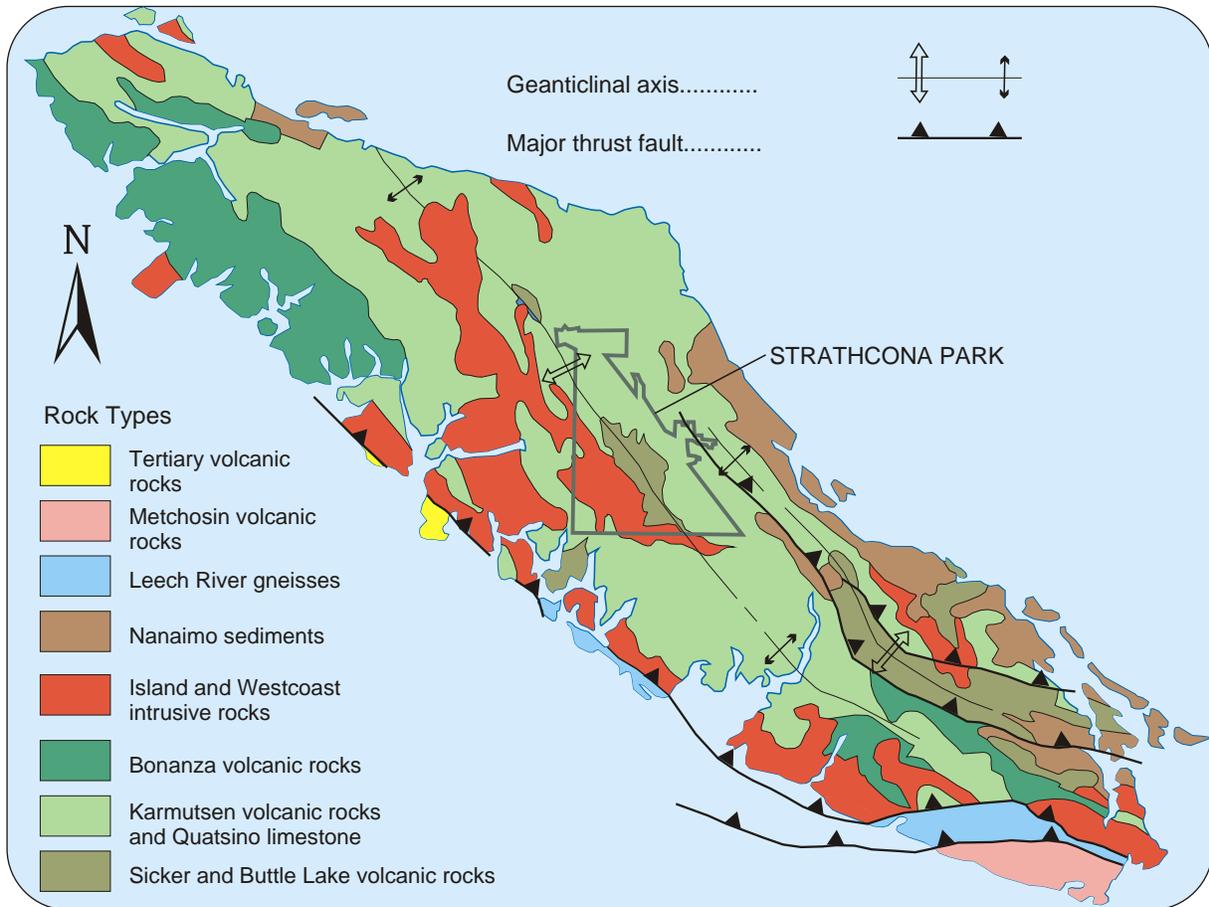


Geology of Strathcona Provincial Park

Geology of Strathcona Park

Vancouver Island



The location of Strathcona Park on a geological map of Vancouver Island. The major types of rocks, sediments, volcanics and intrusives are shown with different colour coding. Detailed geology is presented on the large geology map of Strathcona Park.

Introduction

The scenery of Strathcona park is dramatic. High mountain peaks, deep shaded valleys, lakes and waterfalls are all there in magnificent profusion. From the valley floors, clothed in mature forest, to the wildflower-carpeted alpine meadows it is easy to be impressed.

It is also easy to forget that beneath your feet lies a history stretching back 380 million years. It is a history of violent volcanic eruptions on ancient seafloors and quiet interludes when gardens of sea lilies waved in gentle ocean currents. It is a history of rocks torn and folded by the extraordinary forces which can move continents, and of mountain ranges sculpted by the immensely thick ice sheets which only vanished a few thousand years ago. No matter how long your visit, or whatever your interest, a knowledge of the geology of Strathcona Park will enhance your enjoyment of this spectacularly beautiful area.

Whether you are planning an adventurous hike, or do not intend to stray far from the highway, the rocks are there for you to contemplate and enjoy. They are the key to the past and the source of great mineral wealth. This website is intended to help the curious visitor read the story in the rocks and understand some of Vancouver Island's turbulent history.

The Westmin Mine is surrounded by a Class A park and the boundary of its mineral claims fall entirely within the Strathcona-Westmin Class B Park. Hence all mining activities, and the eventual reclamation and rehabilitation of the sit, fall under a park-use permit. Constant monitoring ensures that environmental concerns and public safety are an integral part of the continuing mine program. It is interesting to note that not only are recreational activities not impeded by mining activities but mine tour have become an important additional attraction for park visitors.

Remember that, like the animals and plants, the rocks, minerals and fossils are part of Strathcona Park's invaluable heritage; please don't destroy or remove them.



Myra Falls is incised into thin beds of the Sicker Group. These volcanic rocks are called tuffs and are deposited as fine, volcanic ash settles out of the water following an eruption.

Park Facts

Strathcona Park, named for Lord Strathcona, the driving force behind the Canadian Pacific Railway, was created in 1911 as B.C.'s first provincial park. With 2200 square kilometres, it is about half the size of Prince Edward Island and 7 percent of Vancouver Island. It extends from sea level on Herbert Inlet to the highest point on Vancouver Island (Golden Hinde, 2210 metres). Strathcona Park also contains Buttle Lake, one of the largest lakes on Vancouver Island, Della Falls, B.C.'s highest waterfall, and the Westmin Resources mine, one of the largest copper-lead-zinc mines in the province. Its geological history is the history of Vancouver Island and its story is an integral part of the story of western North America.



View from Comox Glacier looking southwest towards Mount Harmston, across Milla Lake.

The incredible scenery of Strathcona Provincial Park is a natural draw for many hikers.

Geological history of Strathcona Park

Today, it is a short trip from Vancouver to Vancouver Island and the scenery of Strathcona Park, but it was not always so. Vancouver Island began to form 380 million years ago on the ocean floor in what is now the deep eastern Pacific. Over some 200 million years, three distinct episodes of volcanic eruption built on each other to raise a landmass above the surface of the sea. In the long interludes between the eruptions, limestones and sediments accumulated on the tops of the dormant volcanoes. This ancient land is called Wrangellia by geologists, for the Wrangell mountains in Alaska. Sometime between 140 and 65 million years ago, Wrangellia was gradually carried eastward on its crustal plate to collide with other terranes and, eventually, with North America. Today the Wrangellia terrane stretches from Vancouver Island, through the Queen Charlotte Islands into the Yukon and southeastern Alaska.

Rocks in the Park

Rocks are solid, naturally formed masses composed of minerals. There are three main types of rocks, igneous, sedimentary and metamorphic, each of which can be sub-divided into numerous sub-types:

Igneous rocks

Deep within the Earth, it is so hot that rocks melt to form magma. This molten material rises through the Earth's crust, resolidifying as it does so. If the magma breaks out onto the surface it cools quickly in air or water to form rocks with small mineral crystals, a characteristic of extrusive rocks or lava. If the magma cools before it reaches the surface it does so slowly, forming the larger, interlocking crystals characteristic of intrusive rocks. The majority of rocks within Strathcona Park are igneous and include the following major types:

Extrusive rocks

Basalt is the most common volcanic rock in the Park, particularly in the eastern and southwestern portions. It is black to dark grey and dense, with a dull, granular appearance. It usually formed as very extensive flows of lava on the earth's surface, and may contain gas bubbles which are commonly filled with light-coloured minerals such as quartz.

Andesite is lighter coloured than basalt, varying from light to dark grey or greenish grey. It commonly contains large crystals suspended in a fine-grained matrix (porphyritic texture).

Rhyolite is lighter still. It is white to grey, generally granular and rough to the touch, but may be cherty in appearance. Some rhyolites have parallel bands of different colours. These bands may be wavy and give the impression of the rock having been frozen in the act of flowing. Rhyolites are not very common in the Park, but are very important because they embrace the ore deposits of the Myra Falls mine of Boliden Westmin Limited.

Volcanic breccia and **tuff** contain a variety of angular fragments that were blown out of volcanoes and fell through the air or water. Accumulations of large blocks of volcanic rock about the size of cars, and bombs, about the size of kitchen appliances are called *breccia*; the finer-grained ash forms *tuff*.

Intrusive rocks

Gabbro and **diabase**, are the dominant rocks in the central portion of the park. They are the coarse and medium grained intrusive equivalents of basalt and are a similar dark colour. The dark minerals are mainly pyroxene, the



light minerals plagioclase-feldspar. Occasionally, the diabase develops coarse porphyritic textures in which white feldspar crystals are spectacularly grouped together in daisy-like clusters. Rockhounds call these "flower gabbros" or "snowflake porphyries."

Granite is a coarse-grained, pink to grey rock composed predominantly of quartz and feldspar minerals. Within the park, however, much of the intrusive rocks are more correctly termed **granodiorite**, which is a grey coloured rock, the intrusive equivalent of andesite. The granodiorite contains quartz and feldspar minerals mixed with the dark coloured minerals hornblende and mica to give the rock a salt-and-pepper appearance.

Clusters of white feldspar crystals form "flowery-gabbro". These clusters grew as magma deep within the earth slowly started cooling and crystallizing. The chemistry of the magma was just right for the white feldspar to rapidly outgrow the other types of crystals and form these clusters.

Sedimentary rocks

Over long periods of time, rocks on the Earth's surface are broken into smaller pieces, like gravel, sand or even smaller like glacial rock-flour, that are carried away by streams, rivers or glaciers. The pieces eventually settle and build up as layers of sedimentary rocks. Some of the weathered rock dissolves in stream waters and is carried out into the oceans, where it can precipitate out as a chemical sediment, *e.g.*, calcium. The most common sedimentary rocks in the park are:



Limestone, a grey rock composed of the mineral calcite which has precipitated out of sea water. Limestones often contain fossils which may make up a large proportion of the rock.

Limestone sample containing a fossilized brachiopod and fossils of broken crinoid stems.

Sandstone consists of rounded sand grains cemented together and may exhibit obvious layers or beds of various thickness. Sandstones vary in colour, but in the park are often grey or reddish-orange.

Conglomerate, which is common in the Forbidden Plateau area, is a poorly sorted, coarse-grained sedimentary rock composed of numerous rounded and sub-angular rock fragments in a matrix of sand and mud.

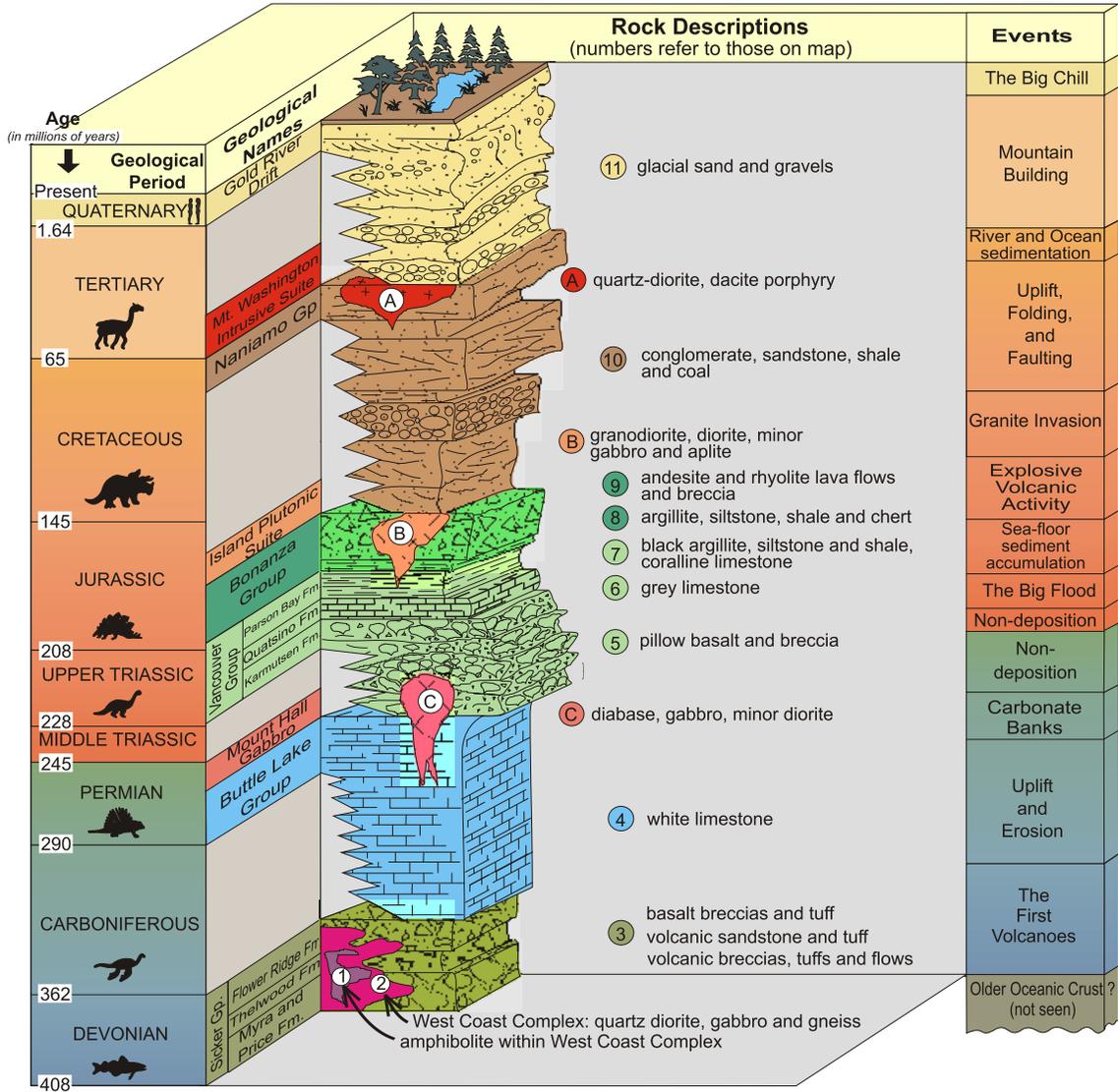
Shale is a finer grained sediment, mud or clay, that has been compacted. Shales can vary in colour but are generally grey to black or brown. Beds in shale are usually thin, flat and of uniform thickness.

Metamorphic rocks

Igneous and sedimentary rocks can be changed by heat and/or pressure to form metamorphic rocks. Such rocks are absent within Strathcona Park, although the effects of metamorphism can be seen in blocks of volcanic rocks which were caught in the margins of the extensive granodiorite intrusion that underlies the southwest corner of the park.

Geology of Strathcona Park

Stratigraphic Section



Geologists commonly portray a sequence of rocks as if they formed an ideal cliff outcrop with all units present. The oldest rocks, deposited first, are shown at the bottom with progressively younger layers at higher levels. This diagram shows the sequence of rocks (the stratigraphy) that occurs within the park and immediately adjacent to it, including the names and ages of the natural rock layers or strata. The column on the extreme right identifies many of the major geological events that to which contributed to the geology of the park or the nature of the topography.

ok place and

These blocks, originally fine-grained, were heated by the molten magma and recrystallized as masses of coarse-grained, black hornblende.



View of Della Falls with Nine Peaks in the background. A glacial remnant is visible in the higher areas around Nine Peaks. The valley around the lake has been scoured out during times when the glacier was much larger.

Plate Tectonics

The Earth's surface is not a static unchanging place. In addition to the observable processes happening around us, the crust below our feet is continually moving and being formed and destroyed.

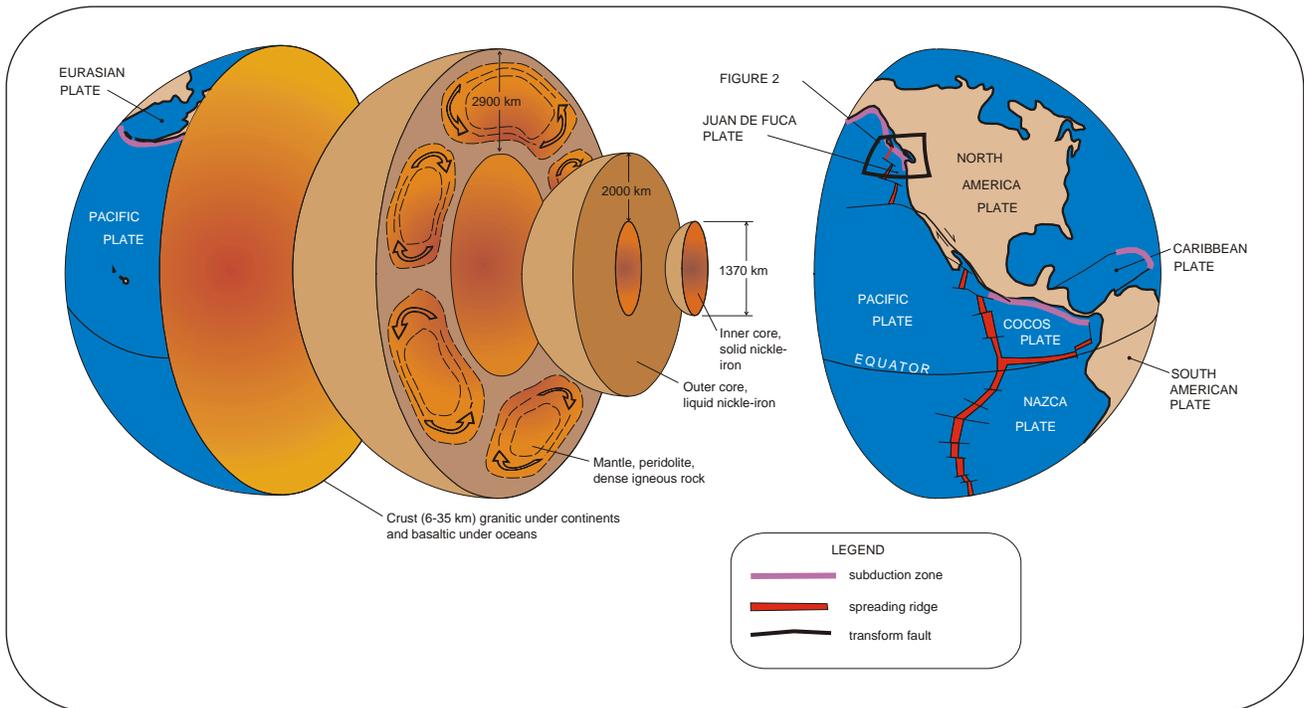
The Earth's crust is a relatively thin skin floating on top of the more fluid, and hot dense mantle rocks beneath. There are two types of crust; oceanic crust, around 6 kilometres thick and composed of basaltic lava, and continental crust, up to 35 kilometres thick and composed of granitic and sedimentary rocks. The crust is divided into many irregular shaped plates which move around in response to convection currents within the mantle. These plates can meet in three ways:

- **spreading ridges** - are crustal growth zones where the crust is moving apart and new oceanic crust forms. This is occurring along the mid-Atlantic ridge as America and Europe move farther apart. It is also occurring along several ridges, e.g., the Juan de Fuca Ridge, which occurs just a few hundred kilometers off the west coast of British Columbia.
- **subduction zones** - are destructive zones where oceanic crust is forced down into the mantle as two plates converge. This is happening beneath British Columbia as the Juan de Fuca Plate is forced beneath the North American Plate.
- **transform faults** - where two plates are sliding past one another. The San Andreas fault in California is of this type.

All three of these situations are present today off Canada's geologically complex west coast. All three have played their part in creating Strathcona Park and bringing it to its present location.

Geology of Strathcona Park

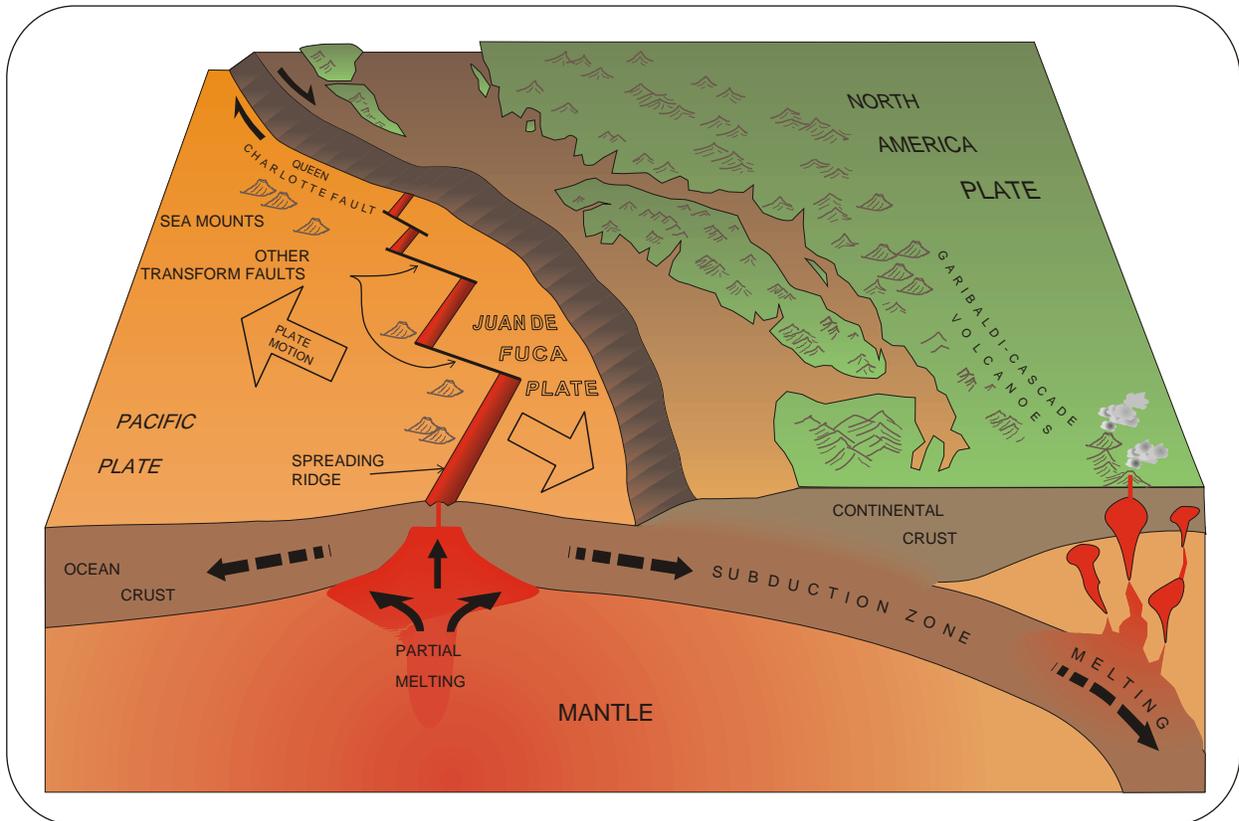
Earth's Internal Structure



Internal structure of the earth and the three types of plate boundaries. Convection cells of hot, molten rock deep beneath the crust provide the energy which causes plate motion on the earth's surface. Plate motion, particularly one plate moving against another, is a common cause of earthquakes.

Geology of Strathcona Park

Plate Tectonics



A spreading ridge, a subduction zone (ocean trench) and transform faults all occur off the west coast of Vancouver Island. Mount Baker and Mount St. Helens are represented by the smoking volcanoes on the right side of the figure.

The first volcanoes: 380 to 360 million years ago

During the Devonian Period a long gently-curving arc of volcanoes was built by explosive eruptions in the deep eastern Pacific Ocean. These undersea mountains were built up by successive volcanic eruptions and were subject to massive rock slides cascading down their slopes. In the modern world, this situation is similar to the submerged volcanoes of the Marianas arc of the western Pacific.

Sicker Group

This overall term is used by geologists to describe the rocks from these ancient volcanoes and it refers to about 2000 metres of basalt, andesite and some rhyolite layers. The name is from Mount Sicker, near Duncan.

Flower Ridge Formation

The uppermost, or youngest volcanic unit is characterized by the rocks along Flower Ridge, and is composed chiefly of fragmental basalts and tuffs. Most of the fragments contain abundant small round grains of white quartz. These originated as gas bubbles in the lava which were filled with white quartz, and other minerals, during cooling. These filled bubbles are called *amygdules*. In these rocks, the amygdules may form up to a quarter of some fragments so we infer the eruptions were very gassy and violently explosive.

You can find these rocks on the upper slopes and ridges southwest of Buttle Lake, in roadcuts at the very southeast end of the lake and along the lower part of the Flower Ridge trail.



First large tarn on Flower Ridge

Thelwood Formation

This unit, which is older than the Flower Ridge Formation rocks, lies on top of the Price and Myra Formations and is composed of thick beds of coarse, hard greenish-grey sandstone. The sandstone itself consists of grains of volcanic material and is interbedded with thin beds of hard cherty, very fine-grained, white, grey-green and dark grey tuff.



These rocks were formed from sediments eroded from the volcanoes and include abundant white feldspar crystals and some small fragments of buff-coloured rhyolite. The thin tuff layers are formed from volcanic ash from eruptions which took place while the sediments were accumulating.

You can see these rocks well in the roadcuts on the hill rising from the south end of Buttle Lake to the Westmin mine and even better by walking the short trail to Myra Falls. There the rocks lie horizontally and are stained with yellow and brown iron oxides derived from the weathering of the mineral pyrite (iron sulphide better known as fool's gold). On the road, they are tilted 25 degrees westward. Bedded rocks of the formation can also be traced along the distant slopes of Mount Phillips and the ridge between Thelwood and Price Creek.

An horizon of volcanic tuff containing larger crystals of feldspar (feldspar phyric tuff) in a sequence of cherty-argillite tuffs within the Tehlwood Formation.

Price and Myra Formations

These are the oldest rocks of the Sicker Group and consist of many different rock types mostly formed by volcanic rock and mud slides. The most important of them are the light-coloured rhyolites that are the host of the copper-lead-zinc deposits at Myra Creek.

These formations outcrop in the valley and along the sides of Mount Myra. You can see them most easily along the road to Jim Mitchell Lake west of Thelwood Creek, from about 2 kilometres south of Buttle Lake.



Jim Mitchell Lake reservoir, with view of Mt. Thelwood

Fossils: Age of the Sea Lily – 290 to 260 million years ago

In the long interval before the next geological cycle, the volcanoes were partly levelled by erosion. About 300 metres of limestone, called the Buttle Lake Group by geologists, was slowly deposited on this shallow submarine platform during the Permian Period. Although thin relative to the volcanic rocks of the park, the limestone is a prominent and unique feature. It is strikingly visible as a white layer separating two dark coloured volcanic units. The limestone is made up of coarse grains broken from the skeletal remains of *crinoids* or *sea lilies* which are the ancient relatives of starfish. These are now preserved as fossils and are cemented together by fine crystals of the mineral calcite.



Life on the sea bottom during deposition of the Buttle Lake Formation exposed at Marble Meadows in the Park. Dense meadows of waving crinoids strain food particles from the sea water above fan-shaped bryozoans and clusters of spiriferid brachiopods, productid brachiopods, and rugose corals (Sea Lily Illustration by Tina Beard. Originally published in: West Coast Fossils - A Guide to the Ancient Life of Vancouver Island by Rolf Ludvigsen and Graham Beard, Whitecap Books, Vancouver, Toronto, 1994).

The limestone is best exposed in the Marble Meadows area, where it supports an unusual alpine flora. However, you can see limestone formations more easily along Buttle Lake near Karst Creek where it is exposed in road cuts on either side of the creek. This locality shows features characteristic of limestone erosion by underground chemical solution. Groundwater percolating through these rocks dissolves the limestone and this results in unique *karst* erosional features including sinkholes, and disappearing and reappearing streams. All these are evident while walking the short trail. Elsewhere in the Park, the limestone forms cliffs that are riddled with wide joints, sink holes and caves. This type of topography is developed to extreme in the Karst area of Yugoslavia, hence the name given to this type of erosion feature and to the creek.

Fossils

The study of fossils is called paleontology and is an important branch of geology. Fossils are the remains or traces of animals and plants that are preserved in rock. To be preserved, an organism must first be buried rapidly in sediment. Even then, it is usually only the hard parts, such as bones, shells or their impressions, which we find as fossils today. During and after burial, the original material of the fossil may be recrystallized or even dissolved away and replaced by a new mineral such as silica or calcite. Fossils tell us about forms of life that existed in the past, the conditions in which they lived and how they evolved over time. Fossils can also be valuable indicators of the age of the rocks in which they occur.



Fragments of fossil crinoid stems, bryozoans and spiriferid brachiopods in limestone of the Buttle Lake Group at Marble Meadows. Because crinoid stems are made from calcium carbonate and not organic matter, they do not rot away when the crinoids die, but instead accumulate, along with some limy mud, into thick beds which are then buried and cemented to form limestone.



Crinoid stems preserved as fossils in limestone within the park.

The most common fossils seen in the rocks of Strathcona Park are the small, doughnut-shaped fragments of crinoids. These make up a large proportion of the Buttle Lake Group limestone. Crinoids, although relatives of starfish and sea cucumbers, grew attached to the seafloor like corals. Their jointed calcareous skeleton was branching and plant-like in appearance, hence the name sea lily. A few crinoid species still exist today but they were most abundant in the late Paleozoic Era (400 to 250 million years ago). The columnar plates of the branches were formed of large crystals of the common mineral calcite (calcium carbonate) and so when broken up they form a glistening, coarse-grained limestone easily mistaken for marble. Other fossils are common in the Buttle Lake Group, but they are swamped in crinoid debris, indicating that the ancient seafloor must have been covered with extensive gardens of the waving crinoids.

Brachiopods, or "lamp shells," are found as scattered broken shells throughout the limestone. These marine animals were very abundant during the Paleozoic Era. They are similar in appearance to bivalved molluscs such as clams, though the shell was made of two unequal valves, one with a rounded beak-like protrusion. They generally lived in shallow water, attached to rocks or other solid substrate.



A few corals have been found in the lower beds of the limestone. They include the now extinct horn-like solitary corals and small colonies of corals characterized by their plated surfaces. Far more common are the colonial animals known as bryozoans or "moss animals". These minute individuals were housed in tiny cups strung along a horny or limy supporting structure. They encrusted other shells or rocks, like moss, or formed branching or fan-like growths.

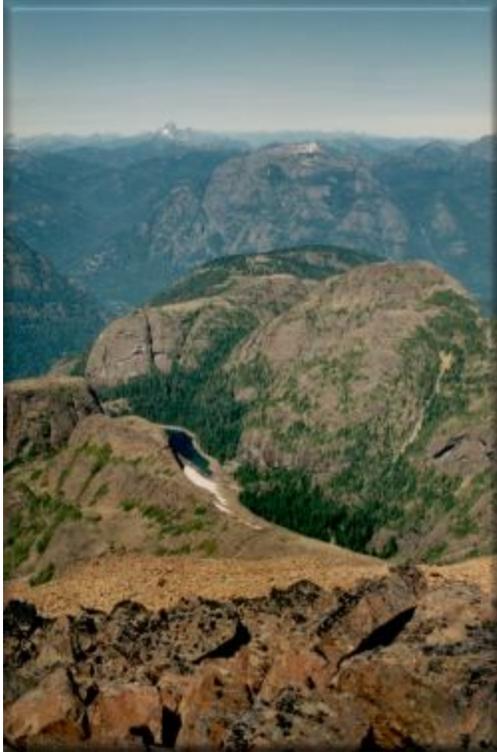
Limestone with exposed fossils of a brachiopod (center) as well as a fragment of a crinoid stem (bottom right)



Fossilized colonial animals known as bryozoans or 'moss animals'

The Volcanic Flood: 225 to 230 million years ago

The second volcanic cycle occurred during the Triassic Period and consisted entirely of the quiet outpouring of great volumes of basalt to form a large, shallow, submarine volcanic plateau. The lava was not erupted through conventional cone-shaped volcanoes, like Mount Baker or Mount St. Helens, but flowed out over the seabed from long fractures or rifts. The fluid lava gave rise to extensive flat plains or broad, gently-sloping shield volcanoes like those on the islands of Hawaii. Some magma solidified in the fractures as dikes and more was injected parallel with the older layered rocks to form sills.



Reddish brown, dome-shaped peaks formed by the Karmutsen Formation. The thick layering of these lavas is visible in some cliff exposures. The view is from Mount Filberg towards Big Den Mountain.

Karmutsen Formation

This 6500-metre-thick pile of basalt flows (named after the Karmutsen Range near Nimpkish Lake) is the most abundant rock unit in the park. About half the mountains, including the highest ones, are carved from these basalts. This formation has a characteristic look from afar; being prominently layered in thick beds and forming reddish-brown dome-shaped peaks. It is also unique close up, as the pillowed form of much of the lava is very distinctive. The Karmutsen Formation is separable into three thick subunits, which have identical chemical compositions but differing appearances.

The lower subunit is comprised entirely of roughly ellipsoidal shaped pillows. These pillow lavas form when basaltic lava erupts under water and is partially chilled by contact with the water. The lava thereby forms a rubbery skin through which more hot lava keeps flowing and expanding. This expansion results in ruptures of the skin and new balloon shaped buds and branches, some of which break off and roll down the slope of the sea floor to form pillows. Over time, the steady submarine eruption of lava, from cracks and fissures, built up a thick, extensive pile of these pillow lavas which totally blanketed the older rocks. They form most of the mountains west of Buttle Lake and south of Upper Campbell Lake and Elk River.

You can see the pillow shapes readily in road cuts along the mine road from about 1.5 kilometres south of park headquarters to beyond Lupin Falls. You can also see them in a few good outcrops along the Gold River road. Good natural exposures also occur on the alpine part of the Flower Ridge trail.



Pillow basalt lava of the Karmutsen Formation on Crest Mountain. Molten lava commonly erupts from cracks and fissures in the earth's crust onto the ocean floor. Each pillow is formed by lava which squirted forward in front of an advancing, submarine lava flow, like toothpaste from a toothpaste tube. As the lava contacts the colder water it forms a tough crust, like a loaf of bread. However, the molten interior of each pillow makes it relatively plastic and pillows therefore tend to take on weird shapes as they settle and pile up on the ocean floor.

Dikes and Sills

These intrusions of volcanic rock cut the thick basalts and other, older rocks. The large dikes were the conduits up which magma flowed to form the lavas on the sea floor. Sills were formed by the molten magma which was injected parallel to the layering of older volcanics or sediments. After an eruption the molten magma cooled in fractures, or conduits, to form diabase dikes and sills. Diabase is the geological term for a basalt which cooled before it reached surface.

You can see them on the Flower Ridge trail at the upper viewpoint before the alpine meadows. The diabase sills stand out as prominent dark layers, especially within the limestone, on the slopes west of Buttle Lake and Marble Meadows. A thick diabase dike is exposed for about 2 kilometres along the road near the south end of the lake.

Quatsino and Parson Bay Formations

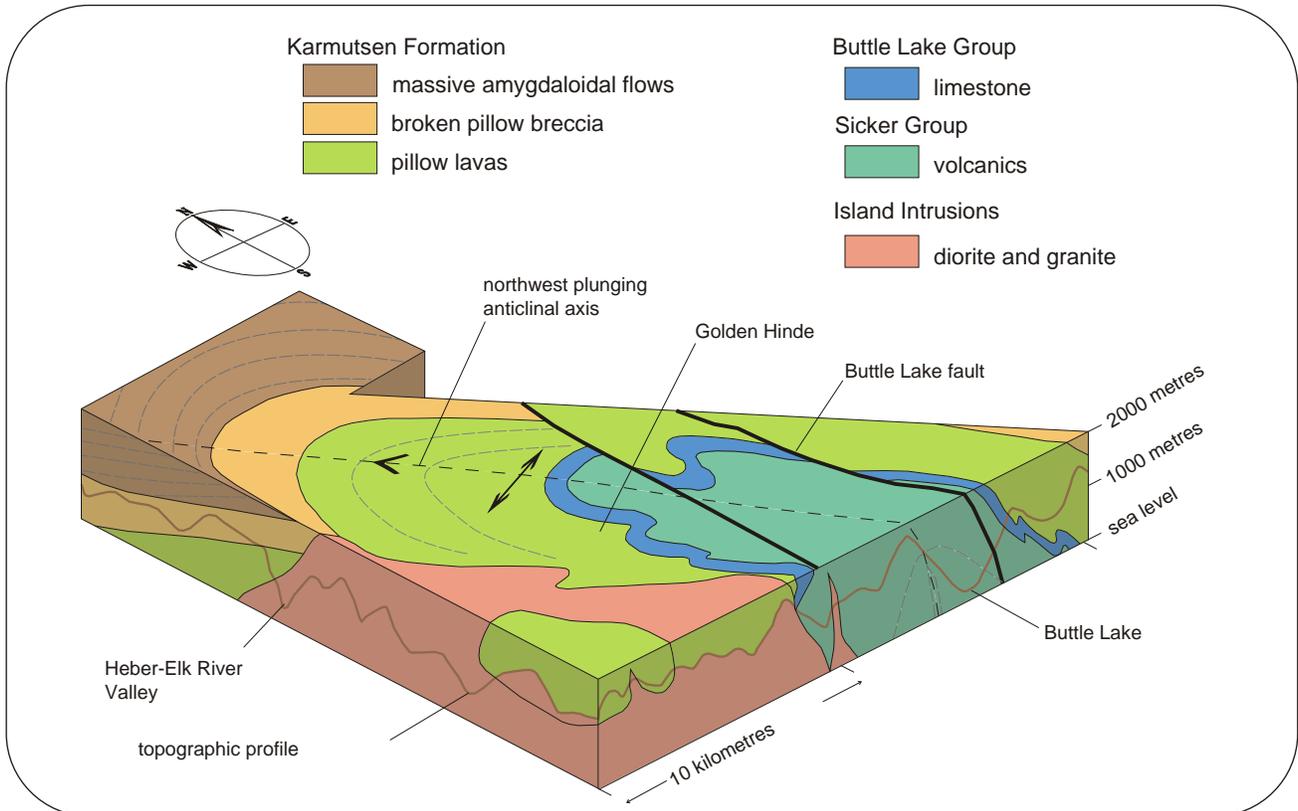


On top of the basalt lava platform a second limestone accumulated. Called the Quatsino Formation after Quatsino Inlet, this limestone is fine grained with few fossils. On top of it is a thin limy shale, called the Parson Bay Formation, which contains the spiral shells of ammonites, extinct cousins of the modern-day Nautilus. However, none of these sediments occur within the park, though they can be seen on the northwest end of Upper Campbell Lake and in the upper reaches of the Iron River. These same limestones are mined in the large quarries on Texada Island.

Amygdule trains in massive lava flows near entrance to Strathcona Park

Geology of Strathcona Park

Cross-section



A cross-section through the large fold which is located across the central area of the park. A line drawn through the crest, or highest point, of the fold is termed the fold axis. Rocks east of the fold axis are tilted to the east and those to the west of the fold are tilted west. Because the sides of the fold dip away from each other, the fold is called an anticline.

Invasion of the granite magma: 190 to 180 million years ago

The last volcanic cycle occurred in the Jurassic Period and includes rocks of many compositions. Chief among these rocks are the products of explosive volcanic eruptions (andesite and rhyolite breccias). The volcanoes which produced these rocks grew on top of the now shallow ocean floor, forming islands that, with time, coalesced into an essentially continental volcanic arc similar to present-day Indonesia. Exposures of these volcanics lie outside the park, but can be seen at the north end of Upper Campbell Lake.

Much of the magma from this final cycle was not erupted onto the ocean floor. It solidified before it reached the surface, forming great granitic bodies called batholiths. These bodies represent the frozen magma chambers which fed the overlying volcanoes. One large batholith occupies nearly a third of the park in the southwest, underlying Mount Tom Taylor, Mount Thelwood and Splendor Mountain. It is mostly granodiorite composed of interlocking crystals of white feldspar, glassy quartz and speckled with black plates of biotite mica. Around the borders of the batholith the rocks are much less uniform and in many places you can see swarms of dark, fine-grained lenses that are actually blocks of older volcanic rocks trapped within the granodiorite. You can also see many large and small dikes of granitic rocks that extend beyond the borders of the batholith.

About this time crumpling, folding and uplifting of the rocks of Vancouver Island occurred. The rocks which had been laid down during the long period of construction of the island did not remain flat like a layer cake but were compressed into large folds like a crumpled carpet and broken by faults. Most the large folds and faults are parallel to the trend of the island. One of the largest and most continuous anticlinal (uparched) folds on the island runs through the centre of Strathcona Park. As you travel about the park, it is possible to confirm this fold's existence, and even its domal nature, by carefully observing the varying tilts of the layered rocks.



In an area above Buttle Lake a 2 metre sized glacial erratic sits on pillow lavas. The erratic, which may have been transported several kilometres, was left there by retreating glaciers.

Wearing down the mountains: 80 and 56 million years ago

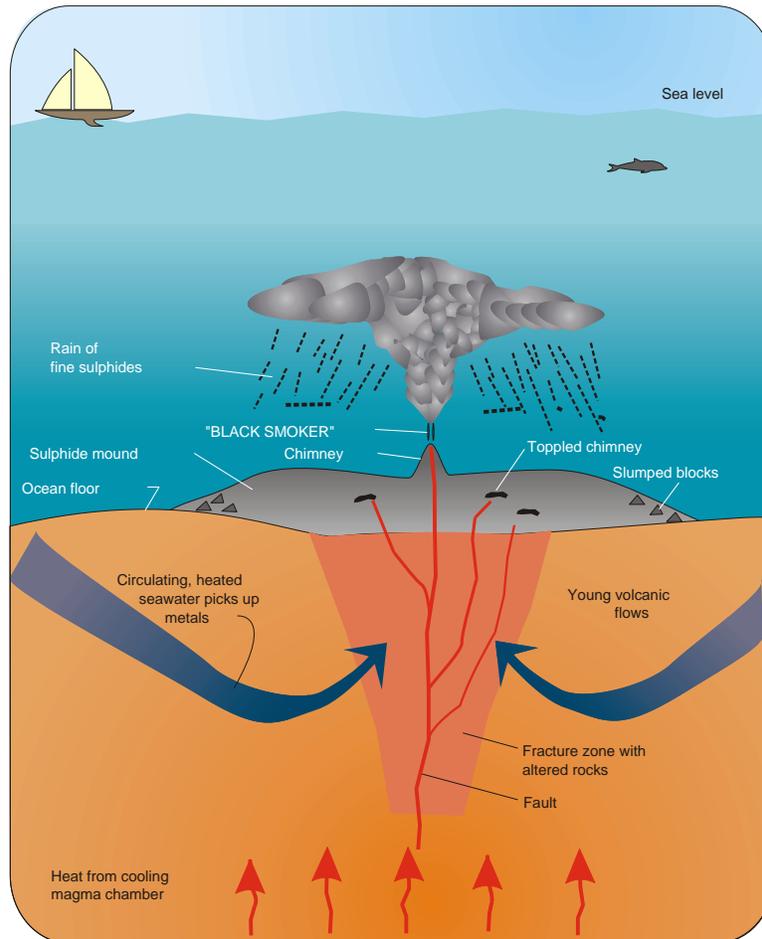
During the glacial period, the weight of the overlying ice-sheets depressed the land surface. After the ice retreated, the land surface rebounded. New streams and rivers recommenced the Erosional attack on the land, further eroding the jagged glaciated terrain. The mountain slopes valley sides became steepened and unstable, and prone to failure as rockslides or avalanches.

The jumbled debris of erosion and rockslides is a common sight along the base of slopes in the park. These are formed of angular rubble of all the rocks that outcrop higher on the slope. These are formed of angular rubble of all the rocks that outcrop higher on the slope. The rocks range in size from blocks the size of a car down to sand grains. These slides are shaped like upside-down cones and generally overlie any glacial deposits there might be on the valley floor. They occur widely but are best seen on the road up Thelwood Creek to Jim Mitchell Lake.

A major landslide can also be seen on the northern slopes of Mount Colonel Foster at the head of the Elk River Trail. This slide cuts a broad swathe through the trees from the ridge crest down to the shores of Landslide Lake. It was one of several landslides triggered by a large earthquake on June 23, 1946. This earthquake was the most damaging quake in western Canada and was felt widely throughout British Columbia. It appeared to be centred on a fault near Comox Lake and caused much damage to buildings in central Vancouver Island, including the school-house in Courtenay.

Geology of Strathcona Park

Volcanic Activity



Black smokers are dense, metal rich hot springs on the ocean floor. Ores of base metals are commonly formed on the sea floor along ridges where the earth's plates are spreading apart. The hot, metal-rich fluids are vented through cracks and the metallic minerals precipitate out and build up large deposits as they encounter the cooler, sea water. The ore at Myra Creek formed this way about 380 million years ago.

The Big chill: 1 million to 10 000 years ago



Comox Glacier, looking east towards Georgia Strait.

Over the last million years, Vancouver Island was, except for the highest peaks, completely covered in ice several times, the latest glaciation ending only 10 000 years ago. This glaciation had a major effect in shaping the mountain scenery and covering the lowlands with ice-borne debris and sediment.

For thousands of years snow and ice accumulated on the peaks and uplands of the island. The heavy winter snowfalls from Pacific storms were only slightly melted during the cool ice-age summers. Compacted ice formed glaciers which flowed into the valleys and choked them, building up until they coalesced into an ice-cap that covered all but the highest peaks. Strathcona Park was at the centre of ice accumulation because of its high peaks and extensive upland. Ice flowed outward from the park, channelled, in part, by the mountain valleys.

The glaciers ground down the lower hills, rounded higher ridges, chiselled out U-shaped valleys and ground away their sides to help create the rugged, towering peaks.

The deep, straight U-shaped glacial valleys are ideal sites for building dams such as the one at the end of Upper Campbell Lake. As the climate warmed up about 13 000 years ago, the ice sheet shrank until only remnants, such as the Comox and Cliffe glaciers near Mt. Harmstom and Milla Lake, remained.

The grinding power of the heavy glaciers polished the bedrock, and rock trapped at the base of the ice cut deep grooves, or striations, into the bedrock. The 'rock flour' created by this scouring causes many glacial-fed streams and lakes to exhibit a muddy, greenish colour. Large quantities of gravel, sand and mud were carried along by the glaciers to be spread over a wide area, mostly in the lowlands and deep valleys. Deposits of till were laid down at the base of the glaciers and this till is composed of a mixture of faceted boulders and pebbles in a matrix of silt and sand, and rock flour. Some sediment was carried by the fast-flowing streams of meltwater to be deposited farther away or on top of the till. These outwash gravels and sands are recognized by their bedding and layering, versus the more homogenous and unsorted nature of the till deposits. You can see good examples of thick till overlain by outwash sand opposite the east entrance of the park and also beside the mine road opposite Marble Peak.



Glacial outwash, opposite Marble Peak



Glacial striations carved into rock by ice during "the Big Chill". The striae, or grooves, are caused by boulders frozen in the base of the glacier being dragged across the solid rock by the moving ice. Geologists can tell the direction of ancient glacier movement by examining the glacial striae left in the rocks. Eventually, the boulders are worn away to form rock flour but the glacier continually picks up new boulders and the process continues.

Renewed Erosion: the last 10 000 years

During the glacial period, the weight of the overlying ice-sheets depressed the land surface. After the ice retreated, the land surface rebounded. New streams and rivers recommenced the erosional attack on the land, further eroding the jagged glacial terrain. The mountain slopes valley sides became steepened and unstable, and prone to failure as rockslides or avalanches.

The jumbled debris of erosion and rockslides is a common sight along the base of slopes in the park. These are formed of angular rubble of all the rocks that outcrop higher on the slope. These are formed of angular rubble of all the rocks that outcrop higher on the slope. The rocks range in size from blocks the size of a car down to sand grains. These slides are shaped like upside-down cones and generally overlie any glacial deposits there might be on the valley floor. They occur widely but are best seen on the road up Thelwood Creek to Jim Mitchell Lake.



Avalanche debris rock slide along Jim Mitchell Lake road

A major landslide can also be seen on the northern slopes of Mount Colonel Foster at the head of the Elk River Trail. This slide cuts a broad swathe through the trees from the ridge crest down to the shores of Landslide Lake. It was one of several landslides triggered by a large earthquake on June 23, 1946. This earthquake was the most damaging quake in western Canada and was felt widely throughout British Columbia. It appeared to be centred on a fault near Comox Lake and caused much damage to buildings in central Vancouver Island, including the school-house in Courtenay.

Myra Falls Mine



Boliden Westmin Resources' copper-lead-zinc mine at Myra Falls

The occurrence of metallic minerals in the rocks of the Sicker Group is a direct result of volcanic processes which took place on the seafloor. During the volcanic activity, sea water circulated through the hot lavas and dissolved metals contained in them. In the same process the sea water was heated, eventually rose and was expelled on the seafloor at submarine hot springs or vents. The metallic-sulphide minerals, precipitated out to form mineral deposits when the hot water chilled after contacting cooler sea water.

This process still occurs on the seafloor today and these features, called '[black smokers](#)', have been photographed and sampled by geoscientists using deep-sea submersibles. The sulphide minerals rain down and collect around the vent, or hot-spring, to form solid mounds called 'chimneys'. These chimneys are often covered with unusual life forms which are particularly adapted to this environment; such as tube-worms, large clams, mussels, galatheid crabs and chemosynthetic microbes. If these deposits of sulfide minerals are to be preserved they must be quickly covered and protected, usually by sediments or the next layer of volcanic rock. These ore deposits are an integral part of the resulting rock package in which they occur and the presence of volcanic rocks, such as rhyolite, can provide important clues to the location of new ore.

Prospecting, focused on the mineral potential of the volcanic rocks of the Sicker Group, has taken place at the south end of Buttle Lake since 1917. In the early stages of exploration at Myra Falls, access to the area was not nearly as easy as it is today. A wagon road led to Upper Campbell Lake and, from there, a packtrail continued to the northern end of Buttle Lake. Prospectors then had to boat the full length of the lake to the mouth of Myra Creek. Despite these difficulties, three separate groups of mineral claims were staked on outcrops of mineralization; two in Myra Creek valley and the other in Thelwood Creek valley to the southeast. These original claim blocks are over the Lynx and Myra Mines and the Price prospect, all of which lie along one ore horizon which was exposed by the glaciation of Myra and Thelwood valleys.

Sporadic exploration continued on the claim blocks until 1961, when Western Mines (the forerunner to the present Boliden Westmin Limited) acquired all the claims and instituted a concerted program of trenching, tunneling and diamond drilling. This work was successful in confirming the persistence of ore to depth and sufficient ore reserves to justify mining. Production began with the Lynx Mine open-pit in 1966, augmented by underground production from the Lynx Mine in 1968, and the Myra Mine in 1972. By the mid-1970s, ore reserves were declining and the operations' future was in doubt. A large-scale exploration program was organized to find new sources of ore, millions of dollars were spent, and the large HW ore body was found in 1979. This ore deposit is located in a different rock horizon 350 metres below the bottom of Myra Creek valley and was found through geological deduction and explored by diamond drilling from the surface. The HW Mine started production in 1985 and is currently the main source of ore. New ore discoveries have been made since 1990 and these will become the mining areas of the future as HW Mine reserves decline.

At the end of 1993, the mines had produced a total of 14.2 million tonnes of ore and a similar amount is known to exist and is waiting to be mined. The exploration potential of the mine property is still excellent and over half of it has not been tested in any detail. These mines produce mainly zinc and copper ore, which is concentrated and trucked to Campbell River for shipment to overseas markets. They have also produced significant quantities of precious metals, yielding nearly 22 million grams (700 000 ounces) of gold and over 778 million grams (2.5 million ounces) of silver - making them the tenth largest producer of gold and the fifth largest producer of silver in British Columbia.

The Boliden Westmin Mine is relatively unique in that it is surrounded by a Class A park and the boundary of its mineral claims fall entirely within the Strathcona-Westmin Class B Park. Hence all mining activities, and the eventual reclamation and rehabilitation of the site, fall under a park-use permit. Constant monitoring ensures that environmental concerns and public safety are an integral part of the continuing mine program. It is interesting to note that not only are recreational activities not impeded by mining activities, but mine tours have become an important attraction for park visitors.



Boliden Westimin's Myra Falls Operations
Conveyor belt housing from HW mine to mill.



Boliden Westimin's Myra Falls Operations
View looking west over HW minesite (lower left) and conveyor belt to mill and water recovery ponds (center). Tailings ponds lower right.

Contributors

The field research for this website, as well as the original brochure, was completed by Athol Sutherland Brown at the request of Ron Smyth, Chief Geologist of the B.C. Geological Survey. Nick Massey, also of the Survey contributed to the geological descriptions.

The initial manuscript was edited by John Newell and the resulting technical material was rewritten for the layperson by John Wilson of Nanaimo, B.C.

Cliff Pearson, of Boliden Westmin's Myra Falls Operations, supplied a detailed description and photographs of the geology of the mine area.

Tina Beard, of West Coast Fossils, kindly provided an illustration of a crinoid meadow. Rolf Ludvigsen and Graham Beard also provided the excellent fossil photographs from Marble Meadows.

Bill Merilees and his fellow professionals in the Ministry of Environment, Lands and Parks reviewed and contributed valuable commentary which greatly improved the final product.

Cartography by Pierino Chicorelli

TM Communications Inc. (formerly T.D. Mock & Associates) were responsible for design and layout of the printed brochure.

Overall co-ordination, preliminary design, and final writing and editing were carried out by Brian Grant and Claudia Logan of the Geological Survey Branch.



MAP OF STRATHCONA PROVINCIAL PARK

