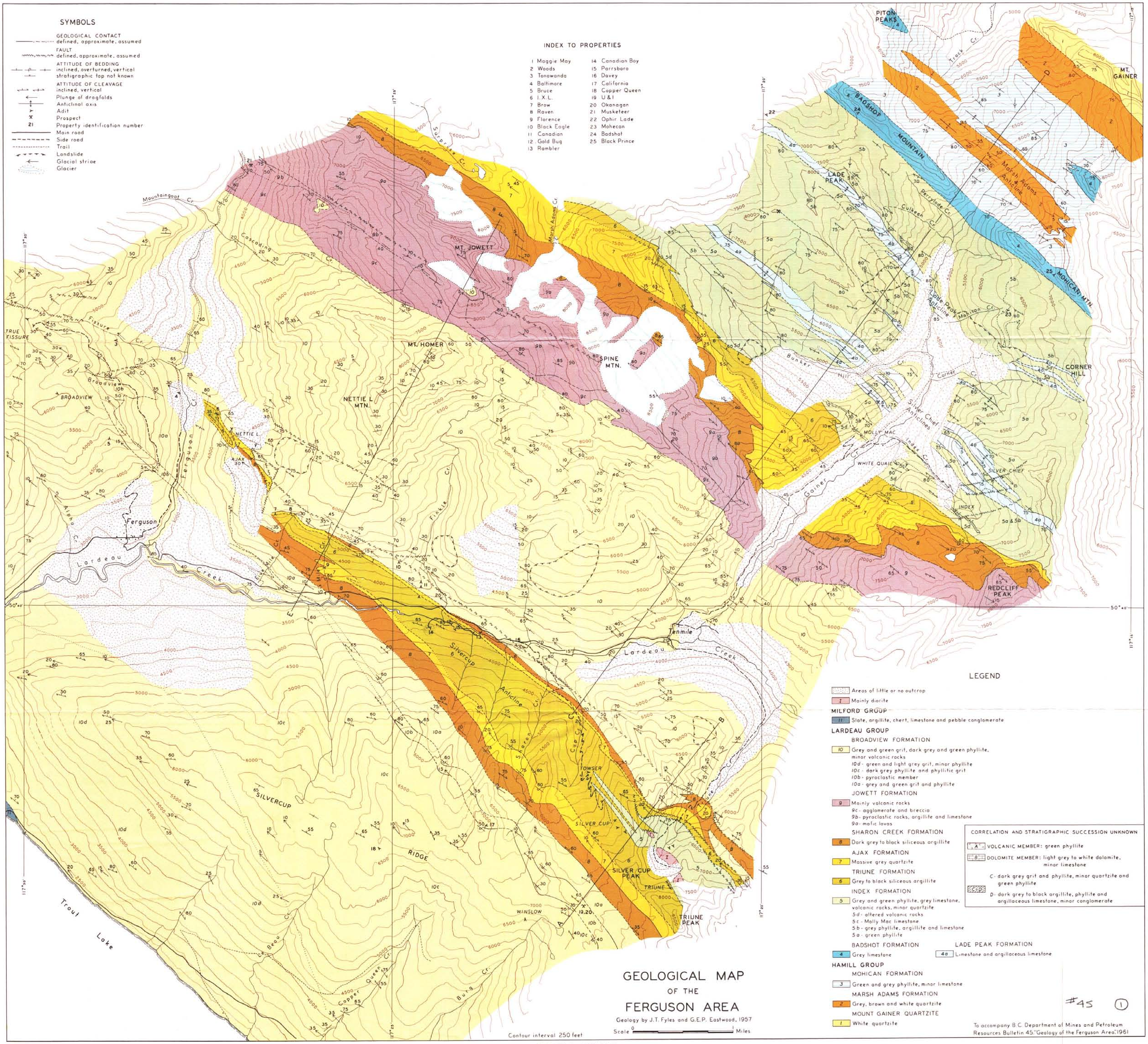

FIGURE 2 SHEET B