

# Exploration and mining in the South Central Region, British Columbia



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## 1. Introduction

With four major mines, the South Central Region is currently the most productive copper mining district in Canada. In addition, an underground gold mine restarted in 2017. The region's varied geology, well-established infrastructure, and access to markets also make it an important industrial minerals centre. The Cariboo area is the province's largest placer gold camp, with active permits numbering in the hundreds. Thermal coal resources in Cenozoic basins were last mined in 2013.

The region has six major proposed metal mines. About 80 exploration projects were tracked in 2019, although this represents a minimum because not all exploration work is recorded, and 2019 work that must be recorded for regulatory compliance is not necessarily reported in the calendar year.

Exploration expenditures for the region are estimated at \$54.5 million; exploration drilling is estimated at 197,100 m (Clarke et al., 2020; EY LLP, 2020).

Several advanced properties changed hands during the year. Notably, Osisko Gold Royalties Ltd. acquired Barkerville Gold Mines Ltd. and its **Cariboo Gold** project, Bayshore Minerals Ltd. bought the **Elk** project from Equinox Gold Corp., Taseko Mines Limited acquired Yellowhead Mining Inc. and its Harper Creek (now **Yellowhead**) project, and Talisker Resources Ltd. purchased Bralorne Gold Mines Ltd. (which operates the **Bralorne** project). From Avino Silver & Gold Mines Ltd. Tempus Resources Limited acquired Sona Resources Corp., formerly a subsidiary of Skeena Resources Limited, which holds the **Blackdome-Elizabeth** project.

Total area under tenure in the region increased about 6% between October 2018 and November 2019 to nearly 2.6 million ha.

## 2. Geological overview

The tectonic and metallogenic evolution of the Canadian Cordillera are intimately linked (Fig. 1, e.g., Colpron and Nelson, 2011; Nelson et al., 2013). The South Central Region straddles three of British Columbia's five morphogeological belts (from west to east: Coast; Intermontane; Omineca). The mid-Mesozoic and older geological framework is represented by cratonic and pericratonic rocks in the east, and a series of

Late Paleozoic through mid-Mesozoic arc and oceanic terranes to the west (Fig. 1). Younger rocks include Jura-Cretaceous siliciclastic and local volcanic rocks, Eocene volcanic rocks, Neogene and Quaternary basalt, and Middle Jurassic to Eocene granitic intrusions.

The oldest rocks in the region are Paleoproterozoic basement gneiss complexes at the eastern boundary, such as in the Monashee complex. These are interpreted as parts of the North American craton (Armstrong et al., 1991), overlain by Neoproterozoic to Paleozoic cover deposited following rifting that formed the western margin of ancestral North America (McDonough and Parrish, 1991; Murphy et al., 1991). To the northwest, the Cassiar terrane consists of Neoproterozoic to mid-Paleozoic siliciclastic and carbonate rocks interpreted as distal facies of the North American platform (Struik, 1988a). Also affiliated with ancestral North America, the Kootenay terrane (deep-water basin strata on Fig. 1) include Neoproterozoic to mid-Paleozoic deep-water facies equivalents deposited west of the North American platform. Lower Cambrian and older rocks are similar to North American strata to the east, but the overlying lower Paleozoic succession is characterized by units of coarse siliciclastic and mafic volcanic rocks that may reflect intermittent crustal extension (Colpron and Price, 1995). This belt also includes Devonian-Mississippian calc-alkaline to alkalic volcanic rocks and associated granitoid intrusions, found mainly in the Eagle Bay assemblage (Schiarrizza and Preto, 1987), which reflect the initiation of east-dipping subduction beneath the North American plate margin. These rocks host polymetallic volcanogenic massive sulphide (VMS) occurrences, and the **Yellowhead** bulk tonnage copper deposit.

Slide Mountain terrane is the easternmost tract of oceanic rocks in the Canadian Cordillera. These rocks may be the remnant of a Late Paleozoic marginal basin that formed behind a westward-retreating volcanic arc in Quesnel terrane. The Fennell Formation hosts copper-zinc-silver massive sulphide mineralization at the **Chu Chua** occurrence.

Quesnel terrane is a Late Triassic to Early Jurassic island arc complex (e.g., Mortimer, 1987; Struik, 1988a, b; Unterschutz et al., 2002). It also includes a Late Paleozoic arc sequence, represented by the Harper Ranch Group (Beatty et al., 2006) and,

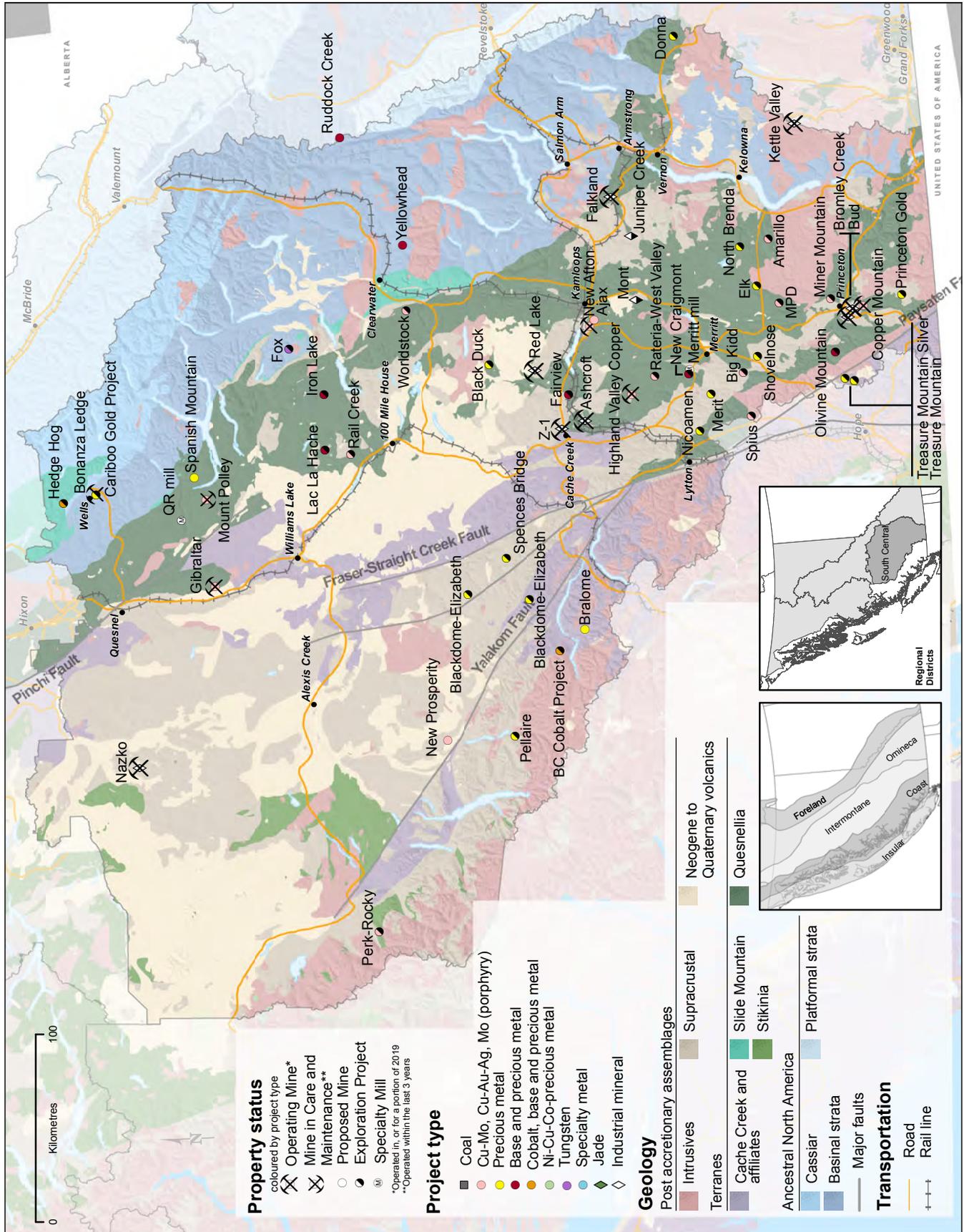


Fig. 1. Mines and selected exploration projects, South Central Region, 2019. Terranes after Nelson et al. (2013).

in the south, assemblages of oceanic rocks (TempelmanKluit, 1989). The Mesozoic rocks are represented mainly by Middle to Upper Triassic volcanic and sedimentary rocks of the Nicola Group, together with abundant Upper Triassic to Lower Jurassic calc-alkaline to alkaline intrusions (Preto, 1977, 1979; Mortimer, 1987; Panteleyev et al., 1996; Schiarizza et al., 2013). The Nicola Group consists mainly of volcanic and volcanic-derived sedimentary rocks, but also includes an eastern sedimentary facies of siltstone and slate intercalated with quartzite and limestone (Bloodgood, 1990; Schiarizza et al., 2013; Mihalynuk et al., 2015; Schiarizza, 2019). The volcanic rocks are mainly augite-phyric shoshonitic basalts, but the western part of the group locally includes a belt of calc-alkaline volcanic rocks with substantial amounts of rhyolite and dacite (Mortimer, 1987; Preto, 1977, 1979). A younger stratigraphic component of Quesnel terrane consists of Lower to Middle Jurassic sedimentary rocks that unconformably overlie the western parts of the Nicola Group (Travers, 1978; Logan and Moynihan, 2009; Schiarizza et al., 2013).

Quesnel terrane is metallogenically important for its porphyry copper deposits (e.g., Logan, 2013; Logan and Mihalynuk, 2014). The plutons that host these deposits conform, in part, to a pattern defined by parallel belts of calc-alkaline and alkalic plutons that become progressively younger from west to east (Schiarizza, 2014). The western (Late Triassic) calc-alkaline belt includes the Guichon Creek batholith, host to the **Highland Valley Copper** copper-molybdenum mines, and the Granite Mountain batholith, host to the **Gibraltar** copper-molybdenum mine. A well-defined belt farther east comprises younger, latest Triassic alkalic plutons, which host alkalic porphyry copper-gold deposits, including producing mines at **Copper Mountain** and **New Afton** and the **Mount Polley** mine, which is currently on care and maintenance. A third belt, younger and farther to the east, is defined by several large, Lower Jurassic calc-alkaline plutons.

Cache Creek terrane, consisting of Carboniferous to Early Jurassic chert, argillite, basalt, limestone, sandstone, gabbro, and serpentinized ultramafic rocks of the Cache Creek complex, forms a belt to the west of Quesnel terrane in the central and northern parts of the region. It is interpreted, at least in part, as a subduction complex responsible for generating the Quesnel magmatic arc (Travers, 1978; Struik et al., 2001).

Cadwallader terrane, as interpreted by Schiarizza (2013), underlies parts of the Intermontane and eastern Coast belts, west of Cache Creek and Quesnel terranes. It includes a Late Permian-Early Triassic primitive oceanic arc complex, and an overlying Late Triassic-Middle Jurassic arc complex and associated siliciclastic apron.

Bridge River terrane occurs in the eastern Coast belt, west of Lytton and Lillooet, where it is partially enveloped by Cadwallader terrane. It is represented mainly by the Bridge River complex, comprising structurally interleaved slivers of chert, argillite, basalt, blueschist, gabbro, serpentinite, limestone, and sandstone (Schiarizza et al., 1997). Both Cadwallader and Bridge River terranes are shown as ‘Cache

Creek affiliates’ on Figure 1.

Stikine terrane is a mid-Paleozoic to Middle Jurassic arc terrane that is markedly similar to Quesnel terrane, and forms a predominant component of the Cordillera in central and northern British Columbia. It is represented in the northwestern part of the South Central Region by a few scattered exposures of volcanic and sedimentary rocks correlated with the Hazelton Group (Upper Triassic to Middle Jurassic; Tipper, 1959, 1969).

Younger stratigraphic units overlap older terranes and cover large parts of the region. These units include: Upper Jurassic to Upper Cretaceous siliciclastic rocks of the Tyaughton-Methow basin, which overlap Cadwallader and Bridge River terranes in the eastern Coast belt (Schiarizza et al., 1997); and mid-Cretaceous arc volcanic rocks of the Spences Bridge Group, which form a northwest-trending belt that overlaps Quesnel and Cache Creek terranes in the Merritt-Lillooet area (Monger and McMillan, 1989), and continues westward across the Fraser River where it overlaps Cadwallader and possibly Stikine terranes (Mahoney et al., 2013). Eocene volcanic and subordinate sedimentary rocks (e.g., Kamloops Group, Penticton Group, Princeton Group) are predominant in some locations. Neogene basalt of the Chilcotin Group overlaps Quesnel, Cache Creek, Cadwallader, and Stikine terranes throughout much of the central part of the region (Dohaney et al., 2010). Granitic plutons, ranging from late Middle Jurassic to Eocene, occur throughout the region and, in some cases, are responsible for significant mineralization (e.g., **IKE**, **New Prosperity**).

### 3. Mines and quarries

The region produces copper, molybdenum, gold, and silver from four large mines, gold from a small mine, and a variety of industrial minerals (bentonite, zeolite, diatomaceous earth, gypsum, pumice, opal, and dimension stone) from about ten quarries. Almost 1000 placer mines and gravel pits have active permits, but not all produce in any given year.

#### 3.1. Metal mines

The South Central Region hosts five of the province’s metal mines (Fig. 1; Table 1). These include the province’s two largest copper-molybdenum producers (**Gibraltar** and **Highland Valley Copper**) and two major copper-gold mines (**New Afton** and **Copper Mountain**). A third copper-gold producer, **Mount Polley**, operated for part of 2019. The region hosts one precious metal mine, **Bonanza Ledge**, which is undergoing development and permitting for its next phase of production.

##### 3.1.1. Bonanza Ledge (Barkerville Gold Mines Ltd.)

Barkerville restarted the **Bonanza Ledge** mine (Fig. 1; Table 1) in 2017 as an underground long-hole and cemented fill operation below the existing pit. The mine operated in 2018 but mining and milling were suspended in December of that year. Underground development and permitting are underway for the Bonanza Ledge Phase II project, which will exploit the BC Vein for a projected two years at a targeted rate of 650 tpd. About

Table 1. Metal mines, South Central Region.

Mine	Operator (partner)	Commodity; deposit type; MINFILE	Forecast 2019 Production (based on Q1-Q3)	Reserves	Resource	Comments
<b>Bonanza Ledge</b>	<b>Barkerville Gold Mines Ltd.</b>	Au; Au-quartz veins; 093H 140	na	na	M: 175,000 t 6.1 g/t Au I: 55,000 t 4.6 g/t Au	Production suspended for underground development and phase 2 permitting. Resource at 3.0 g/t cut off. Excludes BC vein.
<b>Copper Mountain</b>	<b>Copper Mountain Mining Corporation 75%, Mitsubishi Materials Corporation 25%</b>	Cu, Au, Ag; Porphyry Cu-Au, Alkalic; 092HSE001	72-80 Mlb Cu, 29,500-32,500 oz Au, 260,000-290,000 oz Ag (management's guidance)	P+Pr: 476,795,000 t 0.23% Cu, 0.10 g/t Au 0.73 g/t Ag	M+I: 598,850,000 t 0.23% Cu, 0.10 g/t Au, 0.73 g/t Ag	0.10% Cu cut-off. Resources inclusive of reserves. Includes New Ingerbelle.
<b>Gibraltar</b>	<b>Taseko Mines Limited 75%, Sojitz Corp. 12.5%, Dowa Holdings Co. Ltd. 6.25%, Furukawa Co. Ltd. 6.25%</b>	Cu, Mo; Porphyry Cu+/-Mo+/-Au; 093B 012	130 Mlb Cu+Mo (+/-5%) (management's guidance)	P+Pr: 594 Mtons 0.25% Cu, 0.008% Mo	M+I: 1109 Mtons 0.25% Cu, 0.007% Mo Inf: 59 Mtons 0.21% Cu, 0.004% Mo	0.15% Cu cut-off. Resources inclusive of reserves. Does not include Cu oxide.
<b>Highland Valley</b>	<b>Teck Resources Limited</b>	Cu, Mo; Porphyry Cu+/-Mo+/-Au; 092ISW012, 45	115,000-120,000 t Cu, 8.0 Mlb Mo (management's guidance)	P+Pr: 535.5 Mt 0.300% Cu, 0.007% Mo	M: 499.4 Mt 0.30% Cu, 0.008% Mo I: 671.8 Mt 0.24% Cu, 0.009% Mo Inf: 166.0 Mt 0.21% Cu, 0.007% Mo	Resources exclusive of reserves. Evaluating plans for extension of mine life.
<b>Mount Polley</b>	<b>Imperial Metals Corporation</b>	Cu, Au, Ag; Porphyry Cu-Au, Alkalic; 093A 008	3.825 Mlb Cu 10,619 oz Au 11,119 oz Ag (to shut down)	P+Pr: 53.772 Mt 0.337% Cu, 0.299 g/t Au, 0.89 g/t Ag	M+I: 194.32 Mt 0.294% Cu 0.285 g/t Au, 0.727 g/t Ag Inf: 5.619 Mt 0.374% Cu, 0.276 g/t Au, 2.187 g/t Ag	Reserves in 5 zones. Resources inclusive of reserves. Shut down mid year pending improved copper price.
<b>New Afton</b>	<b>New Gold Inc.</b>	Au, Ag, Cu; Porphyry Cu-Au, Alkalic; 092INE023	215-246 koz AuEq (management's guidance)	P+Pr: 52.642 Mt 0.64 g/t Au, 1.9 g/t Ag, 0.78% Cu	M+I: 52.407 Mt 0.63 g/t Au, 2.2 g/t Ag, 0.77% Cu Inf: 13.564 Mt 0.39 g/t Au, 1.4 g/t Ag, 0.45% Cu	Resources exclusive of reserves. Ongoing exploration program.

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

2600 m of development are necessary, some of which will be in ore. In addition to the development, they require Mines Act and Environmental Management Act permit amendments at both the mine and mill to commence Phase II production.

Two types of mineralization are of interest at Bonanza Ledge: pyrite replacement and vein mineralization consisting of native gold in quartz veins in pyrite-bearing, carbonaceous and chloritic phyllite of the Snowshoe Group (Proterozoic-Paleozoic).

### 3.1.2. Copper Mountain (Copper Mountain Mining Corporation 75%; Mitsubishi Materials Corporation 25%)

The **Copper Mountain** copper-gold open-pit mine (Fig. 1; Table 1), has been producing since August 2011 and mills at a rate of close to 40,000 tpd. Planned addition of a third ball mill in 2020 would increase it to 45,000 tpd. Expected production in 2019 is at the lower end of guidance of 72-80 Mlbs Cu, 29.5-32.5 koz Au, and 260-290 koz Ag. In the first three quarters it produced 53.362 Mlbs Cu, 20,547 oz Au, and 185,212 oz Ag.

Approximately 15,000 m of drilling at **Copper Mountain** in 2019 was directed at searching for resources close to existing reserves. Following 2017-2018 drilling at New Ingerbelle, in 2019 Copper Mountain Mining Corporation converted resulting resources to reserves. Additional work then further increased reserves at the New Ingerbelle, North Pit and Main Pit. Expected mine life is now 31 years based on current reserves and planned production level.

The **Copper Mountain** ore bodies are Late Triassic alkalic porphyry Cu-Au deposits mainly in Nicola Group rocks (Triassic) intruded by the high-level Copper Mountain intrusions (Upper Triassic). Holbek et al. (2015) described the deposit as a structurally complex alkalic porphyry Cu-Au system with strong vertical continuity.

### 3.1.3. Gibraltar (Taseko Mines Limited 75%; Cariboo Copper Corp. 25%)

The **Gibraltar** copper-molybdenum open-pit mine (Fig. 1; Table 1) is operated by Taseko Mines Limited and Cariboo Copper Corp., whose 25% interest is divided between Sojitz Corp. (12.5%), Dowa Holdings Co. Ltd. (6.25%) and Furukawa Co. Ltd (6.25%). Production began in 1972 but was suspended from 1999 to 2003. Taseko restarted the mine in 2004 and carried out modernization between 2009 and 2012, which included expanding mill capacity to 85,000 tpd, and building a separate molybdenum circuit. In 2013, the mine completed its first full year of operation after this modernization. Gibraltar was projected to produce approximately 130 Mlb Cu in 2019. By the end of the third quarter, it had produced 92.5 Mlb Cu and just more than 2 Mlb Mo. Reserves updated in November (Table 1), support a projected 19-year mine life. Taseko has a multi-year permit for exploration north and northwest of the mine.

Ore comes from five pits (Connector, Gibraltar, Granite, Extension, and Pollyanna), but not all operate at all times. The calc-alkaline porphyry Cu-Mo deposit is in the Granite

Mountain batholith (Upper Triassic; see van Straaten et al., 2013) in a fault-bounded section of Nicola Group and Dragon Mountain succession volcanic and sedimentary rocks (Quesnel terrane; Schiarizza 2014, 2015) bounded by Cache Creek terrane rocks to the east and west.

### 3.1.4. Highland Valley Copper (Teck Resources Limited)

Ore from the **Highland Valley Copper** copper-molybdenum mine (Fig. 1; Table 1) comes from the Valley and Lornex pits, two of seven in the camp. Projected 2019 production is 115,000-120,000 t Cu and 8 Mlbs Mo in concentrate. Three-year guidance (2020-2022) is 135,000-155,000 t/y Cu and 4.0-5.0 Mlbs/y Mo. This is in anticipation of changing ore characteristics and ramping up of a recently installed ball mill.

Mining began in the Highland Valley camp began at the Bethlehem Mine in 1962. Bethlehem was last active in 1982 but Teck proposes to return to the area as an extension project, with pushback and deepening of the Jersey and Iona pits and extracting 137 Mt of ore with average grades of 0.287% Cu and 0.0048% Mo. The HVC Bethlehem Extension now has a Mines Act permit.

The HVC 2040 extension project is at the pre-feasibility stage. If implemented it could extend mine life 13 years to 2040 or beyond and raise the average production rate to approximately 175,000 tpd. Annual production of copper would increase 25% to 182,700 Mt and production of molybdenum would increase 93% to 8.5 Mlbs. Pre-feasibility level engineering suggests the project is viable and it entered the environmental assessment process in 2019.

All mineralization at Highland Valley is calc-alkaline Cu-Mo type in the Guichon Creek batholith (Upper Triassic), which has been divided into a number of pre-, syn- and post-mineral phases (see Byrne et al., 2013).

### 3.1.5. Mount Polley (Imperial Metals Corporation)

**Mount Polley** is a 20,000 tpd open-pit operation that also has underground resources (Table 1). In January 2019, Imperial announced a decision to stop mining and mill low-grade stockpiles before suspending production. They placed the mine on care and maintenance at the end of May. Production to May 26 was 3,825,000 lbs Cu, 10,619 oz Au and 11,119 oz Ag from 2,231,119 t ore milled.

Rehabilitation work on Hazeltine Creek continued. Exploration may also proceed on lease and on nearby properties. Imperial is proposing an IP survey north of the mine site and has optioned adjacent properties from Commander Resources Ltd.

The mine may restart when copper prices warrant. Opened in 1997, operations were suspended in 2001 when copper prices were low. It reopened in 2005, but a tailings dam breach forced another suspension in 2014-2015.

The deposits exploited at **Mount Polley** are alkalic porphyry Cu-Au in the syenitic to monzodioritic Polley stock (Upper Triassic-Lower Jurassic), which intrudes Nicola Group volcanic rocks. At least eight discrete mineralized zones have

contributed to production or host resources. Rees (2013) and Brown et al. (2016) provide reviews of **Mount Polley** geology and mineralization.

### 3.1.6. New Afton (New Gold Inc.)

The **New Afton** gold-copper mine (Fig. 1; Table 1) is a block cave operation that opened in mid-2012 (Hall and May, 2013). The known New Afton deposits form a high-grade keel beneath the past-producing (1978-1997) Afton open-pit mine, an alkalic porphyry in the Iron Mask batholith (Upper Triassic). In 2015, the company installed a 14,000 tpd mill.

**New Afton** produced 61.2 Mlbs copper and 53,051 oz Au the first three quarters of 2019. Guidance for the year is 215,000 to 245,000 Au equivalent oz, or approximately 75-85 Mlbs Cu and 55,000-65,000 oz Au including Ag by-product.

New Gold Inc. has been drilling deep mineralization at **New Afton** in the westward extension of the SLC zone and in the D-zone target down plunge of the C-zone reserves. The C-zone itself is expected to extend mine life to 2030. They also reported surface geophysics (IP) and geochemistry work to identify drill targets along the Cherry Creek trend within 3 km WNW of the New Afton Mill. They propose drilling at up to 100 sites.

The targets and deposits are alkalic porphyry Cu-Au, hosted by the Iron Mask batholith and volcanic and volcanoclastic rocks of the Nicola Group (Upper Triassic).

## 3.2. Selected industrial mineral mines

More than a dozen industrial mineral quarries and processing plants are in the region (Fig. 1; Table 2). These operations employ more than 250 people. In addition, nearly 300 sand and gravel pits and 45 quarries have active Mines Act permits. Many of these are intermittently active.

### 3.2.1. Ashcroft (IG Machine and Fiber Ltd.)

IG Machine and Fiber Ltd, a subsidiary of IKO Industries Ltd, operates the **Ashcroft** basalt quarry and roofing granule plant. They began production in 2001 and now typically produce around 300,000 tpy. The quarry is permitted to mine 500,000 tpy and about 60% is processed into granule products.

### 3.2.2. Decor (Pacific Bentonite Ltd.)

The **Decor** pit of Pacific Bentonite Ltd. was a supplier of alumina-rich burnt shale to the Lafarge cement plant in Kamloops. This operation is now on care and maintenance because of the Lafarge plant's shutdown. The Decor property also hosts a large bentonite deposit, which has been investigated for other applications.

### 3.2.3. Harper Ranch and Falkland (Lafarge Canada Inc.)

After operating intermittently for many years supplying cement to western Canada, the Kamloops cement plant and **Harper Ranch** limestone quarry of Lafarge Canada Inc. are now on care and maintenance. The facility will continue to serve as a distribution point for cement produced in Alberta. Apart from limestone, the cement plant used gypsum and

anhydrite mined at the **Falkland** quarry, which still supplies gypsum for other uses.

### 3.2.4. Kettle Valley quarries (Kelowna Sand and Gravel Ltd.)

Decorative rock and dimension stone are produced at small quarries throughout the region. Kelowna Sand and Gravel Ltd. mines gneiss, dacite ash, and basalt at the Nipple Mountain, Kettle Valley, Canyon, and Gemini quarries and has been issued permits to explore other sites. Kettle Valley Stone Company of Kelowna produces flagstone, ashlar, facing stone, and landscape rock.

### 3.2.5. Red Lake and Bud (Absorbent Products Ltd.)

Absorbent Products Ltd. produces diatomaceous earth from the **Red Lake** quarry, and bentonite from the **Bud** quarry and uses them to manufacture cat litter, barn deodorizer, industrial absorbents, and carriers for agricultural products at their plant in Kamloops.

### 3.2.6. Bromley Creek (Canadian Zeolite Corp.)

In 2014, Canadian Mining Company Inc. a subsidiary of Canadian Zeolite, concluded its option agreement with Heemskirk Canada Ltd and regained control of the **Bromley Creek** zeolite quarry. Zeolite from the quarry has agricultural and absorbent applications. Mining is by Absorbent Products Ltd.

### 3.2.7. Z-1 (Progressive Planet Solutions Inc.)

The **Z-1** mine is now owned by Progressive Planet Solutions, formerly Ashburton ventures Inc. ZMM Canada Minerals Corp. is the operator. Their product is currently used as an agricultural feed additive, a growth medium, a filtration medium, a component of lightweight concrete, and for soil remediation.

## 4. Placer mines

The region has more than 650 placer mines. Most of these operations are small, intermittent or seasonal, and lack production data.

## 5. Mine development

Mine development projects are those that have a positive production decision and key government approvals and on-site construction has begun. No major projects meet these criteria in the South Central Region.

## 6. Proposed mines

Proposed mines are defined as feasibility-stage projects for which the process of formal socioeconomic and environmental review has begun. For projects that exceed thresholds set by the British Columbia Environmental Assessment Act (or its federal equivalent), reviews are coordinated by the British Columbia Environmental Assessment Office and Canadian Environmental Assessment Agency. Smaller projects are

**Table 2.** Selected industrial mineral mines and quarries, South Central Region.

<b>Mine</b>	<b>Operator (partner)</b>	<b>Commodity; deposit type; MINFILE</b>	<b>Forecast 2019 Production (based on Q1-Q3)</b>	<b>Reserves</b>	<b>Resource</b>	<b>Comments</b>
<b>Ashcroft</b>	<b>IG Machine and Fibers Ltd. (IKO Industries Ltd.)</b>	Basalt (roofing granules); 092INW104	300,000 t (approx. target)	na	Approx. 13.3 Mt in 2002	Typically mines 500,000 t with 60% processed into granule products.
<b>Bromley Creek (Zeotech)</b>	<b>Canadian Zeolite Corp.</b>	Zeolite; Open system zeolites; 092HSE243	na	na	M+I: (as of 2013-06-30): 550,000 t	Operated by Absorbent Products Ltd.
<b>Bud</b>	<b>Absorbent Products Ltd.</b>	Bentonite; 092HSE162	na	na	na	Operating, but volumes not published.
<b>Decor</b>	<b>Pacific Bentonite Ltd.</b>	Alumina, Landscape rock; 092INW084	na	na	na	
<b>Falkland</b>	<b>Lafarge Canada Inc.</b>	Gypsum; 082LNW001	na	na	na	Production affected by shut down of Lafarge's Kamloops Cement Plant.
<b>Harper Ranch</b>	<b>Lafarge Canada Inc.</b>	Limestone; 092INE001	na	na	na	On care and maintenance as of November 2016.
<b>Kettle Valley Quarries</b>	<b>Kelowna Sand and Gravel Ltd./Kettle Valley Stone Company</b>	Ashlar, flagstone, thin veneer; 082ENW109, 111, 112	na	na	na	
<b>Klinker</b>	<b>Opal Resources Canada Inc.</b>	Opal; 082LSW125	Intermittent operation	na	na	Active 2019.
<b>Mount Polley Magnetite</b>	<b>Craigmont Industries Ltd.</b>	Magnetite (recovered from tailings); 093A 008	na	na	na	Mount Polley suspended.
<b>Nazko</b>	<b>Can Lava Mining Corporation</b>	Lava Rock; Cinder cone; 093B 060	na	na	Historical: 45 Mt	1998 resource estimate. Exploration permitted on adjacent property.
<b>Pavilion</b>	<b>Graymont Western Canada Inc.</b>	Limestone; 092INW081	na	na	na	On care and maintenance as of June 2016. In reclamation.
<b>Red Lake</b>	<b>Absorbent Products Ltd.</b>	Diatomaceous earth; Lacustrine diatomite; 092INE081	na	na	na	Operating, but volumes not published.
<b>Z-1</b>	<b>ZMM Canada Minerals Corp.</b>	Zeolite; Open system zeolites; 092INW095	na	na	Approx. 800,000 t	Historical resource.

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

reviewed by an interagency Mine Development Review Committee (MDRC) chaired by the Ministry of Energy, Mines and Petroleum Resources. Seven projects are in this category: **Ajax, Bralorne, Cariboo Gold, New Prosperity, Ruddock Creek, Spanish Mountain, and Yellowhead** (Fig. 1; Table 3). Of these, Yellowhead's environmental assessment has terminated, Ajax's rejected by both levels of government, and New Prosperity's provincial certification may expire in early 2020. In none of these cases has the operator abandoned their project.

### 6.1. Ajax (KGHM Ajax Mining Inc.)

The **Ajax** porphyry copper-gold project, owned by KGHM Ajax Mining Inc., is an 80:20 joint venture between KGHM Polska Miedz S.A. and Abacus Mining and Exploration Corporation. Mineralization is in the Iron Mask batholith, a multi-phase Triassic alkalic intrusive complex. A revised feasibility study released in 2016 modelled Ajax as a 65,000 tpd open-pit mine with a projected 18-year life. In December 2017, the project was denied certification by the British Columbia Ministries of Environment and Climate Change Strategy and Energy, Mines and Petroleum Resources. In June 2018, the Ministers of Natural Resources and Fisheries, Oceans and the Canadian Coast Guard denied federal certification. Although KGHM Ajax has not announced plans for the site, Abacus issued an update stating that the project remains a priority and that they have begun re-engaging those potentially affected by it.

### 6.2. Bralorne (Bralorne Mines Ltd.)

In December, Talisker Resources Ltd. closed its acquisition of Bralorne Mines Ltd., a subsidiary of Avino Silver & Gold Mines Ltd. The cash and shares deal includes a payment of \$8.7 million. Avino acquired the **Bralorne** gold mine in 2014 and suspended mining shortly thereafter because the tailings storage facility reached capacity. The mine had been operating at a 100 tpd trial basis between 2010 and 2014. Since then, Avino has carried out upgrades and plan to meet permitting requirements. In 2017, they received an updated permit for a 100 tpd throughput mining operation. Avino anticipates operating the mine at more than 100 tpd. However, they report that much of their existing infrastructure is inadequate for higher throughput and they are proceeding with redevelopment. The dam for tailings storage was raised in 2015 and the impoundment buttressed in 2016. A new water treatment plant was built in 2016, electrical systems upgraded, and retired equipment and buildings removed or demolished.

Within the new permit boundary, exploration continued, including 28,000 m of drilling, which began in 2018 and extended through 2019. The two-phase program included an under-explored area called the NorthEast block. Reporting gold-bearing veins in 27 of 35 holes, the company considers that the area has greater potential than previously recognized.

Between 1928 and 1971, the Bralorne camp produced 4.15 Moz Au at average grades of about 15 g/t. Veins have characteristics typical of orogenic gold deposits; the age of mineralization is estimated at ca. 68-64 Ma ( $^{40}\text{Ar}/^{39}\text{Ar}$  muscovite; Hart and Goldfarb, 2017).

### 6.3. Cariboo Gold (Barkerville Gold Mines Ltd.)

In November of 2019, Osisko Gold Royalties Ltd acquired all shares in Barkerville Gold Mines Ltd. they did not already own. The deal valued Barkerville at about \$338 million. Barkerville submitted a project description to the British Columbia Environmental Assessment Office, which then issued a section 10 order requiring the project to obtain an Environmental Assessment Certificate to proceed. A 2019 preliminary economic assessment studied a 4000 tpd underground mine beneath Cow Mountain, Island Mountain, and the Valley zone in between. Reserves of 14.7 Mt at 4.5 g/t Au average diluted gold grade would give an expected 11-year mine life. Assuming a base case gold price of US \$1325/oz and C\$1.00=US\$0.77, the study estimated an internal rate of return of 28.1% and net present value of C\$402.2 million at a discount rate of 5%.

A concentrator on site would serve as a pre-concentrator to reduce transportation costs to the QR mill 111 km away. Tailings generated at the mine site would be disposed of as paste backfill. Tailings at the mill site would be dry stacked. The QR mill currently has a capacity of 850 tpd and would require modification to process the higher feed grades of the pre-concentrated material.

A large exploration project is ongoing with about 91,000 m drilling in 2019 at Cow Mountain (including newly discovered Lowhee zone), Island Mountain (Mosquito and Shaft zones) and Barkerville Mountain. Mineralization is orogenic vein and replacement type and Allan et al. (2017) reported ages of mineralization from 148-135 Ma ( $^{40}\text{Ar}/^{39}\text{Ar}$  muscovite).

### 6.4. New Prosperity (Taseko Mines Limited)

The **New Prosperity** project of Taseko Mines Limited, is a porphyry gold-copper deposit with Proven and Probable reserves of 830 Mt grading 0.42 g/t Au and 0.23% Cu. Taseko continues to seek a judicial review of the February 2014 federal decision to deny the project. British Columbia granted Taseko a project certificate in 2010 and extended its expiry date by five years to 2020. In 2017, the British Columbia Ministry of Energy, Mines and Petroleum Resources issued a permit for a detailed site investigation of proposed mine infrastructure.

Most of the activity concerning this project has been in the courts. The Tsilhqot'in Nation challenged the 2017 permit arguing the province breached its duty to consult and accommodate. In 2019, the case reached the Supreme Court of Canada, which ruled that Taseko could proceed with the investigative work. However, before the work could begin, the Tsilhqot'in Nation filed a complaint on different grounds, infringement of aboriginal rights, and a new injunction halted the work.

**Table 3.** Selected proposed mines or quarries, South Central Region.

<b>Project</b>	<b>Operator (partner)</b>	<b>Commodity; deposit type; MINFILE</b>	<b>Reserves</b>	<b>Resource</b>	<b>Comments</b>
<b>Ajax</b>	<b>KGHM Ajax Mining Inc. (KGHM Polska Miedź SA 80%, Abacus Mining and Exploration Corporation 20%)</b>	Cu, Au; Alkalic porphyry; 092INE012, 13	P+Pr (NSR cut-off US\$7.10/t): 426 Mt grading 0.29% Cu; 0.19 g/t Au; 0.39 g/t Ag	M+I (NSR cut-off US\$7.10/t): 568 Mt grading 0.26% Cu; 0.18 g/t Au; 0.35 g/t Ag	Environmental certification denied by provincial (2017) and federal ministers (2018).
<b>Bralorne</b>	<b>Avino Silver and Gold Mines Ltd. (Talisker Resources Ltd. acquiring Bralorne Gold Mines Ltd.)</b>	Au; Au-quartz veins; 092JNE001	na	577,559 t 9.6 g/t Au	Past producer 1900-1971. Operated on a trial basis 2010-2014. Updated 100 tpd permit in 2017. Exploration in 2018-2019 included drilling, airborne and ground geophysics, mapping, and geochemical sampling.
<b>Cariboo Gold Project</b>	<b>Barkerville Gold Mines Ltd. (acquired by Osisko Gold Royalties Ltd.)</b>	Au; Au-quartz veins; 093H 140, 139, 19, 6	na	M+I (cut-off 3.0 g/t Au): 13.495 Mt 5.6 g/t Au Inf (3.0 g/t cut-off): 11.936 Mt 5.0 g/t Au	PEA has u/g mine with 11-year mine life, average 185,000 oz/y Au. In EA pre-application stage. Exploration continued with 91,000 m drilling.
<b>New Prosperity</b>	<b>Taseko Mines Limited</b>	Cu, Au; Porphyry; 092O 041	P+Pr (NSR cut-off \$5.50/t): 831 Mt grading 0.23% Cu and 0.41 g/t Au; containing (recoverable) 3.6 Blb Cu; 7.7 Moz Au	M+I (cut-off 0.14% Cu): 1010 Mt grading 0.24% Cu; 0.41 g/t Au	Project at post-decision stage. Granted provincial environmental certificate but denied federal approval. Exploration and site evaluation proposed in 2019 but deferred pending a new legal challenge.
<b>Ruddock Creek</b>	<b>Ruddock Creek Mining Corporation (Imperial Metals 45.3%, Mitsui Mining and Smelting Co. 30%, ITOCHU Corp. 20%, JOGMEC 4.7%)</b>	Pb, Zn, Ag; Broken Hill-type; 082M 082	na	M+I (cut-off 4.0% Pb+Zn): 6.2 Mt grading 6.50% Zn, 1.33% Pb	Project at environmental assessment pre-application stage. Exploration drilling continued in 2019. Highlight 40.9 m 16.83% Zn, 3.46% Pb, 4.74 g/t Ag. Japan Oil, Gas and Metals National Corporation earning an interest.
<b>Spanish Mountain</b>	<b>Spanish Mountain Gold Ltd.</b>	Au, Ag; Au-quartz veins; 093A 043	na	M+I (cut-off 0.15 g/t Au): 273.2 Mt grading 0.47 g/t Au; 0.71 g/t Ag Inf: 52.4 Mt 0.37 g/t Au, 0.67 g/t Ag	Project at environmental assessment pre-application stage. Preliminary economic assessment updated in 2019.
<b>Yellowhead</b>	<b>Taseko Mines Limited</b>	Cu, Au, Ag; Noranda/Kuroko; 082M 008, 9	P+Pr (cut-off 0.14% Cu): 716 Mt grading 0.26% Cu; 0.029 g/t Au; 1.18 g/t Ag	M+I (cut-off 0.2% Cu) 815 Mt 0.28% Cu; 0.030 g/t Au; 1.3 g/t Ag	BC Environmental Assessment Office terminated EA process 2018. Taseko Mines Limited acquired the project and plans to advance it.

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

### 6.5. Ruddock Creek (Imperial Metals Corporation 45.3%; Mitsui Mining and Smelting Co. Ltd. 30%; Itochu Corporation 20%; Japan Oil, Gas and Metals National Corporation 4.7%)

The project remains in the pre-application phase of environmental assessment. A mineral resource estimate, released in March 2012, reported 4.65 Mt grading 6.77% Zn and 1.38% Pb (Indicated) and 5.38 Mt grading 6.69% Zn and 1.31% Pb (Inferred), using a 4.0% combined Pb+Zn cut-off. Ruddock Creek Mining Corporation is the operator and manager of the joint venture. JOGMEC funded the 2019 program and their share in the venture increased.

The deposit is described as sedimentary exhalative, Monashee or Broken Hill-type, in marble, gneiss, and calc-silicate rocks. The joint venture operators followed up on positive 2018 results by drilling a total of 8800 m in 17 holes on the Q and V zones at the western edge of the **Ruddock Creek** massive sulphide prospect. A highlight from the deep V zone was 40.9 m grading 16.83% Zn, 3.46% Pb and 4.74 g/t Ag.

### 6.6. Spanish Mountain (Spanish Mountain Gold Ltd.)

Spanish Mountain updated their preliminary economic assessment, evaluating an initial, optimized phase that would focus on a central, pit-constrained near-surface area of the deposit. The larger Measured and Indicated resources are 273.2 Mt grading 0.47 g/t Au, 0.71 g/t Ag. In this phase one scenario, 39 Mt at an average diluted grade of 1.00 g/t Au and 0.74 g/t Ag would feed an 11-year, 10,000 tpd operation with average life of mine production of 104,000 oz/y Au. The project has been in the pre-application phase of environmental assessment since 2011. Current efforts are directed more toward optimization studies than environmental certification.

The **Spanish Mountain** deposit consists of disseminated gold in graphitic argillite and gold-bearing quartz veins in siltstone, greywacke, and tuff. Host rocks are Upper Triassic and mineralization is Late Jurassic, older than that at the Cariboo Gold project (Allan et al., 2017). Spanish Mountain is typically compared to sediment-hosted vein deposits.

### 6.7. Yellowhead (Taseko Mines Limited)

The British Columbia Environmental Assessment Office terminated Yellowhead Mining Inc.'s Harper Creek copper project assessment in 2018. However, in early 2019, Taseko Mines Limited acquired Yellowhead Mining, renamed the project **Yellowhead** and is evaluating advancing it. A 2014 feasibility study considered a 70,000 tpd open-pit mine with a 28-year life, based on Proven and Probable reserves of 716.2 Mt at 0.26% Cu, 0.029 g/t Au and 1.18 g/t Ag.

Although porphyry-like in tonnage and grade, **Yellowhead** is generally considered a marine volcanogenic and syngenetic deposit. It is hosted by metavolcanic and metasedimentary rocks of the Eagle Bay assemblage (Lower Cambrian to Mississippian).

## 7. Selected exploration activities and highlights

In 2019, as in 2017 and 2018, the largest exploration project in the region was Barkerville Gold Mines Ltd.'s **Cariboo Gold** (see section 6.3.). Avino Silver & Gold Mines Ltd. continued drilling at **Bralorne**, (see section 6.2.). Westhaven Ventures Inc. followed last year's discovery with a larger drill program at **Shovelnose**. Exploration continued for other gold targets, porphyry copper deposits, skarn deposits (copper; tungsten), stratiform base and precious metals, cobalt-bearing veins, mafic- and ultramafic-hosted sulphides, and industrial minerals (Fig. 1; Table 4).

### 7.1. Selected precious metal projects

The South Central Region has many precious metal deposit types including: orogenic veins; transitional veins; epithermal veins; hot spring systems; replacement deposits; skarns; sediment-hosted deposits; and intrusion-related breccias. Several more properties were active than listed below.

#### 7.1.1. Shovelnose (Westhaven Ventures Inc.)

Westhaven focussed on drilling the **Shovelnose** low-sulphidation epithermal prospect again in 2019 with a planned 20,000 m program. They are on track to reach that target by the end of the year. They have now identified three northwest-trending gold-bearing vein zones at the South Zone (Fig. 2). Vein zone 1 has been extended along strike for about 1000 m with a vertical extent of 300 m. Zone 2 has a 460 m strike length and zone 3 has a 170 m strike length. The company also reported seven new epithermal targets, including drill targets outside the South Zone, resulting from prospecting, ground magnetic (327 line km), soil (more than 6000 samples) and resistivity surveys (18 km).



**Fig. 2.** Quartz, chalcedony and adularia veining with ginguero (black) in lapilli tuff at Westhaven Ventures Inc.'s Shovelnose project.

#### 7.1.2. Lac La Hache (Engold Mines Ltd.)

Engold Mines Ltd. drilled its **Lac La Hache** project in early 2019, stepping out at the Aurizon target. Initial results extended narrow quartz-carbonate gold veins along strike. Engold resumed drilling late in the year and carried out soil surveys on

**Table 4.** Selected exploration projects, South Central 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>Amarillo</b>	<b>Troubadour Resources Inc.</b>	Cu; L04:Porphyry Cu±Mo±Au; 082ENW108	na	Mapping, sampling, drilling 1075 m in 4 holes.
<b>BC Cobalt</b>	<b>Blackstone Minerals Ltd.</b>	Co, Au; I14:Five-element veins Ni-Co-As- Ag+/(Bi, U); 092JNE068, 108	na	Mapping, stream sediment and soil sampling.
<b>Big Kidd</b>	<b>Jiulian Resources Inc.</b>	Cu, Ag, Au; L03:Porphyry Cu-Au; 092HNE072, 73, 74, 109	na	Drilling 4191.5 m in 9 holes.
<b>Blackdome-Elizabeth</b>	<b>Tempus Resources Ltd.</b>	Au, Ag; I01: Au- quartz veins, H05:Epithermal Au-Ag-Cu low- sulphidation; 092O 053, 012	I: 144,500 t 11.29 g/t Au, 50.01 g/t Ag Inf: 90,600 t 8.79 g/t Au, 18.61 g/t Ag	Tempus acquired Sona Resources Corp. Initial soil sampling, update of resource estimate. Notice of Work for drilling in process.
<b>Black Duck</b>	<b>Karam Minerals Inc.</b>	Au, Ag; I01: Au-quartz veins; 092P 092	na	Till and soil samples.
<b>Donna</b>	<b>Pinnacle North Gold Corp. (Eagle Plains Resources Ltd.)</b>	Au, Ag; I05: Polymetallic veins; 082LSE022, 10, 20, 16	na	One hole drilled. Further work permitted.
<b>Elk</b>	<b>Bayshore Minerals Inc.</b>	Au, Ag; I01: Au- quartz veins; 092HNE009, 295, 41, 261	M+I: 1,042,600 t 6.32 g/t Au Inf: 1,096,900 t 5.94 g/t Au	Bayshore is new owner. Airborne geophysics, environmental baseline sampling.
<b>Fairview</b>	<b>Gold Lion Resources Inc.</b>	Cu, Zn, Pb, Ag; I05: Polymetallic veins; 092INW037, 52, 58, 59	na	Airborne magnetic survey (466 km), rock sampling.
<b>Fox</b>	<b>Happy Creek Minerals Ltd.</b>	W; K05: W skarns; 093A 259, 260, 261, 211	I: 582,000 t 0.826% WO <sub>3</sub> Inf: 565,400 t 1.231% WO <sub>3</sub>	Step-out drilling near Nightcrawler zone. 372.5 m in 2 holes.
<b>Hedge Hog</b>	<b>Surge Exploration Inc.</b>	Cu, Pb, Zn, Co; G05: Cyprus massive sulphide Cu (Zn); 093H 156	na	29 test pits.

Table 4. Continued.

<b>Iron Lake</b>	<b>GK Resources Ltd.</b>	Cu, Pt, Pd, Au, Co; M05:Alaskan type?; 092P 132, 113, 182, 222	na	IP survey, rock sampling.
<b>Juniper Creek</b>	<b>ZMM Canada Minerals Corp.</b>	Zeolite; D01:Open-system zeolites	na	Bulk sample.
<b>Lac La Hache</b>	<b>Engold Mines Ltd.</b>	Cu, Au, Ag, Fe; L03:Alkalic porphyry Cu-Au, K01:Cu skarn; 092P 120, 108, 2	I: 7.60 Mt 0.28% Cu, 0.05 g/t, 1.26 g/t Ag, 11.4% magnetite Inf: 15.8 Mt 0.21% Cu, 0.04 g/t Au, 0.93 g/t Ag, 8.32% magnetite Inf: 1.073 Mt 2.480 g/t Au, 0.64% Cu, 5.98 g/t Ag (Aurizon)	Diamond drilling (1276 m, 9 holes), soil sampling. Highlight 6.18 g/t Au, 0.80% Cu and 2.63 g/t Ag across 4.55 m.
<b>Miner Mountain</b>	<b>Sego Resources Inc.</b>	Cu, Au; L03:Alkalic porphyry Cu-Au; 092HSE203, 78	na	Trenching results reported early in the year included 18 m grading 0.96% Cu and 0.31 g/t Au. New drill targets identified.
<b>MPD</b>	<b>Dunedin Ventures Inc.</b>	Cu, Au; L03:Alkalic porphyry Cu-Au; 092HNE243, 55, 191, 244	na	1766 m diamond drilling in 3 holes. Surface trench sample 0.89% Cu across 46 m.
<b>Merit</b>	<b>Independence Gold Corp.</b>	Au, Ag; H05:Epithermal Au-Ag; 092ISW106	na	Prospecting, rock sampling, ground magnetic survey, metallurgy. Sample highlight 9.5 g/t Au and 341 g/t Ag.
<b>Mont</b>	<b>Leo Lindinger</b>	Bentonite; E06:Bentonite	na	3 drill holes-all intersected bentonite clay.
<b>New Craigmont</b>	<b>Nicola Mining Inc.</b>	Cu, Au; K01:Cu skarn; 092ISE035	na	Results of 2018 drilling released, additional drilling 2019. Highlights 84.00 m 0.34% Cu, 44 m 0.45% Cu, 13.00 m 0.65% Cu with magnetite. Soil geochemistry, mapping.
<b>Nicoamen</b>	<b>Independence Gold Corp.</b>	Au; H05:Epithermal Au-Ag-Cu low sulphidation; 092ISW132, 131	na	Mapping, sampling, ground magnetic survey. Samples grading 3.91 and 4.56 g/t Au.
<b>North Brenda</b>	<b>Bitterroot Resources Ltd.</b>	Au, Ag; I01:Au-quartz veins, J01:Polymetallic mantos?; 092HNE318, 294	na	IP and gravity surveys. New carbonate replacement targets.
<b>Olivine Mountain</b>	<b>GSP Resources Corp.</b>	Cu, Au, Pd; M05:Alaskan type; 092HNE201, 092HSE095, 141, 39	na	Approx. 1200 m in 7 holes.
<b>Pellaire</b>	<b>Blue Lagoon Resources Inc.</b>	Au, Ag; I05:Polymetallic veins	na	Ground magnetic survey, IP, rock geochemistry.

Table 4. Continued.

<b>Perk-Rocky</b>	<b>Ethos Gold Corp.</b>	Cu, Au; I01: Au-quartz veins, L04: Porphyry?; 092N 011, 12, 53	na	Mapping, rock sampling, stream sediment and talus geochemistry, airborne VTEM and magnetic survey (657 line km).
<b>Princeton Gold</b>	<b>Canarc Resource Corp.</b>	Au; I01: Au-quartz veins; 092HSE262, 263	na	Trenching (500 m), mapping, sampling.
<b>Rateria-West Valley</b>	<b>Happy Creek Minerals Ltd.</b>	Cu, Mo, Au, Ag Re; L04: Porphyry Cu±Mo±Au; 092ISE199	na	Mapping, rock sampling, 3-D IP, aerial photography.
<b>Shovelnose</b>	<b>Westhaven Ventures Inc.</b>	Au; H05: Epithermal Au-Ag-Cu low sulphidation; 092HNE309, 308	na	Approx. 20,000 m in 50 holes. Third vein zone intersected in South zone. New targets identified in regional prospecting, ground magnetic, soil, and resistivity surveys.
<b>Spences Bridge</b>	<b>Talisker Resources Ltd.</b>	Au, Ag; H05: Epithermal Au-Ag-Cu low sulphidation; 092O 054, 60, 143, 092INW092, 110, 092ISW118, 124, 84	na	Regional stream-sediment survey, prospecting.
<b>Spius</b>	<b>Pacific Ridge Exploration Ltd.</b>	Cu, Mo; L04: Porphyry Cu±Mo±Au; 092HNW027	na	Diamond drilling 1087 m in 4 holes.
<b>Treasure Mountain</b>	<b>Nicola Mining Inc.</b>	Ag, Pb, Zn; I05: Polymetallic veins; 092HSW066, 117, 48, 116, 092HSE240, 136, 261, 75	I: 33,000 t 828 g/t Ag, 3.80% Zn, 4.16% Pb Inf: 120,000 t 925.6 g/t Ag, 4.36% Zn, 2.79% Pb	Soil sampling.
<b>Treasure Mountain Silver</b>	<b>New Destiny Mining Corp.</b>	Ag, Au, Cu, Zn; I05: Polymetallic veins Ag-Pb-Zn±Au, L04: porphyry?; 092HSW066, 117, 092HSE240	na	Trenching, access, diamond drilling (4 holes, 102 m)

M = Measured; I = Indicated; Inf = Inferred

four target areas. Drill results included 6.18 g/t Au, 0.80% Cu and 2.63 g/t Ag across an interval of 4.55 m.

**Lac La Hache** has several different target types related to alkalic intrusions. Copper skarns have had much of the recent exploration attention, but there are also porphyry targets and the Aurizon Au-Ag-Cu vein and breccia zone which has a maiden resource estimate (Table 4).

### 7.1.3. Spences Bridge regional program (Talisker Resources Ltd.)

Prompted by early signs of a significant epithermal gold discovery at Westhaven's **Shovelnose**, Talisker Resources now holds claims covering most of the Spences Bridge belt, which consists of Lower Cretaceous calc-alkaline volcanic rocks extending for 220 km along a northwest trend (Fig. 3).

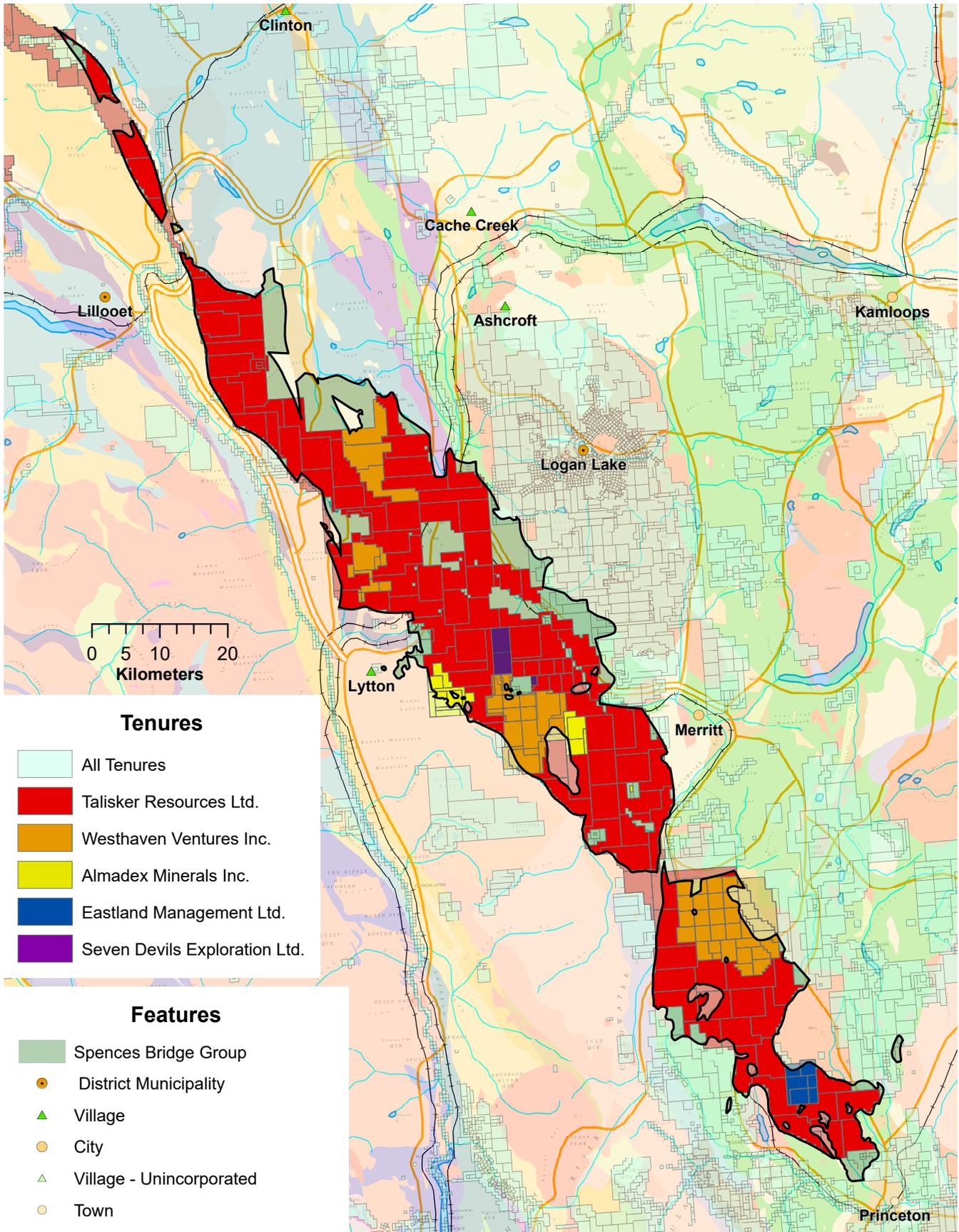


Fig. 3. Mineral tenure ownership covering the Spences Bridge Group.

Talisker is prospecting for epithermal mineralization (Fig. 4) and conducting regional stream-sediment sampling to identify targets. They have also been working on a nearby property covering a target area they call the Remington Belt north of the Bridge River camp in Bridge River complex and Taylor Creek Group rocks. They recently acquired Bralorne Gold Mines Ltd. (see above).



Fig. 4. Epithermal textures (crustiform quartz, chalcedony veining) in hand specimens collected in Talisker Resources Ltd.'s regional exploration of the Spences Bridge belt.

#### 7.1.4. Elk (Bayshore Minerals Inc.)

Bayshore acquired the **Elk** gold project in May. Initial work included a site-wide airborne magnetic and gamma-ray spectrometric survey. They also completed a lidar survey over workings, and baseline environmental monitoring to update existing hydrology, hydrogeology, water quality, and ecological data. Bayshore is currently a private company. **Elk** produced about 51,500 oz of gold between 1992 and 1995 from 14,730 t of ore, mainly from an open pit. Bulk sampling resumed in 2012-2014 when 7761 t with average grade 14.81 g/t were processed. Gold is hosted in quartz-sulphide veins, mainly in the Osprey Lake batholith (Middle Jurassic) near an intrusive contact with Nicola Group volcanic rocks. The quartz veins may be related to later Otter feldspar porphyry dikes and stocks.

#### 7.1.5. Blackdome-Elizabeth (Tempus Resources Ltd.)

Tempus Resources Ltd. acquired the **Blackdome-Elizabeth** project when it bought Sona Resources Corp., a subsidiary of Skeena Resources Ltd. Initial work by Tempus consisted of soil geochemistry and beginning a Joint Ore Reserves Committee-compliant update of mineral resources to include 2010-2011 drilling. They propose additional drilling. Skeena Resources filed a Notice of Work before the sale. The linked Blackdome and Elizabeth properties were the subject of a 2010 preliminary economic assessment in which mining would occur at both sites, with processing at an existing mill at Blackdome. Blackdome is a low-sulphidation epithermal deposit in Cenozoic intermediate to felsic volcanic rocks. Elizabeth, 30 km south, is a series of veins in a Paleocene quartz diorite intrusion in the Shulaps Ultramafic complex. Historically they have been compared to the Bralorne-Pioneer orogenic deposits.

#### 7.1.6. Donna (Pinnacle North Gold Corp. 60%; Eagle Plains Resources Ltd. 40%)

Pinnacle North Gold Corp. optioned the **Donna** project from Eagle Plains Resources Ltd. and drilled one hole. Targets include epithermal and intrusion-related gold veins. Au-Ag-Pb-Zn skarn mineralization is also known. Previous drilling intersected 2.0 m of 8.9 g/t Au. Recent work included an airborne magnetic survey and soil geochemistry. A multi-year permit allows for additional drilling.

#### 7.1.7. Pellaire (Blue Lagoon Resources Inc.)

Recently-listed Blue Lagoon Resources Inc. started work at the Pellaire property with soil and rock sampling and a ground magnetic survey. Anomalous results at the John Henry prospect led them to propose follow up and restoration of damaged access. Pellaire was bulk sampled in the 1990s. Quartz veins with gold, silver, and bismuth telluride were the target.

#### 7.1.8. Princeton Gold (Canarc Resource Corp. 75%; Universal Copper Ltd. 25%)

Late in 2018 Canarc optioned the **Princeton Gold** property and completed a 2350 line-km aeromagnetic survey. Subsequent work included interpretation of the aeromagnetic results, mapping, sampling, and 500 m of trenching. Targets are gold-bearing quartz veins.

#### 7.1.9. Merit (Independence Gold Corp.)

Independence Gold Corp. identified seven gold targets at the **Merit** property in the Spences Bridge belt, based on surface rock samples. A sample from Sullivan Ridge graded 9.5 g/t Au and 341 g/t Ag. They also commissioned a ground magnetic survey over the property. Early-stage metallurgical testing yielded gold recoveries of 99.5% and 96.6% using gravity, flotation, and cyanide leach.

#### 7.1.10. Nicoamen (Independence Gold Corp.)

Independence reported initial results from the **Nicoamen** property, also in the Spences Bridge belt, including surface samples grading 3.91 and 4.56 g/t Au. They mapped the property and completed a ground based magnetic survey.

#### 7.1.11. Black Duck (Karam Minerals Inc.)

Karam Minerals reported a till survey, soil survey, hand trenching, and prospecting at the **Black Duck**, a property acquired by staking in 2018. The work follows mapping, magnetic, and geochemical surveys in 2018. Targets are gold-bearing quartz veins similar to the Vidette epithermal past-gold producer to the west.

#### 7.1.12. Treasure Mountain (Nicola Mining Inc.)

At the **Treasure Mountain** property, Nicola Mining started a soil geochemistry survey, to be completed in 2020. The silver mine produced in 2013 and is currently on care and maintenance. It has a permit for removal of 60,000 tpy to a mill

offsite. Silver-lead-copper mineralization is in fault-hosted, sulphide-rich, quartz-carbonate veins.

## 7.2. Selected porphyry projects

More than 12 exploration projects focussed on porphyry deposits in 2019. Continuing work at Copper Mountain Mining Corporation's **New Ingerbelle**, and near-pit drilling at **Copper Mountain** have added years to mining operations (see section 3.1.2.). Exploration at New Gold Inc.'s **New Afton** may also add to reserves.

### 7.2.1. Big Kidd (Jiulian Resources Inc.)

Jiulian drilled more than 4191 m in 9 holes at the **Big Kidd** project in the Aspen Grove camp. Step-out holes targeting the Bigg Kidd breccia zone encountered porphyry-style alteration and low-grade copper-gold mineralization. One hole intersected a second zone of mineralization and alteration at depth, including potassic alteration. The hole terminated due to drilling difficulty. Another deep hole is under consideration. The **Big Kidd** project is targeting Late Triassic alkalic porphyry Cu-Au mineralization.

### 7.2.2. MPD (Dunnedin Ventures Inc.)

Dunnedin carried out 1766 m of drilling in 3 holes, mapping, prospecting, and sampling at their **MPD** Porphyry project. MPD is a consolidation of the Man, Prime, and Dillard alkalic porphyry Cu-Au targets. Significant surface results include 0.89% Cu across 46 m in a trench sample at the Man area, and grab sample results of 0.80% Cu with 0.32 g/t Au at Dillard, 2 m of 0.49% Cu with 0.26 g/t Au and a grab sample grading 1.03 g/t Au with 9.40 g/t Ag at Prime.

### 7.2.3. Spius (Pacific Ridge Exploration Ltd.)

Pacific Ridge drilled 1087 m in 4 holes at **Spius**, encountering low-grade copper-molybdenum mineralization and porphyry style mineralization. They note the highest grades at the bottoms of two holes and in the north of their target area.

### 7.2.4. Amarillo (Troubadour Resources Inc.)

Troubadour drilled 1075 m in four holes. Three targeted a coincident geochemical, IP and magnetic anomaly and the fourth a chargeability high. Before drilling they carried out mapping, prospecting, and sampling. **Amarillo** is about 10 km south of the **Brenda** past-producing Cu-Mo porphyry. Like **Brenda**, the target is calc-alkaline porphyry mineralization related to the underlying Pennask batholith.

### 7.2.5. Rateria-West Valley (Happy Creek Minerals Ltd.)

Happy Creek Minerals Ltd. carried out 3D IP surveys over two newly identified target areas, the PIM and Abbott prospects, on the West Valley part of the **Rateria-West Valley** property. The geophysics followed geological mapping, prospecting, and high-resolution aerial photography. Initial surface grab samples returned 5 m of 0.41% Cu and 10 m of 0.29% Cu with trace Mo. Samples at Abbott returned 0.21 and 0.51% Cu. The **Rateria-**

**West Valley** property is in the Guichon batholith south of the Highland Valley Copper mine.

### 7.2.6. Treasure Mountain Silver (New Destiny Mining Corp.)

New Destiny Mining Corp. drilled and trenched at the **Treasure Mountain Silver** project. The first holes were to test a porphyry copper-gold target (Superior), the site of recent trenching and historical trenches and adits. The property partially surrounds the Treasure Mountain silver mine.

### 7.2.7. Perk-Rocky (Ethos Gold Corp.)

Ethos optioned and conducted a mapping program at the grass roots stage **Perk-Rocky**, including 89 rock samples, 500 talus samples, and 39 stream-sediment samples. The work revealed numerous occurrences of chalcopyrite+/-bornite+/-Cu oxide and propylitic alteration. They also flew a 657 line-km VTEM and magnetic survey.

### 7.2.8. Worldstock (Pacific Empire Minerals Corp.)

Pacific Empire Minerals conducted a preliminary soil survey at their recently optioned **Worldstock** project. The company has submitted a Notice of Work for drilling. **Worldstock** is an early-stage porphyry Cu-Au target in Nicola Group volcanic and sedimentary rocks intruded by the Thuya batholith and Polaris ultramafic suite to the southwest and by a small diorite stock to the northeast.

### 7.2.9. Mackenzie Copper (Carube Copper Corp.)

Carube Copper completed mapping and sampling at **Mackenzie Copper**, following porphyry style mineralization in the Hurley River pluton, part of the Scuzzy plutonic suite at the northeastern margin of the Coast Plutonic Complex.

### 7.2.10. Miner Mountain (Sego Resources Inc.)

At **Miner Mountain**, Sego Resources identified new targets through data compilation and reviewing existing drill core. Trench sampling returned 18 m grading 0.96% Cu and 0.31 g/t Au early in the year. Multiple targets at Miner Mountain are alkalic copper-gold type. Sego reported targets at the Cuba, Empress, South and Sovereign zones for potential drilling in 2020. They have a multi-year permit for drilling and trenching.

## 7.3. Selected polymetallic base and precious metal projects

The region has numerous polymetallic massive sulphide prospects, including those hosted by the Eagle Bay assemblage (e.g., Harper Creek, Samatosum, Rea) and other Paleozoic strata. Although a few were active in 2019, most projects focused on polymetallic vein targets.

### 7.3.1. BC Cobalt (Blackstone Minerals Limited)

Blackstone conducted mapping, stream-sediment, and soil sampling at its **BC Cobalt** project, formerly called the Little Gem. Targets are cobalt-gold bearing veins, and copper-gold veins in the northwestern Bridge River camp. Blackstone

sees similarities in geological setting to the Bou-Azzer cobalt district of Morocco where economic cobalt mineralization is found near a contact between serpentinite and quartz diorite. Mineralization at **BC Cobalt** is near the contact between the Bralorne-East Liza complex (Permian) and a Late Cretaceous granodioritic intrusion of the Coast Plutonic Complex.

### 7.3.2. Hedge Hog (Surge Exploration Inc. 60%; Eastfield Resources Ltd. 40%)

Surge Exploration Inc. trenched at the **Hedge Hog** project, following up soil geochemistry anomalies from a 2018 survey. The primary target is VMS mineralization, the presence of which is suggested by sulphide boulders discovered in the 1990s. Of 29 excavations, 25 reached bedrock. Surge Exploration announced in December they would be dropping the option for 60% interest.

### 7.3.3. Fairview (Gold Lion Resources Inc.)

Gold Lion flew a 466 line-km airborne magnetic survey over its **Fairview** property, acquired in 2018 by staking. They also reported rock samples anomalous in Cu (1.48%, 1.24%) and Zn (1.78%). Polymetallic vein mineralization is known at several locations on the property.

### 7.3.4. North Brenda (Bitterroot Resources Ltd.)

Bitterroot conducted IP and gravity surveys on its **North Brenda** property. They have identified six areas of potential carbonate replacement-type mineralization at the Summit zone, where they propose drilling.

## 7.4. Selected skarn projects (tungsten, copper, gold)

Historically, copper skarns have been important sources of high-grade ore. One, the Craigmont mine, has been re-activated as the **New Craigmont** exploration project. One tungsten skarn project, the **Fox**, has recently been active.

### 7.4.1. New Craigmont (Nicola Mining)

Nicola Mining announced results of 2018 drilling on both historically mined material piled in waste terraces and in the Craigmont Central zone early in the year. They carried out additional drilling to test the Central zone in 2019. Highlights from the No. 3 mineralized body include 84.00 m 0.34% Cu, 44 m 0.45% Cu, and 13 m 0.65% Cu with magnetite. Other work included soil geochemistry, mapping, analysis of historic core, and multispectral mapping. They are also developing a resource estimate for the Craigmont mine waste terraces. The material was tested using X-ray transmission sorting technology. In five out of eight tests, grades were increased to greater than 1% Cu with up to 50% Fe. They are also carried out flotation tests.

The Merritt Mill is at the Craigmont mine site. It has undergone about \$3 million in recent modifications but is not yet recommissioned. The mill is a 200 tpd crushing, grinding, and flotation mill with a gravity jig and table. Originally constructed in 2012 to process ore from Treasure Mountain,

Nicola operates it as a custom mill and uses the Craigmont tailings storage facility.

### 7.4.2. Fox Tungsten (Happy Creek Minerals Ltd.)

Happy Creek Minerals drilled 372.5 m in two holes near the Nightcrawler zone at its **Fox Tungsten** project. Fox is a tungsten skarn project with an existing resource of 582,400 t 0.826% WO<sub>3</sub> (Indicated) and 565,400 t 1.231% WO<sub>3</sub> (Inferred) at Ridley Creek and BN zones. The two holes were drilled 400 m apart at the Nightcrawler zone, south of the existing resource area. Results included 6.3 m 0.43% WO<sub>3</sub> in one hole and 4.0 m 0.29% WO<sub>3</sub> in the other.

## 7.5. Selected mafic and ultramafic hosted projects

Recent interest in cobalt and platinum-group metals has stimulated exploration on several properties.

### 7.5.1. Olivine Mountain (GSP Resources Corp.)

GSP Resources had a seven-hole 1200 m November drill program at its **Olivine Mountain** project in the Tulameen complex. Grab sampling returned encouraging Cu, Au, and Pd values from target areas and initial drilling intersected visible sulphide. Drilling follows mapping, soil geochemistry, and an airborne VLF-EM survey in 2018. The Tulameen complex is an Alaskan-type Late Triassic mafic-ultramafic intrusion.

### 7.5.2. Iron Lake (GK Resources Ltd. 60%; Eastfield Resources Ltd. 40%)

Eastfield reported an IP survey at **Iron Lake**. GK Resources is an optionee. The property covers a multiphase mafic-ultramafic intrusion that hosts disseminated sulphide copper-gold mineralization with anomalous platinum and palladium, and massive sulphide mineralization with copper, nickel, and cobalt values. Gold values in rock and soil are reported in Nicola Group rocks east of the intrusion.

## 7.6. Selected specialty metals and industrial mineral projects

Exploration for industrial minerals often goes unreported. Probably the most common type of exploration is bulk sampling for test marketing purposes. A few industrial minerals explorers have reported their work.

### 7.6.1. Mont (Leo Lindinger)

Following test pits in 2018, Leo Lindinger drilled the **Mont** property, a bentonite prospect in an accessible area. All 3 holes intersected bentonite clay (Fig. 5). Results so far suggest this is a large deposit. Historically the area has been explored mainly for gold, copper, zinc, and silver in epithermal, hot spring or porphyry and transitional vein environments. Recognition of a potentially economic bentonite deposit is recent.

### 7.6.2. Juniper Creek (ZMM Canada Minerals Corp.)

ZMM is permitted to bulk sample zeolite at its **Juniper**



**Fig. 5.** Bentonite clay in drill core at the Mont bentonite prospect. Photo courtesy of L. Lindinger.

**Creek** project for test marketing. Several species are present, including analcime, chabazite, clinoptilolite, phillipsite, levyne-Ca. The company also have Notices of Work in process for two other locations.

## 8. Geological research

Plouffe and Ferbey (2019) published an indicator mineral study for the Gibraltar and Woodjam deposits, examining mid-density and heavy bedrock sample concentrates for minerals that have the potential to be used as porphyry copper indicator minerals. Shewchuk et al. (2020) examined major oxides and pathfinder elements in subglacial till near the Guichon Creek batholith for potential use as exploration tools. Norris and Fortin (2019) have taken an initial step toward digitizing geochemical data submitted for assessment. They assembled a digital database, taking geochemical data from soil, silt, stream-sediment, and till analyses on more than 34,000 samples included in 120 assessment reports from the Interior Plateau. Schiarizza (2019) summarized stratigraphic studies focussed on the Nicola Group between Quesnel and Kamloops and Schiarizza et al (2020) report new U-Pb zircon detrital ages from the Gun Lake unit in the Bridge River area.

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