

# 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 metal and coal continue in the region, most mining is for construction materials, mainly aggregates for local markets.

The area has one major polymetallic metal mine, **Myra Falls** (Nyrstar N.V.), one coal mine, **Quinsam** (ERP Compliant Fuels LLC), 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. 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.

Mine site exploration at **Myra Falls**, which began late in 2017, continued in 2018 and 2019. **Surespan Gold** and **Pemberton Hills** saw significant exploration programs, and more than 30 other exploration projects were tracked, mainly grass roots or early stage and small scale. There were signs of interest in northern Vancouver Island where mineral tenure coverage increased during the year.

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 Petroleum Resources, the Association for Mineral Exploration in British Columbia, and EY LLP. For the Southwest Region, exploration expenditures were estimated at \$4.9 million and exploration drilling was estimated at approximately 24,700 m (Clarke et al., 2020; EY LLP, 2020).

The total area under mineral, placer, and coal tenure in the region increased about 9% between October 2018 and November 2019 to 624,000 ha; the most notable increase was on northern Vancouver Island.

## 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

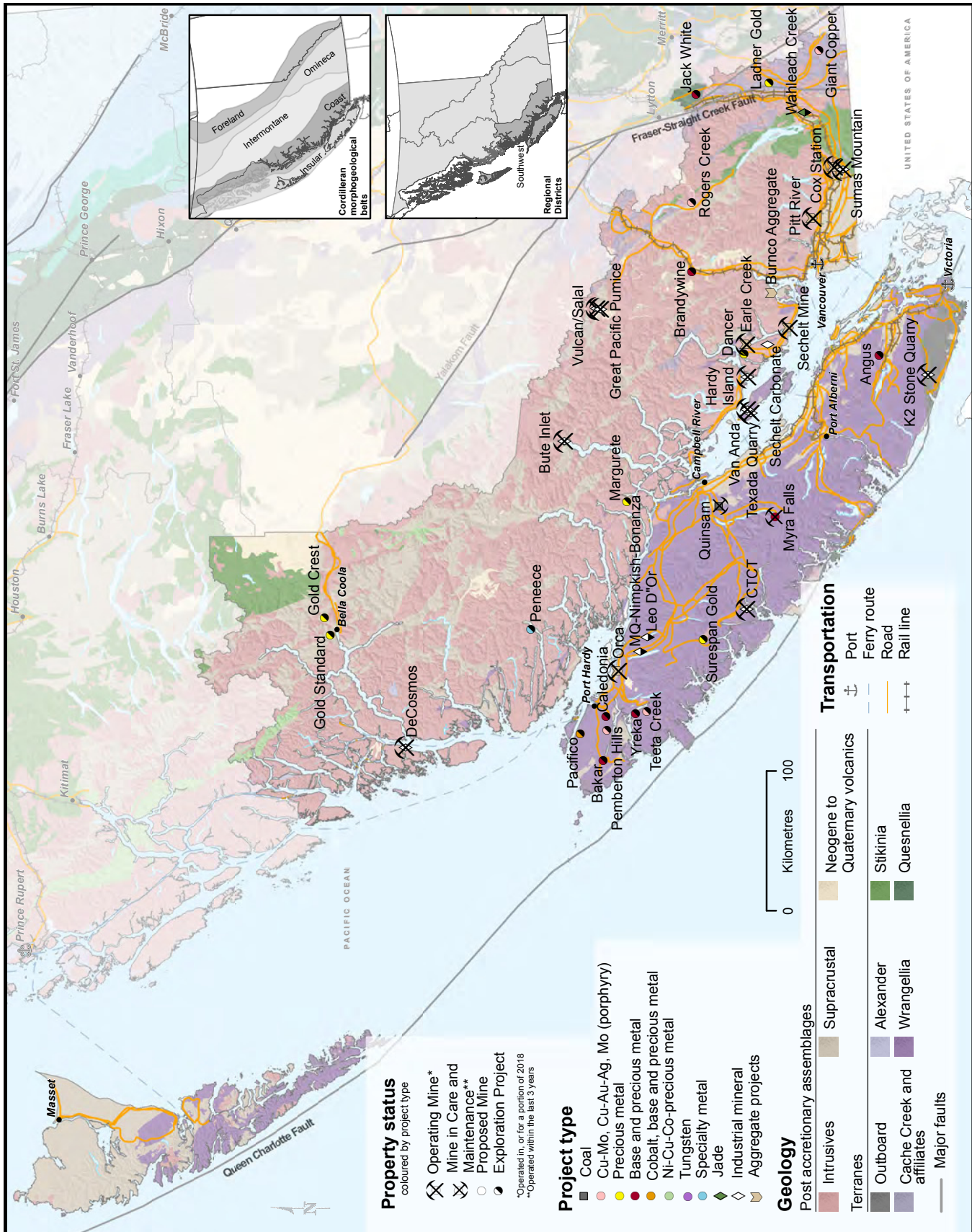


Fig. 1. Mines, proposed mines, and selected exploration projects, Southwest Region, 2019. Terranes from Nelson et al. (2013).

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. 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.

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 2019. Aggregate operations in the region number in the hundreds and only the most prominent (e.g., those producing at least one million tpy) are reported here.

#### 3.1. Metal mines

##### 3.1.1. Myra Falls Operations (Nyrstar N.V.)

Nyrstar N.V. owns and operates the **Myra Falls** underground Zn-Cu-Pb-Ag-Au mine through a 100% owned subsidiary, Nyrstar Myra Falls Ltd. Trafigura Group Pte. owned 98% of parent Nyrstar after a restructuring arrangement in July 2019 and is negotiating to purchase the remaining 2%. Trafigura is a private company and not required to publish a production forecast for the year. After closing for compliance reasons in 2018, the mine reopened in April 2019 with a reported production of 1000 t Zn, 800 t Cu, 216,000 oz Ag and 1000 oz Au in concentrate in the first half. The company anticipated first shipments toward the end of 2019. The mine has a history of replacing reserves through exploration, and mine site exploration continued in 2019 with underground 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.

**Table 1.** Metal mines, Southwest Region.

Mine	Operator (partner)	Commodity; deposit type; MINFILE	Forecast 2019 Production (based on Q1-Q3)	Reserves (December 31, 2018)	Resource (December 31, 2018)	Comments
<b>Myra Falls</b>	<b>Nyrstar Myra Falls Ltd.</b>	Zn, Cu, Pb, Ag, Au; G06:Noranda/Kuroko massive sulphide; 092F 330, 71, 72, 73	Not reported	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	Production suspended for compliance reasons end of 2018. Restarted April 2019.  Underground exploration continued with 17,000 m drilling in 198 holes.

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

**Table 2.** Coal mines, Southwest Region.

Mine	Operator (partner)	Commodity; deposit type; MINFILE	Forecast 2019 Production (based on Q1-Q3)	Reserves	Resource	Comments
<b>Quinsam</b>	<b>Quinsam Coal Corporation (ERP Compliant Fuels LLC)</b>	TC; A04:Bituminous coal; 092F 319	Not reported	Not reported	Not reported. Unofficial, non-compliant resources estimated at 40 Mt in 2013 by mine staff.	Placed on care and maintenance May 2019 and operator filed for bankruptcy in July. Produced about 200,000 t in 2018, the last full year of production.

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

### 3.2. Coal mines

#### 3.2.1. Quinsam (ERP Compliant Fuels LLC)

**Quinsam** is an underground coal mine that began commercial production of thermal coal in 1988. 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 approximately 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. are taking enquiries about sales of the company's assets.

#### 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 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 Mt per year. 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

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

Mine	Operator (partner)	Commodity; deposit type; MINFILE	Forecast 2019 Production (based on Q1-Q3)	Reserves	Resource	Comments
<b>Apple Bay (PEM 100)</b>	<b>Linceo Media Group Inc.</b>	Silica+alumina; R12:Volcanic glass-perlite; 092L 150	na	na	na	Care and maintenance 2019.
<b>Benson Lake</b>	<b>Benson Lake Carbonates ULC</b>	High brightness carbonate; R09:Limestone; 092L 295	na	na	na	Care and maintenance 2019.
<b>Blubber Bay</b>	<b>Ash Grove Cement Company</b>	Limestone, dolostone; R09:Limestone; 092F 479	Up to 50,000 t dolostone annually	na	100+ years	Care and maintenance, most of 2019. Continues to ship dolomite on contract.
<b>Bute Inlet</b>	<b>Ironwood Clay Company Inc.</b>	Clay; E07:Sedimentary kaolin? (or illite)	na	na	na	Not active 2019. Glacial Bay Organic Clay Inc. extracts clay by hand nearby.
<b>Cabin Group</b>	<b>Northwest Landscape and Stone Supply Ltd.</b>	Landscaping stone	na	na	na	
<b>Cox Station</b>	<b>Mainland Construction Materials</b>	Aggregate; R15:Crushed rock; 092GSE103	Typically 2-3 Mtpy	na	na	
<b>CTCT</b>	<b>Vancouver Island Marble Quarries Ltd.</b>	Marble; R09:Limestone; 092E 020	Typically about 400 t annually	na	na	Supplies Matrix Marble and Stone Inc.
<b>De Cosmos Lagoon</b>	<b>Ironwood Clay Company Inc.</b>	Clay; E07:Sedimentary kaolin? (and/or illite); 092M 019	na	na	na	No production reported for 2019.
<b>Earle Creek</b>	<b>Lafarge Canada Inc.</b>	B12:Sand and Gravel	Typically >1 Mtpy	na	na	
<b>Garibaldi Pumice (Vulcan/ Salal)</b>	<b>Garibaldi Pumice Ltd.</b>	Pumice; R11:Volcanic ash; 092JW 039	Approx. 20,000 m <sup>3</sup> annually	na	11,396,000 m <sup>3</sup> pumice 4,990,000 m <sup>3</sup> pumicite (fines)	2014 resource. Additional exploration 2015, 2018, 2019.
<b>Haddington Island</b>	<b>Adera Natural Stone Supply Ltd.</b>	Dimension stone, Building stone; 092L 146	na	na	na	Not active every year.
<b>Hardy Island</b>	<b>Hardy Island Granite Quarries Ltd.</b>	Dimension stone, Building stone; R03:Dimension stone-granite; 092F 425	na	na	na	
<b>Imperial Limestone</b>	<b>Imperial Limestone Co. Ltd.</b>	Limestone; R09:Limestone; 092F 394	Approx. 250,000 t annually	na	50+ years	Production number is their high-quality product. Resource estimated at roughly 200 Mt.

Table 3. Continued.

<b>K2</b>	<b>K2 Stone Quarries Inc.</b>	Dimension stone, flagstone; R08:Flagstone; 092C 159	15,000-20,000 t annually	na	na	Number represents material extracted.
<b>Mount Meager Pumice</b>	<b>Great Pacific Pumice Inc.</b>	Pumice; R11:Volcanic ash; 092JW 039	na	na	na	
<b>Orca</b>	<b>Polaris Minerals Corporation</b>	B12:Sand and Gravel	Up to 6 Mtpy	P+Pr: 121.6 Mt (2005)	M+I: 134.1 Mt (2005)	Subsidiary of U.S. Concrete Inc. Exports to USA.
<b>Pipeline Road (2)</b>	<b>Jack Cewe Ltd. and Allard Contractors Ltd.</b>	B12:Sand and Gravel	na	na	na	Two adjacent operating sites.
<b>Pitt River</b>	<b>Lafarge Canada Inc.</b>	Aggregate; R15:Crushed rock; 092GSE007	Typically >1 Mtpy	na	na	
<b>Sechelt</b>	<b>Lehigh Hanson Materials Limited</b>	B12:Sand and Gravel	Typically 5-6 Mtpy	na	Several decades	
<b>Spumoni</b>	<b>Northwest Landscape and Stone Supply Ltd.</b>	Flagstone; R08:Flagstone; 092GNW100	na	na	na	Seasonal quarry.
<b>Sumas Shale</b>	<b>Sumas Shale Ltd. (Lafarge Canada Inc., Clayburn Industrial Group)</b>	Shale, clay, sandstone; B05:Residual kaolin; 092GSE024	About 500,000 t annually	na	50+ years	Approximately 55% shale, 45% sandstone for cement production.
<b>Tahsis</b>	<b>Pacific West Stone Inc.</b>	Marble; R09:Limestone; 092E 020	na	na	na	Previous owner obtained a quarry permit for Tahsis, but new owner proposed marble production from Leo D'Or site (bulk sample).
<b>Texada Quarry</b>	<b>Texada Quarrying Ltd. (Lafarge Canada Inc.)</b>	Limestone, aggregate; R09:Limestone; 092F 395	na	na	100+ years	Mostly produces limestone for cement manufacture. High brightness carbonate and aggregates also produced.
<b>Treat Creek</b>	<b>Lehigh Hanson Materials Limited</b>	Aggregate; R15:Crushed rock	na	na	na	Formerly a Jack Cewe operation, now Lehigh Hanson.

operates two of the largest aggregate quarries in the region (**Earle Creek** and **Pitt River**) each of which typically produces more than 1 Mt per year.

**Pipeline Road** is the site of large operations by Jack Cewe Ltd. and Allard Contractors Ltd. Together they produce more than 1 Mt most years. Cewe also operated a large quarry on Jervis Inlet at **Treat Creek** which is now operated by Lehigh Hanson Materials Limited They do not release yearly production figures.

Polaris Minerals Corporation, a subsidiary of U.S. Concrete Inc. operates the **Orca** quarry near Port McNeill, which produces sand and gravel mainly for export. The operation is currently permitted for up to 6 Mt per year, but the operator is proposing an increase. Polaris has 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

would supply up to 250,000 tpy of a crushed basalt product.

The **Cox Station** quarry, on the north side of Sumas Mountain, 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 Mtpy. The quarry employs 45-50 people.

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 proposed 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 (70.5% silica), 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 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 that can be found on many older buildings in Vancouver and Victoria.

### 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. 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, is capable of producing for more than 100 years. They produce about 3.5 Mt annually.

### 3.3.2. 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 300,000 tpy of high-purity product, most of which

is shipped to their parent company in Seattle. They also mine and stockpile a larger quantity of lower quality limestone. Quarrying at the Imperial site dates to the 1930s, and the current owners have operated it since the early 1950s. They anticipate reserves will last for more than 50 years.

### 3.3.3. Blubber Bay Quarry (Ash Grove Cement Company)

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 dolomite. It has a contract for 150,000 t and plans 75,000 tpy this year and next.

### 3.3.4. PEM 100 (Linco Media Group LLC)

On northern Vancouver Island, the new operator of the **PEM 100** or Apple Bay quarry, Linco Media Group LLC, left the site on care and maintenance, but with environmental monitoring ongoing. When operating, the quarry ships silica and alumina products from silicified and clay-altered rhyolitic flows and volcanoclastic rocks. The new operator is proposing exploration and a higher production rate, pending discussions with the lease holder.

### 3.3.5. Benson Lake (Benson Lake Carbonates ULC)

At the **Benson Lake** white carbonate deposit on northern Vancouver Island, new owner Benson Lake Carbonates ULC reported 2016 production totalling approximately 19,000 t. The quarry has been on care and maintenance since 2017.

### 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. 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 new site at the head of Bute Inlet, which is 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. 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. 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. produces 15,000-20,000 m<sup>3</sup> of pumice annually from their quarry (Vulcan/Salal). Exploration on the property consisted of 14 test pits to further delineate the existing resource (Table 3). Neighbouring Great Pacific Pumice Inc. has been producing smaller quantities but have stockpiles in Squamish from which they can ship year-round.

### 3.3.9. 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.

## 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 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 2019.

### 6.2. Proposed coal mines

In 2016, the BC Environmental Assessment Office terminated environmental assessment of the Raven Underground Coal mine project of Compliance Coal Corporation, and the region now 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 is the subject of an application to amend the Orca environmental certificate.

### 6.3.1. BURNCO Aggregate (BURNCO Rock Products Ltd.)

The **BURNCO Aggregate** Project in the McNab Creek Valley (Fig. 1) now has environmental certification and may proceed with British Columbia Mines Act and other permitting. 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.

### 6.3.2. 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; activity was not reported for 2017-2019. The property contains resources of calcite- and dolomite bearing carbonate rock and gabbroic rock for potential use as aggregate.

### 6.3.3. Black Bear (Polaris Materials Corporation)

As noted above, Polaris Materials Corporation is including **Black Bear** 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 250,000 tpy of crushed basalt.

## 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 2019 (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 2019, in addition to several smaller projects.

#### 7.1.1. Surespan Gold (Privateer Gold Ltd.)

Privateer Gold Ltd. drilled at **Surespan** in the Zeballos gold camp, completing about 4400 m in 18 holes by the end of 2019. Some published intersections are consistent with narrow gold vein mineralization like that mined historically in the Zeballos Camp and include: 1386.5 g/t Au across 0.3 m in the recently discovered 88 vein; 5.81 g/t Au across 7.12 m in a 50 m step



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

Project	Operator (partner)	Commodity; deposit type; MINFILE	Reserves	Resource	Comments
<b>Black Bear</b>	<b>Polaris Materials Corporation</b> (Parent co. US Concrete, Inc.)	Aggregate; R15; na	na	na	Orca environmental certificate amendment Application Information Requirements approved for proposed 250,000 tpy near the Orca quarry.
<b>BURNCO Aggregate</b>	<b>BURNCO Rock Products Ltd.</b>	Aggregate; B12:Sand and Gravel; na	na	Approx. 20 Mt	Has environmental certification.
<b>Sechelt Carbonate</b>	<b>Ballinteer Management Inc.</b>	Limestone, dolostone, aggregate; R09:Limestone; R10:Dolomite; R15:Crushed rock; 093GNW031	na	Carbonate Rock: 76.1 Mt Gabbro: >700 Mt	Proponent requests project remain in environmental assessment pre-application stage.

out from the Prident mine; and 24.20 g/t Au across 0.55 m in an 80 m step out from the White Star mine. Privateer is a private company working mainly on Crown-granted mineral claims and is not obligated to release results. They acquired additional mineral Crown grants (Central Zeballos property) from CanAlaska Uranium Ltd.

#### 7.1.2. Ladner Gold (New Carolin Gold Corp.)

At the **Ladner Gold** project, New Carolin Gold Corp. completed 850 m of underground drilling in two holes in the footprint of the Carolin Mine. They will await results before proceeding. The fall program also included surface mapping and rock and soil sampling to generate near-surface targets.

#### 7.1.3. Hewitt Point, Margurete (Academy Metals Inc.)

Academy Metals Inc. (formerly Unity Metals Corp.) explored several contiguous properties adjacent to the Phillips Arm gold camp, including **Margurete** and **Hewitt Point**. Packsack drill and outcrop samples produced several results of greater than 10 g/t Au. Packsack drill results included a 2 m core sample grading 6.18 g/t Au and 8.1 g/t Ag and a 0.38 m sample grading 8.62 g/t Au and 3.8 g/t Ag. The area has been intermittently explored for gold-bearing quartz veins since the late 19th century. The Doratha Morton mine produced 4627 oz Au and 10,736 oz Ag, mostly in 1898-99 with minor production in 1925 and 1934. The area is underlain mainly by Coast Plutonic complex diorite to granodiorite with some volcanic rocks, hypabyssal intrusive rocks, and sedimentary and metamorphic rocks near intrusive contacts.

#### 7.1.4. Gold Standard (DSM Syndicate)

DSM Syndicate returned to its gold vein discovery at **Gold**

**Standard**. Channel samples graded 5.86 g/t Au and 14.18 g/t Ag across 12 m, including 5 m of 12.66 g/t Au and 30.20 g/t Ag. They describe mineralization as orogenic quartz vein and shear hosted. Juggernaut Exploration Ltd., a partner in the DSM Syndicate, has agreed on an option deal to earn 100% interest in the property.

#### 7.1.5. Gold Crest (DSM Syndicate)

Juggernaut Exploration Ltd. also reported discovery of a VMS target on DSM's **Gold Crest** property. A highlight of sampling included a 1 m chip sample grading 56.1 g/t Au and 124 g/t Ag.

#### 7.1.6. Angus (Kootenay Zinc Corp.)

Kootenay Zinc optioned the **Angus** property from Longford Capital Corp. in September. Longford reported discovering a visually mineralized showing during reconnaissance work. Angus is about 7 km west of the Lara VMS prospect in Sicker Group and Buttle Lake Group rocks intruded by Mount Hall gabbro. Veins grading up to 13 g/t Au are reported historically.

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

Bayhorse optioned the **Brandywine** past producer and began compiling historical data and preliminary work at the site, including resampling of 2010 drill core. Metallic screen assays in some cases yielded significantly higher Au results (e.g., 11.42 vs. 3.73 g/t across 3.1 m and 20.20 vs. 6.23 g/t Au across 1.6 m). In 1977-78 about 10,000 t of ore from **Brandywine** yielded 23,000 oz Ag and 11,000 oz Au, with Pb, Zn and Cu co-products.

**Table 5.** Selected exploration projects, Southwest Region.

<b>Project</b>	<b>Operator (partner)</b>	<b>Commodity; Deposit type; MINFILE</b>	<b>Resource (NI 43-101 compliant unless indicated otherwise)</b>	<b>Comments</b>
<b>Angus</b>	<b>Kootenay Zinc Corp.</b>	Au, Ag, Cu, Zn; I05:Polymetallic veins; 092C 192	na	New showing reported.
<b>Bakar</b>	<b>District Metals Corp.</b>	Cu, Ag; D03:Volcanic Redbed Cu; 102I 010, 7, 6, 15, 16, 17, 092L 080, 462, 247	na	VTEM, mapping, channel samples returned high-grade Cu.
<b>Brandywine</b>	<b>Bayhorse Silver Inc.</b>	Ag, Au, Pb, Zn; I05:Polymetallic veins; 092JW 001, 21, 22	na	Core reanalysis. Metallic screen assays up to 20.2 g/t Au across 1.5 m.
<b>Caledonia</b>	<b>Surge Exploration Inc.</b>	Ag, Cu, Pb, Zn; K02:Pb-Zn skarns; 092L 061, 209	na	New operator.
<b>Dancer Group</b>	<b>AMA Gold Exploration Ltd.</b>	Au, Ag; Au- quartz veins, polymetallic veins; 092GNW008, 12, 63	na	Trenching, drilling (100 m).
<b>Giant Copper</b>	<b>Imperial Metals Corporation</b>	Cu, Au, Ag, Mo; Porphyry Cu±Mo±Au; 092HSW001, 2, 27, 161	Invermay zone I: 17,532,570 tons 0.226% Cu, 0.011 oz/t Au and 0.310 oz/t Ag  AM Breccia zone Historical: 29,523,030 tons 0.653% Cu, 0.11 oz/t Au, 0.360 oz/t Ag, 0.007% Mo	Permitting.
<b>Gold Crest</b>	<b>DSM Syndicate Holdings Ltd.</b>	Au, Ag; Au quartz veins	na	Mapping, rock geochemistry. Highlight 56.10 g/t Au and 124 g/t Ag across 1 m.
<b>Gold Standard</b>	<b>DSM Syndicate Holdings Ltd.</b>	Au, Ag; I01:Au quartz veins, reported VMS target	na	Mapping, rock sampling. Highlight 5.81 g/t Au across 12 m.
<b>Hewitt Point, Margurete</b>	<b>Academy Metals Inc.</b>	Au, Ag; I01:Au quartz veins; 092K 025, 151, 187, 30, 20	na	Rock sampling, backpack drilling. Highlight 8.62 g/t Au over 38 cm. 6.18 g/t Au across 2 m.
<b>Jack White</b>	<b>Kal Minerals Corp.</b>	Cu, Fe; K01:Copper skarn, K03:Fe skarn; 092HNW026	na	Rock and soil sampling, ground magnetic survey, IP survey.

Table 5. Continued.

<b>Ladner Gold</b>	<b>New Carolin Gold Corp.</b>	Au, Ag; I01: 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	Drilling; 850 m underground. Surface mapping, rock and soil sampling.
<b>MQ-Nimpkish-Bonanza</b>	<b>Graymont Western Canada Inc.</b>	Limestone; R09:Limestone; 092L 186	na	Geophysical work spread across several northern Vancouver Island properties.
<b>Pacifico</b>	<b>Silver Grail Resources Ltd.</b>	Co, Cu, Au; Deposit type undefined; 092L 370	na	Grassroots project. Silt sampling.
<b>Pemberton Hills</b>	<b>Northisle Copper and Gold Inc. (Freeport-McMoRan Mineral Properties Canada Inc.)</b>	Cu, Mo; L04:Porphyry Cu±Mo± Au; 092L 131, 308	na	Drilling 3400 m in 6 holes. IP, geochemistry.
<b>Penece</b>	<b>Delrey Metals Corp.</b>	Magnetite, Ti, V; M05:Alaskan type; 092M 010, 1	na	Airborne magnetic survey. Deposit type is speculative.
<b>Rogers Creek</b>	<b>Tocvan Ventures Corp.</b>	Cu, Mo, Au, Ag; L04:Porphyry; 092JSE033, 34, 35, 36	na	Geochemistry, IP.
<b>Surespan Gold</b>	<b>Privateer Gold Ltd.</b>	Au, Ag; I01: Au-quartz veins; 092L 008, 311, 155	Historical: 122,470 t at 9.26 g/t Au and 324,772 t at 15.09 g/t Au	Drilling 4400 m in 18 holes.
<b>Teeta Creek</b>	<b>ArcWest Exploration Inc.</b>	Cu, Mo, Au; L04:Porphyry	na	Mapping, prospecting, rock sampling. Highlight 21.1 g/t Au.
<b>Wahleach Creek</b>	<b>Inua Studio</b>	Jade; Jade (Nephrite); 092HSW099	na	Trenching, prospecting.
<b>Yreka</b>	<b>Karmamount Mineral Exploration Ltd.</b>	Cu, Ag, Au; K01: Cu skarns, L04:Porphyry; 092L 052, 104, 451, 336, 236, 105, 452	na	IP. Testing for porphyry-style mineralization west of known skarn.

M = Measured; I = Indicated; Inf = Inferred

#### 7.1.8. Dancer Group (AMA Gold Exploration Ltd.)

AMA continued trenching and drilling at the **Dancer** claims. They drilled about 100 m targeting gold veins in Coast Plutonic complex diorite to granodiorite.

#### 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. Pemberton Hills (Freeport McMoRan Inc. 65%; Northisle Copper and Gold Inc. 35%)

In 2018, NorthIsle Copper and Gold Inc. optioned the **Pemberton Hills** area of its North Island property to Freeport-McMoRan Mineral Properties Canada Inc. Work in 2019 included IP, geological mapping, geochemistry, and clay studies to refine possible winter drill targets. A large area of advanced argillic alteration in the Pemberton Hills area (Fig. 2) stretches westward more than 10 km to the **Hushamu** deposit. Minor base and precious metals have been reported in the Pemberton Hills area, but it has not been systematically tested at depth.



**Fig. 2.** Pemberton Hills, silica-clay altered rhyolite with sheeted quartz veins, interpreted as a leached cap above mineralization in the Hushamu area.

### 7.2.2. Giant Copper (Imperial Metals Corporation)

Imperial Metals Corporation proposes drilling (5 trenches and 5 drill sites) at its **Giant Copper** project. The Notice of Work application is in process. In the last several years, Imperial has reported geological work and rock and soil geochemistry at the site that have pointed to a high-grade gold discovery at the Otis zone, east of most past exploration. The company hopes to follow up with trenching and drilling. The Giant Copper property includes the AM Breccia for which there is a historical resource, and the Invermay Breccia, a minor past producer, for which there is a 2006 resource. Porphyry mineralization at depth in the AM Breccia is also a target.

### 7.2.3. Rogers Creek (Tocvan Ventures 80%; Carube Copper Corp. 20%)

Tocvan carried out rock sampling, IP, and short-wave infrared examination of drill core at Rogers Creek. Targets are Miocene porphyry copper occurrences, part of a belt extending from approximately the US border through Pemberton.

### 7.2.4. Teeta Creek (Teck Resources Limited 60%; ArcWest Exploration Inc. 40%)

During mapping and sampling reconnaissance work, ArcWest Exploration Inc. sampled up to 21.2 g/t Au and 15 g/t Ag in an apparent epithermal zone at their **Teeta Creek** project (Fig. 3), primarily known as a porphyry Cu-Mo prospect. Preliminary Re-Os molybdenite geochronology suggests a young (Miocene) age of mineralization (Nixon et al., 2020). The area was drilled in 1968 and 1975 with at least one encouraging copper intersection. Teck Resources Limited has entered into an agreement to explore the property to earn an initial 60%.

### 7.2.5. Yreka (Karmamount Mineral Exploration Inc.)

Karmamount carried out an IP survey at their Yreka project to test possible porphyry stockwork mineralization west of the Yreka past Cu-Au-Ag producer. Lines also extended over the known Cu-Au skarn mineralization.



**Fig. 3.** Teeta Creek, hydrothermal breccia with intensely clay altered felsic volcanic clasts in a chalcedonic matrix.

## 7.3. Selected polymetallic base and precious metal projects

With the exception of a program at Myra Falls, volcanogenic massive sulphide deposits in the southwest saw limited exploration in 2019. The precious metals-enriched **Brandywine** is included under the precious metals section, above. A new project in 2019, **Bakar**, has volcanic red bed copper occurrences.

### 7.3.1. Bakar (District Metals Corp.)

District Metals reported channel sampling up to 10 m of 4.92% Cu and 28 g/t Ag at its newly acquired **Bakar** property. The initial program included rock, soil and stream-sediment sampling, and an airborne versatile time-domain electromagnetic survey. Known mineralization includes copper-silver vein and volcanic red bed copper showings.

### 7.3.2. Pacifico (Silver Grail Resources Ltd.)

Silver Grail reported silt sampling of five streams. This follows preliminary prospecting and silt sampling in 2018. **Pacifico** is a grass roots to early stage Cu-Co-Mn property.

## 7.4. Selected skarn projects

### 7.4.1. Caledonia (Surge Exploration Inc.)

Surge Exploration optioned the **Caledonia** property northeast of Freeport McMoRan's Pemberton Hills project. Following due diligence work, they expanded the property to allow exploration along strike. **Caledonia** is a skarn at contacts between Vancouver Group limestone and basalt with Island Plutonic suite granodiorite. It has an historical (non-compliant) resource of 68,000 t grading 704.2 g/t Ag, 6.1% Cu, 7.45% Zn, 0.6% Pb and 0.34 g/t Au. The 3 to 5 m wide zone has a strike length of 100 m.

### 7.4.2. Jack White (Kal Minerals Corp.)

Kal Minerals conducted an initial program at its **Jack White** property including mapping, rock and soil sampling, a ground magnetic survey, and a 3D IP survey. They obtained up to 44% Fe and 4745 ppm Cu in grab samples.

## 7.5. Selected specialty metals and industrial mineral projects

Carried out by private companies, exploration for industrial minerals commonly goes unreported. Probably the most common type of exploration is bulk sampling for test marketing purposes. This is typically done by building and landscaping stone producers. Exploration for specialty metals is more likely to be carried out by publicly traded exploration companies.

### 7.5.1. Penece (Delrey Metals Corp.)

Delrey flew an airborne survey and identified a large magnetic anomaly at its **Penece** iron-titanium-vanadium project. Delrey increased the size of their land holdings to cover the anomaly. Previously called **Wigwam Magnetite**, this prospect comprises a large, low-grade (5-10%) titaniferous magnetite deposit. Magnetite also has elevated vanadium. It was first recognized as a large magnetic anomaly in the late 1950s or early 1960s. Relatively little work has been done, but it appears as though diorite, metasedimentary and metavolcanic rocks host fine- to coarse-gabbro or hornblende pyroxenite dikes or veins with 5-10% magnetite.

### 7.5.2. Wahleach (Inua Studio)

Trenching and prospecting continued in the Wahleach Creek area seeking jade. Some A-grade nephrite is reported. Quarrying of slate is also under consideration.

### 7.5.3. MQ-Nimkish-Bonanza (Graymont Western Canada)

Graymont reported geophysical work on its northern Vancouver Island limestone properties.

## 8. Geological research

Rukhlov et al. (2020) conducted a multi-media geochemical and Pb isotopic survey on northern Vancouver Island from streams draining prospective rocks of the Bonanza arc. Water, stream sediment, sluice heavy metal concentrate samples were taken to optimize geochemical techniques at the property level and to refine provincial-level surveys. Also on Vancouver Island, Nixon (2011a, 2011b) obtained unexpectedly young U-Pb ages (Miocene) from intrusive rocks in the Klaskish River area as part of a regional mapping project. Nixon et al. (2020) provide new preliminary high-precision U-Pb zircon and Re-Os molybdenite ages for mineralized stocks of the Klaskish Plutonic Suite (ca. 7-4.6 Ma) that confirm emplacement coeval with older phases of Alert Bay volcanism (8-2.5 Ma), and that porphyry Cu-Mo magmatic-hydrothermal systems are genetically linked to pluton emplacement and crystallization. This young Cu-Mo porphyry mineralization forms a well-defined metallotect that is underexplored and rich in opportunities for discovering economic deposits. Truman and Clift (2019) provided background on a 250-m spaced aeromagnetic and radiometric survey across northern Vancouver Island, anticipating that results will be released in early 2020.

Grasby (2019) has been examining the geothermal resources of the Garibaldi belt in a project that includes geological mapping, passive seismic, magnetotelluric and gravity surveys. Work has been carried out intermittently at Mount Meager since the 1970s, including a test well in the 1980s.

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