

Exploration and mining in the Southwest Region, British Columbia



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Recommended citation: Northcote, B., 2017. Exploration and mining in the Southwest Region, British Columbia. In: Exploration and Mining in British Columbia, 2016. British Columbia Ministry of Energy and Mines, British Columbia Geological Survey, Information Circular 2017-1, pp. 133-147.

1. Introduction

This report covers the Southwest Region (Fig. 1), conterminous with the South Coast and West Coast natural resource regions. The area has one major polymetallic metal mine, **Myra Falls**, one coal mine, **Quinsam**, and numerous industrial minerals and aggregate operations. Industrial minerals and aggregate operations serving the construction industry have generally continued in steady production. However, both Myra Falls and Quinsam are on care and maintenance. Nyrstar N.V. is in discussions with potential purchasers of Myra Falls Operations. Vitol Group has also been in discussions on the sale of the Quinsam mine. Both companies have curtailed mine site exploration programs and, in the case of Quinsam, regional exploration programs.

Despite the lack of mine site programs there were some positive signs in regional exploration. A few companies were able to do equity financings and planned, or in some cases proceeded with, drill programs. About 25 active exploration projects were tracked; most were small in scale. One significant proposed mine project has progressed to the BC Environmental Assessment review stage: BURNCO Rock Products Ltd.'s large aggregate project, **BURNCO Aggregate**, on Howe Sound.

As a pilot project, the Ministry of Energy and Mines partnered with the Association for Mineral Exploration and Ernst & Young LLP to develop a comprehensive online survey to replace the surveys conducted previously by the Regional Geologists. For the Southwest Region, exploration expenditures are estimated at \$2.0 million and exploration drilling at about 3,800 m (Clarke et al., this volume; Ernst & Young LLP (E&Y), 2017, in press). The new survey excluded aggregate exploration expenditures and is therefore not directly comparable to estimates of previous years for the Southwest Region. However it is clear that expenditures for 2016 are objectively low and do not reflect a level of exploration likely to sustain metal or coal mining should the trend continue. Suspension of exploration at Myra Falls and Quinsam contributed to the unusually low total.

2. Geological overview

Metallogeny in British Columbia is intimately linked to the tectonic evolution of the Canadian Cordillera, first as an accretionary orogen consisting of allochthonous terranes that

were welded to and deformed with the western margin of ancestral North America primarily during the Jurassic and then as the site of post-accretionary tectonism and magmatism (e.g., Nelson et al., 2013).

The Southwest Region includes parts of the Insular and Intermontane tectonic provinces; most of the area is underlain by rocks of the Wrangell terrane and the post-accretionary Coast Plutonic Complex (Fig. 1). Wrangellia is part of the Insular tectonic province, a Paleozoic-Mesozoic allochthonous assemblage that docked with Intermontane terranes in the Early-Middle Jurassic as Panthalassic oceanic crust subducted beneath them (e.g., Nelson et al., 2013). The Intermontane tectonic province is represented by a group of small terranes in the southern Coast Mountains. Subsequent to terrane accretion, a late Jurassic-Cretaceous-Eocene continent-margin arc was established in the area of the present Coast Mountains. Its roots are represented by the Coast Plutonic Complex. During the Early to mid-Cretaceous, southeast-directed oblique convergence brought the Insular terrane and western Coast Plutonic Complex southward with respect to the Intermontane terranes, trapping segments of oceanic crust and arc rocks that became the terranes of the southeastern Coast Mountains, and transecting and duplicating part of the Middle-Late Jurassic arc (Monger et al., 1994; Bustin et al., 2013; Monger and Brown, in press). From the Cretaceous onward, accretion continued outboard of Wrangellia. Cenozoic ridge subduction converted much of the North America-Pacific plate margin to a transform fault (Queen Charlotte fault). Today, the small oceanic Juan de Fuca plate slides eastward beneath the previously accreted terranes of the Outboard tectonic province on Vancouver Island (Pacific Rim, Crescent, and Wrangell, Fig. 1) along the Cascadia subduction zone (e.g., Hyndman, 1995). The principal deposit types in the Southwest Region are tied to Cordilleran terranes (Fig. 2).

2.1. Insular Superterrane

The Insular Superterrane is represented mainly by Wrangellia in the Southwest Region.

2.1.1. Wrangellia

Wrangellia is a long-lived (Devonian to Jurassic) island arc

Fig. 1. Operating mines and selected exploration projects in the Southwest Region, 2016. Terranes from the BC digital geology map (Cui et al., 2015).

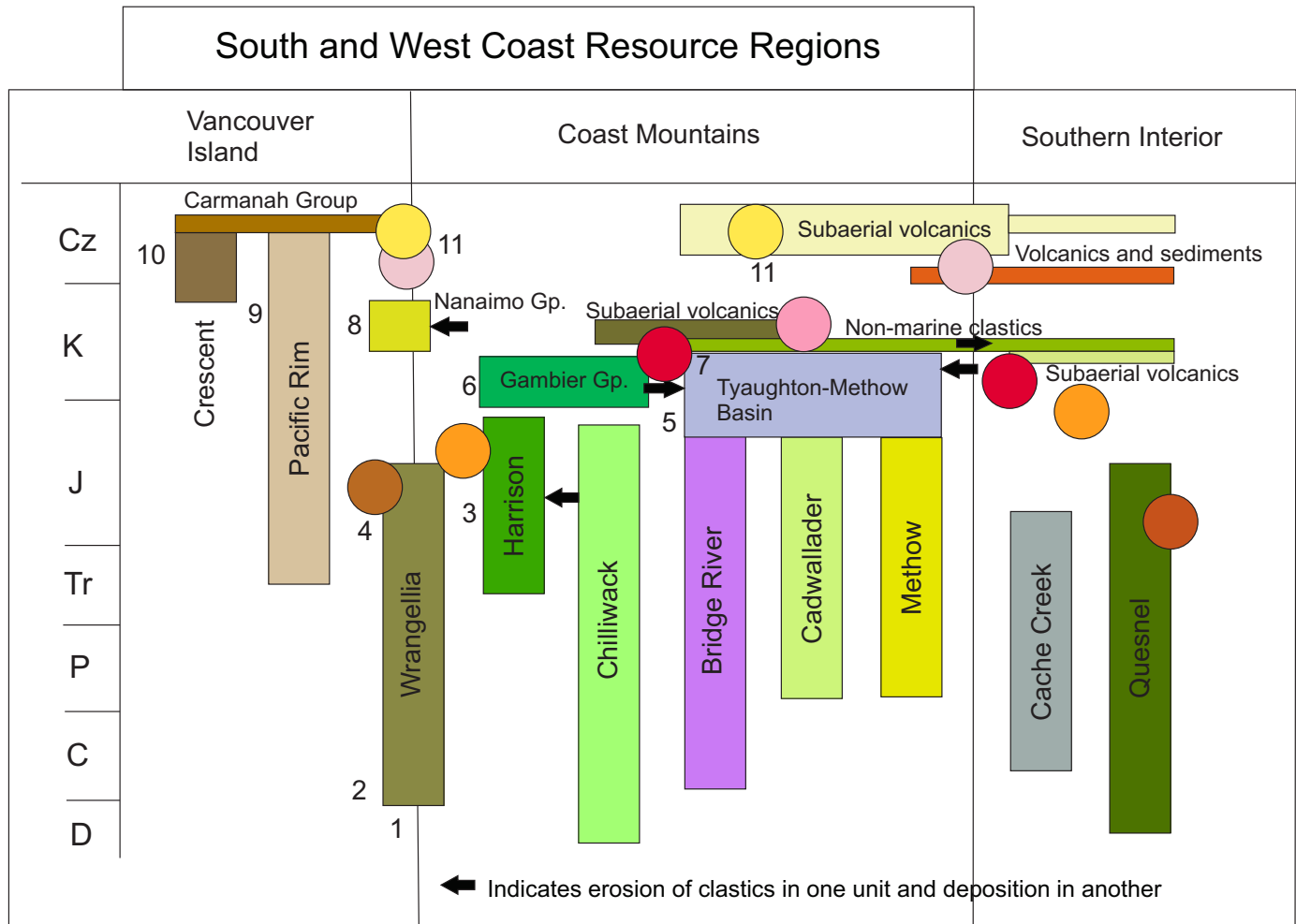


Fig. 2. Time-space diagram showing relations between terranes, basins, plutonic rocks (circles), and some significant mineralizing events on in southwestern British Columbia. 1) Sicker Group volcanogenic massive sulphide; 2) orogenic gold veins in Sicker Group 3) Harrison Formation volcanogenic massive sulphide 4) Island plutonic suite porphyry Cu-Mo, Fe, Cu skarn 5) orogenic Au vein (Coquihalla serpentine belt) 6) Gambier Group volcanogenic massive sulphide 7) tholeiitic intrusion hosted Cu-Ni (Cretaceous) 8) Nanaimo Group coal 9) Orogenic Au veins 10) tholeiitic intrusion hosted Cu-Ni (Eocene?) 11) Porphyry Cu, Mo, Epithermal Au (Eocene to Miocene).

terrane that underlies most of Vancouver Island and Haida Gwaii. The oldest rocks on Vancouver Island are Devonian volcanic arc andesites, basalts, breccias, tuffs and tuffaceous sedimentary rocks of the Sicker Group, and allied intrusive rocks. The Sicker Group is overlain by Mississippian-Permian limestones, argillites, and minor conglomerates of the Buttle Lake Group. This Paleozoic basement is exposed in two major uplifts on southern and central Vancouver Island. The Cowichan Anticlinorium and the Buttle Lake Anticlinorium have particular economic significance as they host past and present volcanogenic massive sulphide polymetallic producers at Mount Sicker (MINFILE 092B 001, 092B 002, 092B 003) and **Myra Falls**, probably emplaced in back-arc settings.

Unconformably overlying the Paleozoic rocks are Middle to Upper Triassic oceanic flood basalts and related sedimentary rocks of the Vancouver Group. The Vancouver Group consists of a thick (up to 6 km) sequence of flood basalts (Karmutsen Formation), and limestones (Quatsino Formation; on Haida

Gwaii, Kunga Formation). The upper part of the Vancouver Group contains numerous skarn occurrences adjacent to Jurassic intrusions (Island Plutonic suite). Iron and iron-copper skarns are particularly abundant. The Tasu past producer (MINFILE 103C 003) on Haida Gwaii is one of the larger examples. Between 1914 and 1983, it produced 12 Mt of iron concentrate as well as copper, gold and silver.

The Vancouver Group is overlain by arc rocks of Bonanza Group (Upper Triassic-Middle Jurassic), which consist of a volcano sedimentary succession (Parson Bay Formation) and Lemare Lake subaerial basal to rhyolitic flows and tuffs (Nixon and Orr, 2007). The Bonanza Group rocks are of economic significance on northern Vancouver Island. North of Holberg Inlet, they host the past-producing Island Copper Cu-Mo-Au porphyry deposit (MINFILE 092L 158) and other undeveloped porphyry and epithermal prospects where the Bonanza Group volcanic rocks are intruded by Island Plutonic suite granodiorite and quartz diorite.

2.2. Outboard tectonic province

On Vancouver Island, the western and southern margins of Wrangellia are structurally juxtaposed with the Pacific Rim terrane, which consists of possible mélangé deposits (Pandora Peak unit, Rusmore and Cowan, 1985; Pacific Rim complex, Brandon, 1989) and the Leech River complex, an assemblage of greenschist- to amphibolite-grade mudstones, sandstones, and mafic volcanic rocks cut by granitic bodies (Groome et al., 2003). Slate and siltstone is quarried for building stone in the Leech River complex. The Leech River complex has been an active placer gold camp since 1864. Gold-bearing quartz veins have been the subject of recent exploration near the Leech River Fault, along the southern margin of the terrane (Fig. 1).

The Crescent terrane represents Eocene accretion of Late Cretaceous or Paleocene to Early Eocene seamounts. The Leech River Fault marks the boundary of Pacific Rim and Crescent terranes. The Metchosin Igneous complex, a partial ophiolite and constituting the northernmost extent of the Coast Range Basalt Province (Massey, 1986), contains three tholeiitic intrusion-hosted past producers of copper and precious metals, the most significant of which was the **Sunro** mine (MINFILE 092C 073).

2.3. Intermontane terranes of the Southeastern Coast Belt

The Southwest Region boundary transects small parts of the Quesnel terrane and a larger area of Stikinia. However, much is covered by parkland and is unavailable for mineral development or is otherwise inaccessible. Exceptions include the Redbird, a molybdenum prospect west of Tweedsmuir Provincial park and east of the Kitlope Heritage Conservancy (MINFILE 093E 026).

The southeastern Coast Belt, north of the international border, is underlain by the Nooksack-Harrison and Chilliwack terranes (equivalent to Stikinia; Monger and Struik, 2006), and the Bridge River, Cadwallader and Methow terranes, which are allied with the main Cache Creek terrane (Fig. 1). These represent slices of oceanic and arc-related rocks enclosed between Intermontane and Insular terranes during Middle Jurassic to Middle Cretaceous regional sinistral faulting (Bustin et al., 2013, Monger and Brown, in press). Historically, these terranes have not been shown to host large deposits, which may explain why the area has not been intensively explored despite its accessibility and proximity to infrastructure. Gambier Group equivalent overlap deposits and parts of the Nooksack-Harrison terrane are prospective for VMS mineralization. The Coquihalla Serpentine belt, along the Hozomeen fault between the Bridge River terrane to the west and the Methow terrane to the east, hosts several gold prospects and five past producers including the Carolin Mine (MINFILE 092HNW007), which operated between 1981 and 1984.

2.4. Post-accretionary intrusions and overlap strata

Post accretionary intrusions include the Coast Plutonic Complex (Jurassic-Cretaceous) and many smaller Eocene-to-Miocene bodies, some of which have associated porphyry

and epithermal mineralization. Upper Cretaceous sedimentary rocks on Vancouver Island host historically important coal deposits, and unconsolidated Quaternary sediments are an important source of construction material.

2.4.1. Coast Plutonic Complex

The Coast Mountain range is underlain by the Coast Plutonic Complex, a large northwest-trending batholith consisting largely of diorite, quartz diorite, tonalite and granodiorite calc-alkaline rocks with less abundant high-grade metamorphic rocks derived from the deep crust of the sutured Intermontane and Insular terranes. For the most part, uplift and erosion appear to have removed the levels at which epithermal and porphyry style mineralization form, however there are exceptions.

At the southern end of the Coast Plutonic Complex, economically important deposits occur in pendants of the Gambier Group, overlapping Late Jurassic to Mid-Cretaceous arc-related volcanic and sedimentary rocks. The most productive of these deposits was the Britannia mine (MINFILE 092GNW003), a Kuroko-type polymetallic volcanogenic massive sulphide deposit that produced 517,000 t of copper along with zinc, silver, gold, lead and cadmium between 1905 and 1974.

The Late Cretaceous Giant Mascot ultramafic-mafic intrusive suite (Manor et al., 2014) hosts the province's only past producing nickel mine, Giant Mascot Nickel (MINFILE 092HSW004, 092HSW093, 092HSW125), which operated between 1958 and 1974.

2.4.2. Nanaimo Group

On the east coast of Vancouver Island, in the Strait of Georgia, and on the western mainland, Wrangellia is buried by rocks of the Nanaimo Group, an Upper Cretaceous continental to marine molassoid succession containing debris derived from unroofing of the Coast Belt and northern Cascades (Mustard, 1994). The Comox Formation, the basal unit of the Nanaimo Group, hosts economically important coal deposits that were mined historically in the Nanaimo area and were recently mined near Campbell River.

2.5. Cenozoic magmatism and volcanism

Eocene to Miocene ancestral Cascades arc magmatism extended as far northward as southwestern British Columbia, as does present day Cascades magmatism. Evidence of forearc Paleocene to Miocene magmatism can be traced from southern Oregon through Alaska. Southwestern British Columbia was an active part of this semi-continuous belt (Madsen et al., 2006). Mineral deposits related to Cenozoic magmatism have not been particularly productive, but neither are they well explored. Between 1964 and 1967, Mount Washington Copper (Eocene; MINFILE 092F 117) produced 3,548 tonnes of copper, 131 kg gold and 7,235 kg silver. Catface Copper (Eocene; MINFILE 092F 120) has a significant undeveloped resource. Other targets of presumed Cenozoic age include Giant Copper (MINFILE 092HSW001) and Okeover (MINFILE 092K 008). Harmony

(MINFILE 103F 034) is a Miocene epithermal deposit with a significant undeveloped gold resource on Graham Island, Haida Gwaii (Fig. 1). More recent Cascades magmatism has produced pumice and other volcanic rocks quarried for construction, landscaping and other applications. The Mount Meager area has also been investigated as a possible source of geothermal energy.

2.6. Post-accretionary faulting

Fraser-Straight Creek is a north-south fault system with at least 100 km right lateral offset in the Eocene. It truncates the Pasayten and Hozameen faults and could be responsible for reactivation of these older structures. Significant prospects along the Coquihalla Gold Belt (MINFILE 092HNW007 and others) and Giant Copper camp (MINFILE 092HSW001 and others) lie on, and immediately east of, the Hozameen fault system. The Late Eocene Chilliwack batholith is not offset by the Fraser-Straight Creek fault (Monger and Brown, in press).

The Harrison Lake fault separates highly deformed and higher metamorphic grade schistose rocks, including Bridge River terrane to the northeast, from rocks of the Harrison-Nooksack terrane to the southwest. Post accretionary activity along the fault includes a series of Tertiary diorite intrusions and gold vein occurrences such as Harrison Gold (MINFILE 092HSW092), Doctor's Point (MINFILE 092HNW071), and Providence (MINFILE 092HNW030).

Vancouver Island is extensively faulted. Among the fault systems are northwest-southeast Eocene thrust faults and folds that bring prospective Sicker Group basement to surface. On northern Vancouver Island, a well-mineralized belt lies north of the westerly trending Holberg fault.

The Queen Charlotte fault is a dextral transform linking the Aleutian and present day Cascadian subduction zones. Eocene magmatism on Vancouver Island (Catface and Mount Washington intrusive suites) may have been products of paleo-Cascade magmatism. A transtensional environment on Haida Gwaii presumably influenced Miocene epithermal mineralization, the most significant example of which is Harmony.

On Northern Vancouver Island, Late Miocene magmatism occurs north of the present Nootka fault, a transform between

Juan de Fuca and Explorer plates.

2.7. Quaternary sediments

As a tectonically active region, southwestern British Columbia has undergone a high degree of uplift and high rates of erosion. Glaciation has influenced the nature of erosion and deposition. The Fraser Glaciation 25,000-12,000 years ago was the last major advance. Most sand and gravel deposits are products of its final, Pleistocene retreat, a period of high-energy erosion and deposition as compared to the Holocene (Clague, 1981; Clague and Luternauer, 1983; Howes, 1983).

Sediments derived from quartz diorite and granodiorite of the Coast Mountains, or volcanic, sedimentary and metasedimentary rocks of Cascades provenance, in clean glaciofluvial deposits, can produce strong, chemically inert, construction material suitable for a variety of applications.

Peat bogs were once exploited for horticultural use in the Fraser delta. Mining of peat on the Fraser Delta ceased in the 1980s due to depletion of the resource.

3. Mines

This section covers significant metal and coals mines that operated in the past year, and selected industrial minerals and aggregate operations. See also Tables 1-3.

3.1. Metal mines

Myra Falls Operations is an underground polymetallic mine, owned and operated by Nyrstar N.V., which exploits a cluster of volcanogenic massive sulphide lenses. Nyrstar suspended mining activities at **Myra Falls Operations** at the beginning of the second quarter 2015. Although the workforce was reduced at that time, work proceeded on restoring and upgrading power facilities and other infrastructure. Mine development planning focussed on the western orebodies with exploration and definition drilling directed at those targets. Generally, exploration was successful, producing high-grade intersections and identifying untested targets.

Late in 2015, Nyrstar halted investment at the mine. The company has not announced specific plans for Myra Falls, but says it has been in discussion with potential buyers. If this does not lead to a sale, there could be exploration at the site to augment reserves in 2017.

Table 1. Metal mines, Southwest Region.

Mine	Operator	Commodity; deposit type; MINFILE	Forecast 2016 Production (based on Q1- Q3)	Reserves (Proven + Probable)	Resource (Measured and Indicated)	Comments
Myra Falls Operations	Nyrstar N.V	Zn, Cu, Pb, Au, Ag; G06: Noranda/Kuroko Massive Sulphide Cu-Pb- Zn; 092F 330, 092F 073	N/A	4.66 Mt 6.91% Zn 0.74% Pb 0.95% Cu 72.5 g/t Ag 1.76 g/t Au	7.49 Mt 6.56% Zn 0.70% Pb 1.01% Cu 69.55 g/t Ag 1.75 g/t Au	Resources are inclusive of reserves. Effective date Dec. 31, 2015. Production suspended April 2015. Reserves decreased compared to 2014, total resources increased with exploration.

Table 2. Coal mines, Southwest Region.

Mine	Operator	Commodity; deposit type; MINFILE	Forecast 2016 Production (based on Q1-Q3)	Reserves (Proven + Probable)	Resource (Measured and Indicated)	Comments
Quinsam	Hillsborough Resources Ltd.	TC; A04: Bituminous coal; 092F 319	N/A	N/A	N/A	On Care and Maintenance. Production suspended Jan. 2016. Reserves and resources are unpublished.

HCC = hard coking coal; PCI = pulverized coal injection; TC = thermal coal; ULV = ultra low volatile

Table 3. Selected Industrial mineral mines and quarries, Southwest Region.

Mine	Operator	Commodity; deposit type; MINFILE	Forecast 2016 Production (based on Q1-Q3)	Reserves (Proven + Probable)	Resource (Measured and Indicated)	Comments
Apple Bay (PEM 100)	Electra Stone Ltd.	Silica+alumina; R12:Volcanic glass-perlite; 092L 150	N/A	N/A	N/A	Continuation of 2015 drilling program to assess resources.
Benson Lake	Benson Lake Carbonates ULC	High brightness carbonate; R09:Limestone; 092L 295	19,000 t	N/A	N/A	New owner 2016. Possible exploration to come.
Blubber Bay	Ash Grove Cement Company	Limestone, dolostone; R09:Limestone; 092F 479	43,240 t +	N/A	100+ years	Dolostone is shipped to Ash Grove in Oregon.
Garibaldi Pumice	Garibaldi Pumice Ltd.	Pumice; R11:volcanic ash; 092JW 039	16,000 m ³	N/A	11,396,000 m ³ pumice 4,990,000 m ³ pumicite (fines)	2014 resource estimate.
Imperial Limestone	Imperial Limestone Co. Ltd.	Limestone; R09:Limestone; 092F 394	250,000 t high grade CaCO ₃ , 317,500 t lower grade limestone	N/A	50+ years	Production to December 2016.
K2	K2 Stone Quarries Inc.	Dimension stone, flagstone; R08:flagstone; 092C 159	20,400 t	N/A	N/A	Material extracted from quarry is cut to size.
Mount Meager Pumice	Great Pacific Pumice Inc.	Pumice; R11:volcanic ash; 092JW 039	1850 t	N/A	N/A	Shipped 5964 t.
Sumas Shale	Sumas Shale Ltd. (Clayburn Industries Ltd., Lafarge Canada Inc.)	Shale, clay, sandstone; B05:Residual kaolin; 092GSE024	500,000 t	N/A	50+ years	Product for cement production.
Texada Quarry	Texada Quarrying Ltd. (Lafarge Canada Inc.)	Limestone, aggregate; R09:Limestone; 092F 395	N/A	N/A	100+ years	Mostly limestone for cement production.

Mining began at the **Myra Falls** site in 1966 and the operation mined its 30 millionth tonne of ore in 2013. Suspensions occurred previously; notably a 16 month suspension in 1993-1994. Since 2006, replacement of reserves and resources occurred at a rate approximately equal to that at which they were mined. In 2014 and 2015, there were after-mining increases to resources (Table 1). The mine employed approximately 350 during production.

The deposits are hosted by the Sicker Group, a Middle Devonian volcano-sedimentary island-arc assemblage that forms basement to Wrangellia beneath much of Vancouver Island (Fig. 1). Ore bodies are in two horizons of the Myra Formation and are generally considered to have formed as Kuroko type, bimodal felsic volcanogenic massive sulphides.

3.2. Coal mines

Underground coal mining on Vancouver Island dates back to 1849. The **Quinsam** thermal coal mine near Campbell River (Fig. 1) began operation in 1986, and suspended mining activity early in 2016, switching to care and maintenance. There have been some discussions with potential buyers, but no sale announced. The site is operated by Quinsam Coal Corporation, a subsidiary of Hillsborough Resources Ltd., which is currently part of the Vitol Group of companies. It is currently the only underground coal mine in the province. The **Quinsam** mine produced from coal seams in the upper part of the Comox Formation, the basal unit of the Nanaimo Group (Late Cretaceous). The mine is capable of producing over half a million tonnes a year. Hillsborough is a private company that does not release reserve and resource figures. The mine has a significant potential resource, however sulphur content varies. Product is blended to meet customers' specifications. Most recently the mine supplied local cement plants. The mine can also serve international markets using a freighter loading facility on Texada Island.

3.3. Industrial minerals and aggregates

Large quarries on the coast serve the Lower Mainland, Vancouver Island, and U.S. Pacific Northwest markets by barge. Those with access to freighter loadout facilities can also supply Pacific international markets and Hawaii. The largest industrial minerals producers in the region are listed in Table 3 (exclusive of aggregate-only quarries) and are discussed in the following sections.

Other smaller producers of slate quarry rocks of the Leech River complex. Van Isle Slate has been offering a line of hand cut products. That quarry had minor production in 2016 and the owner expects to produce again in 2017. Island Stone Landscape Supply is another established producer and supplier of flagstone from the area, as is San Juan Quarries. Matrix Marble and Stone Inc. continues to quarry marble on Vancouver Island and fabricate a line of products including countertops, sinks, tiles, and building products. They quarry Tlupana Blue Grey and Vancouver Island White marble near Hisnit Inlet.

Landscaping stone and dimension stone is quarried in the Squamish-Whistler corridor. The largest operator is Northwest

Landscape and Stone Supply, with the Spumoni quarry and their Cabin Group property, which now has a Mines Act quarry permit. Others active in the area include Bedrock Granite Sales Ltd., Citadel Stone Ltd., and Alpine Natural Stone Ltd.

Haddington Island and Hardy Island (MINFILE 092F 425, 092L 146) have been two regular suppliers of dimension stone on the coast. The Haddington Island product (typically referred to as Haddington Island andesite) is a durable, resistant dacitic volcanic rock (70.5% silica), part of the Alert Bay volcanic belt (Neogene). Haddington Island Stoneworks Ltd. did not quarry in 2016 but expects to supply stone for projects in the Lower Mainland in 2017 or 2018. Most of the product is used in restoration work on historic buildings, but it has also been used in modern monuments and buildings.

Hardy Island Granite Quarries Ltd. produces from a uniform grey Coast Plutonic Complex granodiorite unit. Like Haddington Island, it is an historic quarry that has resumed production in the past 10-15 years, mainly serving the local market. It mined and shipped approximately 2500 t in 2016, a significant increase over 2015. Hardy Island has opened another quarry on Valdes Island that supplies sandstone (Nanaimo Group), another rock type found on many older buildings in Vancouver and Victoria. Response to test marketing appears to be positive; production in 2016 was about 1500 t.

Aggregates are an important part of the mining industry on the south coast, generating more jobs than metal and coal mining. The area hosts some of the largest aggregate pits and quarries in Canada. Most quarries serve local markets, although a few of the largest also export. General sales and production trends follow those of the construction industry. Lafarge North America, Lehigh Hanson Materials Ltd. and a local company, Mainland Sand and Gravel Ltd., are the three largest participants in the Coast Area, although hundreds of pits and quarries produce in the region.

One of the largest aggregate-only mines is the Sechelt Mine, operated by Lehigh Hanson. The company no longer makes production figures public, but volumes have been in the 5 million tonne range in recent years. It is permitted for up to 7.5 Mt per year. A loading facility capable of accommodating Panamax class freighters handles most of the shipments. In addition to the **Texada Quarry**, Lafarge North America operates two of the largest aggregate quarries in the region, **Earle Creek** and **Pitt River** quarries, each of which typically produces more than 1 Mt per year. Production and employment estimates for 2016 reported by Lafarge for their four largest aggregate operation serving the Lower Mainland include: 1.0 Mt and 23 people at **Earle Creek**; 1.1 Mt and 21 people at **Pitt River Quarry**; 1.0 Mt and 17 people at **Central Aggregate**; and 0.9 Mt and 10 people at **Ward Road**. Remediation work continues at Lafarge's **Pipeline Road** site. In total, 4 Mt were produced and 77 people employed at these operations alone.

Near the **Pipeline Road** site are large operations by Jack Cewe Ltd. and Allard Contractors Ltd. Together they produce in excess of one million tonnes per year most years. Cewe also operates a large quarry on Jervis Inlet at Treat Creek. They do

not release yearly production figures.

Polaris Minerals Corporation operates the **Orca** quarry near Port McNeill, which produces sand and gravel mainly for export. Polaris Minerals Corporation reported sales of approximately 2.1 Mt in the first three quarters of 2016 and expects 2.7-2.9 Mt for the year. Polaris reports some initial exploration off site near the quarry for limestone and igneous rock for possible use as crushed products.

One of the largest operations in the area is the **Cox Station** quarry. It is on the north side of Sumas Mountain, and is operated by Mainland Sand and Gravels Ltd. More than 95% of the crushed quartz diorite product goes to the Lower Mainland market via barge on the Fraser River. The quarry also has two CN Rail spur lines, which allow shipment by rail. Production and shipments have recently been 2-3 Mt per year. The quarry employs 45 to 50 people.

3.3.1. Texada (Texada Quarrying Ltd.)

The largest limestone quarry on the coast is the **Texada Quarry** operation near Gillies Bay. Texada Quarrying Ltd. is a subsidiary of Lafarge Canada Inc. A production estimate is not available for 2016. Most of its 2015 production (3.9 Mt) supplied local cement plants. The quarry also produces aggregate, mainly from quartz monzonite to gabbro dikes and sills, which would otherwise be waste rock. The site also hosts a white carbonate quarry, one of only a few sources on the coast. The quarry has been in operation for over 60 years and employs 69 people. The quarry has extensive reserves and, at current rates, is capable of producing for more than 100 years.

3.3.2. Imperial Limestone (Imperial Limestone Co. Ltd.)

The **Imperial Limestone** quarry near Van Anda on Texada Island (Fig. 1) has produced approximately 250,000 to 270,000 t annually and produced approximately 250,000 t of their high-grade carbonate product as of the end of November 2016. In addition they mined a larger quantity of lower quality limestone. Quarrying at the Imperial site dates back to the 1930s, and the current owners have operated it since the early 1950s. They anticipate reserves will last more than 50 years.

3.3.3. Blubber Bay (Ash Grove Cement Company)

Ash Grove Cement Company's **Blubber Bay** limestone quarry on Texada Island has remained mostly on care and maintenance since 2010, after more than 100 years of operation. It reopens for sufficiently large contracts. It can still supply limestone aggregate and continues to supply dolostone to lower Mainland and northwest US markets intermittently. It barged dolostone to Ash Grove's Rivergate Limestone Plant in Oregon in 2016, about 43,240 t as of the end of November, with another shipment planned for December or January.

3.3.4. PEM 100 (Apple Bay) (Electra Stone Ltd.)

On northern Vancouver Island, Electra Stone Ltd. continued to mine silica and alumina products from silicified and clay-altered rhyolitic flows and volcanoclastic rocks at the **PEM**

100 or **Apple Bay** quarry through the first quarter of 2016, but suspended operations thereafter. The site remains on care and maintenance, with ongoing environmental monitoring and a water treatment system upgrade in October 2016. When operating, the quarry ships raw product by barge to Ash Grove Cement Company in Seattle. Ash Grove and Electra conducted mine site exploration programs to better define its resources and to identify higher-silica (>97% SiO₂) material in 2015-2016. The quarry is permitted for up to 249,000 tonnes per year.

3.3.5. Benson Lake (Benson Lake Carbonates ULC)

At the **Benson Lake** white carbonate deposit, also on northern Vancouver Island, new owner Benson Lake Carbonates ULC reported 2016 production totalling approximately 19,000 t. The high-brightness product is used mainly as white filler. The new owner expects to suspend production for 1-2 years and conduct some on-site exploration.

3.3.6. Sumas Shale (Clayburn Industrial Group Ltd.)

The **Sumas Shale** quarry on Sumas Mountain is owned by Clayburn Industrial Group Ltd. and operated by contractor Fraser Pacific Enterprises Inc. It delivers sandstone and shale product to the Lafarge and Lehigh cement plants in Richmond and Ash Grove in Seattle, a joint venture with Lafarge North America (Sumas Shale Ltd.). Production and shipments will be approximately 500,000 t in 2016, up slightly from 2015. Because Clayburn's brick and refractory products plant in Abbotsford closed, fireclay is no longer produced separately.

3.3.7. Bute Inlet (Ironwood Clay Company Inc.)

Ironwood Clay Company Inc. mines glacial marine clay on the central Coast. Until 2015, production had been from the **DeCosmos Lagoon** south of Bella Bella (Fig. 1). They have a new site at the head of **Bute Inlet**, which is likely to supply future raw material. They collected approximately 400 t there in 2015 and expect to return to this site or one of their other sites in 2017-2018. Ironwood produces cosmetic products using the clay at its Richmond plant, a business that has continued for 28 years. Other individuals and companies supply the growing cosmetic clay market at smaller scales from locations on the central Coast and Vancouver Island. Glacial Bay Organic Clay Inc. is extracting material by hand, also near the head of Bute Inlet. They reported increasing sales in 2015, particularly to Asia. Generally, Mines Act permits are not required where material is collected by hand, and therefore some glacial marine clay operations are unreported.

3.3.8. Garibaldi Pumice and Mount Meager Pumice (Garibaldi Pumice Ltd., Great Pacific Pumice Inc.)

In the Mount Meager area, Garibaldi Pumice Ltd. produced 16,000 m³ of pumice from the **Garibaldi Pumice** quarry in 2016, similar to 2015. Production included 11,000 m³ of material for lightweight fill and 5000 m³ of fines. Garibaldi Pumice Ltd. did some exploration in 2015 (test pits and LIDAR) and drone photogrammetry in 2016.

Neighbouring Great Pacific Pumice Inc. produced about 2000 t in 2016 at their **Mount Meager** quarry, and shipped close to 6000 t. They have stockpiles in Squamish from which they can ship year-round.

3.3.9. K2 (K2 Stone)

K2 Stone is a natural stone product supplier with quarries near Port Renfrew on Vancouver Island, (**K2**). In 2014, K2 Stone mined and shipped over 17,000 t from Port Renfrew with a five person crew. They quarried 22,000 t in 2015 and about 20,400 t in 2016. The rock is trucked to Nanaimo for processing into masonry and landscaping products.

3.4. Placer gold

Historic placer camps include the Lower Fraser River, Leech River and China Creek. A gold rush in the Fraser Canyon, which began in 1858 at Hills Bar, was relatively short lived, but did ultimately lead miners farther up the Fraser River into the Chilcotin and Cariboo. In 1864, reports of gold in the Leech River on southern Vancouver Island led to another brief gold rush. Both camps are worked by placer miners to the present day. There was one new Notice of Work on the Leech River in 2016 and another on the Lower Fraser among about five for the region altogether. In 2015, there were two new NOWs in the Leech River camp and two on the Lower Fraser. Many placer miners operate with multi-year permits. Currently 17 permits are active.

4. Mine development

Mine development projects are those for which there is a positive production decision, key government approvals and on-site construction has begun. There are no major mine development projects in the Southwest Region.

5. Proposed mines

Proposed mines are feasibility-stage projects for which proponents have begun the environmental certification process, in the case of large projects, or have submitted applications for Mines Act permits, in the case of projects below British Columbia Environmental Assessment Act thresholds (Table 4). Several small-scale and inactive larger projects are not covered in this report.

5.1. Proposed metal mines

No proposed major metal mines in the Southwest Region are considered to be active projects in 2016.

5.2. Proposed coal mines

No proposed coal mines in the Southwest Region are considered to be active projects. In 2016, the BC Environmental Assessment Office terminated environmental assessment of the Raven Underground Coal Mine project of Compliance Coal Corporation.

5.3. Proposed industrial minerals mines

Proposed mines include the BURNCO Aggregate Project and the **Sechelt Carbonate** project.

5.3.1. BURNCO Aggregate (BURNCO Rock Products Ltd.)

The **BURNCO Aggregate** Project, in the McNab Creek Valley (Fig. 1), submitted its application for Environmental Assessment with both provincial and federal agencies. The Ministry of Energy and Mines new Major Mines Permitting Office will process the Mines Act application. The proposed sand and gravel mine would ramp up to a 1.5 Mt per year operation, initially barging product to BURNCO Rock Products Ltd.'s ready-mix concrete plants in South Burnaby and Port Kells. BURNCO submitted revisions to the project in

Table 4. Selected proposed mines, Southwest Region.

Project	Operator	Commodity; deposit type; MINFILE	Reserves (Proven + Probable)	Resource (Measured and Indicated)	Work Program	Comments
BURNCO Aggregate	BURNCO Rock Products Ltd.	Aggregate; B12: Sand and Gravel; N/A	N/A	Approx. 20 Mt	Permitting	Environmental Assessment Review. Resource not represented as NI 43-101 compliant.
Sechelt Carbonate	Ballinteer Management Inc.	Limestone, dolostone, aggregate; R09: Limestone; R10: dolomite; R15: Crushed rock; 093GNW031	N/A	Carbonate Rock: 76.1 Mt Gabbro: >700 Mt	Baseline monitoring, archaeological studies	Environmental Assessment pre-application. Resource not represented as NI 43-101 compliant.

2014, changing production rate, relocating some facilities and specifying a mine life of 16 years.

5.3.2. Sechelt Carbonate (Ballinteer Management Inc.)

Ballinteer Management Inc. now holds the property comprising the **Sechelt Carbonate** project. They filed engineering, archeological, and baseline environmental studies for assessment in 2016. After a period of quiescence, Ballinteer indicates an interest in advancing the project, which entered the pre-application phase of environmental assessment in 2005 under different ownership. The property contains resources of limestone and dolostone as well as gabbroic rock for potential use as aggregate.

6. Exploration activities and highlights

Exploration projects are categorized as grassroots, early-stage, advanced, or mine evaluation, depending upon the nature of recent work. Work directed at discovering new resources away from ore bodies in an existing mine plan can be considered mine-lease or on-site exploration. The Southwest Region had few large exploration programs in 2016 (Table 5). These and some smaller programs are described briefly.

6.1. Precious metal projects

Precious metal prospects are found in a variety of settings in the region. There was one major exploration project in 2016, in addition to several smaller projects.

6.1.1. Valentine Mountain (Great Thunder Gold Corp.)

Great Thunder Gold Corp. reported gold assays from selected rock samples (162.8 g/t, 2.3 g/t, 37.9 g/t, 13.6 g/t Au) at its **Valentine Mountain** Property on southern Vancouver Island. There was further hand trenching late in the year. The property was last drilled in 2012 and resource estimates were prepared in 2013.

6.1.2. Eliza (Casey Harlinton)

At the **Eliza** gold prospect, owned by Caisey Harlinton, a hand held drilling program tested gold-bearing veins near historical workings. In 1940, 12.7 tonnes of ore yielded 435 grams of gold with silver and copper by products. The area was also explored in the 1980s.

6.1.3. Ashlu (Ashlu Mines Inc.)

Ashlu Mines Inc. is a private company that has assembled a land position near the former Ashlu Mine near Squamish (**Ashlu property**). In 2016, they reported continuing geophysics and geochemistry at the property (MINFILE 092GNW045, 47, 55, 62; MINFILE 092GNW013). A multi-year rock, soil, and silt sampling program has relocated showings near the former mine. The Ashlu Mine is a past producer that exploited a narrow (<1 to 4.6 metres) gold-bearing quartz vein over a strike length of 90 metres and extending 85 metres down dip. In 1981, reserves were just less than 90,000 t of 8.57 g/t Au and 12.31 g/t Ag.

The property is mainly underlain by the Cloudburst pluton (Jurassic).

6.1.4. Harrison Gold (Bear Mountain Gold Mines Ltd.)

Bear Mountain Gold Mines Ltd. proposes a bulk sample at the **Harrison Gold**, or Abo property. The company is seeking a permit for underground development and a bulk sample. Abo has a 1989 (non-compliant) resource in two zones of 1.8 Mt in a “probable resource” category and 613,600 t in a “possible resource” category, with average grades of 2.79 g/t Au. Previous operators took bulk samples in 1972, 1979, and 1985.

6.1.5. Ladner Gold (New Carolin Gold Corp.)

New Carolin Gold Corp. completed its acquisition of the **Ladner Gold** project (Fig. 3) and now holds 100% of the property, including the former Carolin Mine site (subject to percentage of net smelter returns royalty).

Work in 2016 included drilling focused on the Idaho zone (Figs. 3 and 4) and a broader program of mapping and sampling on the property. Before the recent drilling, the company had existing resource estimates intended to represent open pit and



Fig. 3. View of the Ladner Gold project looking north from the Carolin Mine tailings pond. The Idaho zone underlies the mountain with the clearcut area, centre-right.



Fig. 4. Quartz veining intersected at the Idaho Zone. Typical of gold-mineralized intervals intersected in the past.

Table 5. Selected Exploration projects, Southwest Region.

Project	Operator	MINFILE	Commodity; Deposit type	Resource (NI 43-101 compliant unless indicated otherwise)	Work Program	Comments
Apple Bay	Electra Stone Ltd	092L 150	Silica, high alumina clay; R12: volcanic glass	N/A	Drilling (rotary air blast)	Seeking high-silica material.
Ashlu	Ashlu Mines Inc	092GNW013	Au, Ag, Cu; I05: polymetallic Veins	N/A	Geochemistry, geophysics	Ongoing program for past 6 years.
Black Bear	Polaris Materials Corporation	none	Aggregate; R15: Crushed rock	Measured and Indicated: 70 Mt Inferred: 330 Mt	Drilling, (core), surface sampling, testing	Material is basalt for use as crushed aggregate. Located near Orca Quarry.
Bugaboo-Reko	Vancouver Island Iron Ore Corporation	092C 022	Iron, copper; K03: Fe skarn	Inferred: 14 Mt 60% Magnetite	Reporting of 2015 work (geology, geochemistry)	Ownership change.
Eliza	Casey Harlinton	092E 043	Au, Ag, Cu; I06 Cu+/-Ag quartz veins	N/A	Packsack drilling	
Harrison Gold	Bear Mountain Gold Mines Ltd.	092HSW092	Au, Ag; I01: Au quartz veins	Historical (see MINFILE)	Permitting	Consultation, planned bulk sample.
Krof	Mystic Capital Corp.	092HNW070	Cu, Zn, Ag, Au; G04: Besshi massive sulphide Cu-Zn	N/A	Reporting of 2015 work (geology, geochemistry)	
Ladner Gold	New Carolin Gold Corp.	092HNW007, 092HNW003, 092HNW018, 092HSW034	Au, Ag; I01: quartz veins	Inferred 2.6 Mt 3.23 g/t Au (Carolin Mine)	Drilling (~3000 m, 12 holes) Idaho Zone, surface and underground mapping and sampling.	Stated resource before current drill program. There are separate estimates for McMaster Zone and tailings.
Lekcin	Blady, Carlson, Chapman, Paul	092HSW168	Ni, Cu, Co, Pd; M02 : Tholeiitic intrusion-hosted Ni-Cu	N/A	Reporting of 2015 work (geology, geochemistry)	
North Island	Northisle Copper and Gold Inc.	092L 240, 092L 200, 092L 078	Cu, Au, Mo, Re; L04: Porphyry Cu±Mo±Au	Hushamu: Indicated 304 Mt 0.29 g/t Au 0.21% Cu 0.01% Mo Inferred 205.6 Mt 0.26 g/t Au, 0.18% Cu, 0.008% Mo Red Dog: Indicated 23.6 Mt 0.32% Cu, 0.46 g/t Au, 0.007% Mo Inferred 848,000 t 0.23% Cu, 0.33 g/t Au, 0.005% Mo	Drilling to update historical resource at Red Dog. Ongoing preliminary economic assessment.	Hushamu and Red Dog are separate deposits now included in the same project.
OK	Lorraine Copper Corp.	092K 008, 092K 057, 092K 168	Cu, Mo; L04: Porphyry Cu±Mo±Au	Inferred 86.8 Mt 0.31% Cu, 0.014% MoS ₂	Soil geochemistry	Drilling planned pending permitting. Surface work for assessment.

Table 5. Continued.

Rogers Creek	Carube Copper Corp.	092JSE033-38, 092GNE046	Cu, Mo, Ag; L04: Porphyry Cu±Mo±Au	N/A	Geology, geochemistry, geophysics	
Seneca	NSS Resources Inc.	092HSW139, 092HSW165, 092HSW171	Zn, Cu, Pb, Ag, Au; G06: Noranda/Kuroko massive sulphide Cu-Pb-Zn	N/A	Prospecting, geology, geochemistry	Property surrounding the Seneca (MINFILE 092HSW013).
Sunro	New Sunro Copper Ltd.	092C 073	Cu, Au, Ag; M02:Tholeiitic intrusion-hosted Ni-Cu	Historical (see MINFILE)	Physical work	Work to stop mine drainage.
Tahsis	Callache Stone Quarries Inc.	092E 020	Marble; R04: Dimension stone – marble	N/A	Bulk sample	Exploration in the area for additional high-quality marble.
T&S	Cataract Enterprises Ltd.	092F 414	Marble; R04: Dimension stone – marble	N/A	Bulk sample	A new marble quarry. The MINFILE occurrence is a past producer on an adjacent claim.
Valentine Mountain	Great Thunder Gold Corp.	092B 108, 092B 183, 092B 185, 092B 184	Au, Ag; I01: Au quartz veins	Indicated 22,663 t 33.8 g/t (C zone) Indicated 32,100 t 4.1 g/t (B zone)	Hand trenching, sampling	High-grade gold in selected samples.

underground scenarios at the past-producing Carolin Mine:

- Inferred resource at 0.5 g/t cutoff of 12,352,000 t grading 1.53 g/t Au;
- Inferred resource at 2.0 g/t cutoff of 2,589,000 t grading 3.34 g/t Au.

The McMaster zone has an inferred resource of 3,375,000 t grading 0.69 g/t. The Carolin Mine tailings estimate remained unchanged from 2011, with 403,700 t at 1.83 g/t Au in the Indicated category and 84,400 t grading 1.85 g/t in the Inferred category.

Late in the fall, New Carolin began a second phase of their 2016 program, including underground channel sampling and geological mapping.

New Carolin has surrounding tenures covering much of the Coquihalla gold belt, a north-northwest trending series of gold occurrences between Sowaqua and Siwash Creeks that is generally not well explored by modern methods. Veins of economic interest are found in sedimentary and mafic volcanic rocks northeast of the East Hozameen fault and Coquihalla serpentine belt.

6.2. Porphyry (Cu-Au, Cu-Mo, Mo) projects

The region's most advanced porphyry project, the North Island Project, is focused on Jurassic mineralization. Several advanced Eocene to Miocene porphyry copper targets are in southwestern B.C. Two of these, OK and Rogers Creek, saw modest levels of exploration in 2016.

6.2.1. North Island Project, Red Dog and Hushamu (Northisle Copper and Gold Inc.)

Between 1971 and 1994, the Island Copper mine produced 345 Mt with average head grades of 0.41% Cu, 0.017% Mo, and 0.19 g/t Au. Several porphyry copper and epithermal gold targets extend along a 40 km west-northwest trend from Island Copper. **Hushamu** (MINFILE 092L 240), a copper-molybdenum-gold porphyry prospect, is the most advanced with Indicated 304,000,000 t of 0.21% Cu, 0.29 g/t Au, 0.010% Mo, and 0.56 ppm Re and Inferred 205,600,000 t of 0.18% Cu, 0.26 g/t Au, 0.008% Mo and 0.38 ppm Re. An ongoing preliminary economic assessment includes both **Red Dog** and Hushamu.

Northisle Copper and Gold Inc. acquired an option on the Red Dog property, approximately 7.5 km west-northwest of the Hushamu deposit in 2015. In 2016, they drilled (Figs. 5 and 6) to verify a historical resource estimate. At a 0.20% Cu cut off, the updated Red Dog estimate has 23,633,000 t at 0.32% Cu, 0.46 g/t Au and 0.007% Mo in the indicated category and 848,000 t at 0.23% Cu, 0.33 g/t Au and 0.003% Mo inferred. Mineralization remains open on Northisle's tenures to the west. An apparently separate mineralized zone, 400 m east of the Red Dog zone, is cut by post-mineral dikes. Since it was detected as a geochemical anomaly in 1962, Red Dog has seen approximately 9000 m of reported drilling. Hushamu, Hep, Red Dog, and a 2005 discovery (NW Expo) form a roughly 10 km west-northwest trending series of porphyry occurrences. The former Island Copper mine is approximately 30 km east-southeast.



Fig. 5. Mineralized quartz magnetite breccia intersected at Red Dog.



Fig. 6. Strong advanced argillic alteration south of the Red Dog resource area.

6.2.2. OK (Lorraine Copper Corp.)

Lorraine Copper Corp. acquired 100% of the **OK** copper-molybdenum prospect north of Powell River. As they seek a new permit for drilling, 2016 work included a geochemical survey. The North Lake Zone has an Inferred resource of 86.8 million tonnes grading 0.31% Cu and 0.014% Mo). The mineralization is open with untested step-out geophysical and geochemical drill targets.

6.2.3. Rogers Creek (Carube Copper Corp.)

Carube Copper Corp. reports surface geochemistry, geophysics and geological work at its **Rogers Creek** porphyry copper project north of Harrison Lake in 2016. In 2015, an IP survey identified a largely untested chargeability anomaly that may represent a new target, as previous drilling intersected anomalous Cu-Mo-Ag mineralization at the edge of the anomaly.

6.3. Polymetallic base and precious metal projects

Volcanogenic massive sulphide deposits in the southwest saw very limited exploration in 2016. Particular prospective is the Sicker Group on Vancouver Island, which hosts the Myra Falls

deposits and others past producers in the Mount Sicker area.

6.3.1. Seneca (NSS Resources Inc.)

In 2014, NSS Resources Inc. acquired tenures surrounding the Seneca (MINFILE 092HSW013) and Vent (MINFILE 092HSW139) VMS occurrences, last active in 2007. The new land package, the **Seneca** property includes the Fleetwood zone (MINFILE 092HSW165). NSS filed geochemical and prospecting work for assessment in 2016. The Vent and Seneca prospects themselves are now held by Turnagain Resources Inc. The deposits are hosted in volcanic rocks of the Nooksack-Harrison terrane.

6.3.2. Krof (Mystic Capital Corp.)

Early in 2016, Mystic Capital Corp. reported a geochemical survey at the **Krof** project (work occurred late in 2015). Krof is a Besshi-type VMS prospect in Bridge River equivalent rocks. Work in recent years has focused on investigating geophysical and geochemical targets along a north-northwest trend including known mineralization. Krof was drilled by Minnova Inc. in the 1980s and there was a small drill program by Nomad Ventures Inc. in 2010. Mike Blady, Chris Paul, John Chapman and Gerry Carlson are owners of the property.

6.4. Iron, copper and gold skarn projects

Skarn occurrences are numerous in the Wrangell terrane, commonly in Vancouver Group rocks where intruded by the Island Plutonic suite. Very little exploration occurred on these targets in 2016, with the exception of prospecting.

6.4.1. Bugaboo-Reko (Vancouver Island Iron Ore Corporation)

Canadian Dehua International Mines Group Inc. has transferred most of its southern Vancouver Island properties (including **Bugaboo-Reko**) to a new Company, Vancouver Island Iron Ore Corporation. They report no new work but Canadian Dehua filed its 2015 work for assessment.

6.5. Mafic and ultramafic associated projects

Mafic and ultramafic associated deposits are known in the Metchosin Complex on southern Vancouver Island and in mafic-ultramafic assemblages in the Harrison Lake – Hope Area (e.g., Giant Mascot intrusion), which hosted British Columbia's only significant nickel producer. There was little exploration in 2016.

6.5.1. Sunro (New Sunro Copper Ltd.)

New Sunro Copper Ltd., a private company, reported no new technical work, but filed physical work on the New Sunro property, including the **Sunro** past producer. This was part of an ongoing project to stop water flowing from underground workings. Exploration drilling from surface is proposed, but not anticipated in 2016.

Classed as a magmatic deposit (BC deposit model M02 or USGS mafic and ultramafic dike-sill complex related), sulphide

mineralization is reported mainly in shear zones, fractures, and shatter zones in Metchosin basalt, close to gabbroic sills. Some mineralized samples from the site were anomalous in nickel, cobalt and palladium, among other elements, but copper gold and silver are the commodities found in economic concentrations to date. Two orebodies were mined intermittently from 1962 to 1974. Between 1962 and 1978, the mine produced 13,754 t Cu, 203,101 g Au and 2,262,651 g Ag from 1.3 Mt of ore. Exploration has been modest and limited to surface surveys since mining ceased in 1974. The last reported historical resource estimate was in 1973. At that time 1,030,465 t grading 1.47% Cu were in proven and 423,782 t grading 1.33% Cu in probable categories. There are exploration targets in addition to historical ore zones.

6.5.2. Lekcin (Ridgeline Exploration Services Inc.)

In 2016, Ridgeline Exploration Services Inc. reported on 2015 soil and bio-geochemical surveys at the **Lekcin** property. These covered the Big Nic area and a 2014 discovery named the RP showing. Lekcin is adjacent to the Giant Mascot past Ni-Cu producer. Targets at Lekcin are magmatic sulphide Ni-Cu±PGE concentrations similar to those exploited at Giant Mascot. The property is owned by Mike Blady, Chris Paul, John Chapman and Gerry Carlson.

6.6. Industrial minerals and aggregates

Exploration for industrial minerals and aggregates is commonly carried out by individuals and private companies and typically goes unreported. In some cases it remains private as they must compete in limited local markets. More than 600 active quarry and sand and gravel permits are in the region, although not all are currently producing or conducting investigative work.

6.6.1. T&S Mine (Cataract Enterprises Ltd.)

Cataract Enterprises Ltd. is extracting a bulk sample from the **T&S Mine** marble project near Skull Lake on the west coast of Vancouver Island. They truck the product to a plant in Chemainus, currently under construction.

6.6.2. Tahsis (Callache Stone Quarries Inc.)

Callache Stone Quarries Inc. sampled a marble prospect near Tahsis (**Tahsis** quarry) and explored the area for additional high-quality material.

6.6.3. Black Bear (Polaris Materials Corporation)

As noted above, Polaris Materials Corporation conducted exploration at **Black Bear** near its **Orca** sand and gravel quarry for sources of crushed aggregate, and is testing bulk samples.

6.6.4. Apple Bay (Electra Stone Ltd.)

Electra Stone Ltd. continued a drilling and mapping program to define resources at its **Apple Bay** quarry project that began in 2015.

7. Geological research

No new large-scale publicly funded economic geology focused research projects known are in the region in 2016, although some recent British Columbia Geological Survey projects have ongoing components and some student thesis research is ongoing.

7.1. British Columbia Geological Survey

Compilation of Wrangellia terrane bedrock geology on northern Vancouver Island is an ongoing project of the British Columbia Geological Survey. Publications so far include Nixon and Orr (2007), and a series of 1:50,000 geology maps (e.g., Nixon et al., 2011).

In the Nooksack-Harrison terrane, Rukhlov and Ferbey (2015a, b) published findings of a study using the Seneca VMS prospect as a field area to test using lead isotopes in till for mineral exploration. The relatively low-cost high-resolution ICP-MS method they describe is similar to techniques applied to Paleozoic and older targets. This study demonstrates effectiveness with a Jurassic target.

Nixon et al. (2015) and Manor et al. (2014, 2015, 2016) continued to publish results of recent work at the Giant Mascot Ni-Cu-PGE deposit. This work results from collaboration between the British Columbia Geological Survey, the Geological Survey of Canada, and the University of British Columbia in a study of Ni-Cu-PGE mineralization in convergent-margin or supra-subduction-zone tectonic settings. Among the findings is a precise 93 Ma crystallization age for the ultramafic suite that hosts the past-producing deposit, identifying it as the youngest known magmatic Ni-Cu-PGE sulphide deposit.

7.2. Graduate student research.

There are ongoing university-based research projects in the Southwest Region. For example, PhD candidate Brian McNulty is studying the genesis of the Myra Falls deposits with the Centre of Excellence in Ore Deposits (CODES) group at the University of Tasmania.

8. Summary

Although demand for construction materials continues to support industrial minerals and aggregates production and development, coal and metals exploration and production have been curtailed severely over the past three years. There were two major exploration drill programs for metals in the southwest and one reported for aggregate. On and off-lease projects at Myra Falls and Quinsam were suspended.

Acknowledgments

I thank those in industry who generously provided information and access to their properties.

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