92F071 -07

096845

92F/12

92F071, 072, 073
LYNX MYRA PRICE

BUTTLE LAKE

by W.G. Jeffery - 1970

FILED 92F071

PROPERTY FILE

Chapter I

Location and Access

Buttle Lake is situated almost at the midpoint of the northwesterly trending axis of Vancouver Island. The area described in this report includes about 200 square miles of country most of which is situated west and south of Buttle Lake (<u>see</u> Fig. 1, map of area and inset of position on Vancouver Island). The western margins of the map-area lie on the flanks of the Golden Hinde (7,219 feet) which is the highest point on Vancouver Island. The nearest town, Campbell River, is approximately 30 miles northeast of the map-area. The area can be reached by road from Campbell River. A road along the east side of Buttle Lake provides access to Western Mines Limited which is located on Myra Creek 2 miles west of the south end of Buttle Lake.

Apart from a few square miles at the head of Great Central Lake, the area mapped lies within the boundaries of Strathcona Provincial Park. The park is subdivided into Class A nature conservancies and Class B areas.

Geological Statement

The Buttle Lake map-area is underlain by the most northerly exposures of Palaeozoic rocks known on Vancouver Island. Coast Intrusion rocks of a large batholith bound the area of pre-Permian volcanic rocks and Permian limestone to the west and south. On the northwest, north, and east the area of Permian rocks is bounded by the overlying Triassic volcanic rocks known as the Vancouver Group. The volcanic and sedimentary rocks are gently folded and cut by extensive north trending faults. Copper-lead-zinc-gold-silver mineralization has been discovered in the pre-Permian volcanic rocks in sufficient quantities to develop one mine. The boundary of the mapping was established so that the pre-Permian rocks and Permian limestone could be studied as a unit in order to determine the nature of their limits, and to assess the significance of mineralization in relation to the host rocks.

Topography

The topography of the Buttle Lake area is dominated by the prominent north-northwest trending valley that contains Buttle Lake. The lake surface is approximately 725 feet above sea level but fluctuates due to water storage control for the hydro-electric power operation situated at the north end of Upper Campbell Lake. The shores of Buttle Lake rise steeply to mountain summits in the order of 4,000 to 5,000 feet on either side. To the west the rugged topography rises to over 7,000 feet on the Golden Hinde, the highest peak on Vancouver Island. This region is deeply incised with short steep creeks flowing easterly into Buttle Lake. The main streams are Myra Creek, Phillips Creek, Marblerock Creek, and the

Wolf River. To the south the Buttle Lake valley contains the outlets of Thelwood and Price Creeks draining from the southwest and southeast respectively. The ground rises steeply to the clustered summits of Big Interior Mountain, Mount Septimus, Mount Rosseau, and Nine Peaks. This general area contains numerous small lakes and tarns, large cirques and waterfalls which make it scenically attractive. South of this high area the drainage is directed southward down the deeply glaciated valley of Drinkwater Creek, on which is situated Della Falls, to the head of Great Central Lake.

Climate, Vegetation, and Travel

The area has a wet mild winter in the lower areas with temperatures seldom below freezing point. Much snow accumulates on the mountains. Summers can be dry and warm with a relatively small amount of rain. Annual precipitation is in the order of 100 inches of which at least 90 per cent occurs in the winter months.

Below 4,500 feet the hills and valleys are covered by trees, and in the valleys some of the stands of Douglas fir are outstanding for their size. Within Strathcona Park there has been no widespread logging in the map-area except to clear the shores of Buttle Lake prior to flooding and to clean up after a large natural forest fire that occurred in 1958 at the mouth of Thelwood Creek at the south end of Buttle Lake. In general the trees are of moderate to large size and the underbrush is light. At elevations close to the timber line stunted and deformed trees and more abundant undergrowth form a dense tangle that makes travel difficult. The dense growth that develops on old talus slopes in steep sided creeks provide obstacles to travel. Above elevations of about 4,000 feet the country in general is open with grassy meadows, rocky summits, and clumps of alpine trees.

Despite the timber cover, the area is well suited for geological study. A few areas contain extensive till or gravel, and some of the more gentle slopes have only scattered outcrops, but the rock exposure in the map-area as a whole is abundant. Cliffs and canyons at lower elevations and rocky summits above timber line provide excellent exposures.

Most of the area must be travelled on foot or at higher levels, can be approached by helicopter. There are old, rough trails part way up Wolf River, Phillips Creek, and Price Creek. In the southern part of the area the best access is from Great Central Lake on a good trail along the bed of an abandoned logging railroad following Drinkwater Creek. Beyond the end of the railroad a trail extends to Della Falls with one or two old side trails to mineral prospects.

Glaciation

Specific studies of the glacial features of the area have not been made in this work, but the overall effects of glacial activity are clear. There are scoured rock walls in the major valleys and rounded, striated outcrops on the shores and small islands along the length of Buttle Lake. Glacial striae show no dominant direction of ice movement and no overall grain has been imparted to the topography by the action of moving ice. This lack of grain is related to the central location and high elevation of the area which is in the highest part of the Vancouver Island mountains. The striae observed indicate that ice movement was outward from the Buttle Lake area in existing valleys.

Till deposits occur on the more gently sloping valley walls as is the case on the western slopes of Buttle Lake between Wolf River and Phillips Creek.

There is evidence that the water in Buttle Lake has been at a higher level than at present. No detailed attempt has been made to reconstruct the history of the drainage but the following features are pertinent evidence of this former high lake level.

The till-covered slopes north of Phillips Creek to Marblerock Creek show fragmentary evidence of a poorly developed bench which was possibly a temporary lake shore. Between approximately 950 feet and 1,050 feet elevation, the slope is smooth and gentle and extends along the hillside. Below this there are gullies developed in the till cover to the present lake shore at 725 feet. Above the bench-like feature the slope steepens and is normally gullied by small creeks.

A large number of the creeks flowing into Buttle Lake have, over short sections close to their entry to the lake, deeply incised channels, waterfalls and rapids. The most obvious examples are the attractive falls at the mouth of Myra Creek tumbling from a relatively flat valley which extends back for at least 2 miles, and the waterfall a short distance up the Wolf River. Longitudinal profiles along these creeks show a normal stream gradient to a base level which can be interpreted as being from about 900 feet to 1,000 feet elevation. Below this point there is a sharp gradient increase down to the present lake level over a short length of channel to the mouth. Creeks exhibiting such a profile include Myra, Thelwood, Price, Henshaw, Shepherd, Phillips, and Wolf River.

History of Exploration

Strathcona Park was established on March 1, 1911. The initial staking of mineral showings began shortly after the park was opened to prospecting in 1917. At the southern end of Buttle Lake the main claim groups were first known as the Boulder, Paw, and Lynx groups; now are known as Price, Paramount, and Lynx respectively. The Price is on the westerly slopes of Thelwood Creek about a mile from the south end of Buttle Lake. The Paramount and Lynx are on the south and north slopes of Myra Creek about 2 miles west of Buttle Lake.

The Price (Boulder) group was originally located by James Cross and Associates of Victoria. The claims were Crown-granted in 1956, by Price Creek Mines Ltd. but little further work was done and ownership passed to W. T. and M. V. Miller, the former being one of the original associates.

The Paramount (Paw) group of claims was acquired by the Paramount Mining Company Limited represented by Joe Errington of Toronto. The claims were Crown-granted in July, 1924, when 10 diamond-drill holes were put down and a 60-foot crosscut tunnel was driven. Little other development work was done until The Granby Mining Company Limited optioned the property in 1952 and drilled four surface holes.

The Lynx claims were originally located by James Cross and Associates, and were later acquired by T. McQuillan of Vancouver. Development consisted of numerous trenches and an adit that only advanced a few feet. The claims were Crown-granted in March, 1924.

A number of private examinations were made of all these prospects in the 1940's and 1950's. The three properties were consolidated in 1959-60 and two additional diamond-drill holes were put down on the

Paramount. The options from the vendors of the three groups were taken over by Western Mines Limited in May, 1961. Extensive investigation has resulted in production commencing from the Lynx mine in 1967.

Mining activity from 1961 resulted in a number of other claims being recorded in the surrounding area. Exploration work has failed to reveal any further mineralization of major interest.

Previous Geological Work

H. C. Gunning carried out a geological reconnaissance of the Buttle Lake area in 1930. The area covered was more extensive than the present study and included a large area east of Buttle Lake and within the Esquimalt and Nanaimo Land Grant. The map was produced at a scale of 8 miles to 1 inch. Because it was a reconnaissance project no attempt was made to differentiate between Palaeozoic and Mesozoic rocks. The purpose was to outline the areas of intrusive rocks, describe the known mineral showings, and evaluate the mineral potential of the area.

The present study arose out of the successful development of Western Mines Limited after many years of intermittent investigation that often gave encouragement without any definite results. In 1930, Gunning first drew attention to the association of mineralization with the altered and sheared volcanic rocks and suggested that more extensive development was warranted. He also stressed that the best mineralization on the Lynx group was on the western wall of the schist zone and warranted particular attention.

However, the best surface showings were at the Paramount prospect and in subsequent private investigations most effort was directed there until the discoveries on the Lynx group in 1961.

In 1964, J. E. Muller of the Geological Survey of Canada included the Buttle Lake area within a mapping project of a much larger area. The geology essentially as mapped in this present study was published in 1965 at 2 miles to 1 inch as part of a preliminary map of the Comox Lake area.

In 1965, D.J.T. Carson of the Geological Survey of Canada made a study of the Price prospect as part of a metallogenic study of Vancouver Island.

From 1961 to 1963, R. W. Yole made palaeontological studies of the Upper Palaeozoic limestones of Vancouver Island and these studies included work on the Permian limestone of the Buttle Lake area.

In the work here presented, mapping was done on a scale of one-half mile to 1 inch on interim maps of the British Columbia Department of Lands, Forests, and Water Resources. Plotting was done with the aid of British Columbia government air photographs, altimeter readings, and compass resections.

Title Buttle Lake
Author W. G. Jeffery
Date and Typist March 4, 1970 bm 10

ACKNOWLEDGMENTS

Able assistance in the field was given in 1963 by N. E. Haimila, W. Dollery-Pardy, B. Kehlert, and D. Nelson, and in 1964, by N. E. Haimila, T. Moore, and B. Freidrick. In 1965, N. E. Haimila with the assistance of B. Lamb carried out further work in selected areas. The management and staff of Western Mines Limited gave their cooperation and willing assistance at all times. It was a pleasure to work with J. E. Muller and D.J.T. Carson of the Geological Survey of Canada. R. W. Yole gave valuable advice on the palaeontology and stratigraphy of the area.

REFERENCES

Carlisle, D. (1963): Pillow Breccias and their Aquagene Tuffs, Quadra Island, B.C., Jour. Geol., Vol. 71, pp. 48-71.

Carson, D.J.T. (1965): Geol. Surv., Canada, Paper 66-1, pp. 53-54.

Fyles, James T. (1955): Geology of the Cowichan Lake Area, Vancouver Island, British Columbia, B.C. Dept. of Mines, Bull. 37.

Clapp, C. H. (1912): Southern Vancouver Island, Geol. Surv., Canada, Mem. 13.

__________(1917): Sooke and Duncan Map-areas, Geol. Surv., Canada, Mem. 96.

Gunning, H. C. (1930): Buttle Lake Map-area, Vancouver Island, Geol. Surv., Canada, Sum. Rept., 1930, Pt. A, pp. 56-78.

Title Buttle Lake

Author W. G. Jeffery

Date and Typist March 4, 1970 bm 11a

McLellan, R. D. (1927): The Geology of the San Juan Islands, Univ. Wash. Publ. in Geol., Vol. 2.

Muller, J. E. (1963): Alberni Area, Geol. Surv., Canada, Map 49-1963.

__________ (1965): Comox Lake, Geol. Surv., Canada, Map 2-1965.

Sargent, H. (1940): Preliminary Report on Bedwell River Area, Vancouver Island, British Columbia, B.C. Dept. of Mines, Bull. 8.

__________ (1941): Supplementary Report on the Bedwell River Area, Vancouver Island, British Columbia, B.C. Dept. of Mines, Bull. 13.

Stevenson, J. S. (1945): Geology and Ore Deposits of the China Creek Area, Minister of Mines, B.C., Ann. Rept., 1944, pp. 142-161.

Sutherland Brown, A. (1966): Tectonic History of the Insular Belt of British Columbia, C.I.M., Vol. 8, pp. 83-100.

Yole, R. W. (1963): An Early Fauna from Vancouver Island, British Columbia, Bull., Can. Pet. Geol., Vol. 11, No. 2, pp. 138-149.

__________ (1964): A fauna and Stratigraphic Study of ~~Appee~~ Upper Palaeozoic Rocks of Vancouver Island, British Columbia, Ph.D. Thesis, U.B.C.

Wanless, R. K., Stevens, R. D., Lachance, G. R., and Edmonds, C. M. (1967): Age Determinations and Geologic Studies, Geol. Surv., Canada, Paper 66-17, pp. 21-22.

Title: Buttle Lake

Author: W. G. Jeffery

Date and Typist: March 4, 1970 bm 11

Chapter II

GENERAL GEOLOGY

Summary of General Geology

The Buttle Lake area is underlain by Late Palaeozoic and Mesozoic volcanic, sedimentary, and granitic rocks. The Palaeozoic layered rocks comprise a great thickness of volcanic breccias, tuffs, and greenstones, with lesser amounts of thin-bedded argillaceous and cherty tuffs, and sandstones overlain by a fossiliferous Lower Permian limestone bed. The thick lower, probably pre-Permian, pyroclastic sequence appears to be stratigraphically equivalent to the Lower Division of the Sicker Group described and mapped in the southern part of Vancouver Island (Clapp, Gunning, Fyles, Yole). However, it is clear that the facies changes from a dominantly volcanic character in the Buttle Lake area to a mixed volcanic and sedimentary nature to the southeast (Sutherland Brown). Here, as at Buttle Lake, the Lower Division of the southern Sicker Group rocks is overlain by crinoidal, fossiliferous Lower Permian limestone, and calcareous sedimentary rock. The Lower Permian limestone at Buttle Lake, equivalent to the Upper Division of the Sicker Group in southern Vancouver Island, has been studied and named the Buttle Lake Formation by Yole (1963, 1964). The unit is a well-developed massive crinoidal limestone with ribbon cherts in places.

Title: Buttle Lake

Author: W. G. Jeffery

Date and Typist: March 4, 1970 bm ~~14~~ 12

Table of Formations

Period	Name		Lithology
Jurassic (?) Lower Cretaceous (?)	Coast Intrusions		Granodiorite
	Intrusive Contact		
Triassic (and Permian ?)	Vancouver Group	Karmutsen Group	Basalt flows, pillow lavas, breccias, aquagene tuffs, and related sills of diabase. Thin-bedded clastic sediments.
	Disconformity		
Lower Permian	Sicker Group	Henshaw Formation	Clastic sediments, reworked volcanics, ash, and conglomerate.
		Buttle Lake Formation	Crinoidal limestone, dolomitic limestone, chert. Thin basal sandstone.
Lower Permian and/or Pennsylvanian		Lower Division	Thin-bedded clastic rocks.
			Mainly massive breccias and lesser bedded tuffs. - - - - - - - - - - - - - - - Mixed bedded tuffs and volcanic breccias, flows, tuffaceous cherts, and sediments.

The existence of a disconformity or paraconformity (Yole, 1964) between the Sicker Group and the overlying Triassic Vancouver Group has long been suggested by various workers. In the Buttle Lake area there is strong, though still somewhat circumstantial evidence of a break in the stratigraphic sequence at the top of the Permian limestone (Buttle Lake Formation). A thin heterogeneous assemblage of ash, clastic sediments, and calcareous conglomerates exposed in Henshaw Creek and correlated lithologically with other poorer outcrops in the area is termed in this report the Henshaw Formation. Although it is nowhere seen lying directly on the Buttle Lake Formation there are fragments of crinoidal limestone in the conglomerate, and the Henshaw Formation is believed to indicate a local erosional interval at the top of the Sicker Group.

Above rocks of the Sicker Group are the Karmutsen volcanic rocks which are the lower part of the Vancouver Group. The Vancouver Group rocks are dominantly volcanic in character but there is a prominent Upper Triassic limestone unit (Quatsino Formation) which can be traced widely throughout Insular Belt of British Columbia. These rocks are regarded mainly as Triassic in age but the lower part (Karmutsen) may extend down into the Permian period. The Karmutsen rocks consist of a great pile of basaltic volcanic flows, pillow lavas, pillow breccias, and aquagene tuffs. The basalts and pillow lavas are prominent in the Buttle Lake area where they overlie the Sicker Group rocks. At the base of these volcanic rocks and intercalated within them are, in a few places, thin beds of black and cream argillites. These rocks clearly occur above the Buttle Lake Formation, but appear to be lithologically distinct from the rocks of the Henshaw Formation, and are nowhere seen in contact with the Henshaw Formation. Thus there are some sediments of a minor extent that are thought to be the basal part of the Karmutsen rocks.

The upper part of the Sicker Group including the Buttle Lake Formation and the lower part of the Karmutsen rocks are intruded by diabase sills. These basic intrusions are related to the Karmutsen volcanic episode and are thus regarded as Triassic in age being part of the Vancouver Group rocks.

The Palaeozoic and Mesozoic layered rocks are cut by granitic masses belonging to the Coast Intrusions which are mostly granodiorite in composition. The intrusive rock, which is of batholithic dimensions, extends along the western margin of the map-area and also cuts off the Palaeozoic rocks to the south. Age determinations (Wanless, et al.) have indicated a Middle Jurassic age of intrusion.

The Permo-Pennsylvanian rocks of the Buttle Lake area appear to be exposed as part of a structural uplift in central Vancouver Island. Folds are gentle and open with a trend west of north. Folds in the overlying

Mesozoic rocks are also broad and open. Mapping by others indicates that the Mesozoic fold trends are more northwesterly and the divergence of fold structures between the two groups of rocks suggests a separation in time. Faults are more important than folds in considering the present distribution of the rocks and the tectonic pattern of the area. A set of northerly trending faults has offset the Buttle Lake Formation in more than one place. There are also lesser faults with northwesterly and westerly trends.

Northward the Permo-Pennsylvanian rock exposures are limited by the northerly gentle plunge of the overall anticlinal structure. To the south the upper part of the Sicker Group remain as remnants in the barely unroofed portion of the granitic batholith in this area.

Sicker Group

Rocks of the Sicker Group underlie most of the area studied at Buttle Lake; in fact the limits of the Palaeozoic exposures selected as those defining the area of study centred on Western Mines Limited.

Clapp (1912) first used the term Sicker but at that time the "Sicker Series" was incorrectly placed in the stratigraphic sequence. Later work on the San Juan Islands (McLellan), in the Buttle Lake area (Gunning), Bedwell River (Sargent), and the Cowichan Lake area (Fyles), has established the Sicker Group as comprising Lower Permian and probably older sedimentary and volcanic rocks. Yole (1964) has divided the Sicker

Group into a Lower Division of volcanic rocks with overlying non-calcareous, clastic sedimentary strata. The overlying Buttle Lake Formation is a limestone unit which in turn has an overlying unnamed unit of thin-bedded non-calcareous, clastic rocks.

The thin-bedded sediments overlying the Buttle Lake Formation were observed by Sargent (1941) and by Yole. The age and position of these sediments remain unclear and they may be a part of the Henshaw Formation described in this report from new observations in the vicinity of Henshaw Creek, or they may be related to the initial stages of the overlying Karmutsen volcanic rocks.

Lower Division

The rocks of the Lower Division of the Sicker Group underlie the area around the southern part of Buttle Lake, extending south toward the head of Great Central Lake and west to the slopes of the Golden Hinde and the valley of the Wolf River. The sequence can be divided into two parts, The lowermost and by far the greatest amount consists of a large but unknown thickness of volcanic breccias, tuffs, and flows. The upper part is composed of tuffaceous sediments, argillites, some sandstones, and minor conglomerates and has a considerable variation in thickness from place to place within the area.

Lower Division, Volcanic Unit

The base of the volcanic pile is not seen, but the thickness of the sequence is at least the order of 8,000 feet. One of the most easily accessible and most prominent exposures is on the steep slopes and cliffs on the southwest side of Buttle Lake just north of Myra Creek. These are some of the lowermost rocks and are clearly bedded with gentle dips to the west. They are fine-grained cream, green, blue, and purple tuffaceous rocks some of which appear to have been reworked and are now cherty tuffaceous sedimentary rocks. There are some sections of massive coarse tuffs lacking bedding and others with graded bedding coarse to fine upwards. Above elevations of about 1,000 feet above Buttle Lake, bedded rocks become fewer and there are only short sections of cream and yellow and green tuffs in otherwise unbedded massive greenstone. This decrease in amount of bedded fine-grained pyroclastic rocks with only thin sections of cherts and fine-grained cherty tuffs continues at higher levels in the volcanic sequence. Exposures along the ridge, which at its highest point forms Phillips Mountain and the eastern end of the ridge north of Myra Creek, show a considerable amount of coarse volcanic breccia with fragments up to 1 foot across. Westward and higher in the sequence toward the base of the Buttle Lake Formation the volcanic breccias become coarser.

Another locality where the dominantly bedded character of the lower part of the Lower Division is very evident is on the steep bluffs between Price and Thelwood Creeks. These rocks are very clearly seen from the south end of Buttle Lake. Higher in the rock sequence, along the ridge to the south, these well-bedded siliceous green and cream tuffs and minor reworked tuffaceous sediments give way to massive coarse volcanic breccias with fragments up to 2 feet across. As elsewhere these breccias are intercalated with relatively thin sections of fine-grained pyroclastic rocks, tuffs, and flows with some of the tuffs exhibiting graded bedding coarse to fine upwards.

The overall character of the volcanic rocks of the Lower Division of the Sicker Group indicates that the earliest stages represented were periods of quiet or somewhat distant volcanic activity possibly interrupted for short intervals that allowed reworking of the fine pyroclastic rocks and deposition of tuffaceous cherts and greywackes. Volcanic activity increased with time so that large volumes of volcanic breccia were deposited. Intermittent quieter periods resulted in deposition of ash and tuff.

<u>Lower Division, Sedimentary Unit</u>

The sedimentary rocks of the Lower Division of the Sicker Group are irregular in distribution and vary considerably in thickness from place to place. At the type section measured by Yole (1964) the basal sedimentary rocks are the order of 30 to 50 feet thick, but there are places where the limestone of the overlying Buttle Lake Formation rests directly upon the pyroclastic rocks of the Lower Division. In general the strata are usually not greater than about 100 feet thick. Exceptionally, traverses made on the western shores of Buttle Lake below Marble Peak revealed intermittent outcrops of strata that unless repeated by faulting must aggregate about 1,300 feet in thickness. Another area where there is evidence of large thicknesses of the upper sedimentary part of the Lower Division is on the slopes of El Piveto Mountain at the head of the west fork of the Wolf River. Large parts of this section are covered but it would appear that the overall thickness is at least about 500 feet.

The rocks exposed are variably thin to medium bedded. They consist of grey, green, and black argillites, grey to green fine sandstone beds with some graded bedding, and pale green, dark green, and buff tuffaceous beds that are probably in part reworked, and water-lain volcanic material. All these rocks are interlayered in varying proportions with the tuffaceous facies dominating the lower part of the sequence. As a consequence the contact between the lower volcanic unit and the overlying sedimentary sequence is difficult to define especially because all the exposures of these rocks are in areas where there is a large amount of cover and continuous exposures of the section are lacking. In addition to the above sedimentary rocks, seen wherever a thick or thin section is exposed, the sequence on the slopes of El Piveto Mountain included conglomerates. This is the farthest west in the area that this upper unit of the Lower Division was observed. The conglomerates occur in beds up to 6 feet thick and as lenses in the sandy horizons. Pebbles of volcanic rocks and argillite up to 4 inches across were seen together with angular fragments of black argillite in places.

The nature of this sedimentary sequence and its irregular distribution indicates an interval of local sedimentary deposition at the end of a long period of volcanic activity. Some local erosion at this time is suggested by occurrence of conglomerates in parts of the area. This suggests that there was some uplift or other deformation if only in a minor form, and a break in the overall rock sequence just prior to the deposition of the Lower Permian limestone.

The bedded rocks have shallow to moderate attitudes that reflect a pattern of broad open folds in the area. The only steep dips were noted where there was local disruption by faults.

Buttle Lake Formation

The Buttle Lake Formation and other occurrences of Permian limestone on Vancouver Island has been described by Yole (1964).

In mapping the Buttle Lake area the limestone formation provides a distinctive horizon at the top of the Sicker Group. The massive volcanic rocks that occur both above and below the Buttle Lake Formation obscure many geological features so that problems of the geological structure in the area were resolved by the distribution of this limestone.

The limestone is well bedded to massive in places so that the thick massive beds provide little indication of structure where the outcrops are small. The formation is mainly a medium-grained, light grey limestone with little dolomite but with a number of zones containing nodules, lenses, and irregular thin bands of light and dark grey chert.

The type section given by Yole (1964) is described as a nearly complete section measured 0.7 mile south of the west end of a small lake (Azure Lake) at the headwaters of the west branch of Marblerock Creek. The limestone was not seen exposed so completely in any other part of the area mapped, and the section was remeasured (see Fig.   ) in the vicinity of Yole's original section. There are some short covered intervals, some evidence of local faulting, and the section is intruded by medium- to coarse-grained diabase sills.

The underlying rocks consist of green and purplish tuffs and volcanic breccias of the Lower Division of the Sicker Group. In this locality there is no sedimentary upper unit of the Lower Division directly underlying the limestone. There are thin-bedded partly calcareous and fossiliferous sediments at the base of the section that have been included in the Buttle Lake Formation following inclusions by Yole (1964) of a basal 10 feet of greywacke sandstone with pebble lenses in the type section. The basal beds consist of 4 feet of dark grey, fine-grained greywacke, 3 feet of 6-inch beds of sandstone with thin conglomerate lenses, and 18 feet of thin-bedded black, fissile argillite. The lowest fossiliferous horizon lies in the bedded sandstone and the assemblage indicates a Late Palaeozoic age. Above the argillites a short covered interval obscures the contact with overlying buff to light grey, massive limestone. The first fossil assemblage that can be specifically dated as Early Permian (Wolfcamp-Leonard) occurs 160 feet above the base in limestone with irregular brown shaly partings. From the hidden contact with the basal argillites to the top of the section the bulk of the Buttle Lake Formation is composed of medium-grained grey crinoidal limestone with a considerable amount of ribbons, nodules, and lenses of grey, blue, and cream chert. In places chert comprises up to about 40 per cent of the rock. Bedding has a range from tens of feet of massive crystalline limestone to approximately 6-inch partings, and there are also some thin shaly partings in places. A large intrusive diabase sill 210 feet thick intrudes the Buttle Lake Formation 350 feet above the base of the section.

Steatite was observed in the 5-foot section of limestone and chert overlying the sill. From 555 feet above the base to a local fault at 665 feet the rock is dark grey to black in places with abundant thin grey chert beds imparting a well-bedded appearance to the limestone. Overlying this to about 700 feet is,with sandy layers, one of the few dolomitic sections of the formation.

The top of the Buttle Lake Formation is close to the top of the ridge (named Limestone Ridge in the field mapping) and is overlain by an intrusive diabase sill. At the crest of the ridge are some thin exposures of thin-bedded clastic green, red, and purple sediments that are possibly a part of the Henshaw Formation.

Considering the whole area, the limestone in and at the headwaters of Marblerock Creek is by far the most extensively exposed, accessible outcrop. Elsewhere there are many good exposures of limestone with similar features to those described in the type section.

In many places the limestone section is parted by the intrusive diabase rock associated with the overlying Karmutsen volcanic rocks. Apart from the Limestone Ridge area and Marblerock Creek diabase, intrusions are also prominent on the ridge south of the Golden Hinde and in the area of Henshaw Creek. The cliff exposures of the limestone and diabase on the north wall of Marblerock Creek show that the sill transgresses the limestone beds along strike in places.

Gunning (1930) observed that there are at least two other beds of limestone, lower in the Palaeozoic section, exposed on the west side of

Buttle Lake. One of these exposures is in the bay just north of Phillips Creek. There are in fact three limestone outcrops of limited extent in this area, one being on both banks at the mouth of Phillips Creek and the other two to the north. Evidence from mapping suggest that these exposures are either faulted and eroded parts of the Buttle Lake Formation or possibly local lime deposition associated with the Henshaw Formation rocks. There is evidence, to be described later, of the presence of Henshaw sediments in association with the limestone.

The other limestone occurrence noted by Gunning was at the first point on the lake shore south of Marblerock Creek. No outcrops were noted along this section of the shoreline but, because of hydro-electric development, the lake level has risen since the 1930 observations were made. The slopes above this part of Buttle Lake are almost completely covered with glacial till and outcrops are very sparse. However, the limestone had been interpolated as underlying these slopes. If it extends to the lake shore an excessive thickness would be indicated unless there is some undetermined faulting. An alternative possibility is that the outcrop observed by Gunning was a portion of the limestone on a north trending fault similar to the small exposures to the south on the lake shore. Air photographs and other field evidence of major north trending faults in this part of Buttle Lake suggest a fault at the first point south of Marblerock Creek.

However limestone has not been shown on the map at this point as none was observed in the field. In the first bay immediately north of the mouth of Marblerock Creek, a limestone outcrop was observed at a time of very low water level in Buttle Lake (Muller, personal communication). This confirms the mapped and interpreted extension of the limestone north of the lower reaches of Marblerock Creek.

A thin limestone member, about 40 feet thick, was seen about 300 feet below the base of the main limestone on the eastern slopes of the Golden Hinde. Here, there is abundant diabase, intrusive sill rock which may have separated the thin limestone member from the main part of the Buttle Lake Formation.

Evidence of limestone at lower levels than the Buttle Lake Formation was not seen elsewhere in the area. Consequently it is thought that there is only one limestone member and Gunning's original suggestion of there being more than one, may not be so in view of mapped structure of the area.

The Buttle Lake limestone is medium- to coarse-grained crinoidal limestone. As described by Yole (1964), under Folk's classification the majority of the rocks fall into Classes I and II (crinoidal biosparite and biosparrudite, and crinoidal biomicrite and biomicrorudite). Chert, forming about 5 per cent overall, is widespread. The chert occurs as irregular lenses and layers with uneven but smooth, rounded contacts with fresh limestone. Based on evidence derived from a study of petrography, stratigraphy, sedimentary structures and fossils, Yole concludes that the environment of deposition of the Sicker Group was one of moderately deep waters in a basin on the continental borderland. Abundant silica in the cherty sediments of this sequence was derived diagenetically from volcanic activity.

The Buttle Lake limestone is indicative of deposition in a shallow environment possibly in connection with the development of islands in the former marine basin. Muddy bottoms inhabited by Bryozoans allowed colonization by crinoids and other invertebrates. The shallow waters with suitable temperature, salinity, and organic life caused precipitation of calcium carbonate and deposition of lime mud.

Chert formation in the limestone beds was mainly diagenetic but probably at a late stage of burial. The origin of the silica may be associated with the waning stages of volcanic activity and this would undoubtedly have fluctuated considerably both in time and place throughout the region.

Yole concludes that the Permian deposition was primarily in eugeosynclinal conditions exemplified by the deep-water volcanic and minor thin-bedded sedimentary pile. These conditions were temporarily modified during deposition of the shelf or miogeosynclinal Buttle Lake limestone.

Title Buttle Lake

Author W. G. Jeffery

Date and Typist March 5, 1970 bm 27

This Upper Palaeozoic limestone may be akin in overall environment to the Upper Triassic limestone of the Western Cordillera in that these shelf deposits were transitory within major trough-like accumulations of the eugeosyncline.

The Henshaw Formation

The Henshaw Formation is a proposed new formational name of a heterogeneous and irregularly distributed group of rocks that appear to disconformably overlie the Buttle Lake limestone. All the evidence for their distribution and relationship is presented below. The Henshaw Formation is placed as the uppermost unit in the Sicker Group.

Although a break in the stratigraphic sequence at the top of the Palaeozoic section has long been suspected by previous workers, the rocks exhibit no marked angular unconformity with the overlying Triassic rocks. Other positive proof has been lacking in the past, but the observations that resulted in the recognition of the Henshaw Formation provide strong indications of an erosional surface at the top of the Permian limestone.

The name of the formation is taken from the location of the most widespread occurrence of the rocks close to the mouth of Henshaw Creek where it flows into the east side of Buttle Lake. These observations came when the mapping project was well advanced but their recognition helped to resolve some of the confusion that previously existed regarding the contrasting lithologies of the rocks seen immediately above or very close to the top of the Buttle Lake limestone.

In general the Henshaw Formation consists of conglomerate with crinoidal limestone boulders, varying amounts of purple and green volcanic material, purple lithic volcanic ash and agglomerate, reworked andesitic breccia with limestone fragments ("sharpstone" conglomerate) and limy cement, and purple to grey glassy volcanic ash and reworked tuff.

Title Buttle Lake

Author W.G.J.

Date and Typist March 4, 1970 bl 29

Distribution

The Henshaw Formation is exposed in the gorge of Henshaw Creek for about 1 mile, between 780 feet and 1,900 feet elevation, from a point close to Buttle Lake where the creek cuts through a low flat benched area extensively covered with forest and overburden. The most widespread outcrops are in the creek although there are smaller but more accessible exposures just off the foot trail that extends from the lake to Flower Ridge. Regional mapping has shown that many faults must occur under this low-lying area and that there is a considerable amount of intrusive diabase in this area.

A less varied lithology is exposed from the north bank of Ralph River to the east shore of Buttle Lake at a point approximately opposite the mouth of Phillips Creek. Most of the outcrops occur in the creeks which flow west into Buttle Lake.

In the vicinity of Phillips Creek there are exposures of the Henshaw Formation for about a quarter of a mile upstream from the lake, and also intermittent exposures with limestone for about 1 mile north of Phillip Creek along the lakeshore.

Small outcrops of Henshaw Formation were observed on the shoulder north of Phillips Creek between 1,450 feet and 1,950 feet elevation and possibly others at 2,800 feet elevation.

Conglomerates that are believed to be the Henshaw Formation occur on the plateau area at an elevation of 5,100 feet west-southwest of Marble Peak. A fine-grained part of the formation is exposed on the western ridge of Marble Peak, and also at 4,900 feet elevation directly south of the peak.

Thin, disrupted exposures of fine-grained clastic rocks of the Henshaw Formation occur on and near the crest of Limestone Ridge. Most of the ridge is underlain by diabase sill rock that overlies the Buttle Lake limestone. The Henshaw rocks lie below the sill at the southern end of the ridge, above the sill in the centre, and both above and below the sill at the north end towards Mount McBride. The extensions northward to the steep southeasterly face of Mount McBride are not known.

Purple clastic sedimentary strata about 12 feet thick were seen at 4,500 feet elevation on the east slope of the Golden Hinde. These rocks appear to be exposed for almost 1 mile along the slope. They overlie the Buttle Lake limestone, and are below a series of alterating basalt layers and black to green, fine-grained cherts and argillites that are believed to be the basal part of the Karmutsen Group.

In addition to all these localities, thin sediments that may be equivalent to Henshaw rocks were observed overlying Permian limestone at some places along Flower Ridge, and may extend southward to the vicinity of Cream Lake. The correlation of these sediments is uncertain due to their small extent, and the considerable faulting in the area.

Lithology

Rock types of various localities are described in order of decreasing aerial extent and partly according to degree of lithologic similarity and reliability of correlation with the type exposures at Henshaw Creek. It is emphasized that correlation of the scattered outcrops of these rocks is made on the basis of lithologic similarities and their observed position in relation to the Permian limestone and the overlying Karmutsen rocks.

Henshaw Creek. The area of type exposures is complicated by a considerable amount of faulting and intrusion of diabase. The following description is based on numerous separate observations. No section was measured in the rather difficult area of Henshaw Creek so the thickness of these rocks as described remains very tentative.

The presence of crinoidal limestone fragments in the sharpstone conglomerates first indicated a post-Buttle Lake Formation age, but the direct relationship to the limestone was not seen. Immediately to the east of the Henshaw Creek exposure, on gentle wooded slopes between Henshaw and Shepherd Creeks, no trace of the Permian limestone was found although the regional topographic pattern would indicate its presence. Where reasonably thick, limestone beds similar to those seen immediately to the north and south of this area, usually reveal their presence even when covered by overburden by irregular topography, potholing, and a change in the surface vegetation. Thus it seems likely that in this area the Buttle Lake limestone is either unusually thin (as indicated on the map) or has locally been removed completely, and so the Henshaw Creek rocks may represent a part of a locally thick sequence of post-Buttle Lake Formation rocks preserved in a fault zone.

The interpretation of the rocks in Henshaw Creek is further complicated by the fact that some of these rocks could be part of the sedimentary unit of the Lower Division; that is, pre-Buttle Lake Formation sediments. In this event the Henshaw Formation rests directly on the upper part of the Lower Division with an undetected erosion surface separating the two. This is illustrated below.

The following lithologic description and estimated thickness is based on observations of exposures that are complicated by many faults, and is therefore open to revision.

The lowermost rock of the Henshaw Formation appears to be a conglomerate composed of fine-grained limestone and aphanitic andesite pebbles and boulders in a matrix of calcite, green volcanic, and black shale fragments that grades upward to a coarse-grained calcarenite of the same components with pyrite forming up to 1 per cent of the rock. The conglomerate is about 40 feet thick. It is overlain by a non-calcareous, fine-grained purple welded tuff which may be from 10 to 30 feet thick.

These rocks are overlain by a massive unit of reworked volcanic breccia and ash that in some layers contains scattered limestone fragments and boulders, and fragments of siliceous clastic sedimentary rock and chert. This unit appears to be between 100 and 200 feet thick. Overlying the reworked volcanic breccia is a thin ripple-marked sandstone bed that grades rapidly up into what has been termed in the field "sharpstone conglomerate." This conglomerate is composed of angular fragments, 1 or 2 inches across, of light to medium green aphanitic andesite and fine-grained purple clastic sedimentary rock set in a fine-grained matrix of the same material with some carbonate. Rare crinoidal limestone fragments and boulders occur within the sharpstone conglomerate.

Similar rocks are seen elsewhere which are grey and green in colour but lack the purple sedimentary rock fragments and contain more rounded pebbles which makes them conglomeratic in appearance. These may be part of the Henshaw Formation but are similar in many respects to the clastic sediments seen in places underlying the Permian limestone. There are also included sandy and silty beds. The sandstones show some cross-bedding, and local patches of disseminated pyrite form up to 5 per cent of the rock. The fine-grained silty beds have yielded poorly preserved fossils which have been described by Yole as Lower Palaeozoic. At a higher elevation and possibly overlying these conglomerates there is further sharpstone conglomerate similar to that described previously.

As the fossiliferous beds are the only rocks that provide any indication of age, the possibility that they are not post-Buttle Lake Formation but are part of the Lower Division of the Sicker Group underlying the limestone, must be considered. The alternative relationships are illustrated in the sketch of Figure . The lithology and appearance of the fossiliferous clastic rocks and conglomerates is more similar to the Henshaw Formation rock types than to the known pre-Buttle Lake Formation strata. Thus the inclusion of the fossiliferous horizons as part of the Henshaw Formation is favoured (Fig. , sketch B). The sharpstone conglomerate together with the fossiliferous beds is about 200 feet thick.

Above the sharpstone conglomerate there are some greywacke and welded tuff beds. The tuff is a massive dark green rock that grades over about 10 feet into purple siliceous ashy and lapilli tuff and volcanic breccia. Throughout these rocks the matrix colour varies from green to purple, and the fragments range from sparse to abundant, giving rise to a wide variety of textures. In places the fragments are dominantly brick red jasper. This sequence of rocks is possibly 300 feet thick and is the uppermost part of the Henshaw Formation in the Henshaw Creek area. A sketch of the proposed stratigraphic sequence is shown in Figure 2.

The Henshaw Creek area is complicated by a large number of faults. North trending faults cut across an earlier set of faults trending east-southeast. There are also east-northeast and northeast trending faults. The regional study clearly indicates that the largest movements have occurred on the north trending faults.

The Henshaw Formation rocks exhibit widely variable dips and rapidly changing lithology in section and along strike. The suggested environment may have been irregular channel filling with intercalation and reworking of material on a local scale.

Ralph River. North of the Ralph River, the Buttle Lake Formation is overlain by sedimentary strata that are interpreted as belonging to the Henshaw Formation.

Directly above the limestone is a 1-foot thick bed of foliated siliceous to glassy light green and purple ash. In Ralph River poor exposures at approximately 1,500 feet elevation indicate that this ash bed is covering an uneven or undulating surface. Above the ash bed there is a 5- to 10-foot thickness of purple lapilli tuff, covered by 5 feet of blocky purple breccia with fragments up to 6 inches in size.

Overlying these thin units is a massive conglomerate with greyish-green and occasionally purple siliceous and glassy fragments in a fine-grained glassy purple matrix. The exposures are not good but a rough estimate of thickness is 100 feet. This conglomerate grades upward into a similar rock that has dominantly purple fragments in a fine-grained greyish-green groundmass. This zone is in the order of 200 feet thick. The entire conglomerate zone is weakly foliated with incipient shear planes at low angles of dip.

South of the Ralph River no equivalent rocks were observed at the top of the Permian limestone. But the top of the limestone here is considerably higher in elevation than on the north side. An east northeasterly trending fault is inferred along the upper part of the Ralph River.

The Henshaw Formation is intermittently and poorly exposed in creeks draining into Buttle Lake north of Ralph River. The general lithology is similar to that described above, and the dips and strikes of the Henshaw Formation are in accord with the attitudes in the underlying limestone. East-northeast trending faults occur in the area and toward the north one such fault downfaults both the Henshaw Formation and the Buttle Lake limestone so that most of the more northerly surface exposures are below lake level. Diabase dykes cut the Henshaw rocks.

Phillips Creek. The exposures of sedimentary, volcanic, and reworked volcanic rocks seen along the shore of Buttle Lake for up to 1 1/2 miles north of the mouth of Phillips Creek reveal a varied lithology. The low shoreline makes the outcrops intermittent; there is considerable faulting in the area with probable repetition of beds, so that the full picture remains unclear.

The coarse-grained crinoidal limestone at the mouth of Phillips Creek carries much fine-grained, purplish-red material that stains and colours the rock is both disseminated and occurs in stringers. The limestone occurring along the shore farther north is of a similar character. Here it grades down into limy tuffs and thin bands of pebble conglomerate. Above the limestone, though not seen in direct contact with it, are red, green, purple, and brown sedimentary strata interlayered with tuffs, ashy beds, and coarser pyroclastic rocks. The limestone and the associated volcanic rocks contain corals, bryozoans as well as abundant crinoid ossicles. The purple sediments and reworked tuffs containing some cross-bedding grade up to sedimentary breccia beds at a point on the shore opposite a small island. These "shale-chip breccias" consist of angular to sub-angular fragments of dark purplish mudstone set in a lighter coloured similar matrix. Part of these clastic rocks are also fossiliferous and calcareous. There are additional sedimentary conglomerate beds. All these strata dip to the north and northwest and thus appear to grade up to the next outcrop of well-bedded purple and grey crinoidal limestone. This is very similar to the limestone at the mouth of Phillips Creek so that the evidence suggests that these small disrupted limestone occurrences along the western shore of Buttle Lake may represent a local area of lime deposition within the Henshaw Formation. Northward along the shore the rocks are volcanic and coarse clastic rocks with some sparse but widespread crinoid remnants and rare limestone fragments. Similar volcanic breccia and tuff-like rocks bearing remnant crinoidal debris occur on the west side of the rocky peninsula in Buttle Lake opposite the mouth of Ralph River.

The correct sequence at Phillips Creek is uncertain but allowing for possible repetition by faulting, the sequence in the northward dipping sedimentary and volcanic rocks is lithologically comparable to the lower parts of the Henshaw Creek sequence. In summary the sedimentary rocks consist of mixed purple ash and limestone debris with increasing amounts of ash and tuffaceous material and lesser amounts of limestone fragments upward. Above these rocks are purple and green volcanic agglomerates and reworked breccias with crinoid remnants. There may have been a greater amount of reworking of the rocks at Phillips Creek than at Henshaw Creek.

A schematic section of the Henshaw Formation at Phillips Creek and its possible relation to the rocks observed at Ralph River is presented on Figure . An approximate thickness of 100 feet of Henshaw rocks is exposed.

The rocks described above at Phillips Creek are bounded on the west by a north trending fault inshore from Buttle Lake, and they are probably repeated by east-northeast trending faults. Apart from the exposures at lake level described above, traverses on the wooded and largely till-covered slopes up from the lake north of Phillips Creek revealed several small exposures of sedimentary rocks that are interpreted as being part of the Henshaw Formation. The rocks consist of purple grits, reworked tuffs, and calcareous tuffs. These strata were observed at elevations between 1,400 and 2,000 feet on the hillside but whether the rocks occur intermittently or continuously is unknown. Their correlation with the Henshaw Formation remains tentative but if this is the case their location may be due to a north trending fault. The geology is complicated by the presence of abundant diabase intrusives on the slope above the Henshaw rocks.

On the same slope a single outcrop of purple, calcareous, tuffaceous rock at 2,750 elevation may indicate another faulted slice of the Permian rock sequence.

Marble Peak. On the plateau area south and southwest of Marble Peak there are rocks that are similar to the Henshaw Creek exposures.

To the southwest of Marble Peak there are conglomerates with grey-purple cobbles and pebbles of andesite in a purple, tuffaceous matrix, blue-green, aphanitic, andesite pebbles in a light purple, calcareous, volcanic sandstone. Some of the textures closely resemble those seen at Phillips Creek.

Directly south of Marble Peak there are outcrops of bedded, argillaceous, ashy tuff that overlies limestone with a pronounced karst topography. Similar rocks occur on the hill between Marble Peak and the head of Marblerock Creek adjacent to an east-southeasterly trending fault.

This overall upland plateau area reveals numerous faults. It is apparent that both north and east-southeast trending faults form some of the boundaries and control the distribution of the Henshaw strata.

Limestone Ridge. A thin set of bedded sedimentary rocks assumed to belong to the Henshaw Formation are exposed near the top of Limestone Ridge. The rocks are thin-bedded, light grey, and purple cherts approximately 40 feet thick overlain by purple, irregularly bedded, argillaceous tuff or ash that is about 20 feet thick. The east trending faults and diabase sills complicate the relationships. The Henshaw rocks occur both below and above the diabase sill.

Golden Hinde. On the steep easterly slope of the Golden Hinde there is an irregularly bedded, purple, argillaceous, tuff bed that is about 12 feet thick which lies directly on the limestone and is seemingly conformable with the limestone. Intermittent observations indicate that this bed may persist along strike for about 1 mile at 4,500 feet elevation.

Flower Ridge. At 4,400 feet elevation on the west side of Flower Ridge jasperoid sediments, purple to brick red in colour, were observed overlying the limestone. Correlation with the Henshaw Formation must remain doubtful but the siliceous cherty nature of the strata is similar to those occurring on Limestone Ridge. The numerous southeast trending faults may have influenced the extent of deposition of these rocks.

Cream Lake. No mapping was done in the vicinity of Cream Lake but the area was visited. On the east side of the lake there is a clastic limestone with intercalated layers of fine-grained, green, and purple ash rock. Some of the fragments consist of weathered corals and brachiopods and the rock is similar to that seen at and near the mouth of Phillips Creek. There are many north and east trending faults and also irregular intrusive rocks in the area.

Correlation and Age

The evidence for the correlation of these separate rock exposures rests on their similar lithology and on their definite or interpreted stratigraphic position. The dominant feature of the lithology is that there is considerable evidence of crinoidal limestone debris in parts of the sedimentary sequence. The other lithological similarity is the purple-red tuffaceous and ash facies.

The evidence for the age of these rocks is outlined as follows:

1. The sediments occur immediately above the Buttle Lake Formation. In the area of Ralph River there is evidence of a lapies surface, that is, water-worn grooves and ridges, on the top of the Buttle Lake limestone.
2. Parts of the sequence include crinoidal limestone indicating a post-Buttle Lake Formation age.
3. Purple tuffaceous material is widespread and at Phillips Creek this is mixed with a crinoidal limestone.

4. The Henshaw Formation rocks are overlain in places by younger, thin, argillaceous strata believed to be a part of the Karmutsen Group.

5. The Henshaw rocks are intruded by diabase intrusions related to the overlying Karmutsen volcanic rocks.

6. Faults appear to displace the Henshaw Formation rocks in a similar manner to the underlying limestone.

7. Limited fossil evidence indicates a Late Palaeozoic age.

8. The clastic sediments include fragments of crinoidal limestone, chert, andesite, purple clastic and tuffaceous rocks, and minor black, argillaceous rocks. No evident Karmutsen basalt, diabase, or granitic rocks were seen.

9. The pyroclastic character of the Henshaw volcanic material is different from the overlying Karmutsen basalts and pillow lavas.

The observations made in the area mapped indicate that the thickest accumulations of the Henshaw Formation are east of Buttle Lake and that the sediments may thicken from west to east. There is some evidence that the rocks are in places bounded by easterly trending faults, indicating that this faulting and the deposition of the Henshaw Formation may have taken place at about the same time.

The sporadic distribution of crinoidal limestone debris indicates an erosional surface on the Buttle Lake limestone. A karst lapies surface infilled with overlying volcanic material can be observed at the top of the limestone in Ralph River. Elsewhere, evidence of overlying volcanic flow rock infilling an irregular limestone surface was seen (<u>see</u> Plate).

The Buttle Lake limestone as measured on Limestone Ridge is 1,120 feet thick and in comparison with estimates made elsewhere in the area it is clear that this measured section happens to be about the thickest limestone section in the area. No other estimates are greater than 1,000 feet. Yole (1964) gives thicknesses of 858 feet in Marblerock Creek and about 800 feet on the west fork of the Wolf River. Further to the south in the area the limestone bed is clearly much thinner. Sargent (1941) studied the isolated and faulted segments of Permian limestone at Big Interior Mountain, Beauty Lake, and at the headwaters of Drinkwater Creek. In the vicinity of Cream Lake he gave an estimate that the minimum thickness was 350 feet. Sargent concluded that although the area was considerably faulted the original deposition of the limestone was probably basinal in character.

The Henshaw sediments are taken to represent a break in sedimentation at the top of the Buttle Lake limestone. The rocks are the result of local erosion and reworking with material which indicates the onset of the next cycle of volcanic activity in the area.


CON REID
EL PIVETO MTN
Wolf River
River
MT McBRIDE
MARBLE PK
BUTTLE LAKE
STRATHCONA PARK
GOLDEN HINDE
Burman Lake
MT BURMAN
Phillips
PHILLIPS MTN
Ralph R
Shepherd Cr
Henshaw Cr
Myra Cr
Tennent Lake
MT MYRA
Thelwood Lake
Price Cr
FLOWER RIDGE
49°35'
LEGEND
Drift and alluvium
Granite, granodiorite intrusive rocks
VANCOUVER GROUP
Karmutsen Group
Karmutsen volcanic rocks; basalt flows, pillow lavas, breccias, diabase intrusions.
Intrusions of diabase
Lower sediments, argillites
PERMIAN ?
Henshaw Formation.
Conglomerate, sharpstone conglomerate, greywacke, ash beds.
SICKER GROUP
PERMIAN
Buttle Lake Formation.
~~Mainly~~ limestone, ~~thin bedded sediments~~.
Lower Division
Mainly sediments; argillites, cherts, tuffs.
Volcanic tuffs, pyroclastic rocks, breccias, some volcanic flows, diabase intrusions.
SYMBOLS
Geological boundary
defined
approximate
assumed
Bedding
Strike and dip
Vertical
Horizontal
Faults
defined
approximate
assumed
Foliation
Schistosity with dip
Mineral Prospects.
PROPERTY FILE
92F071
TO ACCOMPANY 1970 RPT BY JEFFREY