A Component of British Columbia's Land Use Strategy

North Coast LRMP

# Background Report

# Mineral Resources of the North Coast Region


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Ministry of Energy and Mines



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BRITISH COLUMBIA

# Executive Summary

The North Coast plan area has a 100 year history of exploration and mine development and contains some of the most highly prospective parts of the Province. It includes past-producing mines near Stewart, at Anyox, in the Kitsault River valley, at Alice Arm, on Porcher Island, on Smith Island and on Aristazabal Island. These past producers illustrate the range of metallic (gold, silver, copper, lead, zinc, molybdenum) and non-metallic (limestone) commodities that can be produced along the coast. The local abundance of relatively untested mineral showings in the area hints at possible mining opportunities still to come.

In the late 1800s and early 1900s, prospectors explored the coast by boat. They worked without geology maps, or any real understanding of the local geology and had, at best, poor topographic maps. They prospected for "high-grade" mineralization and were remarkably successful in finding it. Where the deposits lay close to surface, they were able to turn some of these discoveries into mines by trenching and tunneling; however many of their sites have yet to be properly explored. With better knowledge and using modern methods that make it possible to locate large deposits below surface, some of these relatively untested prospects may yet become mines. Our knowledge of the geology and mineral deposits of the North Coast area has improved considerably since the early 1900s, and will continue to improve as more exploration and research are done. In 10 to 20 years, our understanding of the mineral potential of the area will be far better than it is today.

The relatively isolated and mountainous nature of much of the North Coast is less of a problem for mine development than one might expect. Most past-producing mines in the region were "stand-alone" operations that derived considerable benefit from locally generated hydroelectric power and easy access to tidewater, benefits which future mines may share.

Metal markets are hard to predict, but the long term outlook for metal and mineral demand is encouraging as relatively underdeveloped countries need resources to build the infrastructure required for a modern lifestyle. In the short term, commodity prices should continue to mirror fluctuations in global economic growth and rise and fall in response to temporary imbalances in supply and demand. In the long-term, new mines will be needed to replace those that are depleted in order to maintain global supply. British Columbia has highly prospective geology and is well placed to contribute to the global mineral economy.

Mineral resources in the North Coast have the potential to make a significant contribution to the local, regional and provincial economy. Mining is a temporary usage of the land. British Columbia's mines are regulated and bonded to cover environmental damage and to ensure that new mines are developed and operated in a safe and environmentally responsible manner.

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# 1.0 Definitions and Descriptions relevant to Mineral Resources

**Acid Rock Drainage** – acidic seepage from rocks, containing sulphides, which have been exposed to the combination of air and water.

**Adit** – a nearly horizontal passage by which a mine is entered from the surface.

**ARIS** – Assessment Report Information System of the BC Ministry of Energy and Mines. The system tracks reports that outline data gathered by industry on mineral exploration and development projects.

**Bedded Sulfide Deposit** – layers of sulphide minerals parallel to rock masses (beds) occurring in large horizontal planes.

**Coast Plutonic Complex –** an intrusive, mainly granitic, mountain chain extending the length of coastal British Columbia formed as a result of the heating and melting of an oceanic plate that was forced under the continental plate.

**Concentrate** – a product containing the valuable metal and from which most of the waste material has been eliminated.

**Dike** – a long and relatively thin body of igneous rock that, while in the molten state, has intruded a fissure in older rocks and solidified.

**Igneous** – rocks formed by the solidification of molten material that originated within the earth.

**Intrusion** – a body of igneous rock formed by the consolidation of magma intruded into other rocks, in contrast to lavas, which are extruded upon the surface.

**Mineral** – a naturally occurring homogeneous substance having definite physical properties and chemical composition and, if formed under favourable conditions, a definite crystal form.

> **Industrial Mineral** – a broad range of minerals such as gemstones, dimension or building stone plus minerals which are used in industry and manufacturing processes in their natural state, e.g. asbestos, salt, talc.
>
> **Metallic Mineral** – a mineral that is typically fusible, opaque, a good conductor and shows a metallic luster such as gold, lead, zinc, silver.

**Mineral Tract** – an area of similar geology that is used for the projection of mineral potential by the British Columbia Ministry of Energy and Mines, Mineral Potential Assessment Project.

**Mineralized Vein Deposits** – an occurrence of ore in a fissure, fault or crack in a rock filled by minerals that have travelled from some other source.

**Minfile:** A database developed and maintained by the Ministry of Energy and Mines which documents known mineral occurrences in British Columbia, supplying information on the location, commodities, geology, known extent and level of development of each occurrence. Occurrences are largely compiled from government and industry sources (i.e. geological survey crews, regional geologists and industry assessment reports). The database is based on reported occurrences and is continually updated.

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**Ore** – a mixture of ore minerals and gangue (waste) from which metals can be extracted at a profit.

**Ore shoots** – the portion, or length, of the vein or other ore structure, that carries sufficient valuable mineral to be profitable to mine.

**Placer** –an alluvial deposit of sand and gravel containing valuable minerals such as gold, platinum or tin.

**Schist** –a foliated metamorphic rock whose grains have a roughly parallel arrangement ; it is generally developed by shearing.

**Vein Stockwork Deposits** – also known as "porphyry" deposits. These are large volume low-grade deposits of copper, molybdenum, silver, and gold formed from fluids released by a rising intrusion as it solidifies.

**Tailings** – material rejected from a mill after the recoverable valuable minerals have been extracted.

**Waste Rock** – barren rock in a mine, or material too low in grade to be of economic value.

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# 2.0 Introduction

The mineral resource sector is poorly understood by many people outside of the industry (a definition of the term, mineral, can be found in Section 1). It is a unique resource in that it is site-specific, mostly hidden, and unquantifiable except at enormous cost. If the resource is to be developed, it must be mined where it is found. The hidden nature of the resource requires access to large areas of land for exploration. A multitude of mineral occurrences need to be evaluated through repeated and expensive exploration campaigns, over a span of years or decades, before a commercially viable mineral deposit is delineated.

This report provides background information on historical mineral activity and the current understanding of mineral resources in the North Coast plan area. Mineral infrastructure, geographical considerations for mine development and the economic significance of mineral development, both provincial and global, is discussed. Information on the administration, regulation and permitting of the resource is provided as a quick reference for persons unfamiliar with the mineral sector.

Unlike many other resources, it is extremely difficult if not impossible to forward plan for development of mineral resources. Planning for mine development has been likened to planning for meteor impact zones - until it happens, one does not know where the site will be. Fortunately, though development of the resource requires access to a large land base, most mineral exploration programs are low impact, requiring no roaded access. A very small portion of the landbase (less than 1% of the province for both historic and current mining) has been used for mineral mining.

Environmental regulation was not as stringent in the past as it is now, as can be witnessed by past practices in municipal waste disposal, tourism, forestry, and mining. Current practices and proposals should not be judged by historical mine sites. Recent mine development is subject to an extensive environmental review process and must address concerns identified, prior to obtaining approval to proceed. Prior to commencing development, the proponent must commit to an environmentally sound reclamation plan and sufficient reclamation securities must be placed to cover the cost of reclamation or any ongoing remediation of the site.

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# 3.0 Historical Perspective on Mineral Resource Development

The North Coast was virtually unknown to all but First Nations people in the mid-1800s. However, the discovery of lode gold at Juneau, Alaska, in 1880, and of placer gold in the Klondike area of the Yukon in 1898 brought thousands of prospectors up the coast. Most headed for Skagway and took the Chilkoot Pass route into the Klondike; however many either stayed on the coast or later returned to the coast to look for new discoveries. Over time, they covered the shoreline and worked their way up the major drainages in southeastern Alaska and northwestern British Columbia.

Their exploration techniques were simple by today's standards. They panned for gold, traced mineralized boulders to their source, sampled rusty rocks or "gossans", hand trenched showings and drove small adits on the larger mineral occurrences. They were only interested in high-grade deposits, particularly gold and silver-rich veins that were within easy reach of the coast, as their equipment had to be packed in from the shore and the "ore" had to be carried out. The early prospectors would have had little interest in many of the large, lower-grade deposits that are mined today.

In 1900, the British Columbia Minister of Mines established a Recording Office at the Hudson Bay Company Fort at what is now Port Simpson, at the north end of the Tsimpean Peninsula. The resident Mining Recorder (Mr. John Flewin) registered mineral tenures by name and location and ensured that the local prospectors did the work required for them to keep their claim "in good standing". Some of the claims were later surveyed and "crown granted" and are still valid today, others were allowed to lapse and were dropped from the Ministry's maps.

The Ministry's reports show that considerable exploration and small mine development occurred in the North Coast area prior to the 1930s. Most of it was conducted from well established mining centres that grew up at Stewart, Hyder, Alice Arm, Anyox and Fort Simpson. These communities, along with numerous canneries, lumber-mills and First Nation villages, were then linked and serviced by boat and barge. Today, few remain. Alice Arm and Anyox shut down when their mines and lumber mills closed and the Hudson Bay post at Fort Simpson declined as Prince Rupert grew in importance.

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The section below provides a brief history of the communities of Alice Arm, Kitsault and Anyox.

**Alice Arm/Kitsault**

Alice Arm, at the mouth of the Kitsault River, was an important staging point for the mining and exploration community from the early 1900's, through to the 1960s. The primary impetus for development came in 1917, when Dolly Varden Mines Company arranged for a contractor to build a narrow-gauge railway up the river to a newly discovered silver deposit at Dolly Varden. Unfortunately, the war in Europe limited the supply of materials, which greatly increased construction costs and eventually bankrupted the company. However, the project was taken over by the contractor who completed the railway and ran the mine, until it closed in 1921. It shipped high-grade ore by rail to a load-out facility at Alice Arm, from where it was barged to Anyox for smelting. The company employed approximately 250 people at the mine and on the railway.

The community remained after the Dolly Varden mine closed, sustained by the Torbrit silver mine in the late 1920s and a lumber mill in the 1920s/30s, both of which were serviced by the rail line. In its hey-day, of rail-based commercial logging, the community is reported to have housed over 2,000 people. Thereafter, the railway fell into disrepair and, in the mid 1940s, it was replaced by a road which handled traffic during the next round of mining at Torbrit, between 1949 and 1959. The community experienced short revivals in the late 1960's and 70's, when the Kitsault mine across the bay was in production. However, with no road connection to the outside, the community gradually withered away. It is now largely abandoned except for a few seasonal residents.

The town of Kitsault, on the south side of Alice Arm, was built on the abandoned site of Silver City, which existed in the early years of the community of Alice Arm. British Columbia Molybdenum Limited built the Kitsault town-site in 1968, to service its molybdenum mine. The town was connected to the highway grid in 1979, by an all-weather road to Terrace built by the second mine operator, Amax of Canada Limited. The community had over 100 houses, apartment buildings and a wide range of facilities, including a health clinic, swimming pool/recreation centre and primary school. The mine employed a staff of 450 and, at its height, the town serviced approximately 1,200 people. With the closure of the mine in 1981, the town was placed on "care and maintenance" and a caretaker stays on site year round. As it appears unlikely that the mine will re-open in the near future, the company is now actively promoting the sale of the townsite.

**Anyox**

Anyox, on Observatory Inlet, was an exceedingly important coastal community in the early 1900's. The copper deposits in the area were located in the late 1890s and acquired by Granby Consolidated, Mining, Smelting and Power Company in 1910/1912. The company recognized that the site had the ingredients required for a successful operation: large mineral deposits, abundant cheap hydroelectric power, and easy access for deep water shipping. It quickly invested over C$3.6 million (dollars of the day) in construction of a mine at Hidden

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Creek, a hydroelectric plant, a smelter complex, docking facilities and a full company town.

The mine opened in 1914, and for the first ten years copper ore went straight to the smelter for processing; however, it later built a concentrator and also shipped out concentrate. The Anyox smelter required silica and carbonate flux in order to process the ore. These commodities had to be brought in and the search for suitable sources of supply was a significant impetus to exploration in the area. The company quarried limestone at Swamp Point, on Portland Canal and silica from numerous gold-bearing quartz veins on Granby Peninsula.

The smelter custom-processed ore from deposits up and down the coast of British Columbia and southeastern Alaska. High-grade copper ore was also brought in from Quadra Island. The coke required for the smelting process was originally brought in pre-made from Union Bay, on Vancouver Island. However, in 1918, Granby built coke ovens at Anyox and thereafter shipped in coal from its colliery at Cassidy, near Nanaimo.

Like most company towns, Anyox was dependent on a single commodity and it succumbed to low prices during the Great Depression. The company kept the operation going for several years but, with unsold copper ingots building up on the docks, it was forced to shut it down in 1935, laying off 1,000 employees. Prior to the mine closure, approximately 3,000 people lived at Anyox. It had churches, a hospital, school, a government agent's office, police station, library, hotel, movie theatre, telegraph station, assay office and was one of the first communities in the province to have electric lighting.

Cominco Limited bought the mine and moved the smelter to Trail, in southern British Columbia, where it was used to process zinc-rich ore from the Sullivan mine. Silica slag from the Anyox smelter is now being mined for use in abrasives.

Juneau, in southeastern Alaska, is similar to what Anyox might have become had it not been dismantled. Gold was first discovered in the area in 1880 and small mines opened up shortly thereafter and operated intermittently through to 1944. Most of the early development was on Douglas Island, across the water from Juneau. However, the Alaska-Juneau ("A-J") mine, on the outskirts of town, was a major gold producer, particularly between 1933 and 1944. Juneau is a rare example of a road inaccessible mining community that has managed to outlast its mine. Becoming the state capitol must have helped!

# 4.0 Current Understanding of Mineral Resources

## 4.1 Bedrock Geology of North Coast plan area

With the exception of the Stewart-Anyox area, most of the North Coast plan area is underlain by the "Coast Plutonic Complex". This complex is a belt of predominantly granitic and

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metamorphic rocks that extends the length of the Province. It is the boundary that separates rocks found on Vancouver Island and in the Queen Charlotte Islands from very different rocks found in the interior of the Province. The belt displays a pronounced northwesterly trend throughout the plan area and is approximately 150 kilometres wide at the latitude of Prince Rupert.

The “Coast Plutonic Complex” can be divided into two general rock categories: intrusions and layered rocks. The layered rocks are metamorphosed volcanic and sedimentary remnants that lie within and adjacent to the intrusions. These volcanic and sedimentary remnants are highly prospective for metallic mineral deposits. The Ecstall belt, which lies in the core of the complex in the Ecstall River area, is one of the largest and most significant belts of these rocks. Volcanic and sedimentary rocks in the Stewart - Anyox area are also highly prospective for metallic mineral deposits, though they are unrelated to the Coast Plutonic Complex.

Igneous intrusions comprise the bulk of the Coast Plutonic Complex. Prior to solidifying, numerous pulses of magma invaded and locally digested and recrystallized remnants of layered volcanic and sedimentary rock. These intrusions include large “batholiths” that may cover hundreds of square kilometres, small “plutons” that are a few kilometres in diameter and thin tabular dikes that are too small to show at these map scales. They vary in texture. Batholithic rocks, formed at considerable depth, tend to be relatively coarse-grained (crystals > 1.0 cm) and weakly to strongly deformed as a result of the mountain building processes that brought them to surface. Smaller plutons and dikes which crystallized nearer surface are finer-grained and commonly less disrupted. Intrusions vary in composition and, depending on their mineralogy and rock chemistry, are described on modern maps as “granite”, “quartz diorite”, “granodiorite”, “diorite” and “gabbro”.

The volcanic and sedimentary remnants in the Coast Plutonic Complex also vary in texture and composition. Those near the flanks of the complex commonly retain enough evidence of their volcanic and/or sedimentary origin to allow for correlation with similar rocks elsewhere. Where identifiable, rock names such as “limestone", andesite”, “basalt”, “tuff”, “shale” and “sandstone” provide useful insight into the depositional history, origins and mineral potential of the package. Other remnants, that are perhaps older or more deeply embedded in the complex, may be so highly deformed and recrystallized that their original form is lost. They are commonly described based on their current texture and mineral content, which is partly a function of chemical composition. Terms such as “amphibolite”, “schist” or “gneiss” hint at the origin of the rock.

The layered rocks underlying the North Coast planning area are a mix of relatively old and younger volcanic and sedimentary rocks. The age of volcanic-sedimentary belts can be important with respect to mineral potential, however the deformation and cooking that the rocks have undergone makes it difficult to distinguish the belts. They have been dragged to several kilometres depth in the earth’s crust, deformed and cooked, intruded by igneous rocks and squeezed upwards along major faults and shear zones. On the earth's surface, they have been exposed by a prolonged and ongoing process of erosion. Given the complexity of the rocks and the rugged nature of the terrain, the geological maps provide only a general picture

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of their distribution. This picture is evolving and will improve with additional work.

## 4.2. Mineral Assessment and known Mineral Deposits in the North Coast Plan Area

The mineral assessment of an area is a measure of the perceived probability of finding any type of mineral deposit in a given area. It is commonly a composite of several probabilities as an area may contain all, or none, of a variety of different deposit types. Mineral assessments, focusing on a small selection of commodities, are commonly conducted by mining companies and individuals to direct their exploration efforts. However, broad-scale mineral assessments, encompassing the entire range of mineral deposits, is generally conducted for use in land planning processes. This type of assessment has been conducted in various parts of the USA, Canada and Venezuela using similar methodologies.

Mineral assessment mapping for British Columbia was initiated in 1992, for use in regional and sub-regional land-use planning (i.e. CORE and LRMP processes). As several of these land planning processes were ongoing at the time, the Ministry of Energy and Mines initiated mineral assessment mapping on a regional basis. Over a period of 6 years, mineral assessments were completed for the province, so that the mineral assessment used today is a provincial rating. No changes have been made to the provincial assessment since it was completed in 1998.

The current mineral assessment for the province is based on methodology developed by the U.S. Geological Survey. The assessment process can be simplified into 3 stages:

1. Development of Mineral Tracts: Tracts are polygons of similar geology at a scale of 1:250,000. Geologic units within a tract have similar lithology, structure and geological history, particularly where these are important to the deposition of minerals. Tract boundaries are geological features such as faults or differences in rock types/stratification.
2. Estimation of Future Deposit Potential: Using ministry databases (Minfile, ARIS, geochemical surveys, etc.), tract geology, and their expertise in mineral development, industry experts estimated the number and type of mineral deposits within each tract. Several estimates were made at different probability levels for each deposit type, then all estimates were run through a program simulating the grade and tonnage of deposit types to determine the amount of mineral commodity predicted by the estimate.
3. Rating of Mineral Tracts: The predicted amounts of each commodity for all deposit types in a tract are combined, given a dollar value and the tract is rated on its overall 'value' as compared to other tracts in the province.

Analysis of mineral potential was initially done for ***metallic*** minerals (i.e. gold, silver, zinc, molybdenum, etc). A second analysis, using the same mineral tracts, was done for ***industrial*** minerals (i.e. dimension stone, limestone, fertilizers, etc.). However, the data available on industrial mineral deposits and the level of industry expertise was considerably smaller than that for metallic mineral deposits. As well, a slightly different methodology was used to rate

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the tracts, as unlike metallic mineral deposits, the location of an industrial mineral deposit will greatly influence the probability of it being developed. For example, granite near the coast has higher potential for dimension-stone than similar rock inland, because the cost of transporting the product will be much lower.

Mineral deposits are a hidden resource and the mineral assessments should be used keeping the following points in mind:

- Large areas of the province are under-explored or have poor quality geology maps because a layer of glacial till or heavy vegetative growth masks the underlying bedrock.
- Mineral rankings are restricted to within the province of British Columbia and do not take into account the overall high mineral potential of the province in comparison to the rest of Canada. This problem is further exacerbated by a mandate to declare one third of the province as having low mineral potential.
- It is an estimation of future mineral potential and must be used for that purpose. Other values must be used to assess current economic potential, such as mineral tenure and current industry activity.
- The mineral deposit probabilities were based on information that was available at the time. It is worth noting that this was not evenly distributed. For example, the North Coast area north of Prince Rupert had been covered by Ministry regional stream sediment geochemical surveys whereas the area to the south had not. This is important as geochemical surveys show up areas of anomalous metal content and are a useful tool in identifying areas of high mineral potential.
- Although the ranking process highlights tracts with known high mineral potential, it emphasizes past exploration success, so that areas that are less well known or less well explored may be undervalued.
- There is often very little information available on a remote area before a discovery is made. However, once an initial discovery has been announced, prospectors commonly move into the area and the database starts to grow[1]

Thus, although "high" potential areas will always remain "high", new ideas and new discoveries will almost certainly cause some of the "moderate" to "low" tracts to rise in estimation. "Low" potential does not mean "no" potential.

It is also worth noting that metallic and industrial mineral potential values may overlap but they are very different. Massive granite rated with a low metallic mineral assessment may have a high industrial mineral assessment, as it may be perfect for dimension-stone.

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[1] Example: The "potential" for diamonds in the North West Territories has always been there but, prior to the discovery of the first diamond-bearing pipe in 1991, the Northwest Territories were not considered a particularly favourable area to look for diamonds. Now it is considered one of the most prospective diamond areas in the world, with one producing diamond mine, two more mines on stream, and exploration activity that will continue for decades.

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### 4.2.1 Metallic Mineral Deposits

Metallic mineral deposits are a natural and expected part of the geological endowment and are defined in Section 1. Different types of rock formed under different circumstances can be expected to contain different types of deposits. Although modern science does not know all there is to know about the formation of mineral deposits, it is clear that the layered and intrusive rocks in the "Coast Plutonic Complex" have considerable potential for three main types of occurrence:

1. Bedded sulfide deposits: Remnants of layered marine volcanic and sedimentary rock may contain *bedded sulphide deposits*. These are lenses of polymetallic (copper, zinc, lead, gold, silver) sulphide deposited by hot fluids on or near the ocean floor.
2. Mineralized vein deposits: Faults and shears may contain *mineralized veins*. These are formed from metal-bearing (commonly gold and silver-rich) fluids moving through fractures during the process of mountain building.
3. Vein Stockwork deposits: Small intrusions may host *vein stockwork deposits, which are also known as "porphyry" deposits*. These are large volume low-grade deposits of copper, molybdenum, silver, and gold formed from fluids released by a rising intrusion as it solidifies.

Depending on the size, richness, physical shape and location of these deposits in the ground, the first two types are either mined as low-tonnage underground or less commonly as larger-tonnage, open-pit operations. The third is most commonly developed as an open-pit operation. There are past-producing examples of all three types of deposits and both types of mines in the North Coast area.

There are 337 mineral occurrences in the North Coast area in the Ministry's MINFILE database. The majority are metallic mineral prospects. However, this is clearly a minimum number for mineral showings as it only includes well-documented prospects.

A recent (1999) review of lapsed tenure sites in the Coastal Region confirms that prospectors have, over the years, staked many more sites than are currently described in MINFILE. Most of these sites are probably mineralized but they are too poorly documented to be included in the database.

When MINFILE occurrences and Lapsed Tenure sites are plotted on a geology map, it is clear that they are not randomly distributed. The sites are preferentially located:

(a) over layered volcanic and sedimentary rock remnants;

(b) along major faults and structures, and

(c) around the contacts of igneous intrusions.

These sites are consistent with the styles of mineral deposit to be expected in the area. Although there are isolated occurrences, most of the MINFILE locations fall in seven clusters. This may be partly a function of the underlying geology; however, it may also be partly a response to exploration intensity. Prospectors commonly focus their activity around mines and around previously discovered deposits.

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The following section provides an overview of the most prominent deposits within the seven areas. It should be noted that there are several more mineral occurrences that are not mentioned. For more information, the reader is referred to the MINFILE database on the Ministry's website (www.em.gov.bc.ca/geology).

**Anyox Mining Camp**

The Anyox mining "camp" at Granby Bay, west of Observatory Inlet, is one of the top copper production areas in British Columbia. It includes two past-producing mines (Hidden Creek and Bonanza) and several small, (relatively) high-grade developed prospects. The mines produced ore from *bedded sulphide* deposits.

The Hidden Creek and Bonanza deposits were discovered in the late 1890s and developed into mines by Granby Consolidated Mining, Smelting and Power company, in 1914 and 1928 respectively. *- is a repeat of the history section.* The mines produced until 1936, when low metal prices of the Great Depression forced the mines and town to close.

Following the closure, Cominco Limited acquired the mineral properties. In the years following, Cominco conducted numerous exploration programs which established a large resource in several zones around the old Hidden Creek and Bonanza workings and on adjacent sites at Redwing, Double Ed and Eden. Most of Cominco's early work was directed at finding higher-grade lenses similar to the ones previously mined but, by the 1980s, there had been a marked change in approach. Then, Cominco, with various joint venture partners, explored the area for larger volumes of lower-grade, potentially open-pit mineable, ore. In the late 1980s, Cominco sold its residual interests in the area to Moss Management.

The Anyox camp has good potential for future mine development. This may occur as a small underground mine exploiting high grade lenses or as an open pit mining of low grade ore adjacent to the past producing mines. New technology, employing deep geophysics, is being used in current exploration and may lead to the discovery of deeper high grade zones.

**Ecstall - Scotia Camp**

The Ecstall - Scotia camp lies within the Ecstall belt of metamorphosed volcanic and sedimentary rock. It is considered highly prospective for hosting *bedded sulfide* deposits, similar to the deposits mined at Anyox. There are 36 sulphide occurrences in the area, including three deposits with identified mineral reserves (Table 1).

The Ecstall *bedded sulphide* deposit is exposed in the floor of a narrow canyon on Red Gulch Creek. It was probably located by prospectors who traced massive, granular pyrite boulders up the creek in 1890. The deposit was initially explored as a possible source of sulphur for sulphuric acid, however significant metal values encouraged exploration for base and precious metals. In the late 1910s, Granby Consolidated Mining, Smelting and Power Company explored and drilled the prospect looking for possible sources of feed for the Anyox smelter. Exploration resumed in the late 1930's, when Texas Gulf Sulphur Company drove a tunnel underneath the main zone to provide access for more detailed drilling and established a composite resource, in several lenses (Table 1). The grade of this resource is

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uneconomic for mine development, however in bedded sulfide deposits, it is not unusual to find relatively metal-rich and metal-poor lenses close to each other. The property owner, Ecstall Mining Corporation, is planning further drilling.

The Packsack *bedded sulphide* deposit is 10 kilometres southeast of the Ecstall deposit. It is a similar, pyrite-rich deposit with relatively low base and precious metal values. The occurrence was located in 1957, and explored intermittently through to 1990. A preliminary resource (Table 1) has been identified through limited drilling, however, the sulphide body has yet to be completely outlined and may be larger than indicated. The area, owned by Ecstall Mining Corporation, is highly prospective.

The Scotia *bedded sulphide* deposit was located through a regional exploration program conducted in 1958. It is a rod-shaped lens that is exposed on a cliff face approximately 25 kilometres northwest of the Ecstall deposit. A sub-economic resource, higher in grade than either the Packsack or Ecstall properties has been identified (Table 1). The deposit plunges into the mountain and is not fully delineated, so there is strong potential for further exploration to discover new reserves. Doublestar Reources Ltd. recently acquired the property from Falconbridge Ltd.

In 2000, the Provincial Government sampled the Pitt Island/Grenville Channel area and the Ecstall River area. The results of these surveys were be released to the public in May of 2001. and will likely generate further exploration interest in the Ecstall Belt.

The geology and known mineralization of the Ecstall belt is very prospective for the discovery of an economic bedded sulfide deposit. There is good potential that exploration will lead to the development of an underground mine similar to the Myra Falls mine, near Campbell River.

**Upper Kitsault Mining Camp**

The Upper Kitsault mining camp, north of Alice Arm, is the 9th largest silver producing area in the province and one of the most prospective areas in the district. It contains several important styles of mineralization. The past-producing silver mines (and numerous similar occurrences ranging in size from developed properties to early-stage prospects) are fault controlled *vein* and possibly unusual *bedded sulphide* deposits. The remaining prospects include copper and gold-bearing *stockwork vein* deposits found in a broad zone known as the "Copper Belt", on the west side of the Upper Kitsault River. The latter showings are rich in pyrite that has weathered to produce an extensive rust-coloured surface alteration or "gossan".

Many of the high grade silver vein deposits were initially located in the period from 1917 to 1927, however their development extends over a much longer period. The Dolly Varden mine, located approximately 23 kilometres north of Alice Arm, operated intermittently between 1919 and 1940, with the most of its production coming in the first three years. The Torbrit mine, located across the river a few kilometres upstream from the Dolly Varden, was briefly in production from 1928 to 1929, then reopened for more sustained production from 1949 to 1959. The Wolf and Northstar deposits, located proximal to the Torbrit, have yet to be developed. The four deposits are similar and may be fault off-set portions of the same deposit. Ore reserves remain at all four (Table 1).

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There have been several attempts to reactivate the mines in the upper Kitsault River area. Most notably, Dolly Varden Mines Limited proposed construction of a 150 ton/day mill at Alice Arm in 1979. The plan was to mine the Wolf and Northstar deposits for six months of the year, with the ore trucked and stockpiled at the coast for processing year-round. The operation could have supported approximately 50-75 people. The plan was later shelved as a result of declining silver prices but it has been revisited periodically.

The "Copper Belt" area lies on the west side of the Kitsault River, extending north from the Torbrit deposit up to, and potentially continuing under, the Cambria Icefield. Though underlain by similar rocks to those in the Dolly Varden - Torbrit area, the "Copper Belt" differs in its mineralization style, which is dominantly copper and gold-bearing *stockwork vein* deposits. Many of the mineral occurrences were discovered in the early 1900's, and were explored intermittently until the 1960's and 1970's, when several extensive exploration programs were conducted.

Discovery of the exceptionally high-grade Eskay Creek gold-silver deposit in 1988, generated considerable interest in the Kitsault River area which continues today. It was recognized that the rocks of the Eskay area are similar to those of the Upper Kitsault, suggesting a previously unrecognized potential for *bedded sulfide* deposits. The possibility of finding another Eskay type deposit has led to several exploration programs in the late 1980's and 1990's, and has spurred recent staking of mineral tenure in the area.

The upper Kitsault is a promising area for future mines. In the Torbrit area, a small underground silver mine is feasible when the price of silver recovers. The recently recognized potential for *bedded sulfide* deposits has increased exploration efforts in the area. If successful, it could also lead to the development of an underground mine, possibly with a resource similar to the Eskay Creek mine. Should a mine be developed, the associated infrastructure would greatly enhance the probability of further exploration and mine development in the area.

**Kitsault Mine Area**

The Kitsault mine, on Lime Creek south of Alice Arm, is a much more recent, open-pit mine. It is a large-tonnage, relatively low-grade, *vein stockwork* (*porphyry)* molybdenum deposit. Molybdenum is used in steel as a hardening and strengthening agent and its price has always been very susceptible to changes in supply and demand brought about by economic cycles. In 1977 molybdenum sold for approximately US $4.00/lb. Two years later, it had risen to US $23.00/lb. but, by 1982 it was back to around US $3.00/lb. Since the early 1980s, large copper-molybdenum deposits have been producing by-product molybdenum which meets most of the current market demand and keeps the price relatively depressed.

Also known as the Lime Creek prospect, the Kitsault deposit was located around 1916, but little was done until 1959, when extensive drilling of the site began. The first stage of mining occurred from January, 1968 to April, 1972, when it closed as a result of low metal prices. The mine was sold to Climax Molybdenum Corp. of B.C. and further drilling was conducted, which led to reopening of the mine in April, 1981. Prior to beginning the second phase of

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mining, the mine and mill facilities were upgraded to double the previous production, the town and barge load-out facility on Alice Arm were expanded, and a road link to the Terrace - Stewart highway was constructed. The mine operated until November, 1982, when low metal prices again closed the operation.

The Kitsault deposit is one of many "porphyry-molybdenum" occurrences in the North Coastal region. There are similar deposits at Tidewater, Roundy Creek and Bell Molybdenum near Alice Arm. They also occur at Ajax on Mount McGuire, on the east side of the Kitsault River, and at Moly May on Observatory Inlet, south of Anyox.

The Kitsault mine facilities were recently removed and the pit area is in the process of being reclaimed. However, significant reserves remain in the ground at Kitsault and other proximal deposits, which could lead to reopening of the mine should the price of molybdenum recover in the future.

**South Stewart Camp**

The rocks around Stewart are well mineralized and the area is well known for its mineral potential. Many of the currently more important deposits (Red Mountain) and past producing mines (Silbak Premier, Granduc) lie to the north of the North Coast study area. However, south of Stewart, in the North Coast planning area, there are several important *vein* deposits. The Prosperity - Porter Idaho mine and Georgie River property are two examples of vein deposits known in the area. Both were discovered by prospectors in the early 1900's.

The Prosperity - Porter Idaho mine produced silver, gold and lead from mineralised quartz veins between 1922 and 1981, with the greatest mineral production occurring in the period from 1924 to 1931. The early miners traced the veins for approximately 1,000 metres into the hill; however, they suspected that they continued through the mountain and joined up with similar veins at the smaller, Silverado mine, near Stewart. In 1985, Teck Corporation conducted major surface and underground drill programs looking for a resource large enough to warrant extending the underground workings through the mountain. Though a significant resource was outlined, the price of silver did not warrant proceeding with development. The property is currently owned by Pacific Cassiar Ltd.

The Georgie River property covers a series of cross-cutting gold-bearing quartz *veins*, with the best mineralization occurring in ore shoots at the vein intersections. Early workers explored the veins by tunneling and produced a small amount of ore in 1937. Diamond drilling in the 1980's, defined a potentially mineable gold resource that was included in a scoping project assessing the feasibility of processing coastal deposits using a barge mounted mill. Further exploration is required on the property as the *veins* pinch and swell and the best ore shoots may not have been located yet, let alone delineated. The property is owned by Blackline Oil Corporation.

Should the price of silver increase, there is good potential for the development of an underground silver mine exploiting known vein deposits in the South Stewart camp.

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### Porcher Island Mine Area

The Surf Point and nearby Edye Pass mines on Porcher Island were small, independent operations until amalgamated by Reward Mining Company in 1937. They produced 634 kilograms of gold and 226 kilograms of silver from a single system of quartz *veins* between 1919 and 1939. The company's mill burnt down shortly before the outbreak of the Second World War. At the time, the company considered building a larger (50 tons/day) mill and it may have started to do so. However, the mine was forced to close that year, presumably because of the war. Since then, the property has been explored intermittently.

The early workers mined a series of narrow, steep-dipping, quartz-pyrite *veins* and processed relatively small tonnages of high-grade ore. In more recent times, exploration companies have looked for broader zones of mineralization within the *vein* system that might be amenable to bulk mining. In 1994/5, the feasibility of barging ore to the Silbak Premier gold mine and mill operation, near Stewart, was studied and permitting was initiated for a bulk sample. The Silbak Premier mine has since closed, but the mill is still being maintained.

Cathedral Gold Corporation is the current owner of the Porcher Island property. Drilling conducted on the property in 1996/7 reported a resource of 1,380,000 tonnes grading 6.86 g/t gold and 5.49 g/t silver, most of which could be accessed from an existing mine tunnel. Future development of the site could lead to opening of a small underground gold mine.

### Banks Island Gold Camp

The Bob, Tel, Discovery and Kim zones on Banks Island are the best known of a cluster of gold showings found over an area of approximately 20 square kilometres on the west side of Banks Island. The Bob, Tel and Discovery zones are "higher-grade" vein-lense deposits, formed where gold-rich fluids channeled along faults and intrusion contacts and reacted with limestone to form tabular, sulphide-rich lenses. The Kim zone is a more-typical quartz-*vein* stockwork in an altered granitic intrusion. Collectively the 4 zones are known as the "Yellow Giant" property.

The first showings were located in the 1960s and companies such as Falconbridge Mines Ltd. and McIntyre Porcupine Mines Ltd. explored the ground intermittently through to the late 1980s. From 1977 to 1987, substantial exploration work was conducted by Trader Resources, including road construction from tidewater on the west side of the island, tunnelling along the Bob zone, extensive drilling and a feasibility study for processing ore using a portable, modular (barge-based) mill.

The Bank's Island property is now co-owned by Trader Resources Corporation and Doublestar Resources Limited. They are currently considering development options that include processing the ore on or off-site. If the economics are favourable, an underground or small open pit gold mine could be developed.

### Other Areas

There are numerous other MINFILE mineral occurrences in the North Coast area. However

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three stand out because of what they tell us about the exploration process.

The Pitt/Trinity property on Pitt Island, west of Grenville Channel was discovered by a subsidiary of U.S. Borax Inc. following a stream reconnaissance survey carried out in 1980. The company located what is probably a *"bedded sulphide*" showing on "Pyrite Creek". Exploration by B.P. Minerals Inc. and others, has extended the surface expression of the mineralization for a minimum of 1.7 kilometres; however, it has done little to determine its projection to depth and more drilling is required.

The Clone property covers several small, shear-hosted gold-copper-cobalt *vein* showings in a small (4 km square) nunatak on Treble Mountain, at the head of the Sutton and Kshwan glaciers. The prospect was discovered by Teuton Resources Corp. and Minvita Enterprises Ltd. during a $250,000 reconnaissance sampling and prospecting program in 1994. The showings extend under the ice and were most likely covered during the earlier phases of exploration in the Stewart area. As the ice recedes, new prospects continue to come to light.

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Table 1: Ore Reserves of Selected Metallic Mineral deposits in the plan area

| Mining Camp | Deposit Name | Tonnage | Gold (g/t) | Silver (g/t) | Lead (%) | Copper (%) | Zinc (%) | Moly |
|---|---|---|---|---|---|---|---|---|
| Anyox | Bonanza | 10,620 | 0.16 | 13.71 | | 1.76% | | |
| Anyox | Double Ed | 1,977,666 | | | | 1.30% | 0.60% | |
| Anyox | Lower Eden | 122,470 | | | | 1.30% | 1.30% | |
| Anyox | Upper Eden | 36,287 | | | | 1.90% | 2.90% | |
| Anyox | Hidden Creek | 24,221,840 | 0.17 | 10.30 | | 1.08% | | |
| Anyox | Redwing | 181,440 | 1.20 | 85.71 | | 2.00% | 2.70% | |
| Ecstall | Ecstall | 6,349,700 | 0.50 | 20.00 | | 0.60% | 2.50% | |
| Ecstall | Packsack | 2,700,000 | 0.30 | 34.00 | 0.01% | 0.50% | 0.20% | |
| Ecstall | Scotia | 1,340,000 | 0.25 | 13.00 | 0.40% | 0.10% | 3.80% | |
| Upper Kitsault | Dolly Varden | 42,633 | | 754.10 | | | | |
| Upper Kitsault | North Star | 127,901 | | 401.40 | | | | |
| Upper Kitsault | Torbrit | 786,285 | | 311.90 | 0.42% | | 0.50% | |
| Upper Kitsault | Wolf | 485,270 | | 335.60 | 0.59% | | 0.12% | |
| Kitsault | Bell Moly | 32,528,606 | | | | | | 0.06% |
| Kitsault | Kitsault | 104,316,500 | | | | | | 0.11% |
| Kitsault | Roundy Creek | 7,000,000 | | | | | | 0.06% |
| South Stewart | Prosperity Porter-Idaho | 826,400 | | 668.5 | 5.0% | | 5.0% | |
| South Stewart | Georgie River | 267,377 | 27.63 | 20.91 | | | | |
| Porcher Island | Surf/Edye | 1,380,000 | 6.86 | 5.49 | | | | |
| Banks Island | Bob | 45,350 | 40.1 | | | | | |
| Banks Island | Tel | 71,349 | 14.4 | | | | | |
| Banks Island | Discovery | 58,361 | 15.5 | | | | | |
| Banks Island | Kim | 77,896 | 7.1 | | | | | |

### 4.2.2 Industrial Mineral Deposits

Industrial minerals are inert (chemically benign) substances that are used to create products and appliances that support our modern lifestyle. Industrial minerals found in the North Coast area could be used for construction purposes, for environmental rehabilitation, or for the manufacture of silicon metal, glass, paper, abrasives, plastics, cement, ceramics, refractory bricks and electrical appliances.

Regardless of whether they are produced in large (limestone) or small (quartz, graphite) amounts, economically viable industrial mineral deposits owe their marketability to superior technical specifications and competitive production and transportation cost. On-site concentration, processing and value-adding is important as a means of substantially increasing the distance that a product can be transported and still remain competitive. Although many industrial minerals are relatively large volume, low value products (i.e. limestone, clay), a few, such as laska (pure quartz crystals) are exceedingly valuable after processing and are valued at several dollars per kilogram. The demand for industrial minerals grows as populations grow. There is, therefore, considerable room for the growth and development of a major industrial minerals industry in the Pacific Northwest.

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The industrial mineral sites listed in MINFILE for the North Coast cover numerous commodities, including silica, mica, limestone, graphite, garnet, kyanite, silliminite, andalusite, clay and dimension-stone; however, most are poorly documented. Nine are past-producing quarries and the remainder are largely untested prospects.

**Silica Deposits**

Slag from the Anyox smelter had no commercial value at the time it was generated and was allowed to build up on a dump, on the shore-line south of town. Now, after over 50 years of exposure to the elements, it has broken down to fine glassy particles that are suitable for the manufacture of roofing shingles and for use as an abrasive in sand-blasting. In 1990, Tru Grit Abrasives Ltd. obtained permits for processing the slag and currently employs 3-5 people on a seasonal basis, for processing and shipping.

As noted previously, several deposits, near Observatory Inlet, produced silica for the Anyox smelter, along with a small amount of copper and appreciable amounts of gold and silver. The silica came from typical quartz *veins.* These are relatively common in the North Coast area but very few have been examined as possible sources of silica. Those that have, include the Campania Island deposit. This is a broad vein on the west side of the Island. One site there contains an estimated open-pit resource of 270,000 tonnes of coarse milky-white quartz. There is a similar 9,000 tonnes resource at Patsey Cove on the east side of Banks Island.

**Limestone**

The Swamp Point limestone deposit produced 257,316 tonnes of limestone flux for the Anyox smelter in the late 1910s and early 1920s. However, there has been relatively little recorded limestone production elsewhere. Columbia Cellulose Co. Ltd. produced 9459 tonnes of limestone from a small quarry on Smith Island in the early 1950s. However, the site appears to have been rejected and the company went on to explore other sites along the coast, including the Kumealon Inlet limestone deposit, a few years later. The latter is estimated to contain a resource of 19 million tonnes of white, recrystallized limestone.

The Laredo Limestone deposit, on Aristazabal Island, is a large occurrence with potential to develop into a major resource. To date, only a small area has been explored and only 10,886 tonnes of coarse-grained, white limestone has been produced (in 1952). Laredo Limestone Ltd. acquired the property and drilled two relatively small areas in the 1970s and 1980s. It identified a total proven and probable reserve of 36.75 million tonnes of chemical grade "high calcium limestone" (<97% CaCo3) and 35.25 million tonnes of combined cement (<94% CaCo3) and agricultural (<90% CaCo3) grade "limestone". In the early 1990s, the company planned to produce architectural and decorative stone for export to California at a rate of 8000 tonnes/day. However, the project did not proceed.

The property is now owned by North Pacific Stone Limited. In 1999, the company drilled a small part of the property, looking for relatively small volumes of particularly bright, white, limestone suitable for use as a filler in the manufacture of plastic, paint and paper. This is an important potential growth area for the minerals industry as bright, white, fine-ground

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limestone and precipitated calcium carbonate are both used by the pulp and paper industry to make high-end, glossy, (acid-free) paper.

**Dimension Stone**

Dimension-stone is an industrial mineral product. Typically, dimension-stone quarries extract (and in some instances cut) 17 - 20 tonne rectangular blocks of rock and ship them to processing plants for cutting into slabs and tiles for commercial sale. Prospectors look for sites that provide a suitable, homogenous, non-fractured rock that is pleasing to the eye and will take a polish or flaming. Marble (recrystallized limestone), slate, andesite and intrusive rocks such as granite and gabbro are the rock-types usually considered for dimension-stone, although other rock-types are also used. MINFILE shows that many of the limestone showings in the North Coast have been considered for building stone potential at one time or another, but other than the decorative stone option considered for Aristazabal Island none have been thoroughly evaluated.

There are granite-based dimension-stone prospects at Tyee and Smith Islands, however they are not well developed. "Black Granite" is particularly prized for dimension-stone and the Sable Black Granite property, on Princess Royal Island on the southern boundary of the North Coast area, was tested and found to meet the minimum physical requirements in the early 1990s. The development of a rock processing plant in Prince Rupert, Kitimat or Stewart area similar to the one recently established by Garibaldi Granite Group at Squamish, would open the coast up for more intense exploration.

**Mica**

White mica (muscovite, sericite) is abundant in "schists" in the layered rocks in the North Coast area. However, it is rarely of commercial quality. Most industrial-grade flake mica comes from weathered or fresh granitic rocks known as "pegmatites" and "alaskites" and from weathered mica schists. The Baker Inlet pegmatite mica deposit, east of Grenville Channel, was first identified as a source in the 1930s. At the time, the site was sampled and tests were conducted to determine the grain-size distribution of the mica and its separation characteristics. A 73 tonnes sample was collected in 1940 and an unknown amount was removed the following year. There is a similar possible source of pegmatite mica on Campania Island.

White mica has numerous end-use applications. Because of its excellent qualities as an electrical insulator, it is widely used in the electrical and electronic industries. For instance, it is used as a non-electrically conductive filler in specialty plastics. Mica occurs as flakes that are effective as a coating agent to reduce porosity in drill-mud produced for the oil and gas industry. It has also replaced asbestos in the manufacture of some insulating and fireproofing wall-board used in the construction industry.

**Other commodities**

The North Coast *schists* locally contain other commercially important industrial minerals. They commonly contain garnet and, less commonly, either kyanite, sillimanite or andalusite.

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Garnet is used as loose grains and/or as a powder to grind glass, ceramics and other products, in the manufacture of sand-paper and for sand-blasting. Kyanite and the related minerals (sillimanite and andalusite) are used in the manufacture of refractory products, such as firebricks, and porcelain.

Although there are large belts of garnet and/or kyanite-bearing rock mapped in the North Coast area; to date, there has been very little work done to define sites with potential for commercial development. MINFILE lists garnet deposits at Tuck Inlet, Douglas Channel, Banks Island and Kiltuish Inlet. It also refers to garnet with sillimanite at Kwinitsa and Khatada Lake, north and south of the Skeena River, and with both sillimanite and kyanite on Hawksbury Island. The database also refers to stand-alone sillimanite and kyanite occurrences at Kumealon and Tsimpean Peninsula respectively. Some of the most prospective are found around the Ecstall River.

These minerals are physically hard, relatively heavy and resistant to erosion. They weather out of rock fairly easily and commonly accumulate with other heavy minerals (such as gold and magnetite) in placer deposits and beach sands. The rivers found in the North Coast are not particularly conducive to the formation of sizable placer gold and/or heavy mineral deposits but small deposits are to be expected downstream of suitable source rocks. There are no well-developed heavy mineral sands reported in the area, but they are found further south, in the Central Coast area and on the Queen Charlotte Islands. Some post-glacial river valleys contain clay deposits suitable for the manufacture of bricks (e.g. at Prince Rupert).

In some localities, North Coast *shists* also contain graphite. The main graphite occurrences in the area are Payroll, near Kiltuish Inlet and in the Digby Island/Tsimpean Peninsula area, where there are several similar occurrences. There are also smaller prospects on Randall and Dunira Islands. Other industrial mineral commodities not yet noted as specific deposits but likely to be found in the North Coast area include magnetite, barite, perlite and semi-precious stone, such as rhodonite, sapphire and possibly beryl.

## 4.3 Geographical Considerations for Mine Development and Mineral Infrastructure

### 4.3.1 Geographical Considerations for Mineral Development

The geography of the North Coast area has important implications. The mountainous nature of the North Coast is attractive for underground mining as it is far easier to tunnel into a mountainside, below a deposit, and mine upward using gravity to assist in the transportation of ore, than it is to dig a deep shaft and have to haul the ore up to surface.

The relatively isolated nature of much of the North Coast is less of a problem for mine development than one might expect. Although road access is important for large and medium-sized metal mines, it is not essential for a mine or quarry to be connected to the provincial road system. Major mining companies build and operate mines in remote areas that are run as self-contained operations. Though some modern mines in remote areas have

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town sites, government policy and socio-economic costs deter future developments of this sort. Most modern mines provide accommodation on site and operate on a rotational basis, cycling the staff through by plane or boat.

Although the area is inherently rugged, long fjords provide an extensive shoreline with sheltered harbours and local, restricted, areas of flat land suitable for economic development. Some of the fjords cut through the mountains and provide transportation corridors to the interior. The fjordal and island nature of the North Coast area provides access to tidewater, reducing the cost of transporting product.

Access to tidewater is an extremely significant factor in the economics of developing industrial mineral deposits, as most of these deposits become uneconomic if the product must be trucked any great distance before transferring it to barge or rail. Proximity to tidewater also raises the possibility of barge mounted mill facilities being used for processing metallic mineral deposits. In 1986, Trader Resources Corporation, Fleet Development Ltd. and the Ministry of Energy, Mines and Petroleum Resources contracted TRM Engineering Ltd. to conduct a review of gold properties along the British Columbia coast and see if they could be processed using a portable, barge-mounted, mill. The report discusses several deposits (including Porcher Island, Banks Island and Georgia River) in the North Coast region and costs out three possible production scenarios. The barge-mounted mill concept has obvious advantages over a stand-alone operation. The construction costs can be shared between several operators and site reclamation should be easier

Where it is not feasible for a mine operation to connect to the provincial power grid, there are alternate sources of energy. The high rainfall and mountainous nature of the North Coast provides strong potential for small hydro power generation. On remote sites where hydroelectric power generation is not feasible, diesel generators have been used (i.e. Eskay, Snip, Cassiar). Though still in its infancy, the strong potential for wind power generation on the North Coast may in the future, be economically feasible for use at remote mine sites.

### 4.3.2 Mineral Infrastructure in North Coast Communities

The population of the North Coast is concentrated in relatively few communities that have played and continue to play, an important role in the development of the resource industries in British Columbia. Prince Rupert, Kitimat, and Stewart, in particular, have road and/or rail links to the interior and provide deep-sea ports that are essential to the running of the mineral economy of the Province. They ship local products (metal concentrate, industrial mineral products, coal etc.) to Asian markets and handle the importation of raw materials (alumina, iron etc.) that are converted to higher value products using British Columbia's hydroelectric power.

**Stewart**

Stewart, British Columbia and Hyder (its close neighbour) in southeastern Alaska were established when the Portland Canal area was first prospected in the late 1890s. They are mining towns and have been through several cycles of growth and contraction in response to the state of the industry. Stewart offers two main assets to mineral development in the

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northwest region of the province:

1. Existing mill facilities
2. Existing loadout facilities

The mill facilities are at the Silbak Premier mine, located 22 kilometres north of Stewart. The mine was a high-grade, precious metal-rich, vein deposit that produced fairly continuously between 1918 and 1968. In 1988, Westmin Resources Limited acquired the Silbak Premier property and built a 2000 tonne/day mill to process relatively low-grade ore from a series of open pits close to the old mine workings. Although it ceased production in 1996, the current owner, Boliden Westmin (Canada) Limited has maintained the mill while looking for new sources of feed either in the immediate Stewart area, or elsewhere along the coast. This is an important asset for the mining industry, as it is often far cheaper to transport ore to an existing mill than it is to build a new one from scratch.

Loadout facilities were established in Stewart for the shipping of concentrate from the Granduc mine (located north further north of the Silbak Premier mine) which was in production from 1971 and 1984. With the completion of the Stewart - Cassiar highway, in 1972, Cassiar Asbestos Corporation began trucking fibre from its operations at Cassiar and McDame to Stewart for shipment. Cassiar Asbestos continued to use the facility until it closed mining operations in 1991. In the mid-1990s, the load-out was adapted to handle some of the high-grade gold and silver ores and concentrates produced by the Eskay Creek mine. In addition to Eskay, the loadout facility now handles the concentrate from the Huckleberry open-pit copper mine, located southwest of Houston, which began shipping concentrate in 1997.

**Kitimat**

Kitimat shares many of the features that made Anyox such an attractive site for processing metals. It is a coastal community with a deep water port and access to hydroelectric power. In the early 1950s, Alcan Aluminum Company Limited invested C$500 million (equivalent to C$3.3 billion today) in the area, building a major hydroelectric plant at Kemano and aluminum smelter at Kitimat.

Alcan currently imports approximately 500,000 tonnes of alumina (a product derived from bauxite, a tropically weathered rock) annually from Australia and uses hydroelectric power from Kemano to smelt it into aluminum. Unlike Anyox, the community was able to establish road and rail links to the interior of the province and attract other industries. Although it started life as a company town, Alcan is now responsible for only 33% of direct employment.

Pacific Northern Gas Limited's natural gas pipeline in northwestern B.C. links Kitimat with the interior of the province. Methanex Corporation is the lines largest customer and accounts for roughly 62% of gas delivered in northwestern B.C. The natural gas is converted into the value added products of methanol and ammonia for export.

Principal exports from Kitimat include aluminum, paper and linerboard, methanol, ammonia and lumber. Value added exports from this port typically exceed 1 billion per anum with the

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majority being products produced either in Kitimat or northwestern BC. Typically exports are through 40-50,000 DWT (deadweight ton) vessels with the harbour rated for vessels to 320,000 DWT. It remains an important potential growth site for the minerals industry on the north coast.

**Prince Rupert**

The Skeena River valley is one of the few natural communication corridors between the coast and the interior of the province and, in the early 1900s, Prince Rupert and Port Essington were important trans-shipment points for people and goods taking paddlewheel steamers up and down the river between Hazelton and the coast. Their importance increased when the Canadian National Railway Line was completed, in 1914. However, Prince Rupert was handicapped by being on an island and much of its growth occurred after 1930, when it was finally connected to the mainland by a bridge. The development potential of the area increased during the Second World War, when army engineers constructed a road down the Skeena River valley, linking Prince Rupert to the interior of the province. Port Essington's fortunes declined while Prince Rupert's grew. It was on the wrong side of the river.

Since the Second World War, Prince Rupert has been one of the principal commercial ports in British Columbia. Its exports include pulp (New Skeena Forest Products, formerly Skeena Cellulose mill was built in 1950), lumber, grain and coal. Between 1981 and 1994, Equity Silver Mines Limited operated a load-out facility on Ridley Island and shipped out concentrate from its mine near Houston.

In 1984, Ridley Island Terminals Inc. (a federal crown corporation) built a deep-sea load out facility on Ridley Island to handle coal from Northeastern British Columbia. It was built to handle 12 million tonnes of coal annually but had space for double that amount. The terminal is currently operating well below design capacity. In 1998, it shipped only 4.7 million tonnes of coal, from the Bullmoose and Quintette mines near Tumbler Ridge. The latter closed in 2000 and the tonnage going through the port is expected to decline still further over the next few years. However, there are other possible sources of supply from the proposed Willow Creek mine (near Hudson Hope) and Wolverine deposit (near Tumbler Ridge. Despite the recent period of low prices, the coal industry is still viable and may even grow as other sources of fuel for electrical power generation become more expensive.

The rail accessible terminal at Ridley Island is designed to handle ocean-going 250 000 DWT (deadweight ton) vessels and is an important long-term asset for the minerals industry. Several possible, minerals-related uses have been proposed for the site in addition to shipping coal. Some are predicated on the construction of a "co-generation" power plant (one that produces power and utilizes its excess heat in manufacturing, processing or some other constructive use) that could be fueled either by coal or natural gas. For example, Pacific Iron and Steel Products Limited is studying the feasibility of building a slab-steel mill to process iron ore (imported from Brazil), for the Asian market. In December, 2000, the company signed a memorandum of understanding with Western Canadian Coal Corporation to provide 600,000 tonnes of low volatile coal annually from its Burnt River deposit, 50 kilometres south of Chetwynd, if the project goes ahead (Canada Stockwatch, December 21st, 2000). In

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an unrelated, proposal, “pig iron” could be shipped in from off-shore and manufactured into pellets for re-export.

The former owner (Cassiar Mines and Metals Inc. - producing asbestos at Cassiar), thought of using the Ridley site for shipping. It studied the feasibility of constructing, at Cassiar, a plant capable of producing 70,000 – 90,000 tonnes of magnesium metal per year, from serpentine from the waste dumps at the Cassiar/McDame mine.

Sulphur Corporation of Canada Limited is looking into the possibility of shipping sulphur from the northeastern gas fields through the terminal. It plans to transport it to the coast by rail and ship it to Asia and Central and South America, either in its molten state or in pellet form. There is a natural gas pipeline linking Prince Rupert with the interior of the province and another option for the site would be to set up a plant to liquefy and export natural gas.

## 4.5 Economic Perspective on Mineral Development

Mining (the process of extracting metallic and non-metallic mineral deposits from the Earth) refers to a variety of industrial activities that take place over a range of scales. Mines may be very large, or very small. Either way, they are point-focused and time-limited operations that only function as long as the commodity they produce can be extracted at a profit. Ultimately, all mines are depleted and, these days, their sites are reclaimed. It is a temporary usage of the land. Mines range from small shafts and adits driven to extract high-grade material to recover gold (or other metals) to larger open-pit operations developed to extract many millions of tonnes of low-grade “ore”. They all have their own economic significance, based on size and scale of production, richness and need for infrastructure.

The higher-grade styles of mineralization (*veins* and *bedded sulphide* lenses) found in the North Coast Mountains may be amenable to open-pit and/or underground development but the lower-grade (*vein stockwork* and *industrial mineral*) styles are commonly only amenable to open-pit development. The approach taken in mining a deposit will depend on its grade, size, shape and location with respect to the land surface. Miners almost invariably have to remove waste rock to get at ore; however they try to remove as little as possible, as it costs just as much to remove waste as it does ore. In the case of a small “high-grade” deposit exposed at surface, the miner may try to create a small open pit centred on the ore zone (i.e. Porcher Island). However, in the case of a deeper deposit, this will rarely be an option. They require underground tunnels to provide access (i.e. Hidden Creek, Torbrit, Porter Idaho). “Lower-grade” deposits can usually only be mined by surface pitting. With these deposits (i.e. *vein stockwork-type*), miners commonly process large volumes of ore per day and rely on economies of scale to ensure that the operation remains profitable (e.g. Kitsault). Industrial minerals, which are usually low unit value products, are also commonly quarried at surface (e.g. Aristazabal Island). In each case, the value of the “ore” has to be able to carry the cost of production.

A mineral deposit goes through several stages before it becomes a mine. They include: 1) initial discovery, (2) identification of economically mineable mineralization, (3) engineering

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to establish technical and economic feasibility, (4) environmental assessment and mine certification, (5) mine financing and (6) mine construction. Although very few deposits make it through all six stages, all of them start along the same path and many get stalled at some point, only to proceed later. Each stages involves considerable investment in time, talent and money and, even without mining, the exploration process makes a significant contribution to an area's economy.

Early-stage and mid-stage exploration provides employment for prospectors and income for service providers in remote communities. Stewart, for instance, would see immediate benefit from a resurgence of exploration in the Anyox or Alice Arm areas. Although less noticeable, Prince Rupert would benefit from renewed exploration along the coast or in the Ecstall River area. It commonly takes several years of exploration drilling and analytical work to establish the outline of a mineral deposit and it may require underground development before it is considered to be well enough defined to proceed to feasibility. Local communities benefit directly through providing goods and services supporting the exploration program(s). Once it has been found and delineated, it takes a considerable amount of time and engineering to establish the most appropriate way to mine a deposit, and to determine whether it is economically feasible to do so. This type of engineering work is usually carried out in larger communities and benefits contractors based in the Lower Mainland, and elsewhere. Environmental concerns are important, and it takes a considerable amount of time and money to meet the needs of the permitting authorities. Mine financing is, itself, a major hurdle and generates economic activity in the main financial centres. Typically, mining companies can expect to spend $10 to $20 million to bring a major deposit through the "feasibility" process.

Mine or quarry development hinges on economic feasibility. If the size and grade of a deposit is too small, or the profit from mining and processing is too low to carry the cost of building the mine, the development will not proceed and the resource will remain in the ground. However, economic conditions change; commodity prices rise and fall, currencies fluctuate and mine technology and infrastructure improve. Thus, deposits that are not economic under current conditions (e.g. Ajax, Ecstall, Porter Idaho) may become so in the future. Only a small percentage of the showings in the North Coast have been drilled, and few of the deposits can be considered to be completely delineated. Additional work should find more mines.

There is no "average" mine, but it is possible to profile the economic impacts to be expected with the development of different types and sizes of mines. Large metal mines process more than 5,000 tonnes of ore per day. They are commonly open-pit operations, however a few may be underground mines. They need a considerable amount of infrastructure and they are exceedingly expensive to construct. Capital costs, incurred before any ore is processed, commonly exceed $100 million and this figure can easily escalate to $500 million if the operator has to build roads and load-out facilities and/or bring electricity into the mine site. Given the up-front investment required, companies commonly look for sufficient reserves to ensure a minimum 10-20 years of operation before they will put such a deposit into production. Large mines commonly take 2-5 years to build and, once built, provide direct employment for between 125 and 400 people and indirect employment for a further 250 to 800. Examples include Kemess, in the Toodoggone area and Highland Valley Copper, near Kamloops.

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Medium-sized metal mines process approximately 500 to 5000 tonnes of ore a day. Some are open-pit operations but many more are underground developments. They also require a considerable amount of site preparation and infrastructure. They take 2 -5 years to build but commonly at a lower capital cost, in the range from $50 to $250 million. A medium sized mine employs between 50 and 250 people and provides indirect employment for twice as many. Examples include Myra Falls, near Campbell River and Eskay Creek, north of Stewart.

Small metal mines are commonly underground operations that process less than 500 tonnes a day. They have smaller reserves at the outset and they commonly have less complicated processing plants. Some build their own facilities but others ship their ore off-site for custom processing. Small mines take 1-2 years to build. They have a capital cost of between $10 million and $75 million and employ between 25 and 150 people. They also provide indirect employment for an additional 50 to 300 people. Examples include Golden Bear, southwest of Cassiar.

Industrial mineral operations, such as limestone quarries, may produce a considerable tonnage of product but they tend to have relatively simple processing facilities. They resemble small mines in terms of their cost and staff requirement. Examples include the Texada Island limestone deposits, which collectively ship approximately five million tonnes of rock a year.

All mines and their employees pay taxes and contribute to the economic well being of the province.

## 4.6 Global Significance of Mineral Resources

Canada is a major producer and supplier of metals and coal. In 1997, it was the 2$^{nd}$ largest supplier of zinc in the world; the 3$^{rd}$ largest supplier of copper; the 4$^{th}$ largest supplier of silver and gold and 5$^{th}$ largest supplier of lead and molybdenum. A large proportion of this comes from British Columbia. The Province is the nation's largest producer of silver and molybdenum; 2$^{nd}$ largest producer of copper; 3$^{rd}$ largest producer of gold and lead and 4$^{th}$ largest producer of zinc.

In 1999, British Columbia's 12 metal mines and 8 coal mines, along with other sectors of its minerals industry, employed approximately 19,000 people and generated export sales worth C$3.0 billion, (http://www.em.gov.bc.ca/Mining/MiningStats). Most of the minerals produced in the province are shipped to Japan, Korea and other countries in Asia. Although they are few in number, the mines and quarries provide considerable benefit to their local communities and to the province at large.

Metal markets are hard to predict, but the long term outlook for metal and mineral demand is encouraging as relatively underdeveloped countries need resources to build the infrastructure required for a modern lifestyle. Future demand for metals and minerals is likely to increase in China, India, Thailand, Indonesia and elsewhere; which will put additional pressure on existing mines and mineral resources. In the short term, commodity prices should continue to mirror fluctuations in global economic growth and rise and fall in response to temporary

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imbalances in supply and demand. In the long-term, however; new mines will be needed to replace those that are depleted in order to maintain global supply. British Columbia has many world-class deposits (Sullivan, Eskay Creek, Highland Valley) and is well placed to contribute to the global metal and mineral economy. The Province has highly prospective geology and a long tradition of mining. It has excellent infrastructure and globally respected expertise in exploration geology, mine engineering and development, and mining. It has, and should continue to have, cost-competitive mines.

# 5.0 Administration and Regulation of Mineral Resources

The Ministry of Energy and Mines regulates mineral exploration and mine development ("mining"). The principle legislation that governs mining includes the *Mineral Tenure Act*, the *Mines Act*, the *Mining Rights Amendment Act,* the *Mining Right of Way Act*, the Mineral Exploration Code, and the Health, Safety and Reclamation Code for Mines in BC. Many other laws and regulations also apply, some of which are administered by the Ministry of Water, Land and Air Protection (MWLAP), Ministry of Forests (MoF), or the federal Fisheries and Oceans Canada (DFO).

Mineral tenure is acquired by staking. While most of the North Coast plan area is open to claim staking for hardrock (or lode) minerals, none of the area is open to placer staking. Once staking is completed, title is recorded at a local mining division office or a regional Gold Commissioner's office. There are more than 1,000 valid tenures in the plan area, a number that regularly changes due to the dynamic nature of mineral exploration.

Tenure holders must do work (or pay cash in lieu) in order to maintain their claims in good standing. Before a tenure holder may undertake activities that will mechanically disturb the ground surface, a *Mines Act* permit is required. All work proposals are subject to review by regulatory agencies. Depending on the scale of the proposal, this may entail referral to government resource agencies, review by the regional Mine Development Review Committee, or a full-scale environmental impact assessment coordinated by the Environmental Assessment Office. A reclamation bond is required, to ensure that government has sufficient funds to reclaim disturbances in case the operator defaults.

Mineral tenure, regulation of mineral exploration and development, and access management are discussed in more detail in the following sections.

## 5.1 Mineral Tenure

In the *Mineral Tenure Act* the term "mineral" refers to ores of metal and other natural substances that can be mined, including industrial minerals, that occur either:

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- In the place in which they were originally formed or deposited; or,
- In talus rock adjacent to the place where they were formed, and includes materials from mine tailings, dumps and previously mined deposits and dimension stone.

Not included as minerals are coal, petroleum, natural gas, earth, soil, peat, marl, sand or gravel, and rock or a natural substance that is used for a construction purposes.

Placer minerals are ores of metal and other natural substances (excluding substances noted above) that occur either loose or in fragmented rock that has been transported from the original bedrock source by natural means, such as glacial and water action. Minerals commonly mined as placer include gold, platinum and gem stones.

Fossils are protected under the *Heritage Conservation Act*, which is administered by the Archaeology Branch, Ministry of Sustainable Resource Management. To acquire title to fossils on Crown land, application must be made to the regional office of Land and Water British Columbia Inc.

Mineral resources are owned by the province. Legal title to minerals in the province can be held under four types of tenure:

- Freehold sub-surface
- Crown granted mineral claim
- Located (staked) mineral or placer claim, and
- Mining or placer lease.

Freehold and Crown grants are historic tenures administered by the Land Title Branch, Ministry of Attorney General. These tenures may give rights to all minerals or be restricted to specific minerals. Though no Freehold subsurface tenures are located in the North Coast plan area, numerous Crown granted mineral tenures remain, particularly in the area around Observatory Inlet and further north.

The issuance of Crown granted mineral rights ended in 1957, with all new mineral tenures issued under the *Mineral Tenure Act*. Under this act, mineral and placer tenure can be held as claims or leases. With a "claim" the title holder acquires the right to the minerals but has no rights to the surface except for mining purposes. A "lease" contains the same rights as a claim, but is also an interest in the land. Leases are generally applied for on existing mineral claims when mining development is proposed.

The process for staking mineral *claims* in the Province has evolved but the principle remains the same as it was in the early days. Prospectors holding “Free Miners Licenses” identify sites of interest on otherwise unencumbered crown land, cut claim posts and attach metal tags noting the date and time of staking. They then sign a Ministry affidavit to record their claims. Each claim unit has a maximum size of 500 metres x 500 metres. However, under the “four-post” staking system, it is now possible to stake up to 20 units in a single *claim*. The Ministry’s Mineral Titles Branch keeps up to date maps showing the distribution of claims throughout the Province and the data are (albeit with some delay) digitized and posted on the Ministry’s website. Through the act of staking and recording, prospectors acquire sub-surface rights under the *Mineral Tenure Act*.

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To maintain possession of mineral tenure, a company or individual must pay a sum of money (based on a yearly fee and the number of hectares held) or do an equivalent amount of exploration work on the property and sign an affidavit as to the nature and cost of work performed. Since 1947, they have also been required to submit technical reports describing the work carried out. After a year of confidentiality, these reports are released to the public and become a valuable source of geological information. There are 330 reports describing work in the North Coast planning area. The Ministry has scanned them and they are now available on its website (http://www.em.gov.bc.ca/geology).

## 5.2 Mineral Exploration Permitting

Mineral exploration is conducted in accordance with the Mineral Exploration Code and *Mines Act of B.C.* Prior to conducting any mechanical disturbance of the land, the work program must be approved by the Ministry of Energy and Mines and sufficient reclamation securities set in place to ensure that the site is reclaimed. Work programs are referred to affected agencies and First Nations for comments, that are then taken into consideration when approving (or disallowing) proposed mineral exploration.

Full approval of a work program may also require that permits from other ministries be obtained. For example, where timber will be cut as part of a program, a free use permit or License to Cut is required from the Ministry of Forests. Similarly, for road construction off mineral tenures, a Special Use Permit must be obtained from the Ministry of Forests. Programs involving use of surface water must obtain a water use approval or water license from the Ministry of Water, Land and Air Protection.

Most mineral exploration programs involve minimal disturbance of the land. However, where significant volumes of mineralized rock (i.e. greater than 1000 tonnes) are to be blasted as part of a sampling program, testing for acid rock drainage potential is required. Similarly, though not required by the Ministry of Forests, the Ministry of Energy and Mines will request testing for acid rock drainage where road development requires blasting of mineralized rock.

## 5.3 Mine Development Permitting

Though the tenure for aggregate mining operations is administered by Land and Water BC, the Ministry of Energy and Mines is responsible for regulating mining of aggregate resources whether the mining is conducted by the private sector or government. The only exception is the development of pits and quarries for forestry purposes. These sites are currently regulated by the Ministry of Forests.

With the exception of small operations of sand and gravel, rock quarry, and placer, all mine development is subject to review under either the Mining Development Review Committee or *Environmental Assessment Act*. Both processes are multi-agency reviews, often involving both provincial and federal agencies as well as First Nations and the public. Major mine

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projects are reviewed under the *Environmental Assessment Act* and require the approval of both the Ministry of Energy and Mines and the Ministry of Water, Land and Air Protection. Approval under the Mine Development Review Committee is for smaller operations and is signed off by the Minister of Energy and Mines. For a more complete description of these processes and applicable mine thresholds, please refer to the following websites:

Ministry of Energy and Mines
Permit Application Requirements: http://www.em.gov.bc.ca/Mining/MinePer/permreq.htm.

Environmental Assessment Office: http://www.eao.gov.bc.ca

## 5.4 Access Management

Current management of access for mineral exploration and development has three main objectives:

1) guaranteed access to Crown (and private) land by free miners for exploration and development, outside of protected areas;
2) prediction and mitigation of impacts by project proponents; and,
3) balanced consideration of the benefits and costs of access in the light of environmental, social and economic values.

The *Mineral Tenure Act*, the *Mining Right of Way Act*, and the *Mining Rights Amendment Act* define legal rights of access. The *Mineral Tenure Act* establishes a right of entry, occupation and use of Crown (and private) land outside of protected areas, subject to conditions. The means of access are not specified. Mechanized access (including road construction) to a mineral tenure is regulated by the *Mining Right of Way Act*, the *Mining Rights Amendment Act*, and *the Forest Practices Code of British Columbia Act*. This differs from mechanized access on a mineral tenure, which is regulated by the *Mines Act* and the Mineral Exploration Code.

The *Mining Rights Amendment Act* establishes a link between higher level plans and special use permits issued under the Forest Practices Code. The Act states that a special use permit for the construction of an access to a mineral claim must be issued by the Ministry of Forests, subject to conditions the ministry sets, and any applicable higher level plan. The Act also states that the statutory decision-maker with respect to granting or refusing permission to construct the access is the Chief Inspector of Mines.

Current management strives to ensure that exploration and development activities are conducted in a way that predicts and mitigates impacts on known sensitive values. Impact prediction and mitigation are implemented through legislation, regulation, planning, specific permit conditions, inspections, consultation, and communication.

For further information, the reader is directed to the mineral access section of the ministry website at: http://www.em.gov.bc.ca/Mining/Landuse/CurrentIssues/Access/default.htm

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# 6.0 Issues facing the Mineral Sector

Geological resource development presents unique challenges. The resources themselves are mostly hidden, non-quantifiable (except at enormous cost), and fixed in place. If they are to be developed at all, they must be mined where they are found. Finding new mines requires time, patience, knowledge, and money. International markets drive the search for commodities. Large areas of land and many mineral occurrences need to be evaluated through repeated and expensive exploration campaigns, over a span of years or decades, before a commercially viable mineral deposit is delineated.

In order to sustain the exploration and development process, the mineral sector needs security of tenure, security of access for exploration and development, and certainty with respect to other resource values and land uses that must be addressed in permit approval processes.

Another concern is that overlapping, or competing, land-use designations, objectives, and strategies for non-mining values can result in the inadvertent, "fragmentation" of mineral lands and the perception of land-use uncertainty. This can cause decreased opportunities for sustained, long-term, mineral exploration and development programs, and loss of investment in mineral exploration and development.

# 7.0 Summary

The North Coast area is now one of the least populated and least readily accessible parts of the province. In the late 1800s and early 1900s the population was larger and more dispersed and there was more infrastructure than the present day. The communities of Anyox, Alice Arm and Stewart, along with Juneau in southeastern Alaska, were important mining towns and a significant proportion of the inhabitants of the North Coast owed their living to the minerals industry. Over time, the significance of mining has decreased. This is partly because access costs are high and, in recent years, prospectors have focused most of their attention on the interior of the province. The Coast Mountains are now relatively under-explored. However, the potential for new discovery and development is good.

The terrain in the North Coast is extremely rugged and its population is concentrated in relatively few communities that have played an important role in the development of the resource industries in British Columbia. Prince Rupert, Kitimat, and Stewart, in particular, have road and/or rail links to the interior and provide deep-sea ports that are essential to the running of the mineral economy of the Province.

Prince Rupert has a history of minerals handling and processing and, given its access to both natural gas and transportation, is a logical centre for increased development of a minerals processing industry. This could be based on local or imported raw materials. The current proposals for Ridley Island hint at developments that may take place over the next twenty

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years or so. Similarly, Stewart has had a long history of mining and remains an important load-out centre for the minerals industry. The Silbak Premier mill, near Stewart, is an important strategic asset for the mining industry as mill construction is a major cost in mine development. There may be cost benefits to mining deposits around the coast, shipping the ore to Stewart and processing it through the existing mill.

The relatively isolated and mountainous nature of much of the North Coast is less of a problem for mine development than one might expect. Most of the past-producing mines in the region were "stand-alone" operations that derived considerable benefit from locally generated hydroelectric power and easy access to tidewater. Future mines may share the same benefits.

Although it is impossible to predict what sort of deposits will be found in the area, or when or where they will be located, past discoveries provide some idea as to what we can expect. There appears to be good potential for precious and base metal quartz-*vein* deposits (similar to Porcher Island, Dolly Varden, Torbrit, Porter Idaho, etc.); high-grade *bedded sulphide* lenses (similar to Hidden Creek, Bonanza and Ecstall River, etc.) and *vein-stockwork* deposits (similar to Kitsault and Kim on Bank's Island). The most prospective areas for these deposits are indicated in a general way on the Mineral Potential Maps. They include layered rock remnants, major faults and rocks found around the contacts of small intrusions. It is worth noting that even low-potential granites may be cut by mineralized faults.

The layered rocks found along the coast, at Anyox, near Alice Arm, and along the Ecstall River are particularly important as potential hosts for *bedded sulphide* deposits. The Scotia, Ecstall and Packsack deposits in the Ecstall River area clearly illustrate potential for the sort of deposit that makes Myra Falls, Westmin Boliden's mine at Buttle Lake on Vancouver Island, such an important modern-day mine.

The need for industrial minerals (limestone, garnet, clay, dimension-stone etc.) increases as populations grow and is a growth area within the Provincial economy. There is always going to be a need for high quality, low cost industrial mineral deposits to replace product shipped in from elsewhere. Suitable deposits along the coast should be well placed to meet demand.

New mines will be discovered through exploration, which is an expensive, high-risk process. Future prospectors will benefit from the collective increase in knowledge gained from work carried out by both government and industry and through access to improved technologies, such as remote sensing (LANDSAT, etc.), more sophisticated airborne surveys and more effective ground-based geophysical surveys. Historically, B.C.'s prospectors have always found new mines to replace those that are depleted and have thus sustained the mining industry. Given access to the land, they should continue to do so.

Although it is impossible to predict the location and value of a hidden resource, it is reasonable to expect numerous new mineral showings to be discovered and several deposits to be delineated over the next 10 to 20 years. Some may be economically viable. The types of deposits found and the scope of the developments that will result are unknown but, based on past experience, they may include medium-sized underground operations. It is quite

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possible that some of the proposals discussed in this report (e.g. reactivation of the Silbak Premier mill at Stewart, construction of a small operation at Alice Arm, barge-based processing of coastal deposits etc.) may become economically viable. The environmental impact of a "typical" mine/mill complex would typically be limited to a few hundred hectares within a single valley, a road to the coast and a load out facility. Any such development would be regulated and would benefit the nearest main community, and the province as a whole.

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# Appendix A: Mineral Exploration Techniques and Tools

**Stream Geochemical Surveys**

The soils formed above sub-cropping metallic mineral showing become enriched in metals (copper, lead, zinc, gold, silver etc.) and, as they wash into nearby creeks, they are entrained in the sediment producing geochemical anomalies that are a powerful tool in mineral exploration. Since the 1960s, many exploration companies have carried out regional stream geochemical surveys over prospective areas of the province, however most of these results are proprietary. In 1976, the Provincial Government started its own sampling program. To date, it has released geochemical data covering approximately 70% of the province. The northern part of the North Coast planning area (north of 54 latitude) has been covered and it is clear that known MINFILE occurrences alone do not account for all of the stream sediment anomalies detected. Some of the geochemical data are available on the Ministry's MapPlace website.

# Appendix B: Metallic Mineral Processing

Several stages of processing are generally required to release the metal commodity from a metallic mineral deposit. First the "ore" (containing the commodity of value) has to be removed (i.e. mined) from the ground, then it is transported to a milling facility which separates the mineral (commonly sulphide) containing the metal from the ore. In most cases, ore is crushed to a consistency of sand and passed through a series of tanks and the sulphide is floated off as a scum. The sulfide is then collected, dried and shipped to smelters as "concentrate". At the smelter, the metal and other commodities are removed from the concentrate.

Concurrent with the extraction of metal from a deposit, is the deposition of waste materials produced at each stage of processing. Mining of ore generally requires removing a volume of rock that does not contain ore, which is disposed of as "waste" rock on the mine site. In the milling process, after the sulfide has been removed, the crushed-rock residue is collected in a depression or pond as "tailings". At the smelter, the material remaining after the metal and other commodities have been removed is deposited as "slag".

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