# Open File 659

# CENOZOIC ROCKS IN THE WESTERN CANADIAN CORDILLERA OF BRITISH COLUMBIA AND YUKON TERRITORY

BY

G. A. Noel

G. A. Noel and Associates Inc.

Vancouver, B. C.

April 1978

# CENOZOIC ROCKS IN THE WESTERN CANADIAN CORDILLERA OF BRITISH COLUMBIA AND YUKON TERRITORY


## ABSTRACT

A systematic compilation of all available data on Cenozoic rocks and structures in B. C. and Yukon Territory has been prepared on a 1:2,000,000 base map. The accompanying report covers the tectonic and structural framework as well as a detailed description of all Cenozoic lithologies.

This compilation is expected to serve as a data base for current geothermal research in the Canadian Cordillera.

## TABLE OF CONTENTS



## ILLUSTRATIONS

# INTRODUCTION

This report is based on library research carried out during several months in 1976 and 1977. The purpose of the investigation was to compile fairly detailed information on the character, structure, distribution and stratigraphic relationships of Cenozoic rocks in British Columbia and Yukon Territory and present these data on a 1:2,000,000 scale map with an accompanying correlation chart.

The method of investigation included research of all available literature concerning Cenozoic rocks in British Columbia and Yukon Territory. Pertinent information was summarized and compiled using seven map-areas of convenient size. The Cenozoic geology was plotted on map sheets of these areas at scale of 1:1,000,000. Correlation sections were prepared for each of the map-areas to establish isochronous units wherever possible and to compile a compatible legend in each case. Potassium-argon ages were plotted on the maps wherever pertinent and these data were also used in stratigraphic correlation. The time-scale of the Geological Society of London (1964) was used as the basis for the time intervals of the Cenozoic epochs. The 1:1,000,000 geology sheets and sections were integrated and an overall legend was prepared. The 1:1,000,000 sheets were then reduced to half scale and the Cenozoic geology was traced on a 1:2,000,000 base map.

## TECTONIC SUMMARY

The Laramide Orogeny, which began in late Cretaceous and continued into early Oligocene resulted in the development of the Rocky Mountain Thrust Belt, and the Mackenzie and Northern Yukon Fold Belts. During this orogeny, numerous discordant plutons were emplaced, mainly in the Insular Fold Belt, Coast Plutonic Complex, Cascade Fold Belt and Omineca Crystalline Belt. (Douglas, R.J.W., 1970).

During the Paleocene and early Eocene, non-marine clastics were deposited along the Pacific Shelf and western edge of Vancouver Island and in restricted synorogenic basins in south-western British Columbia, the Interior Plateau and the northern Omineca as well as parts of the Rocky Mountain Trench. Widespread subaerial synorogenic volcanism followed this early Cenozoic sedimentation particularly along the southwest coast of Vancouver Island, on northern Queen Charlotte Islands, in the Interior Plateau of B. C., in northwestern B. C. and in southwestern Yukon Territory.

The mid-Tertiary was marked by a long erosional interval following the Laramide Orogeny. This interval extended through most of the Oligocene into mid-Miocene and resulted in widespread peneplanation and establishment of most of the present drainages. Sedimentation was restricted to the west coast of Vancouver Island, the east coast of Queen Charlotte Islands and along the eastern margin of the St. Elias Mountains.

Widespread extrusion of basalt and olivine basalt from fissure vents in the Miocene blanketed the irregular erosional surface of the Interior Plateau. These sheet flows were generally thin but of great areal extent. Similar euptions occurred from shield volcanoes and fissures over more restricted areas in northwestern British Columbia and southwestern Yukon Territory. During the Miocene, the St. Elias Mountains were formed by north-south crustal compression along the northern margin of the Pacific Ocean (Eisbacher, 1977). This thrusting and folding was accompanied by right lateral transcurrent movement along the major faults of the continental margin. The Miocene was also marked by sporadic plutonic activity in the Cascade Fold Belt and Coast Plutonic Complex.

The extrusion of plateau basalt continued into the Pliocene, which was also marked by the Cascade Orogeny. In late Pliocene, varied lavas were erupted from numerous separate central vents mainly in southwestern and northwestern British Columbia. These eruptions continued through the Pleistocene into Recent time. Many of these volcanic cones follow well-defined north and northwest alignments, probably indicative of deep crustal breaks (Souther, 1970). Some of the youngest volcanic flows overlie glacial till.

GEOLOGY

Table of Formations

| PERIOD | EPOCH | GROUP | FORMATION | MAP SYMBOL | LITHOLOGY |
|---|---|---|---|---|---|
| Quaternary | Recent | | | Qs | glacial deposits and recent alluvium |
| | | | | rQvb | basalt flows, ash |
| | | | | rQvbo | olivine basalt |
| | | | | rQs | sand and shale |
| Tertiary | | | | pQvbo | olivine basalt |
| | | | | pQvr | rhyolite, dacite, tuff |
| | | | | pQvy | latite, trachyte |
| | | | | pQvb | basalt, olivine basalt, cinder cones, basalt breccia. |
| | Pleist-ocene | Selkirk Group | | pQvSK | basalt, andesite, breccia and tuff |
| | | | Miles Canyon Basalt | pQvMC | basalt |
| | | | Not in contact | | |
| | | Garibaldi Group | | pQvG | basalt, andesite |
| | | | Mt. Baker Volcanics | pQvMB | olivine basalt, andesite, dacite |
| | | | Mt. Silverthrone Volcanics | pQvST | breccia, basalt, rhyolite |
| | | | Not in contact | | |
| | | Level Mountain Group | Spectrum Range Volc. | pQvLM | andesite, basalt, alk. olivine basalt, rhyolite, trachyte. |
| | | | Tuya Formation | pQvT | basalt, tuff. |
| | | | Not in contact | | |
| | | | | pQs | sand, siltstone, shale |

| PERIOD | EPOCH | GROUP | FORMATION | MAP SYMBOL | LITHOLOGY |
|---|---|---|---|---|---|
| | | | Erosional interval in part | | |
| Tertiary | Pliocene | | Tow Hill Sills | plTvTH | olivine basalt |
| | | | Not in contact | | |
| | | | Lake Island Fm | plTvb<br>plTvb<br>plTs | basalt flows, tuffs, breccia<br>plateau & valley basalt flows<br>marine and non-marine sand-stone, conglomerate, shale. |
| | | | Erosional interval in part | | |
| Tertiary | Miocene | | ((Columbia River lavas<br>(Plateau lavas | mTvb | plateau basalt, olivine basalt, breccia, tuff. |
| | | | Not in contact | | |
| | | Carmacks Group | | mTvC | andesite & basalt flows & breccias. |
| | | | Donjek Volcanics | mTvD | flows, tuffs, breccias. |
| | | | Little Ridge Volc. | mTvLR | basalt flows and breccia. |
| | | | Wrangell Volcanics | mTvW | basalt and andesite pyro-clastics & volcanic conglom-erate. |
| | | | Not in contact | | |
| | | | Hearts Peak Formation | mTvHP | trachyte, rhyolite. |
| | | | Not in contact | | |
| | | Coquihalla Group | | omTvC | rhyolite, andesite, basalt, tuffs, breccia |
| | | | Deadman River Form. | mTsDR | sandstone, shale, tuff, conglo-merate. |

| PERIOD | EPOCH | GROUP | FORMATION | MAP SYMBOL | LITHOLOGY |
|---|---|---|---|---|---|
| Tertiary | Miocene | | Not in contact | | |
| | | | Skonun Formation | mTsS | sandstone, shale, lignite, conglomerate. |
| | | | Not in contact | | |
| | | | Bella Bella Formation | mTs | sandstone, conglomerate, andesite, breccia. |
| | | | Not in contact | | |
| | | | Sooke Formation | mTsSO<br>mTs | sandstone and conglomerate.<br>sandstone, shale, siltstone, conglomerate, lignite. |
| | | | Unconformity | | |
| Tertiary | Oligocene | | Hannegan Formation<br>Skagit Formation | oTvH<br>oTvS<br>oTvr<br>oTvrp<br>oTv | andesite flows, tuffs.<br>rhyolite & andesite flows, tuffs<br>acid & felsic flows, tuffs.<br>rhyolite porphyry.<br>andesite, basalt. |
| | | | Not in contact | | |
| | | | Amphitheatre Formation | oTsA | sandstone, shale, conglomerate, lignite. |
| | | | Not in contact | | |
| | | | Skaha Formation<br>White Lake Formation | oTsS<br>oTsWL | fanglomerate, slide breccia lahar, sandstone, tuffs, breccia. |
| | | | Not in contact | | |

| PERIOD | EPOCH | GROUP | FORMATION | MAP SYMBOL | LITHOLOGY |
|---|---|---|---|---|---|
| Tertiary | Oligocene | | Not in contact | | |
| | | | Carmanah Formation )<br>Escalante Formation ) | oTs | marine sandstone, siltstone, shale, conglomerate. |
| | | | Not in contact | | |
| | | | Twin River Formation | oTsTR | siltstone, sandstone, conglomerate. |
| | | | Erosional interval in part | | |
| Tertiary | Eocene | Kamloops Group | Tranquille Beds | eTsT | sandstone conglomerate, tuff, lignite. |
| | | | Skull Hill Formation | eTvK | dacite, trachyte, basalt, andesite, rhyolite, breccia. |
| | | | Chu Chua Formation | eTvK | conglomerate, sandy shale, arkose, lignite. |
| | | | Not in contact | | |
| | | Endako Group | | eTvE | andesite, basalt. |
| | | | Not in contact | | |
| | | Princeton Group | | eTvP | andesite, basalt. |
| | | | Not in contact | | |
| | | (Metchosin Group<br>(Crescent Group | | eTvME)<br>eTvCR) | pillow basalt, breccia. |
| | | | Not in contact | | |
| | | | | eTv | rhyolite, dacite, andesite, basalt. |
| | | | Not in contact | | |

| PERIOD | EPOCH | GROUP | FORMATION | MAP SYMBOL | LITHOLOGY |
|---|---|---|---|---|---|
| Tertiary | Eocene | | Not in contact | | |
| | | Midway Group | Marama Formation<br>Marron Formation | eTvMA<br>eTvM/ eTvMR | rhyolite, rhyodacite, conglo- merate.<br>andesite, latite, trachyte. |
| | | | Not in contact | | |
| | | | Masset Formation | eTvMS | rhyolite, dacite, basalt, tuffs, breccia. |
| | | | Not in contact | | |
| | | (Sloko Group<br>(Skukum Group<br>(Mt. Nansen Group | Casino Volcanics | eTvSL<br>eTvSK)<br>eTvMN))<br>eTvC | pyroclastics & volcaniclastics<br>rhyolite and trachyte flows, tuffs and breccia.<br>basalt and flow breccia. |
| | | | Not in contact | | |
| | | Princeton Group | Coldwater Beds<br>(Chu Chua Formation) | eTsP/<br>eTsC | sandstone, grit, shale, conglomerate, coal. |
| | | | Not in contact | | |
| | | | Kulthieth Formation | eTsK | arkose, shale |
| | | | Not in contact | | |
| | | | ((Kettle River Formation<br>(Springbrook Formation | eTsKR))<br>eTsS ) | sandstone, shale, conglomerate, tuff. |
| | | | Not in contact | | |
| | | | | eTs | conglomerate, shale, sandstone, lignite. |
| | | | Not in contact | | |

| PERIOD | EPOCH | GROUP | FORMATION | MAP SYMBOL | LITHOLOGY |
|---|---|---|---|---|---|
| Tertiary | Eocene | | Brothers Peak Form.<br>Sifton Formation | eTsBP<br>eTs | tuff, sandstone, conglomerate<br>siltstone, sandstone, conglomerate. |
| | Paleocene | Sustut Group | Tango Creek Formation | pTsS/<br>pTsTC | siltstone, sandstone, conglomerate. |
| | | Not in contact | | | |
| | | | | pTs | sandstone, shale, greywacke, conglomerate. |
| | | Not in contact | | | |
| | | Ootsa Lake Group | | pTvOL | rhyolite, dacite trachyte flows and tuffs. |
| | | Not in contact | | | |
| | | | | pTv<br>pTvr<br>pTvb<br>pTfp | basalt, trachyte<br>rhyolite, tuff.<br>basalt, tuff.<br>feldspar porphyry flows, dykes |

# GEOLOGY

## Sedimentary and Volcanic Rocks

### Paleocene

Continental clastic sediments were deposited in late Upper Cretaceous and Paleocene time in narrow successor basins in the Intermontane Belt of northern B. C. as well as in the northern Rocky Mountain Trench. The Sustut Group, which includes the Tango Creek Formation, consists of sandstone, shale, siltstone and conglomerate up to 1,800 meters in total thickness (Eisbacher, 1972). The equivalent Sifton Formation occurs as elongated strands along the Finlay River in the Rocky Mountain Trench. Several small basins in northwestern British Columbia and southwestern Yukon Territory also exhibit Paleocene sections of sandstone, shale and conglomerate.

Paleocene volcanism is represented by the Ootsa Lake Group, which consists of acid volcanics with minor sediments. These flows and pyroclastics are restricted to the Interior Plateau of B. C. In southwestern Yukon Territory feldspar porphyry flows and related dykes of similar composition are also considered to be of Paleocene age.

### Eocene

In the Fraser River delta and Bellingham basin, Paleocene and Eocene continental sediments form very thick sections (over 2,000 meters thick) of conglomerate sandstone and siltstone with some lignite (Roddick, 1965).

These sediments were originally designated as Burrard and Kitsilano Formations. Equivalent sediments in Washington include: Huntingdon, Lyre and Aldwell Formations. In the southern Interior Plateau, the Princeton Group, Springbrook and Kettle River Formations and Coldwater and Tranquille Beds are all considered to be of Middle Eocene age on the basis of fossil evidence and radiometric age dating. These non-marine sediments include shale, sandstone, conglomerate and some lignite. The upper member of the Sustut Group, Brothers Peak Formation, occupies an extended northwesterly trending basin northwest of Thutade Lake in the Omineca region of B. C. The Kulthieth Formation of arkose and shale is exposed as scattered small outcrops in the St. Elias Fold Belt.

The Kamloops and Endako Groups and the volcanic part of the Princeton Group are represented by andesite, trachy-andesite, basalt, dacite and rhyolite, which occur as lenticular flows and pyroclastic sheets. These volcanics with associated sediments attain considerable thicknesses (up to 1,500 meters) in the southern Interior Plateau of B. C. The Midway Group and its component Marron and Marama Formations are equivalent to the Kamloops and Endako Tertiary sheets in the Interior Plateau.

The Sloko Group of northwestern B. C. and southwestern Yukon Territory consists principally of pyroclastic dacite, rhyolite and trachyte with volcaniclastic sediments and subordinate dacite, andesite and basalt flows. The pyroclastics include coarse explosion breccias with granitic fragments, vitric tuffs, ignimbrites. The Sloko volcanics are in many places bounded by normal faults or ring fractures, which are occupied by rhyolite and trachyte dykes. The volcanics are underlain by felsite and its intrusive equivalent, quartz monzonite. The Mt. Nansen and Skukum Groups of south central Yukon Territory are very similar lithologically to the Sloko Group consisting of rhyolite and trachyte flows, tuffs and breccias. The Casino volcanics are restricted to isolated exposures in west central Yukon Territory and are represented by relatively local flows of basalt and flow breccias. At the south end of Vancouver Island, the Metchosin Group comprises over 4000 meters of pillow basalts and minor pyroclastics. The correlative Masset Formation on Queen Charlotte Island consists of an extremely thick sequence ( 8000 meters) of rhyolite, dacite and basalt flows, tuffs and breccia with some ash flows and volcanic sandstone. In western Washington, the Crescent Group is equivalent to the Metachosin volcanics and both units unconformably overlie Lower Cretaceous sediments.

Oligocene

Oligocene sedimentation in the Cordilleran of Western Canada was limited to southern British Columbia and southwestern Yukon Territory. Clastic marine sediments of the Carmanah and Escalante Formations form thick Oligocene accumulations (± 2500 meters) along the west coast of Vancouver Island. These sandstones, siltstones and conglomerates unconformably overlie older rocks and are in turn unconformably overlain by glacial drift. The Twin Rivers Formation of northwestern Washington is roughly equivalent to the Carmanah Formation. In the White Lake basin of southern Okanagan valley, British Columbia, the White Lake and Skaha Formations consist of at least 1400 meters of lahar, sandstone, tuffs and fanglomerate. In southwestern Yukon Territory, continental clastic sediments of the Amphitheatre Formation (300-400 meters thick) consisting of sandstone, conglomerate, shale and lignite accumulated in narrow basins along the northeast margin of the St. Elias Mountains.

Oligocene volcanism was also very limited in areal extent. The Hannegan and Skagit Formations of northwestern Washington consist of andesite flows and tuffs. Andesite and basalt flows overlying late Eocene Tranquille Beds of the Kamloops Group in south central B. C. may also be of Oligocene age.

Miocene

Along the southwest coast of Vancouver Island, sedimentation continued into the Miocene in the form of marine clastics of the Sooke Formation, which is up to 500 meters thick in Sooke Basin. The Skonun Formation consists of up to 2000 meters of marine and non-marine sands and shales deposited along the east coast of Queen Charlotte Islands. The Bella Bella Formation of the islands along the north coast of B. C., consisting of volcanic flows and pyroclastics with intercalated sediments, is considered roughly equivalent to the Skonun Formation. The Deadman River Formation (150 meters thick) consists of non-marine tuff, breccia, diatomite, sandstone and conglomerate in the Interior Plateau of British Columbia.

The Miocene is represented by widespread plateau lavas throughout central B. C. These olivine basalt flows are equivalent to the Columbia River lavas of Washington and Oregon. The Coquihalla Group of southwestern B. C. consists of a 1200 meter thick succession of rhyolite, andesite and basalt flows and pyroclastics, probably the forerunner of the extensive Pliocene and Pleistocene volcanism in this region. In northwestern B. C., the Miocene volcanism was represented by shield volcano eruptions; such as, Hearts Peak Formation, at least 300 meters of rhyolite, dacite and trachyte flows and pyroclastics. In southwestern Yukon Territory, Miocene volcanism is prolifically represented as Wrangell Volcanics and Carmacks Group. These volcanics include: volcanic conglomerate and scoria, massive and columnar basalt and andesite pillow lavas, as well as pyroclastic and volcaniclastic members. The Carmacks Group is up to 800 meters thick, whereas the Wrangell Volcanics reach 2000 meters in thickness.

Pliocene

The Pliocene represented the end of Cenozoic sedimentation in British Columbia and Yukon Territory. Marine clastics of possibly Pliocene age accumulated on the continental shelf along the southwest coast of Vancouver Island. Some intercalated continental clastics of probably Pliocene age are found in the southern Interior Plateau of British Columbia. These sediments interfinger with flows of Plateau and Valley basalt.

In southwestern British Columbia, Pliocene volcanism consisted of continuing eruptions from both fissures and central vents. These flows are designated as Garibaldi volcanics and include: basalt, rhyolite, dacite and andesite flows. In the central interior region of B. C., Pliocene volcanism consisted of valley flows of vesicular to massive basalt. On Queen Charlotte Islands, the Tow Hill Sills of olivine basalt up to 100 meters thick, represent one manifestation of Pliocene fissure-type volcanism. On the coastal islands, the Lake Island Formation is probably equivalent to the Tow Hill Sills.

In northwestern British Columbia, the Pliocene marked a continuation of the Miocene shield-type volcanism with the extensive volcanic assemblage (over 1200 meters) of the Level Mountain Group. These volcanics include: pillow lavas, massive and columnar basalt and pyroclastics. Numerous central vent volcanoes also developed as part of the Spectrum Range Volcanic Complex with Mt. Edziza being the most notable. These extrusions include andesite and basalt flows, alkaline olivine basalt, rhyolite and trachyte with a composite thickness in excess of 600 meters.

## Pleistocene

Pliocene volcanic activity continued into the Pleistocene when almost all of the Western Canadian Cordillera was glaciated. Layers of glacial till are intercalated in the Pliocene-Pleistocene volcanic sections in many areas of B. C. In central Yukon Territory the Miles Canyon Basalt and Selkirk Volcanics ($\pm$ 50 meters) are of Late Pleistocene age. They include andesite and basalt flows with some tuffs and breccias. Throughout most regions of B. C., Late Pleistocene is represented by isolated basalt flows, cinder cones and ash.

## Recent

Since the last ice retreat, a number of small vent and fissure volcanoes have been active particularly during the past 3000 years. Included in this group are the following: Aiyansh flows in northwestern B. C., Meager Creek and Garibaldi flows of southwestern B. C., Cascade volcanoes of northwest Washington and the latest ash layers in Yukon Territory.

## Plutonic Rocks

### Early Tertiary

Paleocene and Eocene intrusions are present in southwestern, coastal, southern, central, northern and northwestern B. C. and in southern Yukon Territory. In southwestern B. C. intrusions of 40 - 65 million years include: Yale Intrusions and Hells Gate Pluton (granodiorite) in the Hope area; Sooke Intrusions (gabbro and quartz diorite) on southern Vancouver Island; numerous granodiorite to quartz monzonite plutons on the west coast of Vancouver Island and on northern Vancouver Island; Otter Lake, Trout Creek and Siwash Creek (quartz monzonite to granite) plutons in the Princeton area. On the B. C. coast, Eocene intrusions of quartz monzonite and granodiorite occur south of Prince Rupert, and, to a greater extent, around Alice Arm. In south-central B. C., Eocene intrusions include the Shingle Creek porphyry in the White Lake Basin and intrusive phases of the Midway Volcanics, mainly syenite, monzonite and quartz monzonite. In central B. C., Eocene intrusions include: Goosly Intrusions of granite and quartz feldspar porphyry and Parrott Lake Intrusions of syenomonzonite in the Smithers area; Kastberg Intrusions of high level granite and rhyolite porphyries in the McConnell Creek area. In northwestern B. C., some Eocene granite stocks and sills have been mapped in the Telegraph Creek area. In southern Yukon Territory, Eocene stocks of granite porphyry have been mapped in the Whitehorse and Carmacks areas.

### Mid-Tertiary

Oligocene-Miocene intrusions (20 - 40 million years) occur in south-central B. C. in Queen Charlotte Islands and in parts of the Coast Range

Intrusions. In south-central B. C., the Coryell, McGregor and Sheppard Intrusions of syenite, monzonite and quartz diorite are considered to be of Oligocene age. On Queen Charlotte Islands the post-tectonic phase of the Composite Kano granodiorite batholith is dated at 30 million years. In the Cascades of southwestern B. C. and northwestern Washington, the Chilliwack Composite Batholith (quartz diorite) has several younger phases; such as, Golden Horn granite pluton of 30 million years age and Perry Creek quartz diorite to quartz monzonite dated at 26 million years. In the Hope area, the Needle Peak granodiorite pluton is dated at 39 million years and the Hope granite pluton is considered to be slightly younger.

### Late Tertiary

Most of the late Tertiary intrusions ($<$ 20 m.y.) occur in southwestern B. C. In the Cascades area, a quartz diorite pluton intrudes Pliocene olivine basalt flows. In the Pemberton area, a miarolitic granodiorite stock has been dated at 16 million years and the Salal Creek quartz monzonite pluton at 7.9 million years. Other plutons of similar age in this area include the Hall Creek and Job Glacier stocks. In the Hope area, the Mt. Barr quartz diorite pluton has been dated at 16 million years.

## STRUCTURAL GEOLOGY

### Eastern Marginal Belt

During the Laramide Orogeny, the Cordilleran geosyncline was intensively deformed from late Upper Cretaceous to early Tertiary. The Laramide structures have not been represented on the attached map due to the difficulty of segregating those structures which experienced Cenozoic deformation or movement. Since a large part of the Laramide deformation was Cenozoic, a brief description of its effects has been included (Douglas, 1970).

The Rocky Mountains and Foothills consist of large west-dipping thrust sheets which have been displaced for considerable distances to the east. The thrust sheets are sliced by many closely-spaced, steeply-dipping normal faults. The thrust sheets were warped and folded, both during and following thrust faulting. In the southern Rocky Mountains, several post-orogenic normal faults of probably Early Oligocene age have been defined. These faults roughly parallel the major thrusts and they probably merge with them at depth. Normal faults occur along the margins of the southern Rocky Mountain Trench, which is underlain in the north by the fault-defined early Tertiary Sifton Formation.

The MacKenzie Fold Belt in Yukon Territory, shows a similar pattern of Laramide deformation. The overall displacement is, however, considerably less than in the Rocky Mountains. Most thrust faults are closely associated with folding in this northern orogenic belt and these faults dip both east and west.

Intermontane and Omineca Belts

Tertiary structures include north-northeast trending normal faults associated with the Coryell Intrusions and Midway Volcanics. These plutons and related dykes show north and northeast alignment suggesting that the faults may have acted as feeders to the system. Horst and graben structures are associated with local Tertiary depositional basins; such as, White Lake Basin. Early Tertiary movement probably occurred along the Pinchi fault system where it defines the Paleocene Sustut Group and the associated Tango Creek and Brothers Peak Formations.

The northwest-trending Louis Creek Fault zone and associated north and northeast trending normal faults cut the Kamloops Group and associated Eocene volcanics into numerous angular fault blocks in the southwestern part of the Interior Plateau. These normal faults do not cut the overlying Miocene Plateau lavas which are generally undisturbed. These flows have been warped up for thousands of feet along the northeast margin of the Coast Range. This warping probably occurred in Pliocene or Pleistocene time.

The northwest ends of the Nahlin and King Salmon thrusts, which do not displace Tertiary strata but tail out into steep north-trending arcuate fault segments. These faults displace blocks of the Eocene Sloko Group near Atlin Lake, B. C. South of Telegraph Creek, parallel north-south normal faults displace flows from Quaternary volcanic centers into a series of narrow grabens. These faults are believed closely related to the Quaternary volcanics. West of Telegraph Creek, steep north trending faults outline blocks of Eocene volcanics.

In central Yukon Territory, steep northwest and northeast fault segments cut Miocene Carmacks Group volcanics as well as the closely associated Little Ridge Volcanics.

Coast Crystalline Belt

The Fraser Fault zone shows early Tertiary movement which resulted in segregation of small areas of Eocene clastics prior to intrusion of the Chilliwack Composite Batholith in Late Oligocene. The Chilliwack Batholith is cut by mid-Tertiary or later north-south and east-west normal faults. Early Tertiary movement along the Yalakom Fault has displaced felsitic volcanics of probably Eocene age. Northeast-trending steeply dipping normal and transverse faults displace Early Tertiary plutons in the northern Coast Range near Prince Rupert and Alice Arm.

Northeast-trending, steeply dipping faults cut early Tertiary plutons near Skagway Alaska and Bennett, B. C. In the Carcross area, ring dykes of granite porphyry reflect subsidence of Eocene volcanics, which were displaced by block faulting following extrusion.

Insular Belt

The northwest trending Malaspina and Alberni Faults along the northeast margin of Vancouver Island show early Tertiary movement in Upper Cretaceous sediments which have been dropped on the southwest side of this fault (Douglas, 1970). On the south end of Vancouver Island, the Eocene Metchosin volcanics have been thrust over late Mesozoic meta-sediments. Movement along the San Juan and Leech River Faults apparently occurred during Oligocene as the Carmanah Formation has also been displaced. Folding in the block between these faults has an east-west orientation, parallel to the faults (A. Sutherland Brown, 1966). Numerous northwest-trending, steeply dipping fault segments cut Early and Mid-Tertiary plutons on Vancouver Island. One such fault segment cuts a Late Miocene volcanic plug near the north end of Vancouver Island. Miocene-Pliocene marine clastics have been down-faulted along northwest trending mainly transform faults, off the west coast of Vancouver Island.

On Queen Charlotte Islands, the Eocene Masset volcanics have been displaced by steeply dipping, northwest trending transform faults. These faults show right lateral movement and east-side down-throw. The northwest trending Sandspit Fault off the east coast of Moresby Island displaces Miocene-Pliocene clastics along the marine basin. The northwest trending Queen Charlotte Fault off the west coast of Queen Charlotte Islands is a major transcurrent fault that merges with the Fairweather and Denali Faults in southeast Alaska. This fault system, which extends deep into the oceanic crust, has shown continuing movement through Tertiary and Quaternary periods.

St. Elias Fold Belt

The Shakwak Valley is a young erosional trench which follows the Denali Fault zone. The total right lateral movement along this fault in the last 50 million years is considered to have been about 300 km. Some of this movement apparently occurred in Pleistocene or Recent time but not in the last 3000 years. The Dalton Fault is a major segment of the Denali Fault system extending southeast from the south end of Kluane Lake. Southwest of the Border Ranges Fault, Mesozoic metamorphic rocks have been thrust over Tertiary marine sediments of Paleocene to Pleistocene age. Thrust faults near Mt. St. Elias involve Tertiary and Quaternary marine sediments, indicating that under-thrusting at the continental margin is still continuing (Campbell and Dodds, 1978).

# REFERENCES

Aitken, J. D. (1960): Atlin map-area, British Columbia; Geological Survey, Canada, Mem. 307.

Anderson, R. B. (1975): Geology of the volcanics in the Meager Creek map-area, Southwestern B. C., University of B. C., Bach.Sci.Thesis.

Armstrong, J. E. (1949): Fort St. James map-area, Cassiar and Coast Districts, B. C., Geological Survey, Canada., Mem. 252.

Armstrong, J. E.; Tipper, H. W.; Hoadley, J. W. (1947): Carp Lake, B. C.; Geological Survey, Canada , Paper 47-13.

Aumento, F. & Souther, J. G. (1973): Fission track dating of late Tertiary and Quaternary volcanic glass from the Mount Edziza volcano, B. C.; Can. Jour. Earth Sci., vol. 10, pp. 1156-63.

Baadsgaard, H., Folinsbee, R. E. & Lipson, J. (1959): Potassium-argon age of biotites from Cordilleran granites of central British Columbia; Geol. Soc. Am., Bull. vol 70, p. 1564.

Baer, A. J. (1965): Bella Coola (93D) map-area; Geol. Surv. Can., paper 65-1.

(1973): Bella Coola - Laredo Sound map-areas, B. C., Geol. Surv. Can., Mem. 372.

Black, R. F. & Larochelle, A. (1965): Paleomagnetic results on the Miles Canyon basalts, southern Yukon, Geol. Surv. Can., Paper 65-2.

Bostock, H. S. (1936): Carmacks district, Yukon Territory; Geol. Surv. Can., Paper 65-2.

Bostock, H. S. (1938): Laberge map-area, Yukon; Geol. Surv. Can., Mem. 217.

Bostock, H. S. (1952): Geology of northwest Shakwak Valley, Y.T.; Geol Surv. Can., Mem. 267.

Bostock, H. H. (1966): Feldspar and quartz phenocrysts in the Shingle Creek porphyry, B. C.; Geol. Surv. Can., Bull. 126.

Cairnes, D. D. (1909): The Wheaton River district, Y. T.; Geol. Surv. Can., Mem. 31.

Cairnes, C. E. (1943): Geology and mineral deposits of Tyaughton Lake map-area, B. C.; Geol. Surv. Can., Paper 43-15.

Campbell, R. B. (1964): Adams Lake, B. C., Geol. Surv. Can., Map 48-1963.

(1967): Reconnaissance geology of Glenlyon map-area, Y.T.; Geol. Surv. Can., Mem. 352.

Campbell, R. B. & Tipper, H. W. (1971): Bonaparte Lake map-area, B. C.; Geol. Surv. Can, Mem. 363.

Campbell, R. B. & Eisbacher, G. H. (1974): Operation St. Elias in Report of activities, part A; Geol. Surv. Can., Paper 74-1A.

Campbell, R. B. & Dodds, C. J. (1975): Operation St. Elias, Y.T.; Report of activities, part A; Geol. Surv. Can., Paper 75-1, part A.

Campbell, R. B. & Dodds, C. J. (1978): Operation St. Elias, Y.T.; Current research, part A; Geol. Surv. Can., Paper 78-1A, p. 35-41.

Carson, D. J. T. (1969): Tertiary mineral deposits of Vancouver Island; Can. Inst. Min., Trans. vol. 72, p. 116-125.

(1973): The plutonic rocks of Vancouver Island; their petrography chemistry, age and emplacement; Geol. Surv. Can., Paper 72-44.

Carter, N. C. & Kirkham, R. V. (1969): Geological compilation map of the Smithers, Hazelton and Terrace areas; B. C. Dept. Mines Petrol. Resources, Map 69-1.

Carter, N. C. (1974): Geology and geochronology of porphyry copper and molybdenum deposits in west central B. C.; Univ. British Columbia, Ph.D. thesis, unpubl.

Casey, J. J. & Scarfe, C. M. (1978): Geology of the Hearts Peak volcanic centre, northwestern British Columbia; Geol. Surv. Can., Paper 78-1A, Current research part A.

Church, B. N. (1963): Petrology of some early Tertiary lavas of the Kettle River region, B. C.; McMaster Univ. M.Sci. thesis, unpubl.

(1970): Geology of the White Lake basin; British Columbia Dept. Mines Petrol Resources; Geol., Exploration and Mining in British Columbia, p. 396-402.

Church, B. N. (1973): Geology of the Buck Creek area; British Columbia Dept. Mines Petrol Resources; Geology, Exploration and Mining in British Columbia, p. 353-363.

(1973): Geology of the White Lake basin; British Columbia Dept. Mines Petrol. Resources, Bull. 61.

Christie, R. L. (1957): Bennett, Cassiar district, British Columbia; Geol. Surv. Can., Map 19-1957.

Clapp, C. H. (1912): Southern Vanocuver Island; Geol. Surv. Can., Mem. 13.

(1913): Geology of the Victoria and Saanich map-areas, Vancouver Island, British Columbia; Geol. Surv. Can., Mem. 36.

Clapp, C. H. & Cooke, H. C. (1917): Sooke and Duncan map-areas, Vancouver Island; Geol. Surv. Can., Mem. 96.

Cockfield, W. E. (1961): Geology and mineral deposits of Nicola map-area; British Columbia; Geol. Surv. Can., Mem. 249.

Cox, R. (1965): Biostratigraphy of the Sooke and Carmanah Formations; Geol. Surv. Can., Paper 65-1, Report of activities: field, 1964.

Dolmage, V. (1928): Finlay River district, B. C.; Geol. Surv. Can.; Summary Report 1927, part A.

Douglas, R. J. W. (1970): Geology and economic minerals of Canada; Geol. Surv. Can., Economic geology report # 1.

Duffell, S. & McTaggart, K. C. (1952): Ashcroft map-area, B. C.; Geol. Surv. Can., Mem. 262.

Duffell, S. (1959): Whitesail Lake map-area, B. C.; Geol. Surv. Can., Mem. 299.

Eisbacher, G. H. (1970): Tectonic framework of Sifton and Sustut basins, B. C.; Geol. Surv. Can., Paper 70-1A.

(1971): A sub-division of the Upper Cretaceous - Lower Tertiary Sustut Group in the Toodoggone map-area, B. C.; Geol. Surv. Can., Paper 70-68.

(1971): Tectonic framework of Sustut and Sifton basins, B. C.; Geol. Surv. Can., Report of activities pt. A, Paper 71-1A; p. 20-23.

(1972): Tectonic over printing near Ware, northern Rocky Mountain Trench; Can. Jour. Earth Science, vol. 9, p. 903-913.

(1973): Tectonic framework of Sustut and Sifton basins, B. C.; Geol. Surv. Can., Paper 73-1A.

(1974): Sedimentary history and tectonic evolution of the Sustut and Sifton basins, north central B. C.; Geol. Surv. Can., Paper 73-31.

Eisbacher, G. H. & Hopkins, S. L. (1977): Mid-Cenozoic paleogeomorphology and tectonic setting of the St. Elias Mountains, Y.T.; Geol. Surv. Can., Paper 77-1B, Report of Activities, pt. B; p. 319-335.

Farquharson, R. B. & Stipp, J. J. (1969): Potassium argon ages on dolerite plugs in south Cariboo region, B. C.; Can. Jour. Earth Science, vol. 6, p. 1468.

Farquharson, R. B. (1973): The petrology of Late Tertiary dolerite plugs in the south Cariboo region, B. C.; Can. Jour. Earth Science, vol. 10, no. 2, p. 205.

Gabrielse, H. (1962): Kechika map-area, B. C.; Geol. Surv. Can., Map 42-1962.

(1962): Cry Lake, B. C.; Geol. Surv. Can., Map 29-1962.

(1963): McDame map-area, Cassiar District, B. C.; Geol. Surv. Can., Mem. 319.

(1966): Operation Selwyn; Geol. Surv. Can., Paper 66-1.

(1969): Geology of Jennings River map-area, B. C.; Geol. Surv. Can., Paper 68-55.

(1972): Operation Finlay; Geol. Surv. Can., Paper 72-1A.

(1974): Geological map of MacMillan River map-area, District of MacKenzie and N.W.T.; Geol. Surv. Can., open file 209.

(1978): Operation Dease, Current research, part A; Geol. Surv. Can., Paper 78-1A.

Gabrielse, H. & Souther, J. G. (1962): Dease Lake B. C.; Geol. Surv. Can., Map 21-1962.

Green, L. H. (1960): Finlayson Lake map-area, Y.T.; Geol. Surv. Can., Map 8-1960.

Green, L. H.; Roddick, J. A. & Wheeler, J. O. (1960): Quiet Lake map-area, Y. T.; Geol. Surv. Can., Map 7-1960.

Grove, E. W. (1971): Geology and mineral deposits of the Stewart area; B. C. Dept. Mines Petrol. Resources, Bull. 58.

Hamilton, T. S. & Scarfe, C. M. (1977): Preliminary report on the petrology of the Level Mountain volcanic centre, northwest British Columbia; Geol. Surv. Can., Paper 77-1A, p 429-434.

Hanson, G. & McNaughton, D. A. (1936): Eagle-McDame map-area Cassiar district, B. C.; Geol. Surv. Can., Mem. 194.

Herzer, R. H. (1970): A geological reconnaissance of Bowie Seamount; Univ. of B. C., unpublished M.Sci. thesis.

Hills, L. V. & Baadsgaard, H. (1967): Potassium-argon dating of some Lower Tertiary strata in B. C.; Can. Pet. Geol.; Bull., vol. 15, No. 2.

Hughes, O. L. (1970): Incidental observations on Quaternary crustal movements, central Y. T.; Can. Jour. Earth Science, vol. 7, No. 2, pt. 2.

Hughes, O. L., Campbell, R. B., Muller, J. E. & Wheeler, J. O. (1969): Glacial map of Yukon, south of 65° North latitude; Geol. Surv. Can., Paper 68-34.

Jeletzky, J. A. (1950): Stratigraphy of the west coast of Vancouver Island between Kyuquot Sound and Esperanza Inlet, B. C.; Geol. Surv. Can., Paper 50-37.

(1954): Tertiary rocks of the Hesquiat-Nootka area, west coast Vancouver Island; Geol. Surv. Can., Paper 53-17.

Jeletzky, J. A. (1954): Geological history west coast Vancouver Island; Geol. Soc. Am., Bull., vol. 65, p. 1269.

(1969): Mesozoic and Tertiary stratigraphy of northern Vancouver Island; Geol. Surv. Can., Paper 69-1A.

Kerr, F. A. (1948): Taku River map-area, B. C.; Geol. Surv. Can., Mem. 248.

Kindle, E. D. (1952): Dezadeash map-area, Y.T.; Geol. Surv. Can., Mem. 268.

Kulp, J. L. (1959): Geological time scale; Geol. Soc. America, Bull, Vol. 70, No. 12, part 2, P. 1634.

Lambert, M. B. (1968): Wheaton River and Homan Lake, Yukon and B. C.; Geol. Surv. Can., Paper 68-1A.

(1974): The Bennett Lake cauldron subsidence complex, B. C. and Y. T.; Geol. Surv. Can., Bull. 227.

Lang, A. H. (1942): Houston map-area; Geol. Surv. Can., Paper 67-1A.

Leech, G. B. (1953): Geology and mineral deposits of the Shulaps Range, southwestern B. C., B. C. Dept. Mines, Bull. 32.

Lees, E. J. (1936): Geology of Teslin-Quiet Lake area, Yukon; Geol. Surv. Can., Mem. 203.

Lerbekmo, J. F. & Campbell, F. A. (1969): Distribution, composition and source of the White River ash, Y.T., Can. Jour, Earth Sci., vol. 6, no. 1, p. 109.

Little, H. W. (1957): Kettle River, east half; Geol. Surv. Can., preliminary map 6-1957.

(1960): Nelson map-area, west half, B. C.; Geol. Surv. Can., Mem. 308.

(1961): Kettle River, west half; Geol. Surv. Can., preliminary map 15-1961.

(1962): Trail map-area; Geol. Surv. Can., Paper 62-5.

(1964): Greenwood map-area, Geol. Surv. Can., Paper 64-1.

Little, H. W. & Thorpe, R. I. (1965): Greenwood map-area; Geol. Surv. Can., Paper 65-1, p. 56-60.

Little, H. W. & Monger, J.W.H. (1966): Greenwood, west half; Geol. Surv. Can., Paper 66-1A.

Lord, C. S. (1948): McConnell Creek map-area, Cassiar district, B. C.; Geol. Surv. Can., Mem. 251.

Lowdon, J. A. (1960): Age determinations by the Geological Survey of Canada; report 1, isotopic ages; Geol. Surv. Can., Paper 60-17.

(1963): Age determinations and geological studies; Geol. Surv. Can., Paper 63-17.

Mathews, W. H. (1958): Geology of the Mt. Garibaldi map-area; southwestern B. C., part II, Geomorphology and Quaternary volcanic rocks; Geol. Soc. Am., Bull. 69, no. 2, p. 179-198.

Mathews, W. H. (1964): Potassium-argon ages of Cenozoic rocks, B. C.; Geol. Soc. Am., Bull. May 1964, vol. 75, no. 5.

Mathews, W. H. & Rouse, G. E. (1963): Late Tertiary volcanic rocks and plant bearing deposits in B. C.; Geol. Soc. Am. Bull. vol. 74, p. 55-60.

McCann, W. S. (1922): Geology and mineral deposits of the Bridge River map-area, B. C.; Geol. Surv. Can., Mem. 130.

McLearn, F. H. & Kindle, E. D. (1951): Geology of northeastern B. C.; Geol. Surv. Can., Mem. 259.

Misch, P. (1966): Tectonic evolution of the northern Cascade mountains of Washington State; Can. Inst. of Min., spl. vol. 8, p. 101-148.

Monger, J. W. H.; Souther, J. G. & Gabrielse, H. (1972): Evolution of the Canadian cordillera - a plate tectonic model; Am. Jour. Sci., vol. 272, p. 577-602.

Muller, J. E. (1967): Geology Pine Pass, B. C.; Geol. Surv. Can., Map 11-1961.

(1966): Central Vancouver Island; Geol. Surv. Can., Paper 66-1A.

(1967): Pine Pass area, B. C.; Geol. Surv. Can., Paper 67-1A.

(1967): Kluane Lake map-area, Y.T.; Geol. Surv. Can., Mem. 340.

(1968): Alberni map-area, B. C.; Geol. Surv. Can., Paper 68-1A.

(1969): Northern Vancouver Island, B. C.; Geol. Surv. Can., Paper 69-1A.

Muller, J. E. (1970): Northern Vancouver Island, B. C.; Geol. Surv. Can., Paper 70-1A.

(1973): Geology of Pacific Rim National Park; Geol. Surv. Can., Paper 73-1A.

(1974): Victoria map-area, Pacific Rim National Park, Vancouver Island, B. C.; Geol. Surv. Can., Paper 74-1A.

(1977): Metchosin volcanics and Sooke intrusions of southern Vancouver Island; Geol. Surv. Can., Paper 77-1A, p. 287-294.

Muller, J. E. & Rutter, N. W. (1967): An extensive Tertiary section in the Parsnip River valley; Geol. Surv. Can., Paper 67-1A.

Muller, J. E. & Carson, D. J. T. (1969): Geology and mineral deposits of Alberni map-area, B. C.; Geol. Surv. Can., Paper 68-50.

Muller, J. E. & Tipper, H. W. (1969): McLeod Lake, B. C.; Geol. Surv. Can., Map 1204 A.

Muller, J. E.; Northcote, K. E. & Carlisle, D. (1974): Geology and mineral deposits of Alert Bay-Cape Scott map-area, Vancouver Island, B. C.; Geol. Surv. Can., Paper 74-8.

Mulligan, R. (1955): Teslin map-area, Y.T.; Geol. Surv. Can., Paper 54-20.

(1957): The Cordilleran region in Geology and Economic minerals of Canada; Geol. Surv. Can., Econ. Geol. series No. 1, p. 310-322.

Nasmith, H.; Mathews, W. H. & Rouse, G. E. (1967): Bridge River ash and some other Recent ash beds in B. C.; Can. Jour. Earth Sci., vol. 4, p. 163.

Northcote, K. E. & Muller, J. E. (1972): Volcanism, plutonism and mineralization on Vancouver Island; Can. Inst. Min., Bull. Oct. 1972, p. 49-57.

Okulitch, A. V. (1974): Stratigraphy and structure of the Mt. Ida Group, Vernon, Seymour Arm, Bonaparte Lake and Kettle River map-areas, B. C.; Geol. Surv. Can., Paper 74-1A.

Panteleyev, A. (1964): A late Tertiary volcanic sequence in the Sheslay River vicinity, Stikine area, B. C.; Univ. of B. C., unpublished B.Sc. thesis.

Poole, W. H.; Roddick, J. A. & Green L. H. (1960): Geology, Wolf Lake Y.T.; Geol. Surv. Can., Map 10-1960.

Preto, V. A. (1969): Structure and petrology of the Grand Forks Group, B. C.; Geol. Surv. Can., Paper 69-22.

Read, P. B. (1977): Meager Creek volcanic complex, southwestern B. C.; Geol. Surv. Can., Paper 77-1A, p. 277-281.

Reinecke, L. (1915): Ore deposits of the Beaverdell map-area, B. C. Geol. Surv. Can., Mem. 79.

Rice, H. M. A. (1947): Geology and mineral deposits of the Princeton map-area, B. C.; Geol. Surv. Can., Mem. 243.

Richards, T. A. (1974): Hazelton, B. C.; east half; Geol. Surv. Can., Paper 74-1A.

(1976): McConnell Creek map-area; Geol. Surv. Can., Open file report # 342.

(1978): Geology of Hazelton, west half, map-area, B. C.; Geol. Surv. Can., Paper 78-1A.

Richards, T. A. & Dodds, C. J. (1973): Hazelton east half map-area, B. C.; Geol. Surv. Can., Paper 73-1A.

Richards, T. & White, W. H. (1970): Potassium-argon dates of plutonic rocks between Hope and the 49th parallel; Can. Jour. Earth Sci., vol. 7, no. 1203.

Roddick, J. A. (1965): Vancouver north, Coquitlam and Pitt Lake map-areas; Geol. Surv. Can., Mem. 335.

Roddick, J. A.; Baer, A. J. & Hutchinson, W. W. (1966): Coast mountains project; Geol. Surv. Can., Paper 66-1.

Roddick, J. A. & Hutchinson, W. W. (1969): Northwest part of Hope map-area, B. C.; Geol. Surv. Can., Paper 69-1A.

Roddick, J. A. & Hutchinson, W. W. (1973): Pemberton east half map-area; Geol. Surv. Can., Paper 73-17.

Roddick, J. A.; Okulitch, A. V. & Muller, J. E. (1973): Geological map of parts of B. C. and Washington, Geol. Surv. Can., open file report 165.

Roddick, J. A. & Woodsworth, G. J. (1975): Coast mountains project, Pemberton map-area; Geol. Surv. Can., Mem. 274.

Shouldice, D. H. (1971): Geology of the western Canadian continental shelf, Bull. Can. Petrol. and Geol., vol. 19, p. 405-436.

Souther, J. G. (1959): Chutine, Cassiar district, B. C.; Geol. Surv. Can., Map 7-1959.

(1966): Cordilleran volcanic study; Geol. Surv. Can., Paper 66-1.

(1967): Cordilleran volcanic study; Geol. Surv. Can., Paper 67-1A.

(1968): Cordilleran volcanic study, B. C.; Geol. Surv. Can., Paper 68-1A.

(1969): Cordilleran volcanic study, Telegraph Creek; Geol. Surv. Can., Paper 70-1A.

(1970): Volcanism and its relationships to recent crustal movement in the Canadian Cordillera; Can. Jour. Earth Sci., vol. 7 no. 2, p. 553-568.

(1971): Geology and mineral deposits of Tulsequah map-area, B. C.; Geol. Surv. Can., Mem. 362.

Souther, J. G. (1972): Telegraph Creek map-area, B. C.; Geol. Surv. Can., Paper 71-44.

Souther, J. G. (1973): Cordilleran volcanic study, Spectrum Range; Geol. Surv. Can., Paper 73-1A.

(1974): Cordilleran volcanic study; Geol. Surv. Can., Paper 74-1A.

Souther, J. G. & Armstrong, J. E. (1966): North central belt of the Cordillera of B. C., in Tectonic history and mineral deposits of the Western Cordillera; Can. Inst. Min., spl. vol. 7.

Souther, J. G. & Stanciu, C. (1975): Operation St. Elias, Y. T.; Geol. Surv. Can., Paper 75-1A.

Souther, J. G.; Brew, D. A. & Okulitch, A. V. (1974): Geological map of Iskut River, scale 1:1,000,000; Geol. Surv. Can., open file report 214.

Sutherland Brown, A. (1966): Tectonic history of the insular belt of B. C.; Can. Inst. of Min., spl. vol. 8, p. 83-100.

(1968): Geology of the Queen Charlotte Islands, B. C.; B. C. Dept. Mines, Bull. 54.

(1969): Aiyansh lava flow, B. C.; Can. Jour. Earth Sci., vol. 6, p. 1460-8.

Symons, D. T. A. (1969): Paleomagnetism of the late Miocene plateau basalts in the Caribou region, B. C.; Geol. Surv. Can., Paper 69-43.

(1971): Paleomagnetic studies of radiometrically dated igneous rocks in the Cordillera; Geol. Surv. Can., Paper 71-1A.

Symons, D. T. A. (1971): Paleomagnetic notes on some Tertiary igneous bodies, Vancouver Island, B. C.; Geol. Surv. Can., Paper 71-24.

Tempelman-Kluit, D. J. (1973): Reconnaissance geology of Aishihik Lake, Snag and part of Stewart River map-areas, west cental Yukon; Geol. Surv. Can., open file report 161.

(1973): Geology of Carmacks area, Y.T.; Geol. Surv. Can., open file report 200.

(1973): Reconnaissance geology of Quiet Lake, Finlayson Lake, Sheldon Lake and Tay River map-areas, Y.T.; Geol. Surv. Can., open file 212.

Tipper, H. W. (1957): Anahim Lake; Geol. Surv. Can., Map 10-1957.

(1959): Quesnel; Geol. Surv. Can., Map 12-1959.

(1960): Prince George; Geol. Surv. Can., Map 49-1960.

(1963): Taseko Lakes; Geol. Surv. Can., Map 29-1963.

(1963): Nechako River map-area, B. C.; Geol. Surv. Can., Mem. 324.

(1968): Northeastern part of Mt. Waddington map-area, B. C.; Geol. Surv. Can., Paper 68-1A.

(1969): Mesozoic and Cenozoic geology of the northeast part of Mt. Waddington map-area, Coast district B. C.; Geol. Surv. Can., Paper 68-33.

Tipper, H. W. (1970): Smithers map-area; Geol. Surv. Can., Paper 70-1A.

(1971): Smithers map-area; Geol. Surv. Can., Paper 71-1A.

(1972): Smithers map-area; Geol. Surv. Can., Paper 72-1A.

(1978): Northeastern part of Quesnel map-area, B. C.; Geol. Surv. Can., Paper 78-1A.

Wanless, R. K.; Stevens, R. D.; Lachance, G. R. & Rimsaite, J. Y. H. (1966): Age determinations and geological studies, K-Ar isotopic ages, report 6; Geol. Surv. Can., Paper 65-17.

Wanless, R. K.; Stevens, R. D.; Lachance, G. R. & Edmonds, C. M. (1967): Age determinations and geological studies, K-Ar isotopic ages, report 7; Geol. Surv. Can., Paper 66-17.

Watson, K. de P. & Mathews, W. H. (1944): The Tuya-Teslin area northern B. C.; B. C. Dept. of Mines Bull. 19.

Watson, K. de P. (1948): The Squaw Creek - Rainy Hollow area, northern B. C.; B. C. Dept. of Mines, Bull. 25.

Weaver, C. E. (1944): Correlation of the marine Cenozoic formations of Western North America, Geol. Soc. America, Bull. vol. 55, p. 569-598.

Wheeler, J. O. (1961): Whitehorse map-area, Y.T.; Geol. Surv. Can., Mem. 312.

(1966): Eastern tectonic belt of western Cordillera in B. C., in Tectonic history and mineral deposits of the Western Cordillera, Can. Inst. Min., spl. vol. 8, p. 27-45.

White, W. H.; Harakal, J. E. & Carter, N. C. (1968): Potassium-argon ages of some ore deposits in British Columbia; Can. Inst. Min., Bull. vol. 61, p. 1326-1334.

Wise, S. W. (1969): Geol. and petrology of the Mt. Hood area - a study of high Cascade volcanism; Geol. Soc. Am., Bull. vol. 80, p. 969-1006.