

Exploration and mining in the South Central Region, British Columbia



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1. Introduction

South Central region (formerly Thompson-Okanagan-Cariboo) was established as an administrative area in 2010 after the province reorganized its natural resource agencies. In 2016 the Ministry of Energy and Mines resumed the use of an older name for the region, while retaining its newer boundaries.

For over 150 years the region has been a locus of mining. It is now home to five of BC's largest metal mines, several industrial mineral mines, and many small placer operations, gravel pits and rock quarries. Mineral products include: copper; molybdenum; gold; silver; limestone; bentonite; zeolite; diatomaceous earth; high-alumina shale; precious opal; dimension stone; and aggregate. The region's diverse geology, natural endowment, infrastructure (road, rail, power), and skilled workers sustain the search for new deposits.

In 2016, two limestone quarries (**Pavilion and Harper Ranch**) and related processing operations were placed on care and maintenance due to weak demand. All metal mines reported relentless efforts to reduce costs in the face of low metal prices. **Gibraltar** mine restarted its molybdenum circuit (closed since 2015). Other major metal mines recorded improvements in mining or milling, but small metal mines remained on care and maintenance.

Two projects (**Bethlehem; Bonanza Ledge**) entered formal environmental review under the Minister's permit process. The **Ajax** project, its review well underway, saw steady progress but with a much smaller staff. The **Prosperity** project (which has received provincial but not federal environmental approval) submitted plans for a detailed site investigation.

Exploration focused on defining or expanding porphyry and porphyry-related deposits (copper-gold; copper-molybdenum), gold deposits of various types, and stratiform base-metal deposits, but also included some industrial minerals (limestone; basalt). This year's pace of exploration closely matched last year's, hinting that the steady decline since late 2011 has slowed. Many projects were inactive because operators were unable to raise venture capital or unwilling to spend it in the region.

As a pilot project, the Ministry of Energy and Mines partnered with the Association for Mineral Exploration and Ernst & Young LLP to develop a comprehensive online survey

of exploration data to replace surveys previously conducted by Ministry geologists. For the South Central region, exploration expenditures are estimated to be \$43.5 million; exploration drilling is estimated at 103,000 metres (Clarke et al., this volume; Ernst & Young LLP (E&Y), 2017 in press).

The geological overview section was written by Paul Schiarizza of the British Columbia Geological Survey (and first published in Britton, 2015). It is reproduced here with only minor changes.

2. Geological overview by Paul Schiarizza, BCGS

The tectonic and metallogenic evolution of the Canadian Cordillera are intimately linked (Fig. 1, e.g., Nelson et al., 2013; Colpron and Nelson, 2011). 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, shown on Figure 1, include Jura-Cretaceous siliciclastic and local volcanic rocks, Eocene volcanic rocks, Neogene and Quaternary basalt, and Middle Jurassic to Eocene granitic intrusions.

2.1. Cratonic and pericratonic terranes

The Monashee complex, partly represented by a narrow belt along the eastern edge of the region, comprises Paleoproterozoic orthogneiss, interpreted as part of the North American craton, overlain by a Neoproterozoic to Paleozoic cover sequence that includes quartzite, pelitic schist, calc-silicate schist and marble (Armstrong et al., 1991). Basement gneisses, including the Malton gneiss, are also exposed to the north, near Blue River, where they are associated with Neoproterozoic sedimentary sequences (Windermere Supergroup) that were deposited following initial rifting that formed the western margin of ancestral North America (McDonough and Parrish, 1991; Murphy et al., 1991). Extending northwestward from there, Cariboo terrane comprises Neoproterozoic to mid-Paleozoic siliciclastic and carbonate rocks, represented by the Kaza, Cariboo and Black Stuart groups, which are interpreted as distal facies of the North American platform (Struik, 1988a).



Kootenay terrane comprises Neoproterozoic to mid-Paleozoic rocks that are interpreted as deep-water basin 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 extensional deformation (Colpron and Price, 1995). This belt also includes Devonian-Mississippian calc-alkaline to alkaline volcanic rocks and associated granitoid intrusions, found mainly in the Eagle Bay assemblage east and southeast of Clearwater (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 occurrences, as well as the Harper Creek bulk tonnage copper deposit.

2.2. Arc and oceanic terranes

Slide Mountain terrane comprises the easternmost tract of oceanic rocks in the Canadian Cordillera. It includes the Fennell Formation, near Clearwater; the Antler Formation, near Wells; and, in the intervening area, a narrow, discontinuous belt of rocks referred to as the Crooked amphibolite. The Fennell and Antler formations comprise thrust-imbricated sequences of mainly basalt, chert, diabase, and gabbro, ranging from early Mississippian to mid-Permian (Schiarrizza and Preto, 1987; Struik and Orchard, 1985). 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 (or Quesnellia) is a Late Triassic to Early Jurassic magmatic arc complex that formed along or near the western North American continental margin (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, in the south, assemblages of oceanic rocks that include the Old Tom, Independence, and Shoemaker formations (Tempelman-Kluit, 1989). The Mesozoic rocks are represented mainly by Middle to Upper Triassic volcanic and sedimentary rocks of the Nicola Group, together with abundant Late Triassic to Early Jurassic calc-alkaline to alkaline intrusions (Preto, 1977, 1979; Mortimer, 1987; Panteleyev et al., 1996; Schiarrizza et al., 2013). The Nicola Group consists mainly of volcanic and volcanic-derived sedimentary rocks, but also includes an eastern sedimentary facies of dark grey siltstone and slate intercalated with quartzite and limestone (Bloodgood, 1990; Schiarrizza et al., 2013; Mihalynuk et al., 2015). 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 comprises Lower to Middle Jurassic sedimentary rocks (Ashcroft formation, Windy Mountain

succession, Dragon Mountain succession) that overlie western parts of the Nicola Group unconformably or disconformably (Travers, 1978; Logan and Moynihan, 2009; Schiarrizza et al., 2013).

Quesnel terrane is an important metallogenic province, particularly for porphyry deposits containing copper, gold and molybdenum (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 or alkaline plutons that become progressively younger from west to east (Schiarrizza, 2014). The western (Late Triassic) calc-alkaline belt includes the Guichon Creek batholith, host to the Highland Valley 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 alkaline plutons, which host alkalic porphyry copper-gold deposits, including producing mines at Copper Mountain, Afton and Mount Polley. A third belt, younger and farther to the east, is defined by several large, Early Jurassic calc-alkaline plutons, including the Bromley, Pennask, Wild Horse, Thuya and Takomkane batholiths (Fig. 2).

Cache Creek terrane, comprising 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 includes Late Triassic blueschists farther north (Ghent et al., 1996), and is interpreted, at least in part, as an accretion-subduction complex that was responsible for generating the Quesnel magmatic arc (Travers, 1978; Struik et al., 2001).

Cadwallader terrane, as interpreted by Schiarrizza (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. The older arc system includes bimodal volcanic rocks and associated intrusions of the Wineglass assemblage, southwest of Williams Lake, and Late Permian intrusive rocks within the Mount Lytton complex (Friedman and van der Heyden, 1992; Schiarrizza, 2013). The younger arc system includes Upper Triassic volcanic and sedimentary rocks of the Cadwallader Group and Tyaughton Formation, Late Triassic intrusions in the western part of the terrane and in the Mount Lytton complex, and Lower to Middle Jurassic siliciclastic and local volcanic rocks of the Ladner Group (Schiarrizza, 2013, and references therein).

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 (Schiarrizza et al., 1997). Dated cherts and limestones range from Mississippian to late Middle Jurassic, and blueschist-facies metamorphic rocks yielded Middle to Late Triassic Argon-Argon ages (Cordey and Schiarrizza, 1993;

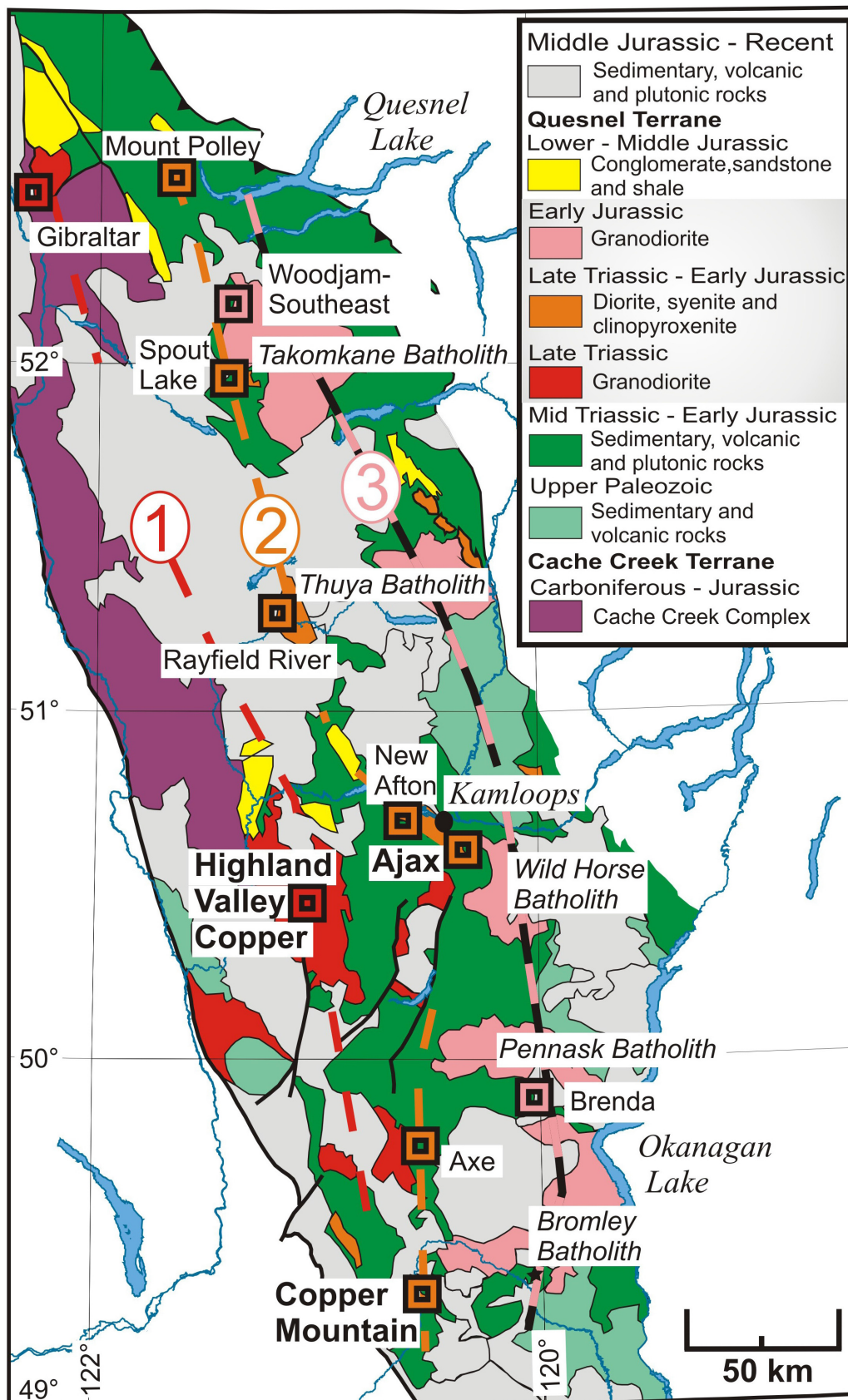


Fig. 2. Generalized geology of southern Quesnellia and Cu±Mo±Au deposits. Mesozoic arc plutons align along the length of southern Quesnellia to define three, north-trending, temporally distinct belts that get younger to the east: 1) Late Triassic; 2) Late Triassic-Early Jurassic; and 3) Early Jurassic. Discrete porphyry copper mineralizing events are directly linked to each of these magmatic episodes. From Logan (2013).

Schiarizza et al., 1997). The Bridge River complex is thought to be the product of accretion and subduction processes, possibly related to Mesozoic arc volcanics of the adjacent Cadwallader terrane. Chert-bearing sequences are locally overlain by siliciclastic rocks of the Cayoosh assemblage (Jurassic-Cretaceous; Journeay and Mahoney, 1994), which forms the youngest component of the terrane.

Stikine terrane (or Stikinia) 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 (Lower to Middle Jurassic; Tipper, 1959, 1969). Upper Triassic volcanic and sedimentary rocks assigned to the Mount Moore and Mosely formations, in the eastern Coast belt west of Chilko Lake, are also considered part of the Stikine terrane (Rusmore and Woodsworth, 1991).

2.3. Late Jurassic and younger rocks

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; Pentiction 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, but are shown only in the southwest, where they form part of the Coast plutonic complex (Fig. 1).

3. Mines and quarries

The region produces copper, molybdenum, gold and silver from five, large, metal mines and a variety of industrial minerals (limestone, bentonite, zeolite, diatomaceous earth, high-alumina shale, precious opal, and dimension stone) from about ten quarries. Almost 1,000 placer mines and gravel pits have active permits, but perhaps only a tenth of that number actually produce.

3.1. Metal mines

South Central region hosts roughly half of the province's metal mines (Fig. 1; Table 1). These include the province's two largest copper-molybdenum producers (**Gibraltar** mine, near Williams Lake, owned by Taseko Mines Limited, and

Highland Valley Copper mine, near Logan Lake, operated by Teck Highland Valley Copper Partnership) and three major copper-gold mines (Imperial Metals Corporation's **Mount Polley** mine, near Likely; New Gold Inc.'s **New Afton** mine, near Kamloops; and Copper Mountain Mining Corporation's **Copper Mountain** mine). The region hosts three precious metal mines. All have less than 300 tonnes-per-day mill capacity; all are on care and maintenance. These include: **Bonanza Ledge**, near Wells, owned by Barkerville Gold Mines Ltd.; **Bralorne**, near Gold Bridge, owned by Avino Silver & Gold Mines Ltd.; and **Treasure Mountain**, near Merritt, owned by Nicola Mining Inc.

3.1.1. Copper Mountain (Copper Mountain Mining Corporation and Mitsubishi Materials Corporation)

The Copper Mountain copper-gold mine, near Princeton (Fig. 2), has been producing since August 2011 (see Holbek and Joyes, 2013). It is operated by a partnership of Copper Mountain Mining Corporation (75%) and Mitsubishi Materials Corporation (25%). The rate of mining has met or exceeded guidance figures, but until a new secondary crusher was installed in mid-2014, milling operations struggled to achieve the targeted 35,000 tonnes-per-day. Quarterly mine production since 2015 has consistently exceeded targets. Milling exceeded the company's benchmark of 40,000 tonnes-per-day for the last two months of the year. Copper Mountain drew ore from Pit 2, Saddle, Virginia and the newly developed Oriole areas. The Virginia and Oriole pits are, respectively, northeast and southeast of the mine's three main pits. A multi-year exploration program seeks to upgrade resources, test ore depths and find mineralization outside the current mine plan. In 2016, the company drilled 5,000 metres to convert resources to reserves. Holbek et al. (2015) described the deposit as a structurally complex, alkalic porphyry copper-gold system wherein most of the copper-gold mineralization occurs in Nicola Group (Triassic) volcanic rocks while subordinate amounts occur in coeval intrusive rocks. Mineralization shows strong vertical continuity.

3.1.2. Gibraltar (Taseko Mines Limited and Cariboo Copper Corp.)

The **Gibraltar** copper-molybdenum mine (Fig. 2) is operated by Taseko Mines Limited and Cariboo Copper Corp. Production began in 1972. In 2013, the mine completed its first full year of operation after extensive modernization. Part of the modernization plan was building a separate molybdenum circuit, which operated until 2015 when it was shut down due to low metal prices. However, in September 2016 Taseko reopened the molybdenum circuit producing some 185,000 lbs of molybdenum in that month alone. Since 2013, the mine has generally met guidance of 85,000 short tons per day from its combined mills. Proven and probable reserves (as of 2014-12-31; 0.15% Cu cut-off) stand at 749 million short tons grading 0.26% Cu and 0.008% Mo, with 3.3 billion pounds of copper recoverable (Jones, 2015). Ore comes from five pits

Table 1. Metal mines, South Central Region, 2016 (listed alphabetically).

Mine	Operator	Commodity; deposit type; MINFILE	Forecast 2016 Production (based on Q1-Q3)	Reserves (Proven and Probable)	Resource (Measured and Indicated)	Comments
Bonanza Ledge (open pit on care and maintenance since June 2015)	Barkerville Gold Mines Ltd.	gold; pyrite replacement; 093H 140	Nil	Nil	Resource (as of 2015-03-31; cut-off 1.7 g/t Au); Measured: 170,000 t grading 8.74 g/t Au (containing 48,000 oz Au); Indicated: 240,000 t grading 6.86 g/t Au (containing 54,000 oz Au); M+I: 420,000 t grading 7.63 g/t Au (containing 102,000 oz Au)	Previously reported reserves were reclassified as resources because test mining did not prove profitable. In 2016, the company submitted plans to government to convert mine to an underground operation.
Bralorne (on care and maintenance)	Avino Silver and Gold Mines Ltd.	gold; vein; 093JNE 001	Nil	Reserve data not available.	Measured and Indicated resources (as of 2016-10-20; cut-off not stated): 273,123 tons grading 0.33 oz/t Au (containing 91,528 oz Au)	2016 work improved tailings storage facility, mill and mine infrastructure; prepared for long-hole mining; updated resource estimate.
Copper Mountain	Copper Mountain / Mitsubishi Materials	copper, gold, silver; alkalic porphyry; 092HSE 001	*83 Mlb Cu; 30,800 oz Au; 291,900 oz Ag	Proven and Probable reserves as of 2014-12-31; 0.18% Cu cut-off): 146 Mt grading 0.35% Cu, 1.47 g/t Ag, 0.12 g/t Au (containing 1.1 Blb of Cu; 6.9 Moz Ag; 560,000oz Au)	Measured and Indicated resources (as of 2014-12-31; 0.18% Cu cut-off): 265 Mt grading 0.33% Cu, 1.33 g/t Ag, 0.40 g/t Au (containing 1.9 Blb Cu; 11.35 Moz Ag; 930,000 oz Au)	Drilled at Pit 2 to convert Inferred resources into Measured/Indicated. *Annual production taken from Copper Mountain news release (2017-01-11).
Gibraltar	Taseko Mines Ltd.	copper, molybdenum; calc-alkalic porphyry; 093B 012	*133 Mlb Cu; 900,000 lb Mo.	Proven and Probable reserves (as of 2014-12-31; 0.15% Cu cut-off): 749 Mt grading 0.26% Cu and 0.008% Mo. (Recoverable metal: 3.3 Blb Cu)	Measured and Indicated resources (as of 2014-12-31; 0.15% Cu cut-off): 1,092 Mt grading 0.25% Cu and 0.008% Mo	Gibraltar's molybdenum circuit resumed operation in September 2016. *Annual production taken from Taseko news release (2017-01-09).

Table 1. Continued.

Highland Valley Copper	Teck Highland Valley Copper Partnership	copper, molybdenum; calc-alkalic porphyry; 092ISW 012	129,100 t Cu; 4.2 Mlb Mo	Proven and Probable reserves (as of 2015-12-31; cut-off not stated): 577.2 Mt grading 0.29% Cu; 0.007% Mo. (Recoverable metal: 1,450,000 t Cu; 30,000 t Mo.)	Resources (as of 2015-12-31; cut-off not stated): Measured: 412.1 Mt grading 0.34% Cu; 0.008% Mo; Indicated: 709.2 Mt grading 0.23% Cu; 0.010% Mo	-
Mount Polley	Imperial Metals Corporation	copper; gold; silver; alkalic porphyry; 093A 008	27.1 Mlb Cu; 46,900 oz Au; 105,200 oz Ag	Proven and Probable reserves (as of 2016-01-01; variable mill head values for cut-off): 73.6 Mt grading 0.274% Cu, 0.293 g/t Au, 0.562 g/t Ag	Measured and Indicated resources (as of 2016-01-01; variable mill head values for cut-off): 247 Mt grading 0.266% Cu, 0.262 g/t Au, 0.667 g/t Ag	-
New Afton	New Gold Inc.	copper, gold; alkalic porphyry; 092INE 023	405,000 oz Au; 1.8 Moz Ag; 95 Mlb Cu.	Proven and Probable reserves (as of 2014-12-31; cut-off NSR US\$21/t or US\$24/t depending on block): 42 Mt grading 0.56 g/t Au, 2.3 g/t Ag, 0.84% Cu; (containing 760,000 oz Au, 3.1 Moz Ag, 781 Mlb Cu)	Measured and Indicated resources (as of 2014-01-01; cut-off 0.40% CuEq): 73 Mt grading 0.75 g/t Au, 2.2 g/t Ag, 0.87% Cu; (containing 1.75 Moz Au, 5.2 Moz Ag, 1.4 Blb Cu)	-
QR (mine on care and maintenance; mill operates)	Barkerville Gold Mines Ltd.	gold; skarn; 093A 121	Not available	Not available	Not available	QR deposit depleted. Mill awaits ore from Bonanza Ledge mine near Wells. -
Treasure Mountain (on care and maintenance)	Nicola Mining Inc.	silver, lead, zinc; vein; 092HSW 016	Not available	Not available	Not available	-

(Connector; Gibraltar; Granite; Extension; and Pollyanna), but not all operate at all times. The deposit occurs in the Granite Mountain batholith (Late Triassic; see van Straaten et al., 2013 for detailed mine geology) in a fault-bounded section of Nicola Group sedimentary and volcanic rocks (Quesnel terrane; Schiarizza 2014, 2015). Exploration at the **Gibraltar North** project, outside the main mining area, is described below.

3.1.3. Highland Valley Copper (Teck Resources Limited)

The **Highland Valley Copper** copper-molybdenum mine (Fig. 2), operated by Teck Highland Valley Copper Partnership, is the largest base metal mine in Canada. For many years the mine was a partnership between Teck (97.5%) and Highmont Mining Company Ltd. (2.5%). In the third quarter of 2016, Teck acquired a 100% stake in the mine. Ore comes from three pits (Valley; Lornex; Highmont). In 2016, production shifted from the Valley pit to the Lornex pit which has softer rock but lower grades. The softer rock allowed mill throughput consistently to exceed the rated capacity of 130,000 tonnes-per-day.

Following ground geophysical survey and drilling programs that started in 2012, Teck Highland Valley Copper Partnership continued to explore targets near the past-producing **Bethlehem** mine, the Valley pit, the southern end of the Lornex pit, and the Jericho zone on the northeast edge of the Highmont pit. All mineralization at Highland Valley occurs in the Guichon Creek batholith (late Triassic), which has been divided into a number of pre-, syn- and post-mineral phases (see Byrne et al., 2013).

3.1.4. Mount Polley (Imperial Metals Corporation)

Mount Polley copper-gold-silver mine (Fig. 2) of Imperial Metals Corporation completed its first year of full operations two years after a breach in its tailings dam caused a year of lost production. The company continues to remedy damage caused by the August 2014 breach, focusing on restoring fish habitat in Hazeltine Creek. Early in 2016, the company released an updated resource estimate based on five zones (Springer, Cariboo, WX, Boundary open pit, Boundary underground, see Brown et al., 2016, and Table 1). In 2016, ore came from the Cariboo open pit and Boundary underground zone. Late in the year, the company initiated a 5,000 m underground drilling program to test two zones (Martel and Green) from the access ramp to the Boundary zone. The Martel zone lies beneath the Wight pit. The Green zone has been tested by widely spaced drilling in 2004. The alkaline intrusive complex (Late Triassic) at Mount Polley has at least eight discrete mineralized zones that have contributed to previous production or resource calculations. Rees (2013) and Brown et al. (2016) provide reviews of Mount Polley geology and mineralization.

3.1.5. New Afton (New Gold Inc.)

The **New Afton** gold-copper mine (Fig. 2) is a block cave operation owned by New Gold Inc. that opened in mid-2012 (Hall and May, 2013). In mid-2015 the company installed a new 14,000 tonne-per-day mill. For 2016, mill throughput has ranged between 15,250 and 15,900 tonnes-per-day, without

loss of recovery. The deposit forms a high-grade keel beneath the past-producing Afton open pit mine, an alkaline porphyry in the Iron Mask batholith (Triassic). Exploration continued to expand resources in the C zone, a down-plunge extension of the area now being mined (Rennie et al., 2015), and test other targets along the eastern edge of New Gold's claims.

3.1.6. Bonanza Ledge (Barkerville Gold Mines Ltd.)

The **Bonanza Ledge** mine, near Wells, is owned and operated by Barkerville Gold Mines Ltd. It began as an open pit, truck and shovel operation with a mine life of four years. Test mining took place between March 2014 and June 2015 when it was halted due to problems with grade control and the cost of trucking ore to the company's mill at QR mine 110 km away. Previously published reserves (as of August 2009, Proven: 130,724 tonnes grading 10.227 g/t Au; Probable: 166,808 tonnes grading 8.114 g/t Au) were reclassified as resources because test mining had been unprofitable (Snowden, 2015). Bonanza Ledge is a pyrite replacement deposit consisting of native gold in quartz veins within pyrite-bearing, carbonaceous and chloritic phyllite of the Snowshoe Group (Proterozoic-Paleozoic).

3.1.7. Bralorne (Avino Silver & Gold Mines Ltd.)

Avino Silver & Gold Mines Ltd. acquired the **Bralorne** gold mine, near Gold Bridge, in 2014 and suspended mining shortly thereafter. In 2016 Avino continued to improve their mill and tailings facility and further develop a strategic operating plan for future production. The mine plan proposes a long-hole mining method, which is considered safer and requires less labour. The company thinks the new plan will support production at a rate of 300 short tons per day. In October the company released a new technical report with increased tonnage and grade estimates in all categories (Kirkham and Yee, 2016). Ore occurs in gold-bearing mesothermal quartz veins between three former mines (Bralorne, King and Pioneer). The veins occupy an imbricated contact zone between Bridge River (oceanic) and Cadwallader (arc) assemblages, subsequently intruded by Cretaceous to Tertiary plutons and cut by major faults (e.g., the Fraser-Yalakom array).

3.1.8. Treasure Mountain (Nicola Mining Inc.)

Treasure Mountain mine, 40 kilometres west of Princeton, owned by Nicola Mining Inc. (formerly Huldra Silver Inc.), has been on care and maintenance since 2015. The Treasure Mountain deposit is a stacked series of high-grade silver-lead-zinc veins in Cretaceous sedimentary rocks of the Pasayten Group in the Methow terrane (Fig. 1). A resource estimate (Indicated but not compliant with NI 43-101) prepared in 2009 was 33,000 tonnes grading 828 g/t Ag, 4.16% Pb, and 3.8% Zn, at a 311 g/t Ag cut-off (Ostenoe et al., 2009). Other targets near the mine have returned high-grade grab samples but have not been drilled.

3.1.9. Merritt mill (Nicola Mining Inc.)

Nicola Mining Inc. (formerly Huldra Silver Inc.) reopened

its 200 tonne-per-day **Merritt** mill and tailings facility at the former **Craigmont** mine site. The mill has processed ore from **Treasure Mountain** mine and the **Elk** gold deposit (owned by Gold Mountain Mining Company). In 2016, the mill processed gold-silver ore from the **Dome Mountain** mine near Smithers under a contract with Metal Mountain Resources Inc. The company hopes the mill and tailings facility will support smaller gold and silver mining operations in the Pacific Northwest.

3.1.10. QR mill (Barkerville Gold Mines Ltd.)

The **QR** mine of Barkerville Gold Mines Ltd. has operated sporadically in recent years due to depleting ore and is now essentially closed. QR's mill has been on care and maintenance awaiting ore from Bonanza Ledge mine 110 km away.

3.2. Coal mine (Basin Mine Limited Partnership)

Basin coal mine (Fig. 1; Table 2) continued on care and maintenance in 2016. The mine is now owned by Basin Mine Limited Partnership after its previous owner, Coalmont Energy Corporation, was assigned into bankruptcy in mid-2015. Basin mine produced thermal coal between June and October 2013 at an initial rate of 250,000 tonnes-per-year of thermal coal. Production halted due to a spill of mine water and has not restarted because of poor coal prices. Basin mine, 18 kilometres west of Princeton, has a 250 tonne per hour Parnaby wash plant, which eliminates the need for a tailings pond. Cleaned coal moved by truck and barge to Texada Island for shipment to local and overseas markets. Coal seams occur in Eocene rocks that form a half graben. The Main seam is about 32 metres thick and has four coal units separated by thin layers of siltstone, tuff or ironstone. Twenty-seven metres below the Main seam is the Lower seam (7 metres thick), which remains an exploration target.

3.3. Industrial mineral mines

More than ten industrial mineral quarries and processing plants operate in the region (Fig. 1; Table 3). These operations employ more than 250 people.

3.3.1. Ashcroft (IG Machine and Fiber Ltd.)

Five kilometres east of Ashcroft, IG Machine and Fiber Ltd, a subsidiary of IKO Industries Ltd, operates the **Ashcroft** basalt quarry and roofing granule plant.

3.3.2. Decor (Pacific Bentonite Ltd.)

The **Decor** pit of Pacific Bentonite Ltd., 20 kilometres west of Cache Creek, has supplied alumina-rich burnt shale to the Lafarge cement plant in Kamloops. This operation will likely go on care and maintenance as a consequence of the Lafarge shutdown. The Decor property also hosts a large bentonite deposit, which is being investigated for municipal engineering and tile manufacturing applications.

3.3.3. Harper Ranch and Falkland (Lafarge Canada Inc.)

After operating intermittently for many years supplying cement to meet demand in western Canada, the **Kamloops** cement plant and **Harper Ranch** limestone quarry of Lafarge Canada Inc. were placed on care and maintenance. The reason cited was poor demand. The facility will continue to serve as a distribution point for cement produced in Alberta. Apart from limestone, the cement plant uses gypsum and anhydrite mined at the **Falkland** quarry and alumina-silica silt obtained from a loess deposit on site.

3.3.4. 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 processes this material to produce flagstone, ashlar, facing stone and landscape rock. In 2010, Spectral Gold Corp. began developing the **Lady King Basalt** deposit, near Vernon, selling basalt columns as landscape rock.

3.3.5. Klinker (Opal Resources Canada Inc.)

Opal Resources Canada Inc. produces gem quality fire opal

Table 2. Coal mine, South Central Region, 2016.

Mine	Operator	Commodity; deposit type; MINFILE	Forecast 2016 Production (based on Q1- Q3)	Reserves (Proven and Probable)	Resource (Measured and Indicated)	Comments
Basin	Basin Mine Limited Partnership	TC; 092HSE 157	On care and maintenance since 2013	Not available	Not available	-

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

Table 3. Industrial mineral mines, South Central Region, 2016 (listed alphabetically).

Mine	Operator	Commodity; deposit type; MINFILE	Forecast 2016 Production (based on Q1-Q3)	Reserves (Proven and Probable)	Resource (Measured and Indicated)	Comments
Ashcroft	IG Machine and Fibers Ltd. (IKO Industries Ltd.)	Basalt (roofing granules); 092INW 104	350,000 t	Not available	Not available	-
Bromley Creek (Zeotech)	Canadian Mining Company Inc.	Zeolite; 092HSE 243	On care and maintenance since 2015	Not available	M+I (as of 2013-06-30): 550,000 t	-
Bud	Absorbent Products Ltd.	Bentonite; 092HSE 162	30,000 t	Not available	Not available	Production is combined amount from Bud and Red Lake quarries.
Decor	Pacific Bentonite Ltd.	Alumina, landscape rock; 092INW 084	100,000 t	Not available	Not available	Production likely to be affected by shut down of Lafarge's Kamloops Cement Plant.
Falkland	Lafarge Canada Inc.	Gypsum; 082LNW 001	6,000 t	Not available	Not available	Production likely to be affected by shut down of Lafarge's Kamloops Cement Plant.
Harper Ranch	Lafarge Canada Inc.	Limestone; 092INE 001	220,000 t	Not available	Not available	On care and maintenance as of November 2016.
Kettle Valley quarries	Kelowna Sand and Gravel Ltd / Kettle Valley Stone Ltd.	Ashlar, flagstone, thin veneer: 082ENW 109; 111; 112	Not available	Not available	Not available	-
Klinker	Opal Resources Canada Inc.	Opal; 082LSW 125	Intermittent operation	Not available	Not available	-
Lady King Basalt	Spectral Gold Corp.	Basalt columns; N/A	Intermittent operation	Not available	Not available	-
Mount Polley Magnetite	Craigmont Industries Ltd.	Magnetite (recovered from tailings); 093A 008	3,000 t	Not available	Not available	Plant operated part time in 2016 due to weak demand.

Table 3. Continued.

Pavilion	Graymont Western Canada Inc.	Limestone; 0921NW 081	20,000 t	Not available	Not available	On care and maintenance as of June 2016.
Red Lake	Absorbent Products Ltd.	Diatomaceous earth; 0921NE 081	30,000 t	Not available	Not available	Production is combined amount from Bud and Red Lake quarries.

from the **Klinker** property, 25 kilometres northwest of Vernon. In 2016, the company closed its retail store, north of Vernon, but continued to market jewelry through a distributor in Whistler and the Internet. Opal forms fracture and vesicle-fillings in andesitic to basaltic lahars and breccias in the Kamloops Group (Eocene).

3.3.6. McAbee and Walhachin (Canadian National Railway Company, Canadian Pacific Railway Limited)

Both of Canada's transcontinental railways have ballast quarries between Kamloops and Cache Creek. At the McAbee quarry, on the north side of the Thompson River, CN Rail extracts ballast from a phase of the Guichon Creek batholith (Late Triassic). CP Rail mines Nicola Group (Triassic) basalt at its Walhachin quarry on the south side of the Thompson River. Ballast extracted from these quarries is used as far east as Manitoba.

3.3.7. Mount Polley (Craigmont Industries Ltd.)

In January 2014, Craigmont Industries Ltd. started producing magnetite from their new recovery plant at **Mount Polley** mine. Operations stopped in August 2014, due to the tailings dam breach. Poor markets have delayed its expected restart. The plant captures magnetite from the mine's tailings stream and produces a dense media used for coal washing operations.

3.3.8. Pavilion (Graymont Western Canada Inc.)

Earlier in the year, Graymont Western Canada Inc.'s **Pavilion** limestone quarry and lime plant was placed on care and maintenance. The operation is a few kilometres west of Decor, and produced quicklime, high-calcium limestone fines, screened high-calcium stone products, lime kiln dust, and rip rap. Graymont has a forty-year lease with the Ts'kw'aylaxw First Nation to mine on their reserve, and most of the operation's employees were Ts'kw'aylaxw.

3.3.9. Red Lake and Bud (Absorbent Products Ltd.)

At their plant in Kamloops, Absorbent Products Ltd. manufactures cat litter, barn deodorizer, industrial absorbents, and carriers for agricultural products prepared from diatomaceous earth from the **Red Lake** quarry, 45 kilometres northwest of Kamloops, and bentonite from the **Bud** quarry 7 kilometres south of Princeton.

3.3.10. Zeotech/Bromley Creek (Canadian Mining Company Inc.)

In 2014, Canadian Mining Company Inc. concluded its option agreement with Heemskirk Canada Ltd and regained control of the **Zeotech/Bromley Creek** zeolite quarry, 6 kilometres east of Princeton. Zeolite from the quarry has agricultural and absorbent applications.

3.4. Placer mines, aggregate pits and rock quarries

A recent tally of 'active' placers, pits and quarries that have valid Mines Act permits, shows there are 652 placer surface mines; 1 placer underground mine (Wingdam); 291 sand and gravel pits; and 45 quarries in the region (A. Hart, pers. comm., October 2016). 'Active' is an administrative classification that does not imply production and includes mines undergoing reclamation and closure. Most of these operations are small, intermittent or seasonal, and lack production data.

4. Mine development

'Mine development projects' are those for which there is a positive production decision, key government approvals and on-site construction has begun. No projects meet these criteria.

5. Proposed mines

'Proposed mines' are defined as feasibility-stage projects for which proponents have begun the process of formal socioeconomic and environmental review. For projects that exceed thresholds set by the British Columbia Environmental Assessment Act (or its federal equivalent), reviews are co-ordinated by the BC Environmental Assessment Office and Canadian Environmental Assessment Agency. Smaller projects are reviewed by an interagency Mine Development Review Committee (MDRC) chaired by the Ministry of Energy and Mines. The MDRC review is informally called the Minister's permit process.

Seven projects are in this category: **Ajax**, **Bethlehem**, **Bonanza Ledge**, **Harper Creek**, **Prosperity**, **Ruddock Creek**, and **Spanish Mountain** (Fig. 1; Table 4).

5.1. Ajax (KGHM Ajax Mining Inc.)

Formal review of the **Ajax** copper-gold porphyry project, owned by KGHM Ajax Mining Inc., continued under the auspices of the BC Environmental Assessment Office and

Table 4. Proposed mines, South Central Region, 2016 (listed alphabetically).

Project	Operator	Commodity; deposit type; MINFILE	Reserves (Proven and Probable)	Resources (Measured and Indicated)	Work Program	Comments
Ajax	KGHM Ajax Mining Inc.	Cu, Au; Alkalic porphyry 092INE 012, 013	Reserves (P+P; NSR cut-off US\$7.10/t): 426 Mt grading 0.29% Cu; 0.19 g/t Au; 0.39 g/t Ag (containing 2.7 Bt Cu; 2.6 Moz Au; 5.3 Moz Ag)	Resources (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 monitoring; Public and First Nations engagement. Compiling comments received during public review periods, and drafting responses.	Project at application review stage. Company temporarily suspended review to respond to comments received.
Bethlehem	Teck Resources Ltd.	Cu, Mo; Calc-alkalic porphyry 092ISE 001	n/a	n/a	Formal review under a Minister's permit process started in September; engineering studies	Project at application review stage. Resource informally stated as 100 Mt, but without grades
Bonanza Ledge (underground)	Barkerville Gold Mines Ltd.	Au; Pyrite replacement; 093H 140		Resources (cut-off 1.7 g/t Au): Measured: 170,000 t grading 8.74 g/t Au (containing 48,000 oz Au); Indicated: 240,000 t grading 6.86 g/t Au (containing 54,000 oz Au); M+I: 420,000 t grading 7.63 g/t Au (containing 102,000 oz Au)	Formal review under a Minister's permit process started in December; engineering studies	Project at application review stage.
Harper Creek	Yellowhead Mining Inc.	Cu, Au, Ag; Stratiform, volcanic- hosted 082M 008, 009	Reserves (P+P; cut-off 0.14% Cu): 716 Mt grading 0.26% Cu; 0.029 g/t Au; 1.18 g/t Ag	n/a	Project on hold.	Project at application review stage. Company suspended review in October 2015 for economic reasons.
New Prosperity	Taseko Mines Ltd.	Cu, Au; Calc-alkalic porphyry; 092O 041	Reserves (P+P; NSR cut-off \$5.50/t): 831 Mt grading 0.23% Cu and 0.41 g/t Au; containing (recoverable) 3.6 Blt Cu; 7.7 Moz Au	Resources (M+I; ; cut-off 0.14% Cu): 1,010 Mt grading 0.24% Cu; 0.41 g/t Au	Preparations for site investigation of proposed mine facilities. Company is seeking judicial review of federal EA decision. Results pending.	Project at post- decision stage. Granted provincial certificate but denied federal approval.

Table 4. Continued.

Ruddock Creek	Ruddock Creek Mining Corporation	Pb, Zn, Ag; Monashee-type sediment-hosted massive sulphide; 082M 082	n/a	Resources (M+I; cut-off 4.0% Pb+Zn): 6.2 Mt grading 6.50% Zn, 1.33% Pb	Environmental monitoring; permitting work.	Project at pre-application stage.
Spanish Mountain	Spanish Mountain Gold Ltd.	Au, Ag; Sediment-hosted gold; 093A 043	n/a	Resources (M+I; cut-off 0.20 g/t Au): 237.8 Mt grading 0.46 g/t Au; 0.69 g/t Ag; containing 3.5 Moz Au; 5.28 Moz Ag	Environmental monitoring. Technical studies to evaluate different scenarios for mining.	Project at pre-application stage.

the Canadian Environmental Assessment Agency. In 2016, KGHM reduced project staff from around 60 to 10 to meet parent company priorities. Because Ajax is on the outskirts of Kamloops, the company has funded independent reviews of its application by the City and local First Nations. A revised feasibility study released at the start of 2016 modelled Ajax as a 65,000 tonne-per-day open pit mine with a projected 18-year life. The company is an 80:20 joint venture between KGHM Polska Miedź S.A. (KGHM SA) and Abacus Mining and Exploration Corporation. Mineralization occurs in the Iron Mask batholith, a Triassic, multi-phase, alkaline intrusive complex (Fig. 2).

5.2. Bethlehem (Teck Resources Limited)

Teck Resources Limited submitted plans to reopen the past-producing **Bethlehem** mine, 2 kilometres east of its Highland Valley Copper operations. Over the past few years, Teck has defined 100 million tonnes of new ore at Bethlehem. If approved, the mine would feed its 140,000 tonne-per-day mill. A Mine Development Review Committee commenced formal review of the Bethlehem Phase 1 proposal in September. Engineering and feasibility studies continue.

5.3. Bonanza Ledge (Barkerville Gold Mines Ltd.)

As noted above, Bonanza Ledge saw limited production as an open pit mine between March 2014 and June 2015. In December 2016, Barkerville Gold Mines Ltd. applied for a permit to mine the remaining resource by underground methods. The company hopes production can resume in 2017. The plan is to mine at a rate of ~500 tonnes-per-day (~150,000 tonnes-per-year) using a long-hole method with cemented rock fill. Initial mine life is estimated at 2 years with \$7 million in capital costs. If successful, this mine will generate income for the company as it advances work on other deposits (e.g., Cow Mountain and Island Mountain: see exploration section below).

5.4. Harper Creek (Yellowhead Mining Inc.)

The **Harper Creek** copper-gold-silver project, 90 km

north of Kamloops, is described as a stratiform, disseminated volcanogenic deposit in metamorphosed volcanic and sedimentary rocks of the Eagle Bay Formation (Devono-Mississippian). Yellowhead Mining Inc.'s application for an environmental assessment certificate to provincial and federal authorities was accepted in January 2015. In October 2015, the company suspended further work on the project (including baseline environmental studies) due to a lack of funds. The project remained on hold in 2016 while the company sought financing to complete the review. Proven and Probable mineral reserves stand at 716 million tonnes grading 0.26% Cu; 0.029 g/t Au and 1.2 g/t Ag (Merit Consultants, 2014). The feasibility study proposes a 70,000 tonne-per-day operation with a mine life of 28 years. Initial capital costs would exceed \$1 billion.

5.5. Prosperity (Taseko Mines Limited)

The **Prosperity** (also known as New Prosperity or Fish Lake) project of Taseko Mines Limited, 125 km southwest of Williams Lake, is described as a gold-copper porphyry with Proven and Probable reserves of 830 million tonnes grading 0.42 g/t Au and 0.23% Cu. Taseko continues to seek a judicial review of the February 2014 Federal decision not to authorize the project. BC granted Taseko a project certificate in November 2013 and has extended its expiry date by five years. In the Fall, Taseko submitted plans for a detailed site investigation of proposed mine infrastructure. If approved, work will start in 2017.

5.6. Ruddock Creek (Imperial Metals Corporation, Mitsui Mining and Smelting Co Ltd., Itochu Corporation)

At the **Ruddock Creek** massive sulphide prospect, 75 kilometres northeast of Clearwater (Fig. 1), Imperial Metals Corporation collected environmental baseline data in preparation for future permitting requirements. The project is owned by Imperial Metals Corporation (50%) and joint venture partners Mitsui Mining and Smelting Co Ltd. (30%) and Itochu Corporation (20%). The operator and manager of the joint venture is the Ruddock Creek Mining Corporation. The deposit is described as sedimentary exhalative, Monashee or Broken

Hill-type, in marble, gneiss and calc-silicate rocks. A mineral resource estimate, released in March 2012, reported 4.65 million tonnes grading 6.77% Zn and 1.38% Pb (Indicated) and 5.38 million tonnes grading 6.69% Zn and 1.31% Pb (Inferred), using a 4.0% combined Pb+Zn cut-off.

5.7. Spanish Mountain (Spanish Mountain Gold Ltd.)

Late in 2014, Spanish Mountain Gold Ltd. suspended exploratory work on its **Spanish Mountain** sediment-hosted gold deposit, 70 kilometres northeast of Williams Lake, until economic conditions improve. Baseline environmental studies continue as the company prepares for formal environmental review. In 2016, the company commissioned engineering studies to evaluate if higher grade zones could support an alternative mine model with a 20,000 tonne-per-day mill and a 20-year mine life (in contrast to a previous scenario of 40,000 tonnes-per-day and a 14-year mine life for the entire resource). The company also commissioned work to assess whether a simplified metallurgical process might achieve planned recoveries at lower capital and operating costs. As of April 2014, Measured and Indicated resources (using a cut-off grade of 0.2 g/t Au) are 237.8 million tonnes grading 0.46 g/t Au and 0.69 g/t Ag (Giroux and Koffyberg, 2014).

6. Exploration highlights

Exploration in 2016 focused on defining or expanding porphyry and porphyry-related deposits (copper-gold and copper-molybdenum), skarn deposits (tungsten; copper), gold deposits of various types and stratiform base-metal deposits. Industrial minerals (basalt; gypsum; jade; limestone; manganese; zeolite) were also sought. Herein, projects are grouped by deposit type and listed alphabetically (Fig.1; Table 5).

6.1. Precious metal projects

South Central region has many mineral deposits in which precious metals are the principal target. Among them are mesothermal veins, transitional veins, epithermal veins, hot spring systems, replacement deposits, skarns, sediment-hosted deposits, and intrusion-related breccias. In 2016, exploration focused on mesothermal and epithermal veins, skarns and replacement deposits.

6.1.1. Cariboo Gold (Barkerville Gold Mines Ltd.)

Barkerville Gold Mines Ltd. advanced its **Cariboo Gold** project by: drilling the **BC vein** to define high-grade, mineable zones; drilling at **Cow Mountain** (site of former Cariboo Gold Quartz mine) to define a bulk-mineable resource; drilling at **Island Mountain** (site of former Mosquito Creek and Aurum mines) to define a bulk-mineable resource; planning an underground mine beneath the **Bonanza Ledge** open pit; and testing early-stage exploration targets across an expanded block of claims and a newly identified, 60-kilometre structural trend called the 'Cariboo Break'. This is by far the biggest exploration project in the region. Approximately 70,750 metres

were drilled in 2016, using four drill rigs.

Refinancing and restructuring in 2013-2014 brought new management and technical staff to Barkerville Gold Mines Ltd. and revived its **Cariboo Gold** project (Stokes, 2015). The project lies 85 kilometres east of Quesnel and covers ~211,900 hectares of claims, including three historic groups of Crown grants (Cariboo Group, Island Mountain Group, and Mosquito Creek Group). Past production has come from gold-bearing pyrite replacement deposits and gold-sulphide-quartz veins. Host rocks are folded and metamorphosed siliciclastic sedimentary and subordinate volcanic rocks of the Snowshoe Group (Neoproterozoic-Lower Paleozoic).

Highlights from work in 2016 are as follows.

- Completion of Phase 1 drilling on the BC vein followed by Phase 2 (infill drilling) to define economically prospective and mineable portions. The BC vein has a strike length of 1,400 metres and has been drilled to a depth of 400 metres below surface.
- KL zone evaluation. In the course of drilling the BC vein, the company discovered new zones of mineralization in both its hangingwall and footwall. Of particular interest is the KL zone, 500 metres east of the Bonanza Ledge pit, which consists of quartz-sulphide veins that parallel the BC vein. Tracing this zone 850 metres to the southeast was delayed until the company could acquire a block of claims owned by Williams Creek Gold Ltd.
- Completion of Phase 1 drilling (242 holes; 32,290 metres) at Cow Mountain to increase confidence in mine data and to upgrade resource categories. Cow Mountain is the site of the past-producing Cariboo Gold Quartz mine. This work discovered a new, undrilled zone of ore-grade mineralization between the Sanders and Rainbow zones within the old mine.
- Initiation of Phase 1 drilling (27,131 metres by year end) at Island Mountain, site of the past-producing Mosquito Creek and Aurum (Island Mountain) mines. Previously, mining had focused on pyrite replacement deposits because of their higher grades. Phase 1 drilling deliberately tested the tenor and continuity of vein mineralization.
- Discovery of two new gold zones (Shaft and 4300) in an undeveloped area between Mosquito Creek and Aurum mines. Both zones have intense silica alteration and an increase in vein density.
- Discovery of the 'Cariboo break' and identification of over 130 exploration targets as part of an assessment of regional resource potential. The Cariboo break is a feature some 60 kilometres long that has a marked spatial association between gold-in-soil anomalies and high-resolution magnetic and electromagnetic signatures. It is interpreted as a shear zone that channeled gold mineralization. The Cariboo break and associated targets will be the focus of regional exploration in the years ahead.

6.1.2. Bonaparte (Westkam Gold Corp.)

At the **Bonaparte** gold property, 50 kilometres northwest

Table 5. Selected exploration projects, South Central Region, 2016 (listed alphabetically).

Project	Operator	MINFILE	Commodity; Deposit type	Resource (NI 43-101 compliant unless indicated otherwise)	Work Program	Comments
Aspen Grove (Ketchikan Lake)	Kaizen Discovery Inc.	092HNE 115	Cu, Au; Porphyry	n/a	Drilling	Improved geological model
Bonaparte	WestKam Gold Corp.	092P 050	Au, Cu; Vein; porphyry	n/a	Underground bulk sampling	Advanced decline but stopped short of target Crow/Grey Jay zone. Plan to resume in 2017.
Bralorne	Avino Silver & Gold Mines Ltd.	092JNE 001	Au; Vein	n/a	Resource estimate; Engineering studies	Assessed viability of long-hole mining.
Brett	Ximen Mining Corp.	082L 04E	Au, Ag; Vein	n/a	Drilling to test main zone and parallel structures	Improved geological model.
Cariboo Gold (Barkerville Mountain; Cow Mountain; Island Mountain)	Barkerville Gold Mines Ltd.	093H 019	Au; Vein; replacement	Cow Mountain block (as of 2015-03-31; cut off 0.5 g/t Au): Indicated: 35.8 Mt grading 2.4 g/t Au (containing 2.8 Moz Au); Inferred: 27.5 Mt grading 2.3 g/t Au (containing 2.0 Moz Au)	Drilling to define resources at BC vein; Cow Mountain; Island Mountain; geochemical and geophysical surveys; explored regional targets	Improved resource definition; discovery of new ore zones near mines; discovery of “Cariboo break” structural feature.
Copper King	Copper King Exploration Ltd.	092INE 024	Cu, Au; Porphyry	n/a	Geophysics; drilling	Improved geological model.
Fox (Ridley Creek; BN; BK; South Grid)	Happy Creek Minerals Ltd.	093A 259	W, Mo, Ag; Skarn	Ridley Creek zone (as of 2016-03-15; cut-off 0.1% WO ₃): Indicated: 505,000 tonnes grading 0.468% WO ₃ ; Inferred: 280,000 tonnes grading 0.456% WO ₃ .	Drilling to delineate target areas and demonstrate continuity of mineralization; trenching; sampling	Published first resource estimate for Ridley Creek zone. Improved geological models for BN and BK zones.
Gibraltar North	Taseko Mines Ltd.	093B 011	Cu, Mo; Porphyry	n/a	Drilling	Intersected high grade Cu-Mo porphyry outside mining area.
Ike	Amarc Resources Ltd.	092O 025	Cu, Mo, Ag; Porphyry	n/a	Drilling; Geophysical surveys	Extended mineralized zone.

Table 5. Continued.

Lac la Hache (Aurizon South)	Engold Mines Inc.	092P 002	Cu, Au, Ag; Breccia	n/a	Drilling; prospecting	Extended structure along strike and down dip.
Lucky Mike	Plate Resources Inc.	092ISE 027	W, Cu, Mo; Skarn; porphyry	n/a	Drilling	Extended mineralized zone; improved geological model.
Prospect Valley	Westhaven Ventures Inc.	092ISW 107; 111; 112	Au, Ag; Vein	North and South Discovery zones (as of 2012-01-11; cut-off 0.30 g/t Au): Inferred: 10.1 Mt grading 0.5 g/t Au, containing 166,000 troy oz Au.	Drilling; prospecting	Extended mineralized zone; improved geological model.
Rabbit North	Tower Resources Ltd.	092INE 071	Cu, Au; Porphyry	n/a	Drilling; mapping; prospecting	Extended mineralized zone; improved geological model.
Redhill	Troymet Exploration Corp.	092INW 042	Pb, Zn, Au; Volcanogenic massive sulphide	n/a	Drilling; mapping; geochemical and geophysical surveys	Discovered new massive sulphide layer.
Shovelnose	Westhaven Ventures Inc.	092HNE 308, 309	Au; Vein; breccia	n/a	Drilling	Mineralized zone extended
Thule (including Titan Queen; Embayment; Eric)	Nicola Mining Inc.	092ISE 034; 035; 036	Cu, Au, Ag; Skarn; porphyry	n/a	Drilling	Improved geological model.
TL	Pacific Ridge Exploration Ltd.	082LNE 047	Pb, Zn; Sedimentary exhalative	n/a	Drilling	Improved geological model.
Woodjam (including Woodjam North; Woodjam South; Megaton)	Consolidated Woodjam Copper Corp.	093A 078; 251	Cu, Au; Porphyry	Southeast zone: Inferred: 227.5 Mt at 0.31% Cu, containing 1.5 billion lbs copper.	IP	Improved geological model.

of Kamloops, Westkam Gold Corp. started underground bulk sampling on the **Grey Jay/Crow** vein system. The company has a permit to extract 10,000 tonnes of ore. To reach the target zone, the company has had to extend an existing 120 metre decline as well as install safety bays and ground support (Fig. 3). En route to the target zone, the decline intersected the Eaglet/Chickadee system of narrow veins, which have yielded historic values of up to ~14 grams per tonne gold. The target **Grey Jay/Crow** vein system is the down-dip extension of

gold mineralization exposed in surface trenches. Previous bulk samples (totalling ~4,000 tonnes) taken from these trenches have grades up to ~25 grams per tonne gold.

6.1.3. Brett (Ximen Mining Corp.)

In November 2016, Ximen Mining Corp. completed drilling (16 holes; ~2,360 metres) at the past-producing **Brett** epithermal gold deposit, west of Vernon. The company hopes to delineate high-grade ore shoots and subparallel mineralized structures



Fig. 3. Bonaparte gold project. WestKam Gold Corp. advanced its decline towards the Grey Jay/Crow vein system to collect a 10,000 tonne bulk sample (Image courtesy of WestKam Gold Corp.).

related to the Main zone. Precious metal mineralization occurs as native gold, electrum and argentite associated with multiphase silica veins, stockworks and breccias in Kamloops Group (Eocene) volcanic and volcanoclastic rocks. Ximen also started grassroots exploration for silver at the **Treasure Mountain North** project adjacent to the Treasure Mountain silver-lead-zinc mine south of Merritt.

6.1.4. Elk (Gold Mountain Mining Corporation)

In April 2015, Gold Mountain Mining Corporation released results from open-pit bulk sampling at the **Elk** project in 2014. The ~6,600 tonne sample averaged 16.7 g/t Au and showed that previous resource estimates were low: more gold was recovered from the bulk sample than expected. Work on this project stalled in 2015 but may resume in the future. Gold mineralization at Elk occurs in pyritic quartz veins in a Mesozoic granite that may be a phase of the Osprey Lake batholith (Jurassic).

6.1.5. Prospect Valley (Westhaven Ventures Inc.)

In February 2016, Westhaven Ventures Inc. increased its interest in the **Prospect Valley** project from 70% to 100%, taking over the property from Berkwood Resources Ltd. who had explored it for several years. Berkwood had identified the North and South Discovery zones and other prospective zones. Taken together, the North and South Discovery zones have a resource of ~10 million tonnes grading 0.5 g/t Au (Inferred; using 0.3 g/t Au cut off; Awmack and Giroux, 2012). The deposit is described as a low-grade, low-sulphidation, epithermal gold system, with potential for higher grade zones, within volcanic and volcanoclastic rocks of the Spences Bridge Group (mid-Cretaceous).

In 2016, Westhaven carried out a program of re-logging old core, prospecting, soil sampling, mapping, geophysical surveys, and drilling (8 holes; ~1,500 m). The focus was on the Discovery trend and offsets to it. Prospecting led to the discovery of new targets, such as the Ridge and Southeast Extension zones, which have gold-bearing quartz stockworks.

Drilling targeted the Early Fault Zone, on the southern side of the South Discovery zone, and the Southeastern Extension zone, seeking higher grade mineralization that can occur deeper in epithermal systems.

6.1.6. Shovelnose (Westhaven Ventures Inc.)

Westhaven Ventures Inc. drilled the **Shovelnose** property, 30 kilometres south of Merritt and southeast of Prospect Valley. Shovelnose (like Prospect Valley) is described as a low-sulphidation, epithermal gold system within the Spences Bridge Gold belt. An initial round of drilling (5 holes; ~1,150 metres) started in May to test the Mik, Tower and Alpine zones. The Mik and Tower zones have been drilled previously, but the Alpine zone was discovered in 2015 by an induced polarization survey. One hole in the Alpine zone intersected 0.27 g/t Au over ~120 metres, starting at bedrock. Higher grades (up to ~17 g/t Au) over narrow widths (0.5 metres) were also found (Fig. 4). Follow-up drilling in November (4 holes; 725 metres) attempted to extend favourable results from the Alpine zone. Analyses are pending. Drilling in 2016 has expanded the Tower and Alpine zones which remain open in all directions.



Fig. 4. Shovelnose gold project. Westhaven Ventures Inc. explored low-sulphidation epithermal gold systems south of Merritt. This sample had ~16 grams per tonne gold and ~30 grams per tonne silver (Image courtesy of Westhaven Ventures Inc.).

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

In the past few years, the southern end of the Quesnel terrane, between Aspen Grove and Princeton, has seen renewed exploration interest (see also Mihalynuk and Logan, 2013a, b and Mihalynuk et al., 2014, 2015) for results of recent British Columbia Geological Survey mapping, and Logan and Mihalynuk, 2014 for a review of Cordilleran porphyry deposits). From north to south, some of the larger properties (and their operators or owners) include: **Big Kidd** (Jiulian Resources Inc.); **Aspen Grove** (60% Kaizen Discovery Inc. / 40% Itochu Corp.); **Man-Prime** (Sunrise Resources Ltd.); **Dillard** (formerly Fjordland Exploration Inc./Sumac Mines Ltd.); **Allison Lake**; **Hit/Aspen Grove South** (Colorado Resources Ltd.); **Axe** (formerly Copper Mountain Mining Corp./Weststar Resources Corp.); **Castle** (Blue River Resources Ltd.); **Miner Mountain** (Sego Resources Inc.); **Copper Mountain** mine (Copper Mountain Mining Corp.); and **Princeton** (Anglo Canadian Mining Corp.). A poor economy has idled most of these projects.

Between Merritt and Kamloops, porphyry projects such as the **Thule** (Nicola Mining Inc.), **Lucky Mike** (Plate Resources Inc.), **Rabbit North** (Tower Resources Ltd.) and **Copper King** (Copper King Exploration Ltd.) saw exploratory drilling.

Farther north, the Quesnel terrane in southern and central Cariboo saw renewed activity at **Wilcox** (Freeport-McMoRan of Canada Ltd.), **Iron Lake** (Eastfield Resources Ltd.), **Woodjam** (Consolidated Woodjam Copper Corp.) and **Gibraltar North** (Taseko Mines Limited).

The eastern flank of the Coast plutonic complex (**Ike** project; Amarc Resources Ltd.) has attracted the interest of explorationists and the national media.

6.2.1. Copper King (Copper King Exploration Ltd.)

Private company Copper King Exploration Ltd. followed up previous mapping and geophysical surveys at its **Copper King** project with a program of shallow drilling (5 holes; ~350 m). Drilling on Crown-granted mineral claims tested near-surface mineralization near an adit and glory hole that, from ~1900-1950, had supported intermittent, artisanal mining. Mineralization occurs as disseminations and veins (Fig. 5) in the Cherry Creek phase of Iron Mask batholith (Late Triassic). The project abuts the TransCanada highway, 20 kilometres west of Kamloops.

6.2.2. Aspen Grove-Ketchan Lake (Kaizen Discovery Inc.)

Kaizen Discovery Inc. acquired the **Aspen Grove** copper-gold project in 2013 and commenced drilling in 2014. The project is a 60:40 joint venture between Kaizen and ITOCHU Corporation. Claims at Aspen Grove include a number of known mineral occurrences (e.g., Zig-Nor, Thalia; Boss-Thor; Par; Ketchan Lake; Coke). The current drilling has focused on **Par** and **Ketchan Lake**. Three seasons of drilling at Ketchan Lake have confirmed the size of the porphyry intrusive. Mineralization spans a zone approximately 500 metres wide and 1,800 metres long. Drilling in 2016 (8 holes; ~4,000 m)



Fig. 5. Copper King copper-gold project, 20 kilometres west of Kamloops. Offset sulphide lens and quartz veinlet in brecciated Cherry Creek monzonite, a phase of the Iron Mask batholith (Image courtesy of Copper King Exploration Ltd.).

focused on expanding known zones of mineralization and testing undrilled areas within the Ketchan Stock. All holes intersected potassic or calc-potassic alteration and all but one returned intervals of copper and gold mineralization. One hole intersected 62 metres grading 0.46% copper and 0.10 g/t gold, including 28 metres grading 0.90% copper and 0.17 g/t gold. Understanding controls on mineralization (in particular grade and distribution) remains a focus of further work.

6.2.3. Rabbit North (Tower Resources Ltd.)

Tower Resources Ltd. followed up 2013 results with prospecting and drilling at the **Rabbit North** project, 25 kilometres southwest of Kamloops. The drill program (11 holes; 3,400 m) tested four distinct copper-gold targets: **Western Magnetite**; **Central Monzonite South**; **Chrysocolla East**; and **Dominic**. All are associated with the Durand stock (late Triassic), a composite pluton with an older rim of diorite and a younger core of monzonite. The best intersection reported to date cut 200 metres of 0.3% Cu and 0.15 g/t Au from a hole in the Western Magnetite zone.

6.2.4. Woodjam (Consolidated Woodjam Copper Corp.)

Consolidated Woodjam Copper Corp. returned to the **Woodjam** area, 45 kilometres northeast of Williams Lake, following a \$20 million campaign by Gold Fields Horsefly Exploration Corporation between 2009 and 2013. Work in 2016 consisted of induced polarization surveys over the **Woodjam North**, **Woodjam South**, **Megaton** (Southeast)

areas intended to fill in or extend known anomalies or zones of mineralization in support of future drilling. The Woodjam project covers a large area (>60,000 hectares) with numerous zones of copper-gold mineralization, some with published resources. Mineralization occurs along the western edge of the Takomkane batholith (Early Jurassic) and adjacent volcanic and sedimentary rocks of the Nicola Group (Triassic).

6.2.5. Gibraltar North (Taseko Mines Limited)

In August 2016, Taseko Mines Limited announced acquiring more than 2,400 acres of mineral claims, adjacent to existing claims but outside current mining areas. The **Gibraltar North** claims are 2 kilometres northwest of the Extension zone (part of Gibraltar mine's current resources). Decades ago, exploration found geophysical anomalies characteristic of porphyry mineralization. Drilling in 1992 intersected 0.4-0.9% copper over 80-100 metres. In September 2016, Taseko released results from a single hole drilled in 2015 that confirmed previous results. The hole intersected ~150 m of ~0.4% copper, within which was an interval of 73 metres of 0.68% copper. In the fall Taseko commenced a six-hole, 4,500 metre drill program. Results are pending. The company's exploration target is a possible high-grade core to known porphyry mineralization.

6.2.6. Ike (Amarc Resources Ltd.)

Amarc Resources Ltd. continued drilling the **Ike** property in the South Chilcotin Mountains, 110 kilometres northwest of Lillooet, with financial assistance from Thompson Creek Metals Company Inc. The principal target is copper-molybdenum-silver porphyry mineralization in an extensive alteration zone on the eastern side of the Coast Plutonic Complex. The project includes the Tasco (or Chilcotin Belle) mineral occurrence. The 2016 drilling program (3 holes; 1,900 metres) helped define the southern part of the deposit and included a step-out hole some 800 metres to the west. All holes encountered mineralization. The two southern holes intersected long intervals with copper-molybdenum-silver values that are comparable to other BC porphyry deposits. The step-out hole intersected lower grade copper and molybdenum over its ~480 metre length. As defined by drilling to date, the main zone at Ike covers an area of 1200 metres east-west, 1000 metres north-south and extends to depths of more than 500 metres. It remains open to expansion laterally and to depth. Drill intersections in the main zone range up to ~600 metres grading ~0.3% Cu, ~0.03% Mo and ~2 g/t Ag. Mineralization occurs as replacements and veins in granitic rocks that show evidence of repeated pulses of magmatism. Other work in 2016 included 77 kilometres of induced polarization on four nearby targets, talus sampling, and regional geological mapping. The company plans extensive drilling in 2017, to delineate known mineralization and to test early stage targets on nearby **Rowbottom**, **Mad Major** and **Buzzer** claims.

6.2.7. Lucky Mike (Plate Resources Inc.)

Plate Resources Inc. has an option agreement with Nexgeo

Inc. and Korea Resources Corporation to advance the **Lucky Mike** project at Swakum Mountain, 25 kilometres north of Merritt. The Swakum Mountain area has a variety of deposit types, including veins, skarns, and porphyries. In the course of drilling a tungsten-copper(-silver) skarn target in 2014, the company discovered molybdenum mineralization extending over tens of metres of core. Drilling in 2015 further explored both the skarn and molybdenum targets. In 2016, the drill program (5 holes; ~3800 m) focused on the molybdenum discovery. The molybdenum target is a 25 hectare area with high magnetic and high chargeability values. Molybdenum mineralization occurs in small veins and fracture fillings. The company's current geological model is a broad molybdenum (-copper) porphyry core zone with subordinate, distal copper-tungsten skarn zones in altered calcareous horizons.

6.2.8. Maggie (Constantia Resources Ltd.)

In May 2016 Constantia Resources Ltd. placed its **Maggie** project, 15 kilometres north of Cache Creek, on care and maintenance, closing the community office, and suspended further exploration for the rest of 2016 and 2017. In November the company solicited bids for multi-year leases on farm lands that overlie the deposit.

Two phases of drilling (in early 2014 and late 2015) have confirmed historic grade and continuity of mineralization and tested possible extensions. Maggie is described as a typical, calc-alkaline porphyry deposit in which copper and molybdenum occur in stockwork veins and as disseminations. The intrusion is a multi-phase, quartz monzonite porphyry with a U-Pb zircon age of ~66 Ma (J. Lang, pers. comm., October 2015). Host rocks are part of the Carboniferous to Permian Cache Creek assemblage, consisting of deformed sedimentary and volcanic sequences of low metamorphic grade that are intruded by pyroxenite dikes and sills.

6.2.9. Generative exploration

Work on the Ike project has revived interest in nearby properties such as the **Mike** (also called Bridge River; Griswold; Russnor) owned by Cresval Capital Corporation, and the **Lorn** operated by Jet Gold Corporation. Farther north, near Tatla Lake, Tchaikazan Resources Inc.'s **Bluff** project (Fig. 6) occurs on the eastern flank of the Coast plutonic complex, in a geological setting broadly similar to Ike.

There have been relatively few grassroots or generative exploration efforts in the region. Private company Tech-X Resources Inc. conducted induced polarization surveys at **Lawless Creek**, 50 kilometres south of Merritt. In the southern Cariboo, Freeport-McMoRan of Canada Ltd. explored the **Wilcox** property, 30 kilometres northeast of 100 Mile House. Eastfield Resources Ltd. announced the discovery of a new gold target on the **Iron Lake** property, 45 kilometres northeast of 100 Mile House.

6.3. Polymetallic base and precious metal projects

The polymetallic category includes stratiform base metal



Fig. 6. Bluff copper project. Intense malachite staining at a possible porphyry in a geological setting broadly similar to the Ike project (Image courtesy of Tchaikazan Resources Inc.).

deposits of diverse origins (e.g., mantos, sedimentary exhalative deposits; and volcanogenic massive sulphide deposits). South Central region has a history of successful exploration, development and mining of polymetallic deposits. However, in the past few years, only a few projects (e.g., **TL**; **Redhill**) have targeted this deposit type.

6.3.1. TL (Pacific Ridge Exploration Ltd.)

Pacific Ridge Exploration Ltd. optioned the **TL Zinc** project, east of Mabel Lake, 60 kilometres northeast of Vernon. Late in the year the company started a drilling program (planned 6 holes; 1,800 m) to test coincident anomalies defined by 2012 EM and 2016 gravity surveys. The target at TL is a sedimentary-exhalative (Monashee or Broken Hill type) massive sulphide deposit.

6.3.2. Redhill (Troymet Exploration Corp.)

Late in 2015, Troymet Exploration Corp. acquired the **Redhill** property, 15 kilometres south of Cache Creek, and began exploring VMS copper-zinc and gold targets. Historical work had identified three zones (Alpha; Alpha South; Beta) with coincident soil geochemical and geophysical anomalies and sulphide mineralization. In September 2016, Troymet commenced a drilling program (5 holes; ~1000 m) on the Alpha zone. Drilling encountered a new, near-surface layer of massive sulphides grading ~0.7% Cu and 6.5 g/t Ag over 6.5 metres. The same hole intersected a 2 metre layer of sulphides grading 0.6% Cu and 1.5% Zn some 200 metres below the upper layer (Fig. 7). Geophysical work (electromagnetic; induced polarization) on the Beta zone refined targets that the company intends to drill next year.

6.4. Skarn projects (tungsten; copper; gold)

The South Central region has a history of successful exploration, development and mining of skarn deposits. In the



Fig. 7. Redhill volcanogenic massive sulphide project. Massive sulphide layer (between pink flagging) at the Alpha zone, 15 kilometres south of Cache Creek (Image courtesy of Troymet Exploration Corp.).

past few years, however, only a few projects (e.g., **Fox**; **Thule**; **Lac La Hache**) have targeted this deposit type.

6.4.1. Fox (Happy Creek Minerals Ltd.)

At the **Fox** tungsten skarn property, 115 kilometres east of Williams Lake, Happy Creek Minerals Ltd. continued to define the extent, grade, and continuity of scheelite mineralization. Skarn mineralization occurs in flat-lying sedimentary rocks of the Snowshoe Group (Neoproterozoic to Lower Paleozoic) that have been intruded by the Deception stock, a mid-Cretaceous (106 Ma) pluton that ranges from quartz monzonite to muscovite-biotite granite.

Work on this project since 2011 has identified seven, near-surface mineralized zones within a tungsten skarn system that extends over an area measuring 3 kilometres by 10 kilometres. From north to south the zones are: North; BK; Ridley Creek (or 'RC'); BN; 708; Nightcrawler-Discovery (or 'NC'); and South Grid.

In March 2016, the company released its first NI 43-101 compliant resource estimate for the Ridley Creek zone (Gruenwald and Desautels, 2016) and in June updated this report with metallurgical data from a 450 tonne sample (Gruenwald et al., 2016). Resources stand at 505,000 tonnes WO_3 (Indicated) and 280,000 tonnes WO_3 (Inferred) with a 0.1% WO_3 cut-off. Ridley Creek deposit currently measures 350 metres by 175 metres, is from 5 to 25 metres thick, and comes within 25 metres of the surface.

Exploration in 2016 focused on four targets (BK; Ridley Creek; BN; South Grid) with a program of geological mapping, trenching and drilling (28 holes; ~2,330 metres). Three of seven holes drilled at BK, near hand-dug trenches, returned values of ~0.7% WO_3 over 2 to 6 metre intersections. Prospecting attempted to correlate mineralized strata at the BK and Ridley Creek zones, which are about 1 kilometre apart. Ten holes drilled at the Ridley Creek zone were designed to expand the existing resource. One hole on the northern edge of the deposit returned ~8.5 metres grading ~1.1% WO_3 . At the BN zone, one hole returned ~4 metres of ~5% WO_3 , which compared favourably with previous drill results. The company believes these tungsten values may represent a higher grade zone (currently 100 by 150 metres) within a larger, lower grade

deposit some 1,000 by 1,500 metres in extent. At the South Grid, the company discovered a new zone of scheelite-bearing calc-silicate float, sub-outcrop and outcrop, poorly exposed over a 500 by 1,250 metre area. The company plans more work to site future trenches and drill holes.

6.4.2. Lac La Hache (Engold Mines Ltd.)

Engold Mines Ltd. (formerly GWR Resources Inc.) focused on the **Aurizon-South** copper-gold-silver hydrothermal breccia structure on its **Lac La Hache** property. The company hopes to demonstrate that the shape, tonnage, and grade of this zone will support mining by bulk-tonnage methods. The 2016 drill program (12 holes; 3,850 metres) extended the structure to 400 metres along strike and to a depth of 700 metres. The steeply dipping zone remains open. A narrow, near-surface quartz vein with visible gold was intersected in one hole. This is the first occurrence of free gold reported on the property. The company plans to resume drilling early in 2017, with a view to establishing a resource estimate as soon as possible, followed by a preliminary economic assessment.

6.4.3. Thule (Nicola Mining Inc.)

Nicola Mining Inc. explored the **Thule** copper property that surrounds the main pit of past-producing Craigmont mine, west of Merritt. One hole drilled on the **Embayment Zone** skarn intersected ~86 m of ~1.1% copper. Other skarn and porphyry targets (e.g., **Titan Queen**; **Eric**; **WP**; **Marb**) on Thule are being pursued. The company also plans to evaluate Craigmont's low-grade stockpiles as potential feed for Teck's mill at Highland Valley Copper since the former mine's cut-off grade was as high as 1.2% copper.

6.5. Industrial mineral exploration

Basalt

Two companies received permits to collect bulk samples of basalt. Kelowna Sand and Gravel Ltd. commenced a multi-year, 10,000 tonne bulk sample at its **Phoenix** property between Kelowna and Beavercreek. Roadway Construction has a one-year permit for 1,000 tonnes from its **Roadway** quarry southeast of Vernon. Both basalt occurrences appear to be from the Chilcotin Group (Miocene) and will be used for decorative purposes.

Graphite

Lithium Corporation evaluated results from 2015 trenching (Fig. 8) their **BC Sugar** graphite project. The current focus is the Weather Station zone but the property comprises a large block of claims between Mabel Lake and Sugar Lake, east of Vernon. The company hopes to find exploitable concentrations of flake graphite. Crystalline graphite occurs in gneiss and marble of the Shuswap metamorphic complex (Neoproterozoic).

Gypsum

Homegold Resources Ltd. has a permit to sample 500 tonnes of gypsum at its **Snapper** project, 15 kilometres west of Merritt.



Fig. 8. BC Sugar graphite project. Lithium Corporation is studying results of 2015 trenching (shown here). Graphite occurs as thin seams in metasedimentary rock of the Shuswap metamorphic complex, east of Mabel Lake (Image courtesy of Lithium Corp.).

This small project has had to address a number of concerns raised by local First Nations.

Jade

Whistler Jade Inc. continued to test and market products from jade-bearing rocks extracted at their **Birkenhead** (Hell Creek) prospect near Lillooet. Products include garden ornaments, decorative stone, and translucent tiles.

Manganese

Vendome Resources Corp. prospected for manganese on the MN claims near Clinton and reported finding grab samples with up to 28% manganese. The company plans further work.

Marble

Prospector N. Mughal evaluated the marketability of crushed marble at his **Clifton** project 60 kilometres north of Lumby. Previous efforts to mine and market marble as dimension stone have been unsuccessful.

Zeolite

ZMM Canada Minerals Corp. returned to its **Back Valley**

zeolite quarry, near Cache Creek, to assess if further extraction of clinoptilolite is feasible. The company also prospected for zeolites in Tertiary rocks between Cache Creek and Vernon.

7. Geological research

The BC Geological Survey supported bedrock mapping southeast of Kamloops, between Stump Lake and the Salmon River. Paul Schiarizza extended the regional stratigraphic framework that he had initially developed in the Cariboo area farther north (Schiarizza, 2016, 2017).

Travis Ferbey and colleagues released surficial geological maps in the Moffat Creek, Woodjam Creek, and Guichon Creek (Highland Valley) areas that covered important porphyry camps (Ferbey et al., 2016a, b; Plouffe and Ferbey, 2016). Alexei Rukhlov and colleagues released data on apatite as a porphyry indicator mineral (Rukhlov et al., 2016).

8. Outlook for 2017

Foreseeable economic conditions seem to offer few incentives for exploration. Financing grassroots or early stage projects continues to be difficult. Producing mines will continue to reduce operating costs, and may reduce production or staff, or go on care and maintenance as a result of weak commodity prices.

Ajax, Bethlehem and Bonanza Ledge will be the only projects to proceed with formal environmental reviews, unless Harper Creek secures alternative financing. Most of the exploration projects active in 2016 that generated positive results are likely to continue. If economic conditions improve, grassroots exploration should pick up in the Gold Bridge area (near the Ike project), the Eagle Bay assemblage near Barriere, and the Quesnel terrane, in particular between Merritt and Princeton and between 100 Mile House and Quesnel.

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