GEOLOGICAL SURVEY OF CANADA
DEPARTMENT OF ENERGY, MINES AND RESOURCES

82K W/2

OPEN FILE
432
GEOLOGICAL SURVEY
OTTAWA

CENOZOIC

QUATERNARY
PLEISTOCENE AND RECENT

Qs	Glacial deposits, recent alluvium, few if any outcrops
Qsl	Landslide and rock slide debris

MESOZOIC

CRETACEOUS AND/OR JURASSIC

Kgd	GALENA BAY STOCK: muscovite-biotite granodiorite and quartz monzonite
Kgal	BATTLE RANGE BATHOLITH (Kgal, Kgdb, Kqmm): Pyritiferous alaskite
Kgdb	Muscovite-biotite granodiorite, granodiorite; includes SUGARPLUM STOCK
Kqmm	Biotite-hornblende quartz monzonite, granodiorite; minor quartz diorite; includes BUGABOO BATHOLITH
Kcc	NELSON BATHOLITH (Kcc to Jqd) CARIBOU CREEK PLUTON: biotite-hornblende quartz monzonite, granodiorite; minor quartz diorite and granite. All contain potash feldspar megacrysts
Kqmb	GOATCANYON-HALIFAX CREEK and WRAGGE CREEK STOCKS: hornblende-biotite quartz monzonite; minor quartz diorite and granodiorite
Kqm	SOUTH WRAGGE CREEK STOCK: hornblende leucoquartz monzonite

JURASSIC AND/OR CRETACEOUS

Jqdm	RUBY RANGE STOCK: biotite-hornblende quartz diorite, diorite, quartz monzonite, monzonite and syenodiorite
Jqd	MEADOW MOUNTAIN and EAST CARIBOU STOCKS: foliated hornblende quartz diorite; minor quartz monzonite

JURASSIC

Jkx	KUSKANAX BATHOLITH AND STOCKS (Jkx, Jkxs, Jkx): Aegerine-augite leucoquartz monzonite; minor leucosyenite and leucogranite
Jkxs	Syenite
lJkx	Foliated and/or lineated leucoquartz monzonite

LOWER JURASSIC
UPPER SINEMURIAN

lJp	ARCHIBALD FORMATION (?): grey argillite, shale and siltstone

TRIASSIC AND (?) JURASSIC
TRIASSIC TO (?) LOWER JURASSIC (SINEMURIAN)
SLOCAN GROUP

HIGH GRADE METAMORPHIC ROCKS

TrJsvb	Augite meta-basalt and meta-andesite flows and tuff		
TrJsvd	Grey meta-andesite and meta-dacite tuff and flows		
Trsp	Grey to black phyllite, argillite, quartzite; minor tuffaceous sediments near top	Trssb	Grey mica schist
Trsc	Grey to black limestone; minor argillite and quartzite	Trssc	Calc-silicate marble
Trscg	Conglomerate, sedimentary breccia; minor sandstone		

PALEOZOIC to MESOZOIC

PERMIAN AND/OR TRIASSIC

gs	Hornblende and pyroxene meta-diorite and meta-andesite (includes Poplar Creek Greenstone). Pattern used where boundaries are undefined.		
PTrub	Serpentinite; minor talc and tremolite schist		
PTrkv	KASLO GROUP Meta-andesite flows, tuff, breccia; minor meta-dacite; rare tuffaceous phyllite	PTrkvm	Amphibolite

PALEOZOIC

MISSISSIPPIAN TO PENNSYLVANIAN OR PERMIAN
UPPER MISSISSIPPIAN TO PENNSYLVANIAN OR PERMIAN
MILFORD GROUP (uMmt to uMmcg)

uMmt	Light green to white chert	uMmq	Calcareous quartzite
uMmp	Grey and brown phyllite and meta-sandstone	uMmsb	Biotite schist, paragneiss
uMmc	Grey and white limestone, locally fossiliferous	uMmsc	Calc-silicate marble
uMmv	Amygdaloidal meta-basalt flows		
uMmcg	Conglomerate		

DEVONIAN(?)
MIDDLE DEVONIAN(?)

Dgdn	Biotite-hornblende granodiorite gneiss

CAMBRIAN TO DEVONIAN OR OLDER
LOWER CAMBRIAN TO MIDDLE DEVONIAN OR OLDER
LARDEAU GROUP (lPbc to lPigr)
BROADVIEW FORMATION (lPbc, lPbs):

lPbc	Limestone, grey phyllitic limestone and grey phyllite		
lPbs	Grey and green phyllitic grit and phyllite		
lPjv	JOWETT FORMATION: green phyllite, limy green phyllite, greenstone		
lPscp	SHARON CREEK FORMATION: dark grey to black siliceous phyllite		
lPaq	AJAX FORMATION: massive grey quartzite		
lPtp	TRIUNE FORMATION: grey to black siliceous phyllite		
lPtas	TRIUNE, AJAX, SHARON CREEK FORMATIONS: undivided		
lPiv	INDEX FORMATION (lPiv to lPigr) Green phyllite, limy green phyllite, greenstone		
lPic	Phyllitic and arenaceous limestone; minor grey phyllite		
lPip	Grey and light green phyllite; minor phyllitic limestone and quartz grit		
lPigr	Quartz grit; minor gritty phyllite		
lPls	Undivided: grey phyllite, siliceous phyllite, gritty phyllite, phyllitic grit, rare quartzite	lPlsb	Biotite schist
lPlv	Undivided: green phyllite, limy green phyllite, greenstone	lPlm	Amphibolite
lPlc	Undivided: limestone, phyllitic limestone	lPlsc	Calc-silicate marble

CAMBRIAN
LOWER CAMBRIAN

lЄbc	BADSHOT FORMATION: Grey and white limestone	lЄbsc	Marble

PROTEROZOIC TO TRIASSIC

PTrm	SHUSWAP METAMORPHIC COMPLEX* Amphibolite
PTrnb	Biotite-quartz-feldspar paragneiss, pegmatite, amphibolite
PTrnc	Calc-silicate gneiss, amphibolite, marble, schist, quartzite
PTrncq	Carbonate-diopside quartzite
PTrn	Layered gneiss
PTrqsb	Quartzite, mica schist
PTrsa	Biotite-quartz-feldspar paragneiss, garnetiferous schist and gneiss
PTrsbq	Biotite-sillimanite schist, impure quartzite
PTrsc	Marble
PTrscq	Marble, thin-bedded quartzite, schist
PTrsn	Undivided

*stratigraphic order unknown

PROTEROZOIC to PALEOZOIC

HADRYNIAN (WINDERMERE) AND/OR CAMBRIAN
HADRYNIAN (WINDERMERE) AND/OR LOWER CAMBRIAN
HAMILL GROUP (lЄmp to lЄmgq)
MOHICAN FORMATION (lЄmp, lЄmv, lЄmc):

lЄmp	Grey and brown phyllite, micaceous quartzite; minor limestone	lЄhb	Grey and brown mica schist, black phyllite; minor limestone
lЄmv	Green phyllite, minor grey phyllite and limestone	lЄhm	Amphibolite
lЄmc	White to light grey limestone		
lЄmas	MARSH ADAMS FORMATION: white, grey and brown quartzite, phyllitic quartzite; minor grey and black phyllite	lЄhsab	Garnet-biotite schist, micaceous quartzite
lЄmgq	MOUNT GAINER FORMATION (lЄmgq, lЄmgv): white quartzite	lЄhq	Tan and white quartzite, micaceous quartzite
lЄmgv	Green phyllite, greenstone		

PROTEROZOIC

HADRYNIAN (WINDERMERE)
HORSETHIEF CREEK GROUP (Hhcvc, Hhcc, Hhclc):

Hhcvc	Upper Division: quartzofeldspathic sandstone and siltstone, grey slate; minor quartzofeldspathic grit; rare quartz pebble conglomerate
Hhcc	Limestone
Hhclc	Lower Division: quartzofeldspathic sandstone and grit; grey slate, minor quartz pebble conglomerate; rare limestone
Hhcs	Undivided

INTRUSIONS OF UNKNOWN AGE

g	Granite, quartz monzonite
qmbh	MOUNT CARPENTER STOCK: biotite-hornblende quartz monzonite
qm	Lineated biotite-muscovite quartz monzonite
fp	Feldspar porphyry
bq	Biotite quartz gabbro

Geological boundary (defined, approximate, assumed) ....

Fault (defined, approximate, assumed) ....

Bedding, facing determined (inclined, vertical, overturned) ....

Bedding, facing undetermined (inclined, vertical) ....

Foliation (inclined, vertical) ....

Cleavage (inclined, vertical) ....

Lineation, fold axis (undetermined vergence, northerly vergence*) ....

Fold (undetermined vergence, northerly vergence*) ....

* Vergence is the direction of the upper member of the rotational couple implied by the asymmetry of the fold.

Road, all weather ....

Other roads ....

Trail ....

Glacier or snowfield ....

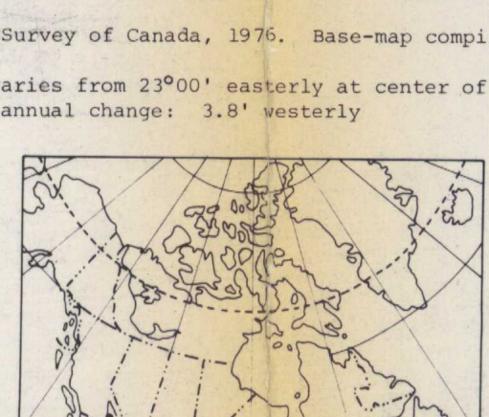
Contours (interval 100 or 200 feet) ....

Height in feet above mean sea-level .... 5000 + 8250

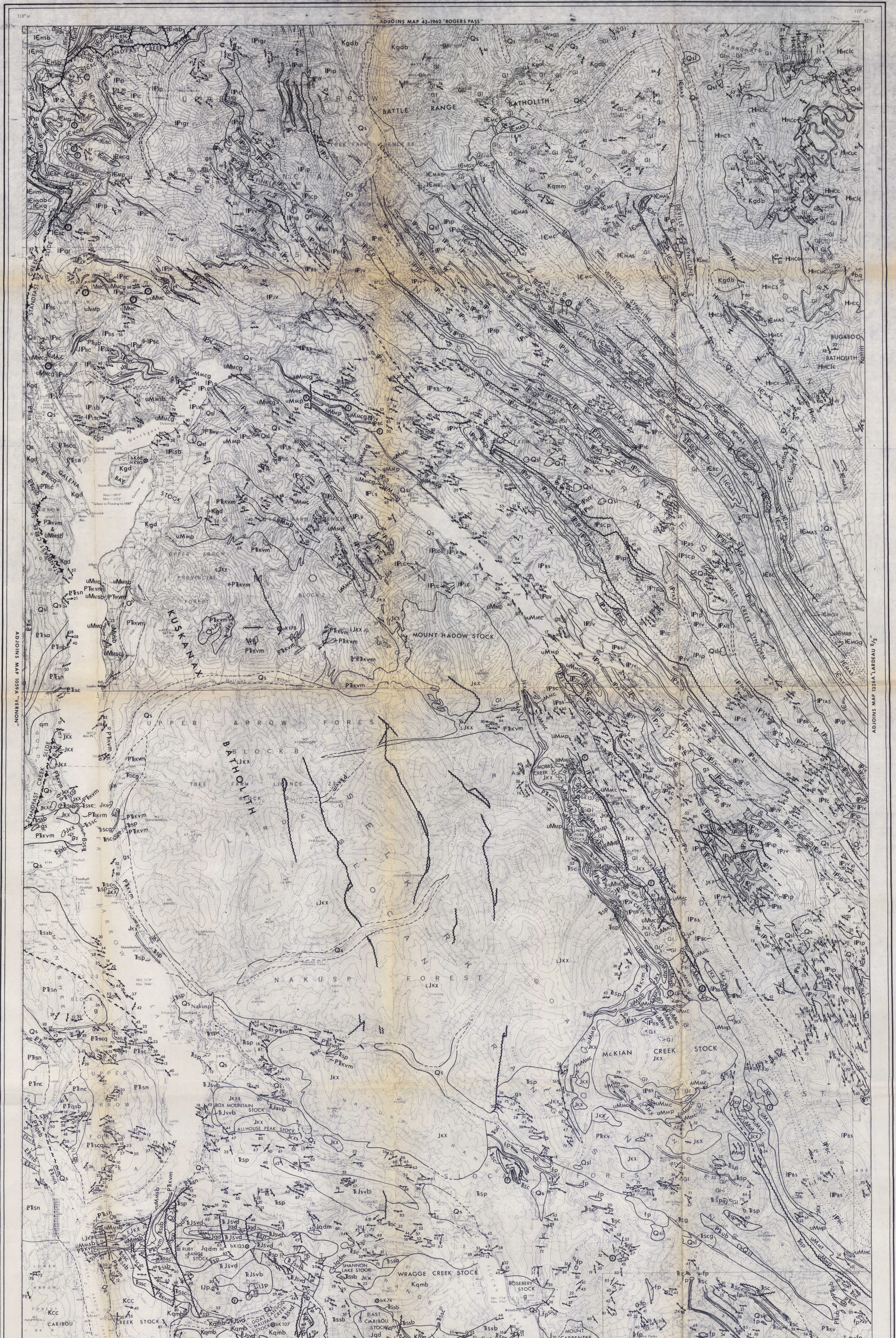
Geology by J.O. Wheeler, 1965, 1967; P.B. Read, 1962-1964, 1971-1976. Revised compilation by P.B. Read, 1976.

Geological cartography by the Geological Survey of Canada, 1976. Base-map compiled and drawn by the Surveys and Mapping Branch, 1971.

Magnetic declination 1957 varies from 23°00' easterly at center of west edge to 23°30' easterly at southeast corner. Mean annual change: 3.8' westerly



INDEX MAP



GEOLOGY
LARDEAU WEST-HALF
BRITISH COLUMBIA

Scale 1:125,000

Miles 2 0 2 4 6 Miles
Kilometres 3 0 3 6 9 Kilometres

DESCRIPTIVE NOTES

Highways 6, 23, 31 and 31A pass through Lardeau west-half, provide access, and join Nakusp to Revelstoke, New Denver and Kaslo which lie just beyond the map-area (Fig. 1). Logging roads allow access to the lower courses of some major creeks and rivers such as Wilson, Akolkolex and Incomappleux. Because pack trails are overgrown now, only helicopters give efficient transportation in the central and northeastern parts of the area. At the turn of the century, mining brought thousands of prospectors to settle at Trout Lake, Ferguson, Beaton, Camborne, Gerrard, Poplar, Zincton, Three Forks, and Retallack. A system of wagon roads, railroads and sternwheelers connected these mining towns. In recent years, lumbering supplemented by tourism forms the economic base.

In the last fifteen years, many detailed studies of parts of the map-area have been completed, but Walker, Bancroft and Gunning's study (1930) was the only regional one. These studies (Fig. 1) and the regional work of Wheeler (1966, 1968) are the basis for this map.

In the Selkirk and Purcell Ranges, exposures are excellent above 6,000 feet, but westward near the Columbia River and Upper Arrow Lake, vegetation and drift obscure the complex geology and diminish the certainty of geologic boundaries and relations.

The map-area straddles the north end of Kootenay Arc and includes the eastern edge of the Shuswap Complex, which lies approximately along Columbia River and Upper Arrow Lake (Fig. 2). In general, the stratified rocks become progressively younger, from Hadrynian in the northeast to upper Paleozoic and Mesozoic in the southwest. In the central and northern parts of the map-area, the Kuskanax and Battle Range Batholiths, transect the northwesterly structural trend.

The oldest rocks in the map-area, the Horsethief Creek Group of Hadrynian age, underlie the Purcell Mountains. Limestone (Hhcc), up to a few hundred feet thick, separates eastern exposures of the group into upper (Hhcuc) and lower (Hhclc) units of clastic sediments. In contrast to the fine clastics of the upper unit, coarser clastics of the lower unit are interbedded with thin limestone layers of which some are mineralized just east of the map-area. Westward, the main limestone (Hhcc) thins, is indistinguishable from other limestone layers, and the group is undivided (Hhcc).

Hadrynian and/or lower Cambrian quartzite of the Hamill Group and limestone of the Badshot Formation (lЄbc, lЄbsc) form a distinctive sequence of marker horizons which outline major structures in the Kootenay Arc. Siliceous metasediments of the Marsh Adams (lЄmas) and Mount Gainer Formations (lЄmgq) are the characteristic "quartzite" of the Hamill Group. The Mohican Formation, at the top of the group, is dominantly grey phyllite, but near Westfall and Duncan Rivers, some phyllite is green and derived from volcanic rocks which extend northward into Rogers Pass map-area (Wheeler, 1963). Southwards from Duncan and Westfall Rivers, the Mohican Formation thins to only a few tens of feet of calcareous schist in the lower part of Meadow Creek. North of Akolkolex River, grey and white limestone of the Badshot Formation (lЄbc) is archeocyathid-bearing. North of Akolkolex River and beneath the gently dipping Standfast Creek fault, mica (lЄhsb) and garnet-biotite schists (lЄhsab), amphibolite (lЄhm), and tan and white quartzite (lЄhq) comprise a succession of amphibolite facies rocks tentatively correlated with the Hamill Group. South of Akolkolex River, near the mouths of Crawford and Wallis Creeks, extensive marble outcrops may belong to the Badshot Formation (lЄbsc).

The unfossiliferous Lardeau Group of presumed lower to middle Paleozoic age forms a broad belt northeast of the Kuskanax Batholith and extends eastward into Lardeau east-half (Reesor, 1973), and northward into Rogers Pass (Wheeler, 1963). The detailed stratigraphy of Fyles and Eastwood (1962) is used with some modifications. Sufficient observations of graded bedding determinations between Akolkolex and Incomappleux Rivers indicate the stratigraphic order of Fyles and Eastwood is upright. Grey and light green phyllite (lPip) and phyllitic limestone (lPic) dominate eastern exposures of the Index Formation, but on the southeast side of Akolkolex River, these rocks undergo a lateral facies change and pass southwestward into quartz grit and gritty phyllite (lPigr). Layered dark green phyllite, commonly calcareous, and greenstone with rare pillows or volcanic breccia, comprise the uppermost member (lPiv) of the Index Formation. Conformably overlying the Index Formation is dark grey to black siliceous phyllite divided by the massive, grey Ajax quartzite (lPaq) into the lower Triune Formation (lPtp) and the upper Sharon Creek Formation (lPscp). Because of probable original variations in thickness of the Triune, Ajax and Sharon Creek Formations and later intense deformation, each of these formations ranges from a few tens to a few thousands of feet in thickness. Along the drainage divide between the Akolkolex and Incomappleux Rivers, detailed mapping shows these three formations pass southwestward through a lateral facies change into grit of the Index Formation (Read, 1975). Farther southeast, this facies change and faulting restrict Triune, Ajax, and Sharon Creek Formations to the area northeast of Lardeau River and Trout Lake. Layered green phyllite, locally limy, and greenstone of the Jowett Formation (lPjv) are lithologically indistinguishable from the uppermost volcanic member (lPiv) of the Index Formation. These two volcanic units have been distinguished because of the intervening, and previously presumed unique sequence of Triune, Ajax, and Sharon Creek Formations. Recent detailed mapping shows rocks similar to the Triune-Sharon Creek interval in the overlying Broadview Formation on the southwest side of lower Sable Creek and in a belt which extends from the head of Horsefly Creek to the lower part of Lake Creek. In the drainage area of Lardeau Creek and Lardeau River and Lake Creek, volcanics of the Index Formation (lPiv) are present where Jowett Formation (lPjv) is absent and *vice versa*. Because of lithologic similarities between the two units and antithetic distribution, further work may prove they are the same unit. Grey and light green phyllite, gritty phyllite, grit (lPbs), and minor limestone (lPbc) compose the Broadview Formation. Metavolcanic rocks formerly mapped with the Broadview Formation (Fyles and Eastwood, 1962; Read, 1973), now are included in the Jowett Formation (lPjv). Because rocks of the Broadview Formation are similar to the Horsethief Creek Group and consist of unfossiliferous and dominantly quartzofeldspathic grit composed of materials derived from a plutonic or high grade metamorphic terrain, the Broadview Formation has been correlated with the Horsethief Creek Group (Wheeler, 1968; Read, 1973). This correlation necessitates allochthonous emplacement of the Broadview Formation above the Hamill, Badshot and other units of the Lardeau Group. Recent mapping (Read, 1975) indicates a lateral facies change from phyllite and phyllitic limestone to gritty rocks which makes a tectonic contact between grits of the Broadview Formation and other rocks unlikely. In the Lardeau Group, the westward lateral facies change from phyllites of the Index, Triune, and Sharon Creek Formations on the northeast to gritty rocks of the Index and Broadview Formations on the southwest, implies a westerly source, possibly in the site of the present Shuswap Complex, to contribute detritus from plutonic and/or high grade metamorphic rocks.

The Milford Group, of latest early Mississippian to Pennsylvanian or Permian age, unconformably overlies the Lardeau Group. It extends southeasterly from Sproat Mountain, encloses the Kuskanax Batholith, and continues southeasterly into Lardeau east-half and Nelson east-half (Rice, 1941) map-areas. Lenses of meta-conglomerate (uMmcg) and amygdaloidal meta-basalt (uMmv) locally lie above the angular unconformity. Although the unconformity is commonly faulted, a cobble conglomerate on Mount Thompson directly overlies the Broadview Formation and contains randomly-oriented, foliated clasts of Broadview (Wheeler, 1966; Read, 1975). North of Mount Cooper, the basal conglomerate contains subrounded cobbles and boulders of granitic rocks which may come from Devonian intrusions on the western margin of the Shuswap Complex (Okulitch, Wanless and Loveridge, in press). A fossiliferous limestone (uMmc), ranging from a few tens to a few thousands of feet thick, lies on, or a few hundred feet above, the unconformity. Overlying grey and brown phyllite and phyllitic meta-sandstone, and some thin phyllitic limestone layers (uMmp) comprise the bulk of the Milford Group. A chert lens (uMmt) extends southeast from Cooper Creek to Blue Ridge west of Kaslo. On Scalping Knife Mountain, biotite schist and paragneiss (uMmsb) and calc-silicate marble and quartzite (uMmnc) of the amphibolite facies probably belong to the Milford Group.

Along the southeast margin of the Kuskanax Batholith and on Blue Ridge just southeast of the map-area, thin grey phyllite and chert layers interfinger over a two hundred foot thickness with metavolcanic rocks of the Kaslo Group (PTrkv). This group fringes the Kuskanax Batholith and extends westerly across Upper Arrow Lake into the Thor-Odin map-area (Reesor, 1971), and southeasterly into Nelson east-half (Rice, 1941). In Lardeau west-half, meta-andesite flows, tuff and breccia comprise the group, but significant thicknesses of metapelite have been excluded as probable infolds of Milford or Slocan Groups. This interpretation limits the Kaslo Group to a few thousand feet of unfossiliferous metavolcanic rocks of Permian or Triassic age; a Permian age is preferred (Read and Okulitch, in preparation). Rocks of the Kaslo Group fringing the Kuskanax Batholith and on Scalping Knife Mountain are amphibolites (PTrkvm) but in the remaining areas are greenschists (PTrkv).

Sills of serpentinite, hornblende and pyroxene meta-diorite and meta-gabbro preferentially intrude the upper part of the Milford Group and the Kaslo Group. They are less common in the Lardeau Group where some meta-andesite dykes, along axial planes of second phase folds, may be as young as early Jurassic.

The Slocan Group lies between the Kuskanax and Nelson Batholiths and extends into Vernon map-area (Jones, 1959), between Thor-Odin and Pinnacles Domes. The group consists of a thick unit of pelitic rocks overlain by approximately 4,000 feet of volcanic rocks. At the base of the group, lenses of conglomerate and sedimentary breccia (Trscg), composed of Kaslo detritus, disconformably overlie the Kaslo Group. Near the base, limestone (Trsc), up to 100 feet thick, forms layers intercalated with grey argillite, phyllite and fine-grained quartzite (Trsp). Near the top of map-unit Trsp, rocks become tuffaceous and pass into meta-andesite and meta-dacite tuffs and flows (TrJsvd), and augite meta-basalt and meta-andesite flows and tuffs (TrJsvb). Between Columbia River and Slocan Lake, these volcanic rocks core the depressions of doubly-plunging synclines. West of Slocan Lake, an increase in metamorphic grade towards Valhalla Dome, which lies south of the map-area, has converted metasedimentary rocks of the Slocan Group to mica schist (Trssb) and marble (Trssc).

The Shuswap Metamorphic Complex consists of metasediments and minor metavolcanic rocks. A distinctive assemblage of cal-silicate marble with quartzite (PTrscq) and PTrnc outlines an east-plunging antiform terminated at the south end of Upper Arrow Lake. In the map-area, proximity of rocks of the Complex to the Kaslo and Milford Groups suggests that rocks in the Complex include Paleozoic and possibly Triassic strata. West of the map-area, rocks as old as 1,960 $^{+35}_{-45}$ m.y. are involved in the Complex (Wanless and Reesor, 1975).

On Blue Grouse Mountain, pelite (lJp) is lithologically similar and may be equivalent to the Archibald Formation of the Nelson west-half map-area (Little, 1960). Lower Jurassic fossils (Sinemurian), similar in age to those of the Archibald Formation, were found in talus a few hundred feet below the contact with the underlying Slocan Group. This contact, formerly interpreted as a thrust fault (Hyndman, 1968), is re-interpreted as a sedimentary contact with possible minor shearing. Bedding attitudes indicate the three outcrop areas mapped are erosional remnants of the core of a northerly overturned syncline. From place to place the pelite overlies different volcanic units of the Slocan Group, hence the contact may be an angular unconformity.

Stratified rocks of Lardeau west-half act as host to a wide variety of alkalic and calc-alkalic plutons. These plutons belong to four intrusive complexes, which in probable order of decreasing age are:

- (a) in the center of the map-area, the Kuskanax Batholith and satellitic stocks;
- (b) In the southern part of the map-area, plutons related to the Nelson Batholith;
- (c) In the northern part of the map-area, the Battle Range Batholith and compositionally related stocks;
- (d) Galena Bay Stock and most intrusions west of the north end of Upper Arrow Lake are peripheral to Thor-Odin Dome (Reesor, 1971).

These plutons range from pre- or syn-tectonic to post-tectonic and from Jurassic to Cretaceous in age. Radiometric dating tends to give anomalously young ages, which in part may reflect cooling following regional uplift rather than cooling at the time of intrusion and consolidation. Most plutons are concordant and elongate westerly to northwesterly, but the Battle Range Batholith is markedly discordant.

The alkalic Kuskanax Batholith (lJkx) and satellitic stocks (Jkx) underlie the center of the map-area. Albite or microcline phenocrysts with coatings of albite and microcline, and finer-grained aegerine-augite or alkali amphibole and albite characterize the batholith and stocks. Leucoquartz monzonite predominates but syenite forms Box Mountain Stock (Jkxs) and leucogranite, Allhouse Peak Stock and Nakusp Range. Much of the contact of the batholith is concordant with structures in the invaded Milford, Kaslo and Slocan Groups which form three long, westerly-oriented septa. Marginal foliation and lineation, defined by mafic minerals, parallel the axial plane and fold axes of folds in the country rock. The eastern contact has a moderate westerly dip as do the axial planes of nearby folds. These structures indicate marginal deformation of this pre- to syn-tectonic batholith. On the north side of Scalping Knife Mountain, an elongate stock of lineated leucoquartz monzonite has similar structural relations. A K-Ar radiometric date of 178 m.y. on an alkali amphibole from the center of the batholith probably represents the time of consolidation and cooling. All satellitic stocks are semi-concordant, steep-sided, and compositionally similar to the batholith, but lack marginal foliation and lineation. A K-Ar radiometric date of 137 ± 7 m.y. for muscovite from Rapid Creek Stock probably represents an anomalously young age.

Along the southern edge of the map-area, the suite of calc-alkalic batholiths and stocks are part of the "Nelson Batholith". They are concordant intrusions elongate parallel to the westerly trend of the country rock. Meadow Mountain and East Caribou Stocks (Jqd) are quartz diorite characterized by potash feldspar megacrysts. Relative timing of intrusion is shown by dykes from Wragge Creek Stock (Kqmb) which cut East Caribou Stock. Biotite-hornblende quartz diorite composes the crudely foliated and very elongate Ruby Range Pluton (Jqdm). Biotite from the stock yielded a K-Ar age of 123 ± 10 m.y. which is probably anomalously young. The stock is not in contact with other intrusions, but faults which truncate its western extension do not offset the younger Goatcanyon - Halifax Creek Stock (Kqmb). The hornblende-epidote leucoquartz monzonite of South Wragge Creek Stock (Kqm) included with the calc-alkalic suite, may be compositionally transitional to the alkalic Kuskanax Batholith and stocks. The presence of oligoclase and hornblende, absence of albite and aegerine-augite, and transitional contact with Wragge Creek Stock favour its relation to the calc-alkalic suite. Hornblende- or epidote-biotite quartz monzonite (Kqmb) forms the major stocks between Slocan Lake and Columbia River. A K-Ar age of 107 ± 8 M.Y. is geologically reasonable and provides a minimum age for faults which are older than Goatcanyon - Halifax Creek Stock. Caribou Creek Pluton (Kcc) distinguished by the dominance of hornblende over biotite and presence of potash feldspar megacrysts, extends westward out of the map-area. A K-Ar age for biotite of 69 ± 6 m.y. comes from the pluton a mile south of the map-area at the junction of Caribou and Goatcanyon Creeks. Numerous small stocks and sills of feldspar porphyry (fp) east of Slocan Lake, of unknown age, may be correlative to the "Nelson Batholith".

On the northern edge of the map-area, Battle Range Batholith discordantly intrudes the Hamill to Lardeau Groups. Within the map-area, the composite batholith includes the following three phases in probable order of decreasing age: (a) biotite-hornblende quartz monzonite (Kqmm) containing sodic andesine forms the southern end of the batholith; (b) muscovite-biotite granodiorite (Kgdb) with calcic oligoclase forms most of the batholith; and (c) pyritiferous alaskite (Kgal) underlies a small central area of the batholith. A crude foliation, defined by mafic minerals, parallels the margin of the batholith. Major phases of the batholith, Sugarplum Stock, and a stock south of Hume Creek (Kqmb) are lithologically similar to the Bugaboo Batholith just east of the map-area. Based on this tentative correlation, Battle Range Batholith is probably of Cretaceous age.

Galena Bay Stock (Kgd) and a lineated biotite-muscovite quartz monzonite (qm), which may be part of Galena Bay Stock, outcrop near the head of Upper Arrow Lake and form a mile-wide belt across and west of Pingston Creek. These intrusions lie in the fringe zone on the eastern and southern margins of Thor-Odin Dome. Along the southeastern margin of the dome, a cataclasite zone produced a local fractured and brecciated augen gneiss within map-unit qm. K-Ar dating on biotite and muscovite from Galena Bay Stock gives 66 and 90 m.y. respectively, which is compatible with surrounding geological constraints but probably represents regional uplift and cooling, and not the time of intrusion and consolidation.

In Lardeau west-half, stratified rocks are complexly folded, faulted and metamorphosed. Rocks in the northeastern section of the map-area, lie on the western limb of the Purcell Anticlinorium and have the northwesterly trend of the northern end of the Kootenay Arc. Westwards, this limb loses its identity because of the intrusions of the Nelson and Kuskanax Batholiths, and the complex deformation and metamorphism associated with development of Valhalla, Pinnacles, and Thor-Odin Domes in the Shuswap Metamorphic Complex. These batholiths and domes effect a gradual transition into westerly trending structures of the west and south parts of Lardeau west-half. From the northeast corner, intensity of deformation increases southwestward, across trend, toward the Kuskanax Batholith. Along trend, folds are tighter northeast of the Kuskanax Batholith than either northwest or southeast of it. South and west of the batholith, intensity of deformation increases with proximity to gneiss domes. Because of a regional structural depression in the Kootenay Arc, folds southeast of Trout Lake plunge northwest and reappear as southeast-plunging folds between Incomappleux and Akolkolex Rivers. Near the eastern margin of Shuswap Complex, a gentle to moderate easterly plunge causes Paleozoic rocks to outcrop on the flanks of Thor-Odin Dome and, beneath the core of Mesozoic rocks exposed east of Columbia River in a complexly deformed synclinorium. Possibly the diapiric rise of Pinnacles and Thor-Odin Domes caused the easterly plunge.

Polyphase deformation has produced three phases of approximately coaxial folds of regional extent. Characteristics of these folds are given in Table I.

TABLE I:

Characteristics of Fold Phases in Lardeau West-Half

Phase	Style	Occurrence
First	Rootless, isoclinal folds with well-developed, axial-plane foliation.	Mesoscopic folds sparse and macroscopic folds rare. Deform rocks older than the Milford Group.
Second	Open to tight folds with a crenulation axial-plane cleavage. Commonly asymmetric with N-profile looking northwest and a vertical to northeast dipping axial plane.	Mesoscopic and macroscopic ubiquitous and deform all stratified rocks.
Third	Open to tight folds with crenulation axial-plane cleavage. Commonly asymmetric with И-profile looking northwest and a vertical to southwest dipping axial plane.	Folds of all scales are areally restricted.
Late	Kink folds of variable orientation.	Mesoscopic folds only in phyllitic rocks

(a) First Phase: On the northeast side of Akolkolex River, Badshot and Hamill outline the recumbent southeast plunging Akolkolex Anticline closing to the northeast and Drimmie Creek Syncline above Standfast Creek Fault (Thompson, 1972). Southwards at the north end of Kootenay Lake, similar first phase folds reappear as the northwest plunging Meadow Creek and Duncan Anticlines (Fyles, 1964). In Lardeau west-half, part of the upper limb of Meadow Creek Anticline outcrops in lower Meadow Creek.

(b) Second Phase: Macroscopic folds of this phase are ubiquitous and prominently affect the map distribution of rock units. Northeast of the Kuskanax Batholith, a series of asymmetric folds rise northeasterly towards the crest of the Purcell Anticlinorium. Because Battle Range Batholith intervenes on the boundary of Lardeau west-half (L.W-H), and Rogers Pass (R.P.) map-areas, correlation to major folds outside the map-area is tentative.

1. Illecillewaet Syncline (R.P.) = Finkle Creek Synform (L.W-H)
2. Ventego Syncline (R.P.) = an isoclinal syncline cored by Mohican Formation which crosses Westfall River (L. W-H).
3. Deville Syncline (R.P.) = syncline cored by Index Formation between Westfall and Duncan Rivers (L. W-H) = Mount Cauldron Syncline (L. E-H)*.

*(L.E-H) = Lardeau east-half.

(c) Third Phase: Folds of all scales are areally restricted to a zone extending beyond the map-area from the southeast end of Trout Lake southeasterly between Lardeau River and the Kuskanax Batholith. Southeastwards, the intensity of this phase increases at the expense of the second phase. Kootenay Lake Antiform runs along the lower course of Meadow Creek (Fyles, 1964), and farther northwest Trout Lake and Rusty Creek fold belts cross the southeast end of Trout Lake (Read, 1973). Mississippian to Jurassic rocks in the southern part of the map-area outline a complexly deformed synclinorium along Columbia River. At the southeast corner, near Kaslo, two coaxial phases of folding plunge gently northwestly, but at the western end, near Columbia River, two or more phases of non-coaxial folding plunge easterly. Third phase folds are present but whether second phase and/or a later regionally restricted phase of folding developed is uncertain.

Timing of deformation places first phase in middle Paleozoic, possibly Devonian, and second and probably third phases in middle Jurassic. A pre-late Mississippian age for first phase deformation and synchronous metamorphism rests on: (a) An exposed angular unconformity between the basal conglomerate of the Milford Group and truncated phyllite of the underlying Broadview Formation (Read, 1975); (b) Randomly-oriented phyllitic clasts of Broadview detritus in the conglomerate (Wheeler, 1966; Read, 1975); and (c) A Rb-Sr whole rock isochron on the Broadview Formation gives an age of 479 ± 17 m.y.

Restriction of the second and third phases of deformation and accompanying post-kinematic metamorphism to an interval between 164 and 178 m.y. depends on: (a) a K-Ar radiometric date of 178 m.y. from the core of the pre- to syn-tectonic Kuskanax Batholith; (b) an episodic lead loss at 175 $\pm^{?}_{?}$ m.y. in zircons from the core of Thor-Odin Dome (Wanless and Reesor, 1975); and (c) radiometric dates at least as old as 164 m.y. for the post-tectonic, northern part of the Nelson Batholith and Mount Carlyle Stock (Nguyen, Sinclair and Libby, 1968). This timing is consistent with rocks as young as Hall Formation (Middle Bajocian) in Nelson west-half being involved in regional deformation.

Two periods of regional metamorphism and later contact metamorphism affect stratified rocks. At Mount Thompson, the basal conglomerate and Rb-Sr dating of the Broadview require a pre-late Mississippian and probably Devonian age for metamorphism. Widespread polymetamorphic textures in the Lardeau Group and their absence in the Milford Group (Read, 1973) indicate the regional extent of this greenschist facies metamorphism, which may be obliterated to the west in the Shuswap Complex and may die out to the east, towards the crest of the Purcell Anticlinorium.

The pattern of metamorphic isograds developed shortly after middle Jurassic deformation. Metamorphic grade increases from northeast to southwest with isograds subparallel to the structural trends. Locally isograds transect structure (Read, 1973, fig. 68), and southwestwards toward Kuskanax Batholith, metamorphic grade increases with shallower structural and stratigraphic levels. Near the Kuskanax Batholith, upper Paleozoic Milford and Kaslo Groups are in amphibolite facies but northeastward the Hadrynian Horsethief Creek Group is in lower greenschist facies. In the southern part of the map-area, Milford and Slocan Groups display chlorite and biotite zones of metamorphism. Isograds parallel the structural grain into the southwest corner of the map-area where high grade metamorphism associated with Valhalla Dome on the south, Pinnacles Dome on the west, and Thor-Odin Dome to the northwest result in the development of staurolite and sillimanite zones. Second and third phase folds show post-tectonic crystallization of metamorphic minerals, but the "Nelson Batholith" and satellitic stocks as old as 164 m.y. imprint a contact aureole on this regional metamorphism. Because study of the metamorphism is in progress, incomplete isograds are shown and contact aureoles have been omitted.

In Lardeau west-half and northward in Big Bend map-area (Wheeler, 1965), cataclastic, mylonite and fault zones dip gently eastward and form the eastern margin of the Shuswap Metamorphic Complex. They truncate folds and isograds and attenuate metamorphic zones. The faults have normal, dip-slip movement and developed between the middle Jurassic metamorphic climax and the middle Cretaceous or earlier intrusion of Caribou Creek Stock (Kcc) and Kqmb.

The complex relations and timing among sedimentation, deformation, metamorphism and plutonism are summarized in Table II.

Early in the century, mining played an important part in the economy of the region. Silver-lead-zinc vein deposits have been the largest producers. Relevant data on all mineral deposits are summarized in an accompanying open file map of mineral deposits of the map-area.

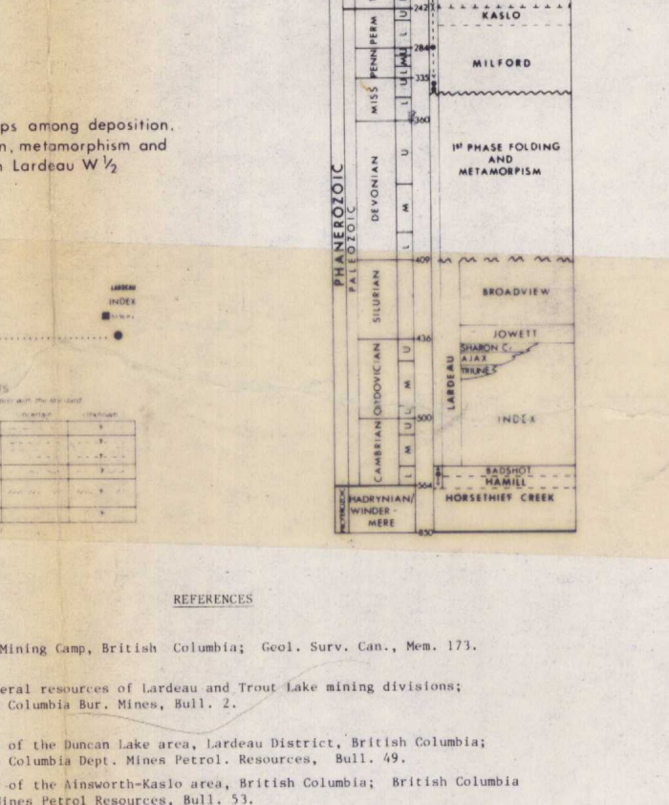


Table II Relationships among deposition, deformation, metamorphism and plutonism in Lardeau W ½

REFERENCES

Cairnes, C. E.
1934: Slocan Mining Camp, British Columbia; Geol. Surv. Can., Mem. 173.

Emmens, N. W.
1914: The mineral resources of Lardeau and Trout Lake mining divisions; British Columbia Bur. Mines, Bull. 2.

Fyles, J. T.
1964: Geology of the Duncan Lake area, Lardeau District, British Columbia; British Columbia Dept. Mines Petrol. Resources, Bull. 49.
1967: Geology of the Ainsworth-Kaslo area, British Columbia; British Columbia Dept. Mines Petrol Resources, Bull. 53.

Fyles, J. T. and Eastwood, G.E.P.
1962: Geology of the Ferguson area, Lardeau District, British Columbia; British Columbia Dept. Mines Petrol. Resources, Bull. 45.

Hedley, M. S.
1945: Geology of the Whitewater and Lucky Jim mine areas, Slocan District, British Columbia; B.C. Dept. Mines, Bulletin 22.
1952: Geology and ore deposits of the Sandon area, Slocan mining camp, British Columbia; B.C. Dept. Mines, Bulletin 29.

Hyndman, D. W.
1968: Petrology and structure of Nakusp map-area, British Columbia; Geol. Surv. Can., Bull. 161.

Jones, A. G.
1959: Vernon map-area, British Columbia; Geol. Surv. Can., Mem. 296.

Kerr, J.
1964: Geology of the Sproat Mountain ultrabasic intrusion; unpub. B.Sc. thesis, Dept. Geology, Univ. British Columbia.

Little, H. W.
1960: Nelson map-area, west half, British Columbia (82F W/2): Geol. Surv. Can., Mem. 308.

Mathews: W. H.
1952: British Columbia Dept. Mines, Geological Assessment Rept. No. 86.

Nguyen, K. K., Sinclair, A. J. and Libby, W. G.
1968: Age of the northern part of Nelson batholith; Can. Jour. Earth Sci., v. 5, p. 955-957.

Okulitch, A. V., Wanless, R. K. and Loveridge, W. D.
1975: Devonian plutonism in south-central British Columbia; Can. Jour. Earth Sci., v. 12, p. 1760-1769.

Read, P. B.
1973: Petrology and structure of Poplar Creek map-area, British Columbia; Geol. Surv. Can., Bull. 193.
1975: Lardeau Group, Lardeau map-area, west half (82K W/2), British Columbia; Geol. Surv. Can., Paper 75-1, Pt. A, p. 29-30.

Read, P. B. and Okulitch, A. V.
The Triassic unconformity in south-central British Columbia; in preparation.

Reesor, J. E.
1965: Structural evolution and plutonism in Valhalla gneiss complex, British Columbia; Geol. Surv. Can., Bull. 129.
1973: Geology of the Lardeau map-area, east-half, British Columbia; Geol. Surv. Can., Mem. 369.

Reesor, J. E. and Moore, J. M.
1971: Petrology and structure of Thor-Odin gneiss dome, Shuswap metamorphic complex, British Columbia; Geol. Surv. Can., Bull. 195.

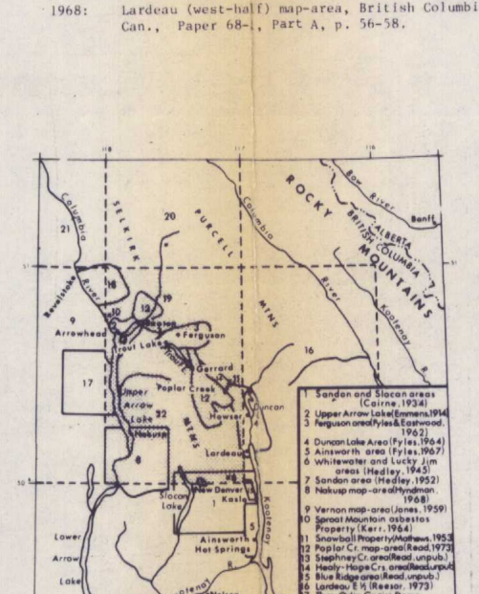
Rice, H. M. A.
1941: Nelson map-area, east half, British Columbia; Geol. Surv. Can., Mem. 228.

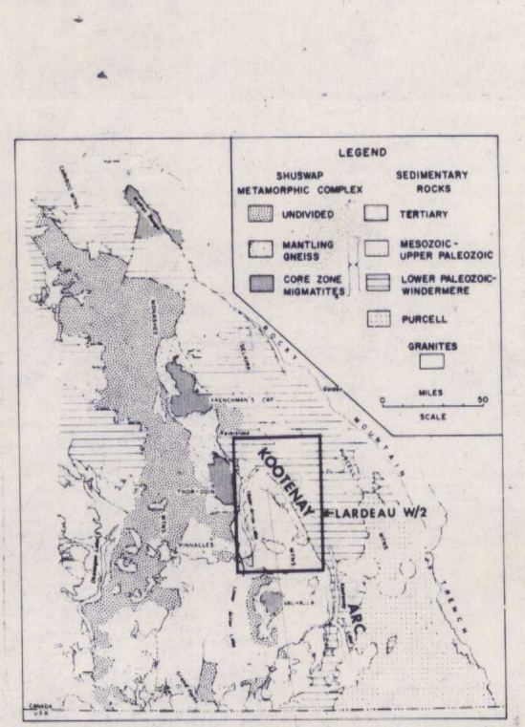
Thompson, R. I.
1972: Geology of the Akolkolex River area near Revelstoke, British Columbia; unpub. PhD thesis, Dept. Geol. Sci., Queen's Univ.

Walker, J.F., Bancroft, M.F. and Gunning, H.C.
1929: Lardeau map-area, British Columbia; Geol. Surv. Can., Mem. 161.

Wanless, R. K. and Reesor, J. E.
1975: Precambrian zircon age of orthogneiss in the Shuswap metamorphic complex, British Columbia; Can. Jour. Earth Sci., v. 12, p. 326-332.

Wheeler, J. O.
1963: Rogers Pass map-area, British Columbia and Alberta (82N W/2); Geol. Surv. Can., Paper 62-32.
1965: Big Bend map-area, British Columbia (82M E/2); Geol. Surv. Can., Paper 64-32.
1966: Lardeau (west-half) map-area (82K W/2); Geol. Surv. Can., Paper 66-1, p. 102-103.
1968: Lardeau (west-half) map-area, British Columbia (82K W/2); Geol. Surv. Can., Paper 68-1, Part A, p. 56-58.





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