

Exploration and mining in the Southwest Region, British Columbia



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1. Introduction

The Southwest Region (Fig. 1) has a long history of mining. This history includes: the use of native copper by First Nations; silver, gold, and coal mining by the mid-19th century; mining of iron in the mid-20th century; and substantial copper production throughout the 20th century. Although mining and exploration for metals continues in the region, most mining is for construction materials, mainly aggregates for local markets with some exports from the largest coastal quarries.

The area has one major polymetallic metal mine, **Myra Falls** (Trafigura Mining Group, Trafigura Group Pte. Ltd.), one coal mine on care and maintenance, **Quinsam** (Quinsam Coal Corporation), and numerous industrial minerals and aggregate operations. Having been on care and maintenance since 2015, Nyrstar prepared to return **Myra Falls** to production in 2017 and produced some concentrate in 2018. Operations were suspended in 2018 for compliance reasons but restarted in April 2019 and continued through 2021. The **Quinsam** mine, on care and maintenance since 2016, had returned to production in 2017, after being purchased by ERP Compliant Fuels LLC, and produced about 200,000 t in 2018. However, the mine was placed on care and maintenance again in May 2019 and remained so through 2021.

Mine site exploration at **Myra Falls**, which began late in 2017, continued in 2018 through 2021. Privateer Gold Ltd. continued a significant exploration program at Zeballos, as did Northisle Copper and Gold Inc. on northern Vancouver Island. More than 30 other exploration projects were tracked, mainly grass roots or early stage and small scale.

Estimates for exploration expenditures, drilling programs, and other metrics were captured in the British Columbia Mineral and Coal Exploration Survey, a joint initiative of the Province of British Columbia Ministry of Energy, Mines and Low Carbon Innovation, the Association for Mineral Exploration in British Columbia, and EY LLP. For the Southwest Region, exploration expenditures were estimated at \$8.0 million and exploration drilling was estimated at approximately 40,400 m (Clarke et al., 2022; EY LLP, 2022).

2. Geological overview

Metallogeny in British Columbia is closely 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, Coast, and Intermontane physiographic regions. Most of the area is underlain by rocks of the Wrangell terrane and the Coast Plutonic complex (Fig. 1). Wrangellia is a Devonian to Jurassic island arc 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 sediments of the Sicker Group and allied intrusive rocks, which are overlain by Mississippian-Permian limestones, argillites, and minor conglomerate 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 host the past volcanogenic massive sulphide polymetallic producer at Mount Sicker and the current mine at **Myra Falls**.

Unconformably overlying the Paleozoic rocks are Middle to Upper Triassic oceanic flood basalts and related sedimentary rocks of the Vancouver Group. The upper part of the Vancouver Group contains numerous skarn occurrences adjacent to Jurassic intrusions (Island Plutonic suite). The Tasu past producer on Haida Gwaii is one of the larger examples of numerous iron and iron-copper skarns. 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 and subaerial basalt to rhyolitic flows and tuffs (Nixon and Orr, 2007). The Bonanza Group north of Holberg Inlet host the past-producing Island Copper Cu-Mo-Au porphyry deposit and other undeveloped porphyry and epithermal prospects where they are intruded by Island Plutonic suite granodiorite and quartz diorite.

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.

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 calcalkaline rocks with less abundant high-grade metamorphic rocks. For the most part, uplift and erosion have removed the levels at which epithermal and porphyry-style mineralization form, with some 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, 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. At the southeastern edge of the Coast ranges, the Giant Mascot ultramafic-mafic intrusive suite (Late Cretaceous, Manor et al., 2014, 2015, 2016, 2017) hosts the province's only past-producing nickel mine, Giant Mascot Nickel, which operated between 1958 and 1974.

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 (Madsen et al., 2006). Mount Washington Copper (Eocene) produced 3548 t of copper, 131 kg gold and 7235 kg silver. Catface Copper (Eocene) has a significant undeveloped resource. Other presumably Cenozoic targets include **Giant Copper** and **Okeover Harmony**, on Graham Island, Haida Gwaii (Fig. 1) is a Miocene epithermal deposit with a significant undeveloped gold resource. Some recent exploration targets Neogene mineralization along a magmatic belt between the Brooks Peninsula and Alert Bay on northern Vancouver Island (Nixon et al., 2011a, b; 2020).

Quaternary 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.

On Vancouver Island, the western and southern margins of Wrangellia are structurally juxtaposed with the Pacific Rim terrane, which consists of possible mélangé deposits (Rusmore and Cowan, 1985; 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 are quarried for building stone in the Leech River complex. The Leech River has been an active placer gold camp since 1864. Gold 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 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.

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, 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, 2016). Gambier Group-equivalent overlap deposits and parts of the Nooksack-Harrison terrane are prospective for VMS mineralization. The Coquihalla Serpentine belt, along the Hozameen 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, which operated between 1981 and 1984.

Tectonic uplift, erosion, and glaciation produced sand and gravel deposits important to the construction and transportation industries of the Lower Mainland. Most are products of the most recent retreat of the Cordilleran Ice Sheet in the Pleistocene (e.g., Howes, 1983; Clague and Ward, 2011).

3. Mines

The Southwest Region has one metal mine, one coal mine placed on care and maintenance in 2019 and numerous industrial minerals and aggregate operations (Fig. 1; Tables 1-3). Of eight large-scale industrial minerals operations in the region, two entered care and maintenance in 2016 and remained so in 2021. Aggregate operations in the region number in the 100s and only the most prominent (e.g., those producing at least 1 Mtpy) are reported here.

3.1. Metal mines

3.1.1. Myra Falls Operations (Trafigura Mining Group)

Trafigura Mining Group, part of Trafigura Group Pte. Ltd. acquired the **Myra Falls** underground Zn-Cu-Pb-Ag-Au mine in 2020 from Nyrstar N.V. Trafigura is a private multinational commodity trading company and is not required to publish compliant production or reserves figures. However, they reported continuing to ramp up to a target throughput of 800,000 tpy of ore and estimate the operation has 10 years of reserves (Table 1). After re-starting following infrastructure upgrades and closing again for compliance reasons in 2018, the mine reopened in April 2019 and continued operation through 2021. The mine has a history of replacing reserves through

Table 1. Metal mines, Southwest Region.

Mine	Operator (partner)	Commodity; deposit type; MINFILE	Forecast 2021 Production (based on Q1- Q3)	Reserves (December 31, 2018)	Resources (December 31, 2018)	Comments
Myra Falls	Trafigura Group Pte. Ltd. (Trafigura Mining Group)	Zn, Cu, Pb, Ag, Au; Noranda/Kuroko massive sulphide; 092F 330, 71, 72, 73	Not reported. Mill capacity 2000 tpd. Long term target 800,000 tpy of ore	P+Pr: 4.7 Mt 7.11% Zn, 0.78% Pb, 0.92% Cu, 76.55 g/t Ag, 1.78 g/t Au	M+I: 7.64 Mt 6.59% Zn, 0.72% Pb, 0.99% Cu, 72.52 g/t Ag, 1.79 g/t Au	Resumed production in April 2019, continued to ramp up 2020-21. Continuing multi-year underground drilling.

P = Proven; Pr = Probable; M = Measured; I = Indicated; Inf = Inferred

Table 2. Coal mines, Southwest Region.

Mine	Operator (partner)	Commodity; deposit type; MINFILE	Forecast 2021 Production (based on Q1- Q3)	Reserves	Resources	Comments
Quinsam	Quinsam Coal Corporation (receiver Bowra Group Inc.)	TC; Bituminous coal; 092F 319	nil	Not reported	Unofficial, non-compliant resources estimated at 40 Mt in 2013 by mine staff.	Placed on care and maintenance May 2019. Property and assets offered for sale. No sale reported with exception of stockpiled coal.

HCC = hard coking coal; PCI = pulverized coal injection; TC = thermal coal;
P = Proven; Pr = Probable; M = Measured; I = Indicated; Inf = Inferred

Table 3. Selected industrial mineral and aggregate mines and quarries, Southwest Region.

Mine	Operator (partner)	Commodity; deposit type; MINFILE	Forecast 2021 Production (based on Q1- Q3)	Reserves	Resources	Comments
Blubber Bay	CRH Canada Group Inc.	Limestone, dolostone; Limestone; 092F 479		na	100+ years	Opens for contracts.
Bute Inlet	Ironwood Clay Company Inc.	Clay; Sedimentary kaolin? (or illite)	na	na	na	Intermittent mining as needed.
Cabin Group	Northwest Landscape and Stone Supply Ltd.	Landscaping stone	na	na	na	
Cox Station	Mainland Construction Materials ULC	Aggregate; Crushed rock; 092GSE103	Approx. 3-4 Mtpy	na	na	
CTCT	Vancouver Island Marble Quarries Ltd.	Marble; Limestone; 092E 020	Typically, about 400 t annually	na	na	Supplies Matrix Marble and Stone Inc.
Earle Creek	Lafarge Canada Inc.	Sand and Gravel	Typically, >1 Mtpy	na	na	

Table 3. Continued.

Garibaldi Pumice (Vulcan/Salal)	Garibaldi Pumice Ltd.	Pumice; Volcanic ash; 092JW 039	Typically 10,000-20,000 m ³	na	11,396,000 m ³ pumice 4,990,000 m ³ pumicite (fines)	2014 resource. Additional exploration 2015, 2018, 2019.
Haddington Island	Adera Natural Stone Supply Ltd.	Dimension stone, Building stone; 092L 146	na	na	na	Not active every year.
Hardy Island	Hardy Island Granite Quarries Ltd.	Dimension stone, Building stone; Dimension stone-granite; 092F 425	3000-5000 tpy	na	Approx. 100,000 t	
Imperial Limestone	Imperial Limestone Co. Ltd.	Limestone; Limestone; 092F 394	Approx. 600,000 tpy	na	75 years	250,000 to 275,000 t high purity product + cement feedstock.
K2	K2 Stone Quarries Inc.	Dimension stone, flagstone; Flagstone; 092C 159	15,000-20,000 t annually	na	na	Production number represents material extracted.
Mount Meager Pumice	Great Pacific Pumice Inc.	Pumice; Volcanic ash; 092JW 039	na	na	na	
Orca	Polaris Minerals Corporation (US Concrete Inc. and 'Namgis First Nation)	Sand and Gravel	Up to 6 Mtpy	na	na	Planning increased production, targeting up to 8.5 Mtpy.
Pipeline Road (2)	Lehigh Hanson Materials Ltd., Allard Contractors Ltd.	Sand and Gravel	na	na	na	Two adjacent operating sites.
Pitt River	Lafarge Canada Inc.	Aggregate; Crushed rock; 092GSE007	Typically, >1 Mtpy	na	na	
Sechelt	Lehigh Hanson Materials Limited	Sand and Gravel	Typically, 5-6 Mtpy	na	Several decades	
Spumoni	Northwest Landscape and Stone Supply Ltd.	Flagstone; Flagstone; 092GNW100	na	na	na	Seasonal quarry.
Sumas Shale	Sumas Shale Ltd. (Lafarge Canada Inc., Clayburn Industrial Group)	Shale, clay, sandstone; Residual kaolin; 092GSE024	About 500,000 t annually	na	50+ years	Approximately 55% shale, 45% sandstone for cement production.
Texada Quarry	Texada Quarrying Ltd. (Lafarge Canada Inc.)	Limestone, aggregate; Limestone; 092F 395	Typically, approx. 3.5 to 4.5 Mtpy	na	100+ years	Mostly produces limestone for cement manufacture.

Table 3. Continued.

Treat Creek	Lehigh Hanson Materials Limited	Aggregate; Crushed rock	Approx. 500 ktpy	na	na
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P = Proven; Pr = Probable; M = Measured; I = Indicated; Inf = Inferred

exploration, which continued in 2021 with significant drilling. The Myra Falls camp hosts Kuroko-type, or bimodal felsic type Zn-Cu- Pb-Ag-Au VMS deposits from which more than 30 Mt of ore have been mined since 1966.

3.2. Coal mines

3.2.1. Quinsam (Quinsam Coal Corporation, Bowra Group Inc.)

Quinsam is an underground mine that began commercial production of thermal coal in 1988 (Table 2). At its peak, it produced approximately 1 Mt clean coal annually. It ceased operation and entered care and maintenance in early 2016. It was then purchased by ERP Compliant Fuels LLC in 2017 and operated by Quinsam Coal Corporation until 2019. In 2018, its last full year of operation, it produced about 200,000 t and employed 50 people.

Quinsam placed the mine on care and maintenance at the end of May 2019. The company subsequently made an assignment into bankruptcy. The receiver and manager Bowra Group Inc. offered the property and assets for sale in 2020. As of the end of 2021 they had not reported a sale, except that of the existing mined coal inventory. One conditional offer for the mine was ultimately rejected. Neither the receiver nor the Province of British Columbia support further marketing efforts. Reclamation is a long-term option for the property. Reclamation liability is estimated at \$12.4 million.

3.3. Industrial minerals and aggregates

Large quarries on the coast (Table 3) serve the Lower Mainland, Vancouver Island, and U.S. Pacific northwest markets by barge. Those with access to freighter loadout facilities can also supply eastern Pacific international markets and Hawaii. Aggregates are an important part of the mining industry on the south coast, generating many more jobs in the region than metal and coal mining. The area hosts some of the largest aggregate pits and quarries in Canada. Most quarries serve local markets. General sales and production trends follow those of the construction industry. Lafarge North America Inc., Lehigh Hanson Materials Ltd., U.S. Concrete, Inc. and a local company, Mainland Sand and Gravel Ltd., are the 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 5-6 Mt range in recent years. It is permitted for up to 7.5 Mtpy. They expect reserves to last several more decades. 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**) each of which typically produces more than 1 Mtpy.

Pipeline Road is the site of large operations by Lehigh Hanson Materials Ltd. and Allard Contractors Ltd. Together they produce more than 1 Mtpy. Lehigh Hanson also has a large crushed aggregate operation at **Treat Creek** on Jervis Inlet.

Polaris Minerals Corporation, a subsidiary of U.S. Concrete Inc. operates the **Orca** quarry near Port McNeill, in partnership with the ‘Namgis First Nation, which holds a 12% interest. The owner-operator partnership is Orca Sand and Gravel LP. The quarry produces sand and gravel mainly for export to California. The operation was originally permitted for up to 6 Mtpy, but Polaris plans to increase production to 8.5 Mtpy in 2021-23. In 2017, Polaris applied to the British Columbia Environmental Assessment Office for an amendment to its Orca project certificate to allow for producing aggregate at a site approximately 4 km from current operations. The new site was previously known as the **Black Bear** project. This site was to supply 250,000 tpy of a crushed basalt product, but in 2020 Polaris revised the proposal to 3-4 Mtpy.

The **Cox Station** quarry, on the north side of Sumas Mountain, is operated by Mainland Sand and Gravel 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 on about 3-4 Mtpy.

Small operations produce building stone on Vancouver Island. Island Stone Landscape Supply is a producer and supplier of flagstone, as is San Juan Quarries. Vancouver Island Marble Quarries Ltd. continues to quarry marble on Vancouver Island and fabricate a line of products including countertops, sinks, and tiles at Matrix Marble and Stone Inc. They quarry marbles referred to as ‘Tlupana Blue Grey’ and ‘Vancouver Island White’ near Hisnit Inlet (**CTCT** quarry). Pacific West Stone Inc. also has a quarry permit near Tahsis and a quarry at the Leo D’Or site at Bonanza Lake.

Landscaping stone and dimension stone is quarried in the Squamish-Whistler corridor. The largest operator is Northwest Landscape and Stone Supply Ltd., 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** have been two regular sources of dimension stone. The Haddington Island product (typically referred to as Haddington Island andesite) is a durable, resistant dacitic volcanic rock, part of the Alert Bay volcanic belt (Neogene). Adera Natural Stone Supply Ltd. supplies the Haddington Island andesite as needed. Most of the product is used for restoration work on historic buildings, but it has also been used in modern monuments and buildings.

Hardy Island Granite Quarries Ltd. produces up to 5000 tpy from a Coast Plutonic complex granodiorite unit. Like Haddington Island, it is an historic quarry that mainly serves the local market. Hardy Island has opened another quarry on Valdes Island that supplies sandstone from the Nanaimo Group, another rock type common to many older buildings in Vancouver and Victoria.

3.3.1. Blubber Bay Quarry (CRH Canada Group Inc.)

The **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 periodically at an average annual rate of about 50,000 tpy.

3.3.2. Bute Inlet (Ironwood Clay Company Inc.)

Ironwood Clay Company Inc. mines glacial marine clay on the central coast. Until 2015, production was from the De Cosmos Lagoon south of Bella Bella (Fig. 1). The company has a site at the head of **Bute Inlet**, which is active and likely to supply future raw material. Mining is intermittent. Ironwood produces cosmetic products using the clay at its Richmond plant, a business that has continued for 30 years. Glacial Bay Organic Clay Inc. also extracts material by hand near the head of Bute Inlet. Other individuals and companies supply the growing cosmetic clay market at smaller scales from locations on the central coast and Vancouver Island. Generally, Mines Act permits are not required where material is collected by hand, and these glacial marine clay operations are unreported.

3.3.3. Garibaldi Pumice and Mount Meager Pumice (Garibaldi Pumice Ltd.; Great Pacific Pumice Inc.)

In the Mount Meager area, Garibaldi Pumice Ltd. produces 15,000-20,000 m³ of pumice annually from their quarry (**Vulcan/Salal**). Neighbouring Great Pacific Pumice Inc. has been producing smaller quantities but have stockpiles in Squamish from which they can ship year-round.

3.3.4. Imperial Limestone (Imperial Limestone Co.)

In recent years, the **Imperial Limestone** quarry near Van Anda on Texada Island (Fig. 1) has produced approximately 250,000 to 275,000 tpy of high-purity product, most of which is shipped to their parent company in Seattle. Imperial Limestone Co. also mine and stockpile a larger quantity of lower quality limestone that goes to local cement plants. Quarrying at the

Imperial site dates to the 1930s. The company anticipate reserves will last about 75 years.

3.3.5. K2 (K2 Stone Quarries Inc.)

K2 Stone is a natural stone product supplier with a quarry near Port Renfrew on Vancouver Island (**K2**). They extract about 15,000-20,000 t annually. The rock is trucked to Nanaimo for processing into masonry and landscaping products.

3.3.6. Sumas Shale (Sumas Shale Ltd.)

The **Sumas Shale** quarry of Sumas Shale Ltd., operated by contractor Fraser Pacific Enterprises Inc., delivers sandstone and shale product to the Lafarge and Lehigh cement plants in Richmond and Ash Grove in Seattle. Sumas Shale Ltd is 50% owned by Lafarge Canada Inc. and 50% by Clayburn Industrial Group. Production and shipments have been approximately 500,000 tpy in recent years. Mining plans include an average 475,000 tpy of approximately 55% shale and 45% sandstone. Because Clayburn's brick and refractory products plant in Abbotsford closed, fire clay is no longer produced separately.

3.3.7. 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. 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, which has operated for more than 60 years, has extensive reserves and, at current rates, could produce for more than 100 years. They produce about 3.5 to 4.5 Mt annually.

4. Placer gold

Historic placer camps include the Lower Fraser River, Leech River, and China Creek. Although short lived, a gold rush in the Fraser Canyon, beginning in 1858 at Hills Bar, led 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. The Lillooet River was also on a historic route to the Cariboo. It also remains an active placer camp.

5. Mine development

Mine development projects are those for which a decision to produce has been made, key government approvals are in place, and on-site construction has begun. The Southwest Region has no such large-scale projects.

6. 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). The

Southwest Region has three such projects (Table 4); several small-scale and inactive larger projects are not covered in this report.

6.1. Proposed metal mines

The Southwest Region had no proposed major metal mine projects active in 2021.

6.2. Proposed coal mines

The region has no active proposed coal mine projects.

6.3. Selected proposed industrial minerals mines

Proposed mines include the **BURNCO Aggregate** Project and the **Sechelt Carbonate** project, which has been inactive apart from a request by the owner to remain in the provincial environmental assessment process. The **Black Bear** aggregate project near Port McNeill was the subject of an application to amend the **Orca** Environmental Certificate. This was withdrawn with a request for review under new legislation.

6.3.1. Black Bear and Orca (Polaris Materials Corporation)

As noted above, Polaris Materials Corporation included the **Black Bear** project near its **Orca** sand and gravel quarry in an Environmental Certificate amendment for Orca. If the project proceeds, it will be a source of up to 3-4 Mtpy of crushed basalt, an increase over the 250,000 tpy proposed in a 2017 project description. Mine life would be extended from 10 to 20 years. This application was withdrawn with a request by the proponent to re-apply under the 2018 Environmental Assessment Act.

6.3.2. BURNCO Aggregate (BURNCO Rock Products Ltd.)

The **BURNCO Aggregate** project in the McNab Creek Valley (Fig. 1) received environmental certification in 2018 and may proceed with British Columbia Mines Act and other

permitting. Certifications are valid for 5 years. Fisheries and Oceans Canada concluded that the project is unlikely to cause significant environmental harm. The proposed sand and gravel mine would ramp up to a 1.6 Mtpy 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 2014, changing production rate, relocating some facilities, and specifying a mine life of 16 years.

6.3.3. 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; activity was not reported for 2017-2021. The property contains resources of calcite- and dolomite bearing carbonate rock and gabbroic rock for potential use as aggregate. The original proposal was for a 4-6 tpy carbonate quarry producing both limestone and dolostone. Product was to be shipped from a barge load out on Sechelt Inlet.

7. Exploration activities and highlights

Exploration projects are categorized as grassroots, early stage, advanced, and 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 2021 (Table 5).

7.1. Selected precious metal projects

Precious metal prospects are found in a variety of settings in the region. There was one major exploration project in 2021, in addition to several smaller projects.

Table 4. Selected proposed mines or quarries, Southwest Region.

Project	Operator (partner)	Commodity; deposit type; MINFILE	Reserves	Resources	Comments
Black Bear and Orca	Polaris Materials Corporation (US Concrete, Inc. and 'Namgis First Nation)	Aggregate; na	na	20 years (proposed life)	Orca environmental certificate amendment application withdrawn. Proposed 250,000 tpy near the Orca quarry revised to 3-4 Mtpy. Indicate intention to re-apply under 2018 Act.
BURNCO Aggregate	BURNCO Rock Products Ltd.	Aggregate; Sand and Gravel; na	na	Approx. 20 Mt	Has environmental certification, would require Mines Act and other permits.
Sechelt Carbonate	Ballinteer Management Inc.	Limestone, dolostone, aggregate; Limestone, dolomite, crushed rock; 093GNW031	na	Carbonate Rock: 76.1 Mt Gabbro: >700 Mt	Proponent requests project remain in environmental assessment pre- application stage.

P = Proven; Pr = Probable; M = Measured; I = Indicated; Inf = Inferred

Table 5. Selected exploration projects, Southwest Region.

Project	Operator (partner)	Commodity; deposit type; MINFILE	Resources (NI 43- 101 compliant unless indicated otherwise)	Comments
Big Frank	Goldplay Mining Inc.	Cu, Au, Mo, Ag; Porphyry Cu±Mo±Au; 092N 051, 29, 28	na	Reconnaissance soil (165) and rock (114) sampling.
Brandywine	Bayhorse Silver Inc., Turnagain Resources Inc.	Ag, Au, Pb, Zn; Polymetallic veins; 092JW 001, 21, 22	na	Permitting, technical report.
Caledonia	Surge Battery Metals Inc.	Cu, Ag, Zn, Pb; Pb-Zn skarn, Polymetallic manto; 092L 061, 209	na	Geochemistry, technical report.
Dot-Apex	Mineral Hill Industries Ltd.	Au, Ag; Au-quartz veins; 092ISW064, 90, 79	na	Geology, rock and soil geochemistry, VLF-EM.
Empire Mine	Coast Copper Corp.	Au, Ag, Cu, Fe, Co; Fe skarn, Cu skarn; 092L 044, 45, 46	M+I: 960,000 t 2 g/t Au, 5.6 g/t Ag, 0.34% Cu, 0.013% Co Inf: 120,000 t 1.2 g/t Au, 2.8 g/t Ag, 0.13% Cu, 0.008% Co	Rock, soil and silt geochemistry, IP surveys, drilling (2346 m, 19 holes).
Fandora	Imperial Metals Corporation	Au, Ag; Au quartz veins; 092F 041	na	Magnetometer, VLF and lidar surveys.
Gold Standard	Juggernaut Exploration Ltd.	Au, Ag; Au quartz veins	na	Drilling 11 holes, 1203 m. Grab sample 34.6 g/t Au, 149 g/t Ag.
Goldstar	Juggernaut Exploration Ltd.	Au, Ag; Au quartz veins	na	Drilling 5 holes, 285 m. Highlight 5.5 m grading 10.8 g/t Au, 260.8 g/t Ag.
Gold Valley	Privateer Gold Ltd.	Au, Ag; Au-quartz veins; 092L 008, 311, 155	na	Drilling 4474 m in 14 holes.
Harrison Gold	Bear Mountain Gold Mines Ltd.	Au, Ag; Au quartz veins; 092HSW092	Historical I: 1.845 Mt 2.79 g/t Au Inf: 0.6 Mt 2.8 g/t Au	Geology, surveying, access, drilling 8 holes, 460 m.
Ladner Gold	Talisker Resources Ltd.	Au, Ag; Au quartz veins; 092HNW003, 7, 18, 092HSW034	Carolin Inf: 12,352,124 t 1.53 g/t Au McMaster Inf: 3,575,000 t 0.69 g/t Au Tailings I: 445,378 t 1.83 g/t Au Inf: 93,304 t 1.85 g/t Au	Late 2020 metallurgical testing of tailings. Project acquired by Talisker Resources in 2021.

Table 5. Continued.

North Island	Northisle Copper and Gold Inc.	Cu, Au, Mo, Re; Porphyry Cu±Mo±Au; 092L 185, 240, 200	I: 527,344,000 t 0.20% Cu, 0.24 g/t Au, 0.008% Mo, 0.31 ppm Re Inf: 417,272,000 t 0.15% Cu, 0.18 g/t Au, 0.006% Mo, 0.29 ppm Re	Drilling at 4 sites (18 holes, 9293 m as of mid December.), IP and ground magnetic surveys, geological and clay analysis mapping, soil surveys.
North Island Copper	Questcorp Mining Inc.	Cu, Ag, Au, magnetite; Cu and Fe skarn; 092L 318, 315, 159, 113	na	Geology, geochemistry, drone magnetic survey.
Scarlett	New Target Mining Corp.	Au; Au, polymetallic veins	na	Rock and soil geochemistry, portable drilling, drone magnetic survey.
Teeta Creek	Teck Resources Limited, ArcWest Exploration Inc.	Cu, Mo, Au; Porphyry Cu±Mo±Au; 092L 454, 235	na	Drilling, 2 holes, 1116 m. Reconnaissance mapping and rock sampling on neighbouring NVI property.

M = Measured; I = Indicated; Inf = Inferred

7.1.1. Dot-Apex (Mineral Hill Industries Ltd.)

Mineral Hill Industries has an option to acquire an interest in the **Dot-Apex** and **Master-ACE** properties. Initial work at Dot-Apex included geological, rock and soil geochemical, and VLF-EM surveys. They reported elevated gold in initial samples and commissioned a technical report that recommended additional work conditional on results. Targets include orogenic gold veins and possible intrusion-related gold.

7.1.2. Fandora (Imperial Metals Corporation)

Imperial Metals reported magnetometer, VLF and lidar surveys at the **Fandora** property in 2021. The property had minor (972 t) production in the 1960s and has a historical resource of about 180,000 t grading 10.3 g/t in quartz calcite veins.

7.1.3. Gold Standard (Juggernaut Exploration Ltd.)

Juggernaut drilled 1203 m in 11 shallow holes to test the Goldzilla Hinge zone at the **Gold Standard** project, a section of the Goldzilla vein. Drilling highlights included 6.5 m grading 2.1 g/t Au and 7.6 g/t Ag. Surface grab samples ranged up to 34.6 g/t Au and 149 g/t Ag.

7.1.4. Goldstar (Juggernaut Exploration Ltd.)

Juggernaut drilled 285 m in 5 shallow holes testing the Goldilocks zone at the **Goldstar** project. All five holes intersected gold mineralization; a highlight included 5.5 m grading 10.8 g/t Au and 260.8 g/t Ag.

7.1.5. Gold Valley (Privateer Gold Ltd.)

Privateer Gold continued to drill its Zeballos area project, formerly the New Privateer project, now called **Gold Valley**. As a private company operating on Crown granted claims, they have no obligation to make public details of their work

or results, but the company maintains a web page with contact information. The target is vein mineralization like that mined historically. Privateer Gold holds a land position including Crown grants covering the Privateer mine and other past producers in the historic Zeballos gold camp.

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

Bear Mountain reported geological work, surface and underground surveying, and drilling (460 m, 8 holes) at **Harrison Gold**. An historical (1989) resource estimate has 1.845 Mt grading 2.79 g/t Au in the indicated category and 0.6 Mt grading 2.8 g/t Au in the inferred category.

7.1.7. Ladner Gold (Talisker Resources Ltd.)

Talisker Resources acquired New Carolin Gold Corp., owner and operator of the **Ladner Gold** project, which includes the past-producing Carolin mine. Late 2020 metallurgical tests on Carolin mine tailings indicated that a gold concentrate could be produced using conventional flotation by regrinding. Apart from plans for 2022, the company reported no new work on the project in 2021.

7.1.8. Scarlett (New Target Mining Corp.)

New Target Mining conducted rock and soil geochemical sampling, including portable drilling, and a drone-supported magnetic survey on the **Scarlett** property. Targets on this grassroots-stage property include porphyry and vein mineralization.

7.2. Selected porphyry projects

Jurassic porphyry mineralization is a target on Vancouver Island. Southwestern British Columbia also has several advanced Eocene to Miocene porphyry copper targets.

7.2.1. Big Frank (Goldplay Mining Inc.)

Goldplay reported initial rock and soil sampling at its recently acquired **Big Frank** property. The property covers several porphyry Cu-Mo and vein occurrences that have seen little recent exploration. They carried out similar initial work on their Goldstorm South property to the east.

7.2.2. North Island (NorthIsle Copper and Gold Inc.)

NorthIsle Copper and Gold's **North Island** property covers an approximately 50 by 8 km block extending west-northwest from the past-producing Island Copper porphyry deposit. Within this area are several porphyry Cu-Au-Mo targets, four of which were drilled in 2021. The most developed targets are the Hushamu and Red Dog deposits, for which there are resource estimates (Table 5) and a Preliminary Economic Assessment. The North West Expo and Pemberton Hills areas were also drilled. In addition, the company reported work at Goodspeed and South Mackintosh targets. Surface work included geologic mapping, mapping of clays using TerraSpec infrared spectroscopy, soil geochemistry, and IP and ground magnetic surveys. Work was continuing as of mid December 2021. An update to the PEA prepared before the 2021 exploration considers a 75,000 tpd, 22-year, two open-pit operation with life of mine average yearly production of 95.9 million lbs Cu and 99.9 koz Au.

7.2.3. Teeta Creek (Teck Resources Limited)

Teck Resources drilled two holes for a total of 1116 m at the **Teeta Creek** project, a Neogene porphyry occurrence. Highlights included 2.4 m grading 1.27 g/t Au, 3.35 m grading 47.2 g/t Ag, and 1.09 m grading 1.047% Cu. The holes intersected quartz-sericite-pyrite alteration. Teck also carried out reconnaissance mapping and sampling on the adjacent NVI project. Teck relinquished its option and its interest returned to ArcWest Exploration Inc.

7.3. Selected polymetallic base and precious metal projects

7.3.1. Brandywine (Bayhorse Silver Inc. 80%; Turnagain Resources Inc. 20%)

Bayhorse Silver Inc. continues to await final permitting for a planned drilling and geophysical program at the **Brandywine** project. In 2021 they commissioned a technical report on the property which recommended a VTEM survey and drilling. Brandywine has vein targets and precious metals-enriched massive sulphide targets.

7.4. Selected skarn projects

7.4.1. Caledonia (Surge Battery Metals Inc.)

Surge Battery Metals carried out soil, silt, moss mat, and rock sampling and commissioned a technical report on the **Caledonia** property. They reported a 3 km Cu skarn trend. Cu-Zn-Pb-Ag skarn mineralization occurs at contacts between Vancouver Group rocks (Quatsino Formation and Karmutsen Formation) with granodiorites of the Island Plutonic suite.

7.4.2. Empire Mine (Coast Copper Corp.)

Coast Copper Corp. completed rock, soil, and silt geochemistry, and extended IP surveys at the **Empire Mine** Cu-Au-Fe skarn property. Drilling (2346 m, 19 holes) late in the year tested targets at the Merry Widow pit, Copper Knob, Raven pit, North Notch and the Benson Lake Mine-Old Sport horizon. The property hosts iron-copper-gold-cobalt skarn mineralization where mafic Island Plutonic suite rocks intrude Vancouver Group Quatsino Formation limestone. Several of these skarns were mined for iron, copper, silver and gold from the late 1950s to early 1970s.

7.4.3. North Island Copper (Questcorp Mining Inc.)

Questcorp Mining, a new, currently private company, conducted geological mapping sampling and a drone magnetic survey on the **North Island Copper** property, which hosts several Cu-Fe skarn occurrences in Vancouver Group rocks intruded by Island Plutonic suite quartz diorite to granodiorite.

8. Geological research

Rukhlov et al. (2021, 2022) continued to test measurement of gaseous elemental mercury as an exploration tool with new surveys at the Lara-Coronation polymetallic volcanogenic massive sulphide occurrence on southern Vancouver Island. They confirmed that direct and continuous measurements in near-surface air using a portable device can map sediment-covered mineralization in real time and that gaseous elemental mercury sampling is a simple and effective technique for mineral exploration in overburden-covered areas. Alberts et al. (2021) used U-Pb and Hf analyses of detrital zircons to investigate the early evolution of southern Wrangellia, documenting a previously unrecognized Mississippian magmatic event, and Isava et al. (2021) conducted an $^{40}\text{Ar}/^{39}\text{Ar}$ geochronologic study of detrital K-feldspar from Nanaimo Group rocks (Cretaceous) on Vancouver Island and the Gulf Islands to establish provenance and constrain the denudation history of the Coast Mountain batholith. Cecil et al. (2021) used zircon Hf and O isotopes together with whole rock and mineral geochemistry to model spatial and temporal flare ups of Coast Plutonic complex magmatism. Morris and Canil (2021) used whole rock geochemistry and oxygen isotope analyses to examine the extent of magmatic skarn, which resulted from assimilation of Ca-rich wallrock in magma, at the Merry Widow deposit on northern Vancouver Island. Grasby et al. (2021) reported on the geothermal resource potential of the Garibaldi volcanic belt, an area of Quaternary volcanism in southwestern British Columbia.

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