GEOLOGICAL SURVEY OF CANADA COMMISSION GÉOLOGIQUE DU CANADA
DEPARTMENT OF ENERGY, MINES AND RESOURCES
MINISTÈRE DE L'ÉNERGIE, DES MINES ET DES RESSOURCES

LEGEND

SURFICIAL DEPOSITS
QUATERNARY

HOLOCENE

I — *GLACIER ICE: ice and semi-permanent snow; thickness largely unknown but in order of tens of metres; occurs as irregular, tongue - and cuspate-shaped masses. Comprises cirque glaciers, small mountain ice caps, and valley glaciers. Includes minor areas of loose morainal debris and nunataks which consist largely of rock and colluvium-covered rock*

O — *ORGANIC DEPOSITS: peat, muck, minor sand, silt, and tephra; up to 3 m thick; occurs under bogs and wetlands. Only a few large deposits are mapped; small unmapped deposits occupy closed depressions in upland areas and abandoned channels and segments of floodplains where alluvial damming has caused ponding*

COLLUVIAL DEPOSITS: rubble and diamicton; consists of products of mass wasting that have reached their present position by gravity induced movements. Includes talus, slope wash, landslide, and solifluucted materials. Colluvial blanket and veneer deposits on slopes are not differentiated as map units

Ca — *Colluvial Apron Materials: rubble and diamicton in the form of aprons consisting of coalescing fans and cones; up to 10 m thick. Consists of rubble, where slope above is dominantly competent rock; diamicton, where source is morainal and other unconsolidated materials; locally includes alluvial deposits*

Ch — *Landslide Materials: rubble and diamicton; topography hummocky to rolling; up to 100 m thick. Consists dominantly of blocks and rubble derived from local bedrock with an admixture of rounded pebbles and finer materials derived from morainal, alluvial, and glaciofluvial sediments*

ALLUVIAL DEPOSITS: sand, gravel, and minor silt, organic sediment and diamicton; 2-40 m thick; deposited on floodplains and in fans

Ac* | Ao — *Alluvial Plain Materials: sand, gravel, silt, and minor organic sediment; up to 20 m thick; deposited as bar, channel, and overbank deposits on floodplains; includes terraces, small alluvial fans, colluial fans and aprons, and local organic deposits.*
Ac: dominantly channel deposits (sand and gravel), terraces common;
Ao: dominantly overbank and deltaic deposits (sand and silt)

Af — *Alluvial Fan Materials: gravel, sand, and diamicton; up to 40 m thick; occurs as fan or terraced-fan deposits. Sediment is bouldery where gradients are steep and has a muddy matrix where morainal deposits are abundant in the sediment source area*

Ax — *Alluvial Complex Materials: gravel, sand, rubble, and diamicton. A complex of intertonguing and overlapping alluvial deposits (Ac,Ao,Af) and colluvial fans and aprons (Ca). Mapped in valleys where small, complexly interrelated units could not be subdivided*

LATE WISCONSINAN

L — *LACUSTRINE DEPOSITS: silt and fine grained sand with minor clay; up to 50 m thick, dominated by rhythmites and laminated bedding; deposited in lakes which formed behind glacier dams or in isostatically downwarped segments of valley. These materials are easily eroded and prone to slumping*

GLACIOFLUVIAL DEPOSITS: gravel and sand; 2-40 m thick; deposited beneath, in front of, and on the surface of a glacier

Gt — *Glaciofluvial Terrace Materials: gravel, sand, and minor till; 2-40 m thick. Occurs as terraces, which may locally contain kettles. In many cases the materials are interpreted as having been deposited between an ice tongue and confining slopes*

Gm | G — *Glaciofluvial Materials, Undulating: gravel, sand, and minor till; 2-30 m thick.*
Gm; sufrace undulating to hummocky;
G; underlies alluvial sediments in Columbia River valley. Materials interpreted as having been deposited on ice which later melted

MORAINAL DEPOSITS: sandy, silty, and gravelly diamicton; 1-18 m thick; deposited directly by glacier ice. In this area the matrix of the diamicton (till) is 40-80% sand, 20-40% silt, and 5-20% clay sized; stone and boulder content is extremely variable

Mb / Mv / Mbv — *Morainal Blankets and Veneer Materials: sandy, silty, and gravelly diamicton mantling and conforming to the surface of the underlying rock*
Mb (morainal blanket): till, 2-5 m thick; includes isolated rock outcrops, patches of thicker till, and minor other deposits
Mv (morainal veneer): till less than 2 m thick; includes patches of bedrock and colluvium, pockets of thicker till and minor other deposits
Mbv: area consisting of approximately equal proportions of morainal blanket and morainal veneer

Mm — *Thick Morainal Deposits: sandy, silty, and gravelly diamicton, in most places bouldery, with small areas of glaciofluvial sand and gravel; up to 18 m thick. Low relief (up to 5 m) hummocks and undulating terrain common*

ROCK
PRE-QUATERNARY

Rs / Ra — *ROCK: crystalline metamorphic and igneous rocks; metasedimentary gneiss and schist with local granitic intrusions; carbonaceous slate, phyllitic siltstone, greenstone and chlorite schist; all of late Precambrian through Paleozoic age. Areas mapped as rock consist predominantly of rock at the surface or rock covered by a discontinuous veneer or blanket of colluvium and till.*
Rs (steep rock area): areas characterized by steep slopes and minor areas of lower slopes with the continuity and thickness of the overlying colluvium and till increasing towards the toes of the slopes.
Ra (alpine rock areas): a complex of rock and rock blanketed by colluvium and till in an alpine mountain area characterized by arêtes and cirques

$*\frac{Ac}{L}$ *and* $\frac{Ac}{G}$ *indicate channel deposits overlying lacustrine and glaciofluvial sediments, respectively*

Geological boundary
Depressional lineament following a structural feature
Cirques and arêtes (fresh, subdued)
Drumlins/drumlinoid ridge (ice flow direction known, unknown)
Striae ice flow (direction known)
Minor moraine ridges
Esker (direction of flow known or assumed)
Abandoned channel large (flow direction unknown)
Abandoned channel small (flow direction unknown)
Landslide and active layer failure scar (large)
Radiocarbon dates

10 000 ± 140	Wood
GSC-1753	500 m

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DESCRIPTIVE NOTES

Seymour Arm map area lies in the Interior System of British Columbia; the west half is in the Shuswap Highlands of the Interior Plateau and the east half in the Monashee and Selkirk mountains of the Columbia Mountains (Holland, 1964). The Shuswap Highlands consist predominantly of gently to moderately sloping plateau areas dissected by several large valleys; the Monashee and Selkirk mountains consist predominantly of ridges of sharp peaks separated by steep sided valleys. The west-central and southwestern part of the area is underlain by schist, limestone, argillite, and greenstone with several large granitic intrusions; the central and northwestern part is underlain mainly by crystalline gneiss with minor quartzite, marble, and granitic intrusions; the area east of Columbia River is underlain by slate, siltstone, quartzite, greenstone, and schist (Campbell, 1963; Wheeler, 1965).

MAP UNITS

Field data and airphoto interpretation were used to produce manuscript maps at 1:50 000 scale, which were recompiled and released at a scale of 1:100 000 (Fulton et al., 1984); these maps used a system of terrain units and compound-terrain units similar to those used by the British Columbia Ministry of the Environment (Resource Analysis Branch, 1978). These complex map units were regrouped and simplified to give more conventional surficial geology units and the data were recompiled at a sale of 1:250 000 for this publication. The following comments amplify the brief description of the surficial geology units.

Rock. Rs is used primarily in areas of steep slopes where rock is at the surface or locally covered by a patchy veneer of colluvium and till. Steep slopes in areas of mountainous relief are commonly subject to mass wasting and avalanche activity. Where this unit is used in areas at higher elevation with low local relief, rock is largely covered by a colluvium-residuum blanket of variable thickness; such areas are in many places marked by nivation and solifluction features and by patterned ground.

Ra is reserved for mountainous areas which clearly display evidence of alpine glacier erosion. In addition to rock, these areas contain abundant colluvium in the form of talus cones and rubble aprons (Ca); small unmapped glaciers and areas of semi-permanent snow (I); a mantle or ridges of rubbly till (Mb, Mm); and in low relief areas, a solifluucted blanket of colluvium-residuum. Alpine areas are subject to mass wasting and to niveal and avalanche activity.

Morainal Deposits. Morainal deposits consist largely of till with texture varying according to the nature of the underlying bedrock. Till derived from granitic and crystalline metamorphic rocks has a sandy texture whereas schist, phyllite, and other low grade metamorphic rocks produce a more silty textured till. Where exposed at the surface the till is generally loose, but at depth it is compact. It is not known whether the loose till is a supraglacial deposit and the more compact till, subglacial, or whether both are subglacial but the near surface till has been eluviated by percolating soil water and loosened by frost and root action.

The blanket (Mb) and veneer (Mv) till units consist of mantles of till which mask most irregularities in the surface of underlying rock but have little form of their own. The veneer till unit is discontinuous and covers only minor irregularities in the rock surface whereas blanket deposits are generally continuous and hide most irregularities. Blanket till deposits in the bottom of valleys may overlie extensive valley fills dating from earlier glaciations and may be overlain by undifferentiated colluvial and alluvial sediments. Thick morainal deposits (Mm) have an undulating to hummocky surface form which is independent of the underlying rock. The thick morainal deposits in the northwestern part of the area are dominantly bouldery till and locally contain areas of hummocky glaciofluvial gravels.

Glaciofluvial Deposits. Glaciofluvial map units are shown in many parts of the area but numerous unmapped glaciofluvial deposits occur within other units. The latter are not shown because they either are too small or are hidden by the extensive forest cover so that they cannot be located on airphotos.

Valley bottoms mapped as Gt are generally underlain by continuous thick gravel and sand. Where this unit is shown as occupying a valley wall position, it may consist of several discrete terrace levels, separated by till and rock slopes, and may be overlain at the valley side by an apron of colluvium.

Undulating to hummocky glaciofluvial deposits (Gm) are generally continuous where they are mapped as occupying a valley floor. Where this unit occurs on valleysides, it commonly consists of: kame terraces separated by till and rock slopes; extensive fans derived from the erosion of glaciofluvial deposits; and aprons of colluvium deposited on the valley side of the kame terraces. Undulating and hummocky glaciofluvial deposits on uplands consist largely of areas of hummocks and scattered hummocks separated by areas of till. The glaciofluvial gravels (G) shown as underlying alluvial sediments in Columbia River valley consist predominantly of ice-contact sediments.

Lacustrine Deposits. Lacustrine deposits were mapped in North Thompson, Adams Lake, Barrière Creek, Shuswap Lake, and Columbia River valleys. In most places these occur as terrace-like remnants at the valley sides, but west of East Barrière Lake and at the head of Seymour Arm they occur on the valley floor. Colluvial sediments overlap the valley wall margin of these deposits; in Columbia River Valley, a nearly continuous cover of alluvial and colluvial deposits blankets the lacustrine sediments.

In addition to the mapped areas, lacustrine deposits underlie alluvial deposits in many valleys, and in the western half of the area, locally occur as kame-like terraces on valley walls and as blankets and basin fills in upland areas.

Alluvial Deposits. Alluvial plains consist largely of channel sediments overlain by a variable thickness of overbank material. The channel sediments are coarse and bouldery where steep gradient tributaries join trunk streams, on steep gradient segments of most rivers, and adjacent to Columbia River. Overbank sediments generally consist of sand and silt with local lenses of organic sediments. Channel deposits (Ac) were mapped where the fluvial system has a braided channel pattern and where overbank sediment is less than 2 m thick. Overbank deposits (Ao) were mapped where the fluvial system has a meandering channel pattern and floodbasins are common.

Alluvial complexes (Ax) generally occur in valleys where the trunk stream is unable to remove the sediment load supplied by tributaries. In these systems, colluvial aprons and cones, and alluvial fans extend from the valley walls and the mouths of tributaries, diverting the trunk stream from one side of the valley to the other. Where the trunk stream flows over the toe of an impinging fan, the floodplain consists of channel gravel and sand; in partly dammed reaches upstream from large fans, the floodplain is underlain by sand and silt overbank sediments and peat. The resulting complex of colluvial and alluvial fan sediments and alluvial channel and overbank materials cannot be subdivided at the scale of this map.

Colluvial Deposits. Colluvial deposits shown on the map are restricted to colluvial aprons and landslides. Colluvial slope deposits do, however, occur within many other map units as blankets or discontinuous veneers of rubble and diamicton, and are generally associated with areas of bedrock outcrop. They are particularly common in rock units (Rs and Ra) and are abundant in high relief areas mapped as morainal veneer (Mv).

Only the most extensive colluvial aprons are shown. In addition to mapped areas, this deposit occurs at the toe of most extensive slopes, overlies unconsolidated deposits at the margin of most valleys, and is an integral but undifferentiated component of alluvial complexes (Ax)

The landslides portrayed on the map are mainly discrete rockfalls and massive landslips. In several areas, such as Ruddock Creek valley, tributary valleys south of Downie Creek, and the headwaters of Mars Creek, entire valley sides are failing and slowly moving towards the valley floor. The valley walls in these areas of failure exhibit bulging and broken slope profiles, and numerous short irregular escarpments and lineations roughly parallel with the valley wall.

Landslides too small to be mapped are common in high relief areas. The greatest concentration of small slope failures appears to be in areas where the rock has been highly sheared or consists of schist and phyllite.

QUATERNARY HISTORY

Geological information gathered in this area can be fitted into the Quaternary framework developed from other studies in the southern interior of British Columbia (Fulton and Smith, 1978). The Quaternary events framework consists of Olympia, a nonglacial period preceding the last glaciation; Fraser, the last glaciation; and postglacial, the nonglacial period since disappearance of the last ice sheet. The Olympia began prior to 43.8 ka and ended about 20 ka and Fraser Glaciation ice advanced into the valleys about 20 ka and had retreated by about 10 ka. Fulton (1975) provided a description of the Quaternary history of the area immediately south of the west half of this map area.

Pre-Fraser. Deposits predating the Fraser Glaciation (underlying the surface till) are exposed in North Thompson valley near Vavenby and in Columbia River valley near Birch Creek. The deposits in Columbia River valley consist of at least 25 m of unfossiliferous sand and gravel; the upper part appears to have been deposited by a river similar in size and source to the present Columbia. The ancient floodplain however was at least 60 m above the level of the modern flood plain. This deposit might correlate with Olympia nonglacial materials deposited about 25 ka in the Rocky Mountain Trench, 25 km to the north (Fulton, in press). The Vavenby deposits consist of at least 25 m of unfossiliferous sand and gravel overlain by laminated silt and sand; these (see below) might relate to the advance of Fraser Glaciation ice.

Fraser. No data which might shed light on the timing of the buildup of Fraser ice were found in the area. Near the mouth of Canoe River in the Rocky Mountain Trench, 20 km north of the map area, Fraser Glaciation till was not deposited until after 21.5 ka (Fulton, in press). The basin of Shuswap Lake immediately south of the map area was not overridden by ice until after 20 230 ± 270 BP (Dyck et al., 1965, p. 10). Expansion of the ice in mountainous parts of the area however probably commenced somewhat earlier than these dates. Advance of the ice into the valleys was probably preceded by deposition of outwash and in local areas by deposition of glacial lake deposits as ice dams, isostatic warping, and rapid deposition of sediment disrupted drainage and caused glacial lakes to form in the valleys. The sand and gravel overlain by laminated silt at Vavenby (see above) might date from this period of proglacial deposition. At the glacial maximum, ice flowed in a general southward direction with local deviations of up to 45°. Most of the map area was completely covered by ice but higher parts of the mountainous eastern part and high peaks, such as Pukeashun Mountain, Dunn Peak, Raft Mountain, Trophy Mountain, and Battle Mountain, in the west probably remained as nunataks.

There is ample evidence in the form of ice-contact deposits and meltwater channels to indicate that ice in the western part of the area retreated largely by downwasting. Also, no evidence has been found in the alpine valleys of the east that ice retreated in a regular manner from lower valleys towards mountain source areas. Hence it appears that once deglaciation began, snowline quickly rose above the elevation of major accumulation areas causing the ice to stagnate instead of receding in a regular manner towards mountain source areas. As the ice receded from the highlands into the valleys, abundant kame terraces and ice-contact deposits were formed between the shrinking ice mass and the valley walls.

The timing of ice recession is not known but a date of 10 000 ± 160 BP (GSC-1753; Fulton, in press) on wood in lake sediments in Columbia River valley and dates of 11 300 ± 110 and 9650 ± 110 BP (GSC-1833, marl, and GSC-1833-2, peat; Lowdon and Blake, 1981, p.7), from the bottom of a bog on Granite Mountain, indicate that these sites were probably free of ice at about the same time. A significant readvance affected several higher areas in the western half of the region during deglaciation, depositing hummocky bouldery till derived from adjacent cirques.

Glacial lakes formed in many of the main valleys during deglaciation. The lakes that occupied the Adams and Shuswap basins were extensions of the Rocky Point and Magna Bay stages of glacial Lake Shuswap, and the lake in North Thompson valley may have been a northward extension of glacial Lake Thompson (Fulton, 1969). The lake that extended northward in Columbia River valley was contiguous with a glacial lake that occupied the Arrow Lakes basin (Fulton, in press).

Postglacial. As mentioned above, the main mass of Fraser ice had largely disappeared from the area by 10 ka. A period of rapid sedimentation followed deglaciation as unstable glacial deposits were swept into the valleys and drainage was re-established in drift clogged valleys. This resulted in the construction of alluvial fans, colluvial aprons, and alluvial terraces. The occurrence of Mazama ash near the tops of many of these deposits indicates that this period of instability had ended by 6.6 ka.

Duford and Osborn (1978) named four moraines associated with cirques in the highlands of the west half of the area. The Harper Lake moraine was built during the significant readvance mentioned above; Dunn Peak moraine was built by a minor advance said to have occurred between 9.2 and 7.4 ka ago (Alley, 1980, disputed this timing and stated that Dunn Peak moraine was constructed after 8.0 ka and before 4.3 ka); Raft Mountain and Spahats Creek moraines were formed during the last 240 years.

This part of British Columbia lay in the path of the eruption plumes of three main Holocene tephra falls: Mazama (Powers and Wilcox, 1964), St. Helens (Mullineaux et al., 1975; Westgate, 1977), and Bridge River (Nasmith et al., 1967; Mathewes and Westgate, 1980). Consequently thin (up to 5 cm) layers of white sandy silt- and silt-sized tephra provide time marker horizons at about 6.6, 3.4, and 2.5 ka in postglacial sediments.

Holocene paleoclimatic studies have not been conducted in this map area but dates on wood above present tree line and/or incorporated in till indicate that climate 5.5 and 3.8 ka ago was warmer than that at present. In a general way the climatic fluctuations in this area were probably similar to those outlined for Okanagan Valley, 100 km to the south (Alley, 1976). In the Okanagan, early postglacial climate was more moist and possibly slightly cooler than that at present. A short time after 8.4 ka, the climate became drier and warmer (the Hypsithermal), and then following 6.6 ka, moisture increased and the climate cooled considerably to something slightly cooler than today. The period since 6.6 ka has been characterized by several fluctuations with cooler and more moist intervals from about 6.6 to before 3.6 ka, 3.2 to about 2.0 ka, and from 1.5 ka to the present.

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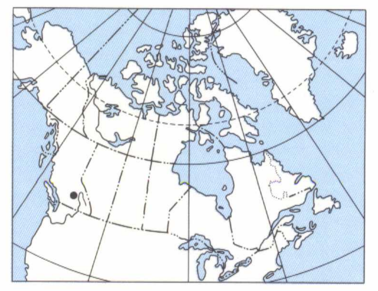

INDEX MAP

Geology by R. J. Fulton (1972, 1981), N. F. Alley (1973-74) and R. A. Achard (1969-70)

Compiled by R. J. Fulton, 1983

Geological cartography by P. St-Amour, Geological Survey of Canada

Any revisions or additional geological information known to the user would be welcomed by the Geological Survey of Canada

MAP 1609A
SURFICIAL GEOLOGY
SEYMOUR ARM
BRITISH COLUMBIA

Scale 1:250 000

Kilometres 5 0 5 10 15 20 Kilometres

Transverse Mercator Projection
CM 116°, Scale Factor 0.9996
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Base map at the same scale published by the Survey and Mapping Branch in 1965

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Magnetic declination 1984 varies from 22°14′ easterly at centre of west edge to 21°49′ easterly at centre of east edge. Mean annual change 10.0′ westerly

Elevations in feet above mean sea level

93 A	83 D	83 C
92 P 1293A	82 M 1609A	82 N
92–I	82 L	82 K

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MAP 1609A
SEYMOUR ARM
BRITISH COLUMBIA
1609A

Canada

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