Exploration and mining in the Southeast Region, British Columbia

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1. Introduction

The Southeast Region (Fig. 1) offers a variety of mining and exploration opportunities accessible by well-developed infrastructure. Five metallurgical coal mines that operated in the Elk Valley in 2018 account for most of Canada's coal production and exports. Several industrial mineral mines produce silica, magnesite, and gypsum. Limestone, smelter slag, rock wool, aggregate, rip rap, railroad ballast, flagstone, dimension stone, sand and gravel are quarried, and placer mining occurs throughout the region. The region hosts many historic producers dating back to the mid-1800s, including the lead-zinc-silver Sullivan mine, and many small producers from the Rossland, Greenwood, Sheep Creek, and Slocan gold and silver camps. Exploration for base metals and precious metals continues to be a focus. The Trail smelter (Teck Resources Ltd.) is still in operation, and produces approximately 305,000 t of refined zinc, 90,000 t of refined lead, and 16 to 18 Moz of silver annually.

Estimates for exploration expenditures, drilling programs, and other metrics were captured in the British Columbia Mineral and Coal Exploration Survey, a joint initiative of the Province of British Columbia Ministry of Energy, Mines and Petroleum Resources, the Association for Mineral Exploration in British Columbia, and Ernst & Young LLP. For the Southeast Region, exploration expenditures were estimated at $64.5 million and exploration drilling was estimated at approximately 126,400 m (Clarke et al., this volume: Ernst &Young LLP (EY), 2019, in press).

Most drilling focussed on large projects that have been active over the past several years, in addition to exploration drilling at the coal mines in the Elk Valley for mine expansion. Exploration also occurred on many grassroots and smaller early-stage projects, with a number of new projects in the region. Forest fires delayed operations and permitting on several projects, and many struggled to get started before winter; some have been delayed until next spring.

2. Geological overview

The Canadian Cordillera has long been of interest to the exploration industry. It is a collage of allochthonous terranes, parathochtonous terranes and authochthonous basement, containing diverse rocks and structures. Metallogenetic processes generated the varied deposit types that contribute to the mineral endowment of British Columbia (Nelson et al., 2013).

The Southeast Region (Figs. 1, 2) contains elements of Ancestral North America (Laurentia) including: Archean to Mesoproterozoic basement rocks; Proterozoic rift and intracratonic basin successions (Belt-Purcell and Windermere supergroups); Paleozoic to Jurassic passive-margin, shelf, and slope carbonate and siliciclastic successions that were deposited on the western flank of the ancient continent (Kootenay terrane, and North American platform); and Jurassic to Cretaceous foreland basin deposits. It also contains parts of the Slide Mountain terrane, which records mid- to late- Paleozoic back-arc extension that split the western flank of Ancestral North America to form the Slide Mountain ocean, and Quesnel terrane (Quesnellia) and its basement (Okanagan subterrane; Nelson and Colpron, 2007; Nelson et al., 2013). Magmatic intrusive rocks such as those formed in the Proterozoic (Moyie intrusions) and Devonian (diatremes and volcanic rocks) represent periods of extension along the margin of Ancestral North America, whereas others (Jurassic and Cretaceous) are related to subduction and crustal thickening. Cenozoic magmatic rocks and exhumation of the normal fault-bounded metamorphic complexes occurred during post-orogenic Tertiary extension.

Historically, the Canadian Cordillera has been divided into five northwest-trending physiographic belts. The Southeast region includes two of these belts (Fig. 2): the Rocky Mountain foreland belt, which consists mainly of unmetamorphosed sedimentary successions that were thrust northeastward in thin-skinned sheets; and the Omineca belt, which includes more deformed and higher grade (greenschist to amphibolite) siliciclastic and volcanic rocks, and basement-cored gneiss domes (Monger, 1999). For further details about the geology of the Southeast Region see Katay (2017).

3. Mines and quarries

The Southeast Region produces metallurgical coal from four

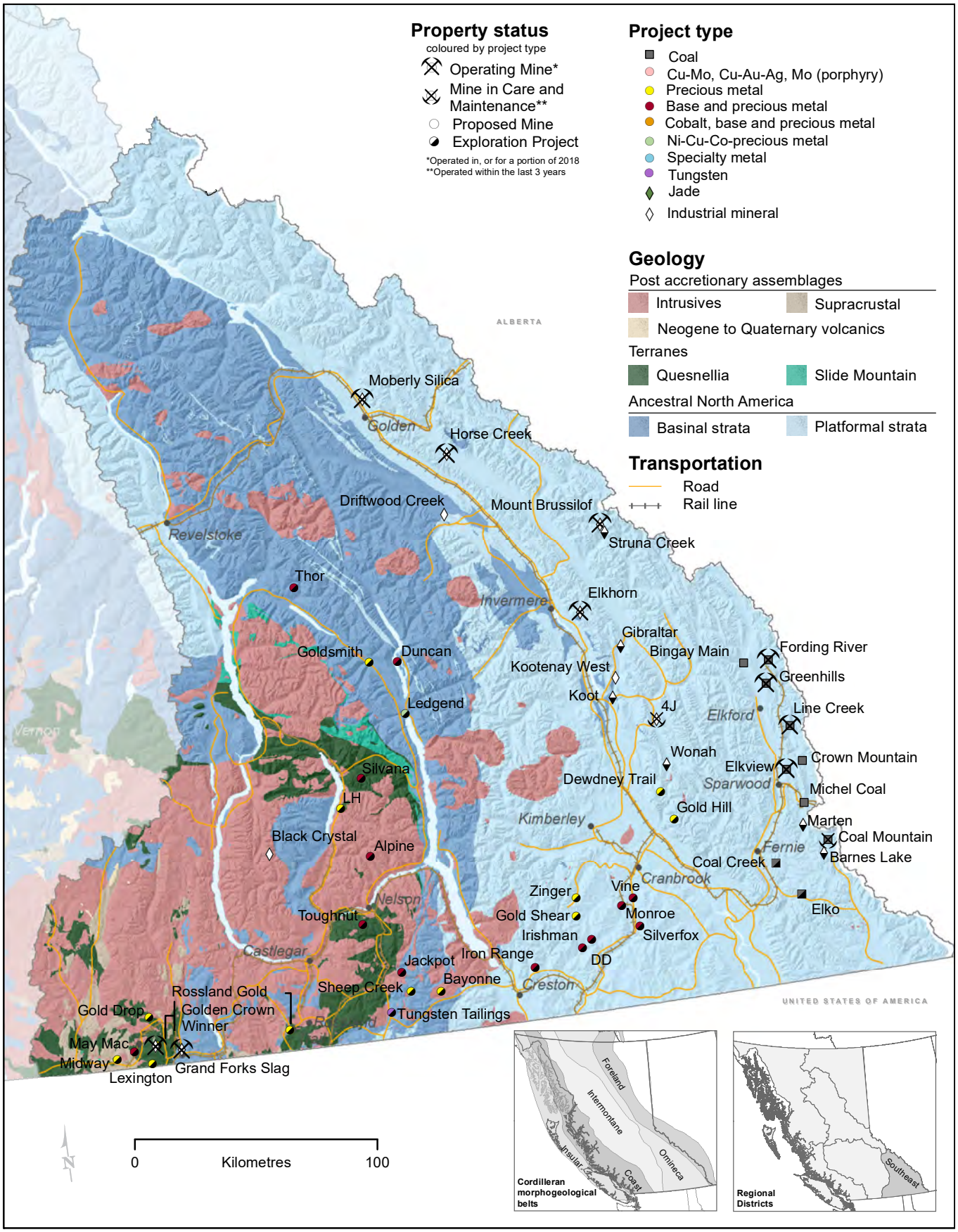

Fig. 1. Mines and selected exploration projects, Southeast Region, 2018.

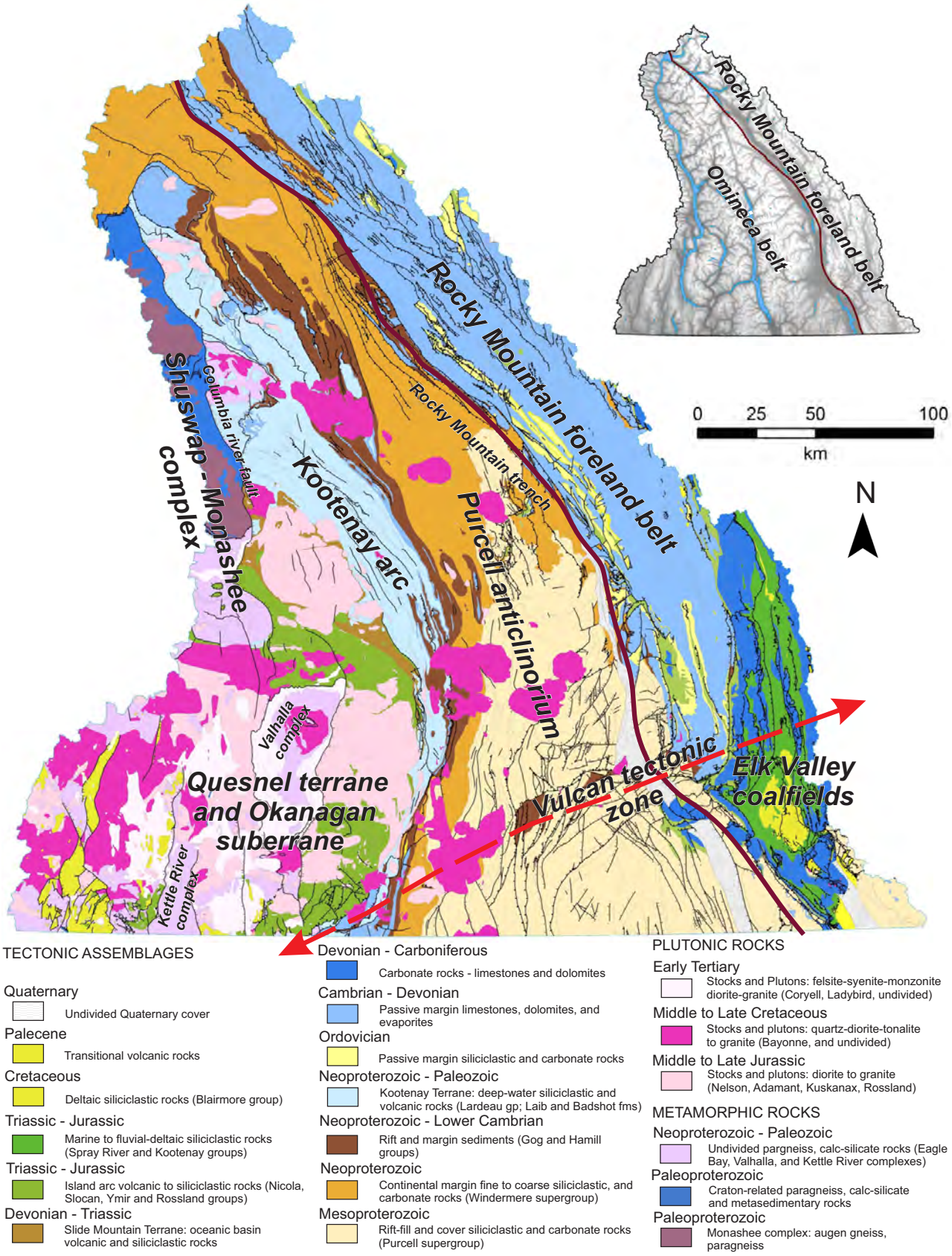

Fig. 2. Geology and physiographic belts of the Southeast Region. Physiographic belts after Nelson et al. (2013). Bedrock units are after Wheeler and McFeely (1991) and Cui et al. (2013) and generalized to highlight temporal and lithological differences in the region. Vulcan tectonic zone is after McMechan (2012).

mines in the Elk Valley, and continues to be an important source of industrial minerals such as gypsum, magnesite, silica sand, mineral wool, dolomite, limestone, flagstone, railroad ballast, rip rap, smelter slag, and aggregate (Fig. 1).

3.1. Metal mines

In 2018, no metal mines operated in the Southeast Region.

3.2. Coal mines

The main coal deposits in southeastern British Columbia extend for 175 km following the northwest-southeast trend of the Rocky Mountain Front Ranges, and coal is produced from structurally thickened seams of the Mist Mountain Formation (Kootenay Group; Jurassic; Table 1; Figs. 1, 3). With a history of coal mining that dates back to the 1800s, several underground mines were in operation by the early 1900s. Open-pit mining began in 1968, with the introduction of large-scale equipment, hydraulic shovels, and bulk mining methods. In 2004, the five Elk Valley mines consolidated into the Elk Valley Partnership and, in 2008, Teck Coal Limited acquired most of this partnership and began operating the open-pit mines. In Q3 of this year, reserves at one of the mines (**Coal Mountain**) were depleted. The pit operation is now suspended, though the plant and load out facilities remain operational and continue to process coal from the other mines. The main product is metallurgical coal (85%), with some thermal and pulverized coal injection (PCI) coal (15% combined). In 2018, total annual production from the mines in the Southeast Region was approximately 26.2 Mt of clean metallurgical coal.

In recent years, all mining in the Elk Valley watershed has been subject to conditions laid out in the trans-border Elk Valley Water Quality Plan (the Plan), which addresses the management of substances released by mining activities. It includes water diversion and treatment on mine sites, and establishes water quality targets for selenium, nitrate, sulphate, cadmium, and calcite in the Elk Valley watershed and flowing into the Libby reservoir system, downstream in Montana. The Plan initially outlined a commitment for constructing five water treatment facilities at the current operating mines, with a projected cost of $850 to $900 million during the next five years, and annual operating costs of about $65 million. However, based on current water quality modelling data and treatment technologies, up to four additional facilities may be required to meet target guidelines after 2023. Teck is engaged in research and development on alternative and passive treatment methods in order to better meet targets.

The first water treatment facility has operated at the **Line Creek** mine since February 2016, with an additional treatment step that was successfully implemented in 2018. A pilot stage has begun for the second facility at **Fording River** (Fig. 3), with construction expected to begin next year. An alternative water treatment project, which relies on biological processes in a saturated fill environment, was constructed at **Elkview** in early 2018 at a total cost of $41 million. This treatment may be combined with other capping and reclamation techniques on waste rock piles. Calcite management test work is also ongoing at both **Greenhills** and **Coal Mountain.** Teck is hopeful that a combination of these alternative techniques may either enhance, or replace the need for active water treatment and construction of additional plants.

3.2.1. Fording River (Teck Coal Limited)

The **Fording River** mine (Fig. 3) consists of approximately 23,000 ha of coal lands, and produces primarily metallurgical coal, and a small amount of thermal coal. The current annual production capacity of the mine is 9 Mt; the preparation plant has a capacity of 9.5 Mt of clean coal. In 2018, production at **Fording River** was mainly from their Eagle Mountain pit, with a small amount of production from three pits in their **Swift** expansion area.

West of the current mine area at **Fording River**, the **Swift** expansion area comprises both previously mined (last in the 1990s) and unmined zones of the Fording property, and multiple seams along both limbs of the Greenhills syncline (Fig. 4). The area is along strike and directly north of the **Greenhills** Cougar North project; eventually the two will merge and collectively become the **Swift**. With a planned 25-year mine life, the expansion project will use the existing Fording mine facilities, and is expected to produce 175 Mt of clean coal. Pilot testing and construction began in 2018 on a selenium water treatment facility at **Fording**, in tandem with continued design modifications and test work at the first facility at **Line Creek**.

Large diameter (9 inch) coring (Fig. 5) for coal quality testing was conducted in new pits, and on Turnbull Mountain, where mine models indicate that relatively thick, gently dipping seams extend into the mountain. Future expansions would include highwall pushback at the Turnbull and Henretta pits, and expansion at their Castle Mountain and Greenhills Ridge areas. Current Proven and Probable reserves are projected to support a further 45 years of mining.

3.2.2. Greenhills (Teck Coal Limited 80%; POSCO Canada Limited ('POSCAN') 20%)

The **Greenhills** mine produces mainly metallurgical coal and lesser thermal coal, and consists of approximately 11,800 ha of coal lands. The mine is on the west limb of the Greenhills syncline (Fig. 3). Coal seams generally grade in rank from medium-volatile bituminous in the lower parts of the section, to high-volatile-A bituminous at higher intervals. The current annual production capacity of the mine and preparation plant is 5.4 Mt of clean coal. Production is mainly from the Cougar pit area, and Proven and Probable reserves are projected to support another 31 years of mining at the current planned production rate.

The **Cougar Pit Extension (CPX)** project (Fig. 3) is the expansion area for Greenhills Operations. Approved in 2016, it lies immediately north of the existing operations, and at full development, will merge with the Fording River **Swift** expansion (Fig. 4). Exploration drilling in 2018 included both in- pit drilling to update structural and seam thickness models,

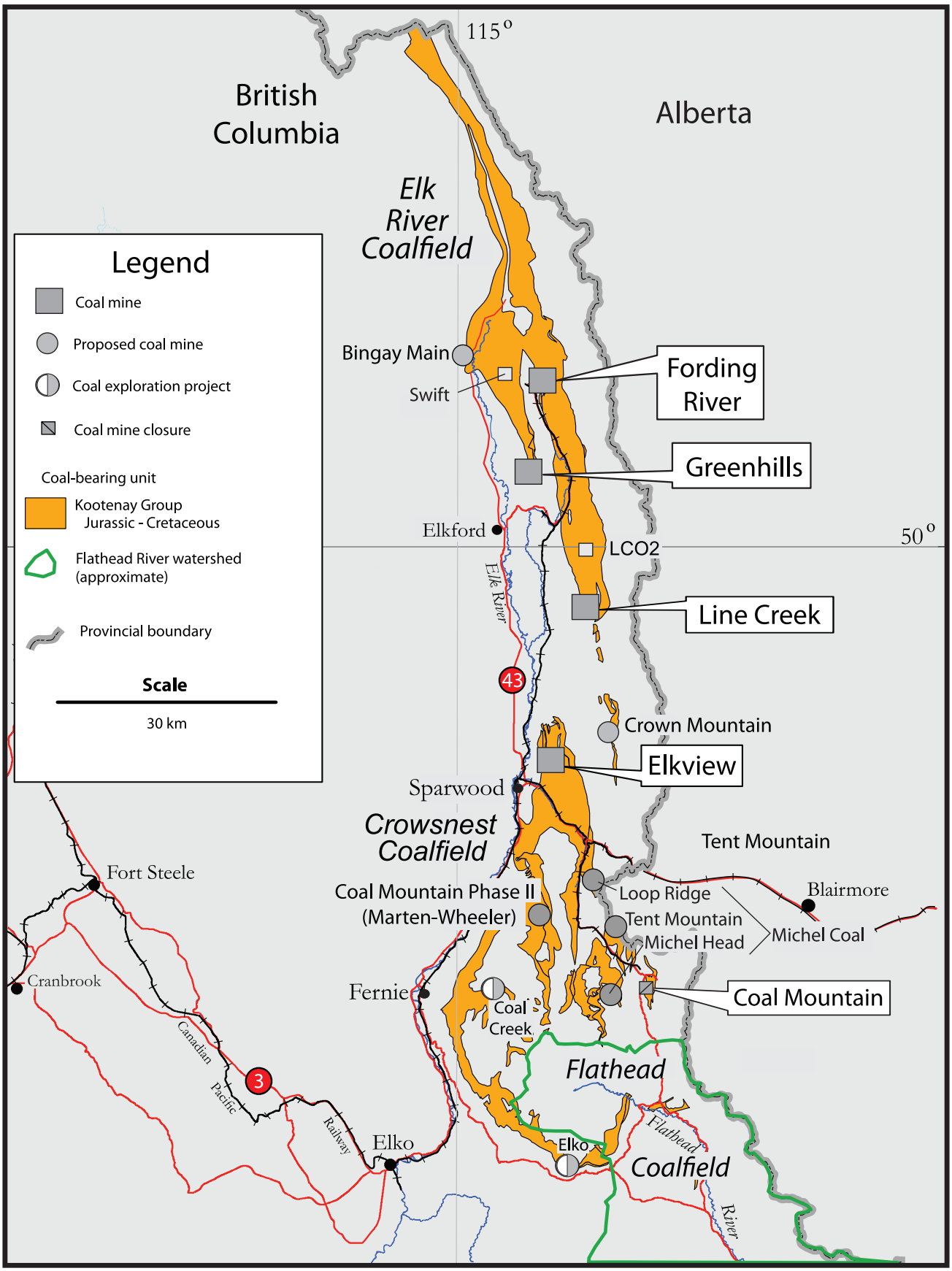

Fig. 3. Coal mines and selected exploration projects, southeastern British Columbia. From British Columbia Geological Survey (2019).

Table 1. Coal mines, Southeast Region.

Mine	Operator; Partner	Commodity	Forecast 2018 Production (based on Q1-Q3)	Reserves (as of December 31, 2017)	Resource (as of December 31, 2017)	Comments
Fording River	**Teck Coal Limited**	HCC	9.0 Mt clean	HCC P: 161 Mt Pr: 221.5 Mt	HCC M: 430.5 Mt I: 938.2 Mt Inf: 787.8 Mt	EA approval of Swift expansion (2015); exploration drilling in active pits and expansion areas; coal quality testing; geophysical work and exploration in future expansion areas; pilot water treatment construction; P+Pr reserves are projected to support a further 45 years of mining at current production rate.
Greenhills	**Teck Coal Limited (80%)**; POSCAN (20%)	HCC	6.1 Mt clean	HCC P: 10.6 Mt Pr: 154.6 Mt	HCC M: 176.6 Mt I: 247.1 Mt Inf: 181.6 Mt	Cougar Pit Expansion (CPX) approved (2016); exploration drilling in expansion areas; coal quality testing; P+Pr reserves are projected to support another 31 years of mining at the current planned production rates.
Line Creek	**Teck Coal Limited**	HCC, TC	3.8 Mt clean	HCC P: 2.1 Mt Pr: 61.5 Mt TC P: 0.5 Mt Pr: 9.4 Mt	HCC M: 312.1 Mt I: 410.5 Mt Inf: 397.1 Mt TC M: 3.7 Mt I: 3.2 Mt Inf: 1.7 Mt	Burnt Ridge Extension (BRX) approved (2016); pre-stripping on Mount Michael (LCO2); exploration drilling and coal quality test work in expansion areas; Additional of treatment process to West Line Creek water treatment facility, with further design optimization underway; P+Pr reserves at Line Creek are projected to support another 18 years of mining at planned production rates.
Elkview	**Teck Coal Limited (95%);** Nippon Steel & Sumimoto Metal Corp. (2.5%), POSCO (2.5%)	HCC	6.7 Mt clean	HCC P: 7.4 Mt Pr: 286.1 Mt	HCC M: 379.5 Mt I: 164.2 Mt Inf: 245.3 Mt	Baldy Ridge Extension (BRE) approved (2016); exploration drilling in active pits and expansion areas; coal quality testwork; P+Pr reserves expected to support approximately 42 more years at the current production rate.
Coal Mountain	**Teck Coal Limited**	PCI	615,000 t clean	na	na	Mineable resource at CMO depleted in Q3 2018; reclamation begun; facilities continue to process coal trucked from Elkview mine; facilities to be placed on Care and Maintenance; Coal Mountain Phase II (CMO2, Marten Wheeler) would utilize facilities from CMO, but project currently remains on hold.

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

Fig. 4. Historic workings on Greenhills Ridge, Swift expansion area.

Fig. 5. Large diameter core drill rig, Fording River mine.

and more than 31,700 m in expansion areas. More than 1430 m of large-diameter (9-inch) core was also drilled for bulk sample coal quality and coke strength testing.

3.2.3. Line Creek (Teck Coal Limited)

The **Line Creek** mine (Fig. 3) consists of approximately 8200 ha of coal lands, and produces mainly metallurgical coal and small amounts of thermal coal. Coal seams are predominantly medium-volatile bituminous in rank, with some high volatile-A bituminous coals near the top of the section. The current annual production capacity of the mine and preparation plant is approximately 4.0 Mt of clean coal.

The **Line Creek Phase II (LCO2)** expansion (approved in 2013) extends operations at Line Creek northward along the Mount Michael and Burnt Ridge North areas, and adds approximately 67 Mt of clean coal to the mine. In 2018, production was mainly from the Burnt Ridge extension (BRX; Fig. 6), North Line Creek extension (NLX), and Mine Services Extension (MSX) pits. More than 8700 m of exploration drilling was completed to further define mine planning and pit

Fig. 6. BRX expansion area, Line Creek mine.

design. Pre-stripping on the early phases of Mount Michael was also completed in 2017, and further exploration and coal quality testing were done in 2018 to prepare for the next phases of mining. Proven and Probable reserves at Line Creek are projected to support planned production rates for a further 18 years.

The West Line Creek water treatment facility was commissioned in February 2016, and was the first facility constructed under the Elk Valley Watershed Management plan. Work and design changes to improve the treatment process and meet water quality targets continued on the facility in 2018. Design changes at West Line Creek will be implemented in the second facility, at **Fording River**. Under the timelines outlined in the Elk Valley Water Quality Plan, the delay in construction of the second facility resulted in a $200 million penalty in 2018, though the additional design work is integral to successfully implementing the overall plan.

3.2.4. Elkview (Teck Coal Limited 95%; Nippon Steel & Sumitomo Metal Corporation 2.5%; POSCAN 2.5%)

The **Elkview** mine (Fig. 3) produces mainly high-quality mid-volatile hard coking coal from thrust repeats of mineable seams in a southwest-plunging syncline. The mine site consists of approximately 27,100 ha of coal lands. The current annual production capacity of the mine and preparation plant is approximately 7.0 Mt of clean coal. Teck estimates a remaining reserve life of approximately 42 years at the current production rate. Production is primarily from the Baldy Ridge and Natal Ridge pit areas. In 2017, the company began pre-stripping on the Baldy Ridge Extension (BRE), which is expected to extend the mine life by a further 25 years. The project will include expansion of their current permit boundary, mining of Baldy Ridge BR3, BR4, BR6, and BR7 pits, expansion of Adit Ridge AR1 and further expansion at Natal Ridge NP2 pit.

In 2018, drilling continued in active pits, as well as in their NP2 and NP3 areas, and included large-diameter core holes for coal quality testing.

3.2.5. Coal Mountain (Teck Coal Limited)

Coal Mountain (Fig. 3) consists of approximately 3000 ha of coal lands, and produces mainly PCI (metallurgical) and thermal coal. Opened around 1905 as the Corbin mine, coal was mined underground intermittently until 1935. Consolidated Mining and Smelting operated an open pit for a brief period in the 1940s. Open-pit mining began in the 1970s. The historic underground workings at the mine posed challenges to mining operations. Underground tunnels created stability issues for heavy equipment, and timber supports and other materials from the underground workings created challenges for coal quality at the wash plants. In recent years, geophysical techniques were used to map the underground workings and redevelop mine strategies.

Coal Mountain is now nearing the end of its mine life. Truck and shovel operations were suspended in Q3 of 2018, and reclamation of the mine is well underway on the final lifts of the dry stacked tailings facility, and waste dump spoils. The wash plant and load out facilities (Fig. 7) continued to operate and produce product trucked from the **Elkview** mine. The plant, designed to wash a different quality of coal than the other mines, will be kept operational. This will enable the company to optimize product and coal specifications for different customers. Teck Coal Limited plans to maintain production levels by optimizing and expanding production and facility capacity at their other metallurgical coal mines, despite the 2.25 Mt of lost production from the **Coal Mountain** shutdown. The recently approved expansion areas at the other four operational mines in the Elk Valley will enable the company to do this. With the possibility of **Coal Mountain Phase II** (**CMO2**; Marten Wheeler) starting, the facilities at **Coal Mountain** (with an annual capacity of approximately 3.5 Mt) will be maintained operational indefinitely.

Fig. 7. Coal Mountain plant.

3.3. Industrial mineral mines and quarries

The Southeast Region hosts several industrial mineral mines, the largest of which are in the Rocky Mountain foreland belt, where upturned strata are exposed and easily mined (Fig. 1). A variety of smaller mines and quarries exist throughout the region (Table 2).

3.3.1. Mount Brussilof (Baymag Inc.)

Baymag Inc. produces high-quality magnesite year-round from their open-pit mine at **Mount Brussilof**. The deposit is in Cambrian carbonate rocks of the Cathedral Formation that were originally deposited on the edge of the Cathedral escarpment, at the continental shelf edge. The deposit is considered to have been produced by magnesium hydrothermal alteration, and displays characteristics similar to Mississippi Valley-type mineralization (Paradis and Simandl, 2017). Several phases of magnesite (and minor pyrite; Fig. 8) suggest episodic flow of hydrothermal fluids along fault structures of the Cathedral escarpment. Sulphides are removed as impurities from the product. Magnesite ore is transported by truck to the company's processing facilities in Exshaw, Alberta for production of magnesium oxide (MgO) and magnesium hydroxide (MgOH). Annual magnesite production is approximately 230 Kt. The company drilled (650 m, 6 DDH) on their **Struna Creek** property south of the mine, which is on exploration tenures. Mapping and drilling extended the productive zone and resources along strike.

Fig. 8. Magnesite with pyrite stringers, Cathedral Formation, Mount Brussilof deposit.

3.3.2. Moberly Silica (HCA Mountain Minerals Limited)

HCA Mountain Minerals Limited (Northern Silica Corporation) continued work on their **Moberly Silica** project. The silica deposit is in regionally extensive orthoquartzites of the Mount Wilson Formation (Middle to Upper Ordovician; Fig. 9). The formation occurs over a 300 km length along the western portions of the Rocky Mountain fold and thrust belt (Fig. 2). Moberly Mountain is the northern extent of the unit, where it is terminated by a thrust fault, de-cemented, and friable. At **Moberly**, the unit is nearly vertical, about 200 m thick, and extends along strike for 800 m. The deposit was mined from the early 1980s to 2008 for silica sand, glass making, and other

Table 2. Selected industrial mineral mines, Southeast Region.

Mine	Operator	Commodity; deposit type; MINFILE	Forecast 2018 Production (based on Q1-Q3)	Reserves	Resource	Comments
Mount Brussilof	**Baymag Inc.**	Magnesite; hydrothermal sparry magnesite; 082JNW001	230,000 t	P: 50 Mt	na	Exploration drilling at Struna Creek project (650 m, 6 DDH); MgO, and MgOH; sediment-hosted sparry magnesite.
Moberly Silica	**HCA Mountain Minerals Limited** (Northern Silica Corp.)	Silica; industrial use silica, frac sand; 082N 001		P: 8.9 Mt of 64% frac sand Pr: 4.6 Mt of 64% frac sand (2014)	M+I: 30 to 140 mesh frac sand (dry): 37.5Mt at 70% frac sand + 11.3 Mt silica as frac sand residues (2016)	Updated mine design and haul roads; geological modeling to upgrade the resource; operation redeveloped for frac sand, and processing plant commissioned in 2017 (300,000 tpy capacity); Phase II expansion to 600,000 tpy will cost an additional USD $15M.
Horse Creek	**HiTest Sand Inc.** (PacWest Silicon)	Silica; industrial use, aggregate; 082N 043	na	na	Estimated: 3 Mt at 99.5% Silica (1987)	Variety of aggregate and industrial use products; initial phases of public consultation for a silicon metal smelter in Newport, WA, USA.
Elkhorn	**Certainteed Gypsum Canada Inc.**	Gypsum, anhydrite; evaporitic bedded gypsum; 082JSW021	Gypsum: 300,000 t; Anhydrite: 120,000 t	na	na	Mine expected to remain open until 2023; the company will replace production by developing the Kootenay West mine (EAO certificate granted in 2018).
4J	**Georgia-Pacific Canada Limited**	Gypsum; evaporitic bedded gypsum; 082JSW009	na; processing stockpiled ore	na	Estimated: 20 Mt	Processing stockpiles; updating mine expansion plans.
Winner	**Rockwool Inc.**	Gabbro/basalt; crushed rock for mineral wool; 082ESE265	Quarrying feed stock for mineral wool plant	na	na	Crushing, screening, stockpiling; environmental monitoring.
Grand Forks Slag	**Granby River Mining Company Inc.**	Slag/silica; tailings from Grand Forks smelter dumps; 082ESE264	Quarrying for abrasives and roofing granules	na	na	Crushing, screening; environmental monitoring.

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

industrial uses. In 2011, the company completed feasibility and engineering studies to produce 30-mesh to 140-mesh frac sand for the western Canadian oil and gas industry, and outlined a mine plan with a 35-year mine life. Redevelopment of the current operation began in 2015, and new 300,000 tpy frac sand processing plant was commissioned in 2017, with the potential for expansion to a 600,000 tpy capacity. In 2018, the company mapped, and updated geological models to redefine the zone and resources, and for the next phases of mine planning.

3.3.3. Horse Creek (HiTest Sand Inc.)

At the **Horse Creek** silica mine, HiTest Sand Inc. operates a seasonal quarry in Mount Wilson orthoquartzites. The orthoquartzites are more consolidated than at Moberly, and HiTest Sand Inc. produces industrial-use and aggregate products. The company is also evaluating producing alternative products, including silicon metal. They have begun initial phases of permitting on a silicon smelter facility in Newport, Washington. Operating under the name PacWest Silicon (a

Fig. 9. Ripple marks on upturned bedding of the Mount Wilson quartzite (Ordovician), Moberly silica mine.

subsidiary of HiTest Sand Inc.), the proposed smelter will produce 73,000 tons of silicon metal each year. Metallurgical silicon can be used in steel smelting, aluminum alloys, and to produce photovoltaic solar cells and electronics.

3.3.4. Elkhorn (CertainTeed Gypsum Canada Inc.)

Gypsum is produced near the western edge of the Rocky Mountains, east of Windermere. Gypsum-bearing, evaporitic strata of the Burnais Formation (Middle Devonian) were deposited in a restricted, shallow-marine embayment, and thrust upwards during the Mesozoic. Steeply dipping, mineable sections are 30 to 180 m thick (Butrenchuk, 1991). The **Elkhorn** mine produces approximately 320,000 tpy from three pits, and the mined gypsum is blended to meet quality standards for their products. The mine recently acquired a new market interest in a blended anhydrite product, and has begun marketing product that was once left behind as waste. This realignment will allow the mine to continue production until 2023. The company plans to replace gypsum production after mine closure with their new **Kootenay West** mine (see 6.3.1), which received conditional approval through Environmental Assessment in January, 2018.

3.3.5. 4J (Georgia-Pacific Canada Limited)

Georgia-Pacific Canada Limited operates the **4J** gypsum mine and a rail load-out facility southeast of Canal Flats. The deposit is in Burnais Formation evaporites (Middle Devonian). The company has been producing mainly from stockpiled material of the fine fraction for use in agricultural.

3.3.6. Winner (Rockwool Inc.)

Rockwool Inc. (formerly Roxul Inc.) operates two small seasonal quarries near Grand Forks, extracting gabbro from **Winner**, and basalt from **Friday** (North Fork). The material is trucked to the Rockwool Inc. manufacturing plant in Grand Forks, where it is blended with other mineral material to make mineral wool insulation, construction board, blankets, and pipe covering. The product is also naturally fire-retardant.

3.3.7. Grand Forks Slag (Granby River Mining Company Inc.)

The Granby River Mining Company Inc. operates the **Grand Forks Slag** quarry, producing abrasives and roofing granules from smelter slag. The historic smelter operated between 1900 and 1918, and processed copper-gold ore from the historic Phoenix mine.

4. Placer operations

Placer mines have operated in southeastern British Columbia since the gold rush began in 1864. Although activities were not tracked in 2018, 58 placer projects currently have active Mines Act permits that allow mechanized work, consisting of more than simple hand panning (Fig. 10).

Fig. 10. Placer mining, hand panning during the 2018 Chamber of Mines of eastern British Columbia prospecting course.

5. Proposed mines and quarries

The Southeast Region has four proposed coal mines (Table 3): **Michel Coal** (North Coal Limited), **Crown Mountain** (Jameson Resources Limited), **Coal Mountain Phase II** (on hold; Teck Coal Limited), and **Bingay Main** (Centermount Coal Ltd.). In addition to the approval of the **Kootenay West**

mine (CertainTeed Gypsum Canada Inc.) earlier this year, another industrial mineral mine, **Driftwood Creek** (MGX Minerals Inc.), is proposed.

5.1. Proposed metal mines

There are currently no proposed metal mines in the region.

5.2. Proposed coal mines

There are currently four proposed coal mines in the Southeast region in various phases of environmental assessment. Each project must demonstrate how they will meet the guidelines set out in the Elk Valley Water Quality Plan as part of their application.

5.2.1. Michel Coal (North Coal Limited)

North Coal Limited, a wholly owned subsidiary of CoalMont Pty Ltd., entered the pre-application phase of environmental assessment for their **Michel Coal** project in 2015. Since that time, with expanded resource delineation and coal quality test work, the company amended their project proposal to include not only **Loop Ridge**, but also their **Loop South, Tent Mountain,** and **Michel Head** areas (Fig. 3), and submitted a revised project description in September 2018. The expanded plan will give them more flexibility in blending product from different areas to client specifications. The project is expected to produce between 2.3 and 4 Mt annually, with a 30-year mine life.

In 2018, work continued on expanded mine design. The project will use diversion, and active and passive techniques for managing waste rock and treating water to ensure that targets identified in the Elk Valley Water Quality Plan can be met. Exploration drilling focussed mainly on the **Tent Mountain** area, work was completed on a 3D model for resource modeling, and mine planning continued. Drilling identified 20 coal seams, between 5 and 20 m thick, and confirmed that coal is representative of typical Elk Valley hard coking coals (HCC). Structure and spacing of the seams gives the project a low (~6:1) strip ratio. The company released an updated NI 43-101 resource estimate with 44.6 Mt Measured and 42.5 Mt Indicated (open pit and underground), and is working towards an updated pre-feasibility engineering and design report.

5.2.2. Crown Mountain (NWP Coal Canada Ltd.)

The **Crown Mountain** property (NWP Coal Canada Ltd.), a subsidiary of Jameson Resources Limited, is along strike with **Line Creek** (Fig. 3), but separated by complex geology and thrust faulting. The property contains seven major Mist Mountain Formation coal seams, with combined average thicknesses of 15 to 35 m. In October 2014, the project advanced to the pre-application stage of environmental assessment, and received their application information requirements (AIR) from the environmental assessment office in April 2018. In June, the company entered into an option agreement with Bathurst Resources Limited who gained a 8% interest in the project, and could become a 50/50 joint venture partner after exercising all tranches in the terms of the agreement, with an investment totaling $121.5M.

In 2018, the company drilled and completed coal quality testing on bulk samples from large-diameter core. Environmental baseline work also included geotechnical drilling and installation of groundwater monitoring wells. Engineering and process design work also continued on spoil pile design and water treatment to meet water quality guidelines. Jameson Resources is also exploring the use of biological reduction of nitrate and selenium using naturally occurring microbes within waste piles and other passive water treatment techniques with hopes to mitigate the need for active water treatment on site.

The project proposal is for an open-pit mine with an estimated production capacity of 1.7 Mt per year of clean coal and a 16-year mine life. In 2014, the company completed a resource estimate of 74.9 Mt (Measured+Indicated) and a preliminary prefeasibility study. In 2016, the study was updated with improved economics related to coal pricing and operating and capital expenditure costs. Coal quality test work indicates that approximately 84% of the coal is hard coking coal, the remainder PCI coal.

5.2.3. Coal Mountain Phase II (Teck Coal Limited)

At Teck Coal's **Coal Mountain Phase II** (CMO2; Marten Wheeler) project, the Mist Mountain Formation contains up to 15 coal seams, 1- 8 m thick, with a cumulative average thickness of 75 m on Marten and Wheeler ridges (Fig. 3). The project entered pre-application stages of environmental assessment in September 2014, but was withdrawn in 2015 and put on hold. The project was proposed to replace production and use infrastructure from the **Coal Mountain** mine. Facilities at **Coal Mountain** will be placed on care and maintenance, but maintained in a ready-to-operate state.

5.2.4. Bingay Main (Centermount Coal Ltd.)

Centermount Coal Ltd. is proposing an open-pit mine on the **Bingay Main** property (Fig. 3). The project entered pre-application of environmental assessment in 2013; the company resubmitted the project description in 2017. Environmental baseline studies are ongoing. The mine would produce approximately 1 Mtpy over an estimated 15-year lifespan, with a total resource of approximately 13 Mt of clean coal. At **Bingay**, the coal-bearing Mist Mountain Formation is preserved in a tight, asymmetric syncline in the immediate footwall of a west-dipping thrust fault (Bourgeau thrust). The coal is medium-volatile to high volatile-A bituminous in rank.

5.3. Proposed industrial mineral mines

There are three proposed industrial mineral mines in the region, the **Kootenay West** (gypsum; Certainteed Gypsum Canada Inc.) and **Driftwood Creek** (magnesite; MGX Minerals Inc.) mines. The **Black Crystal** graphite quarry (Eagle Graphite Corp.) is on care and maintenance while the company is focusing on research and development work for their product. Several other small quarries and pits for

Table 3. Selected proposed mines, Southeast Region.

Project	Operator (partner)	Commodity; deposit type; MINFILE	Reserves	Resource	Comments
Michel Coal	**North Coal Limited**	Coal (HCC and PCI); open pit and underground; 082GSE050	na	HCC M: 44.6 Mt I: 42.5 Mt open pit and underground (2015)	Drilling (5000 m, 23 holes); environmental and baseline work; drilling of 23 groundwater monitoring wells; entered pre-application of EA in 2015, re-submission of their project description in September (2018) to include all 3 mining areas; geotechnical studies and updates to mine design; coal quality testing indicates coal has similar characteristics to Elk Valley hard coking coal; drilling identified 20 coal seams with cumulative thickness of 70 m (14% of a 504 m section in the Mist Mountain Formation).
Crown Mountain	**NWP Coal Canada Ltd. (Jameson Resources Limited 92%, Bathurst Resources Limited 8%)**	Coal (HCC and PCI); open pit; 082GNE018	HCC P: 42.60 Mt Pr: 4.91 Mt PCI P: 7.13 Mt Pr: 1.19 Mt (2014)	HCC+PCI M: 68.9 Mt I: 6.0 Mt (2014)	Option agreement with Bathurst Resources Limited for 8% with ability to earn 50% with investment of $121.5 M; drilling (4200 m, 23 holes); Pre-application of EA (2014); Application Information Requirements (AIR) received in April (2018); coal quality testwork; water quality and treatment studies involving passive biological treatment; engineering studies and mine design; 16-year mine life; 1.7 Mtpy.
Coal Mountain Phase II (Marten Wheeler)	**Teck Coal Limited**	Coal (PCI and TC); open pit and underground; 082GNE006	na	HCC M+I: 173.9 Mt Inf: 7.9 Mt PCI M+I: 6.5 Mt Inf: 0.9 Mt (2015)	Pre-application of EA (2014); Potential of 76.5 Mt; 34-year mine life; 2.25 Mtpy; EA withdrawn in late 2015; project on hold.
Bingay Main	**Centermount Coal Ltd.**	Coal (HCC); open pit and underground; 082JSE011	na	M: 42.43 Mt I: 52.9 Mt (2012)	Pre-application of EA (2012); resubmitted project description (2017); 13 Mt; 15-year mine life; 1 Mtpy.
Kootenay West	**Certainteed Gypsum Canada Inc.**	Gypsum; evaporitic bedded gypsum; quarry; 082JSW005, 20	na	North and South Quarries: Total 16.9 Mt (at average quality of 83-85%)	Granted a conditional EA certificate in January, 2018; environmental baseline work, permitting, and modifications to mine design; 400,000 tpy; 43-year mine life; blended product to market specifications.

Table 3. Continued.

Driftwood Creek	**MGX Minerals Inc.**	Magnesite; hydrothermal sparry magnesite; quarry; 082KNE068	na	M+I: 7.847 Mt grading 43.27% MgO Inf: 55.8 Mt (2016; using cutoff grade of 42.5% MgO)	Preliminary Economic Assessment: 169,700 t of MgO, average grade of 43.27% MgO, 19-year mine life, 2.4:1 strip ratio; scoping study underway; environmental baseline studies; 100 t bulk sample; Preliminary test work indicates recovery rates of 93.4% reverse flotation and removal of up to 70% silica and 30% calcium oxides; bulk of resource is within 100 m of surface; 2016 drilling extended the zone; 20-year mine lease acquired.
Black Crystal	**Eagle Graphite Corp.**	Graphite; metamorphic hosted flake graphite; 082FNW260, 283	na	Regolith+calc-silicate; M+I: 19.23 Mt at 1.35% fixed carbon; Inf: 23.92 Mt at 1.3% fixed carbon (2018)	Research and development; possible application for Li-ion batteries; updated resources; working on Preliminary Economic Assessment.

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

dimension stone, flagstone, sand and gravel are not covered in this discussion.

5.3.1. Kootenay West (Certainteed Gypsum Canada Inc.)

Certainteed Gypsum Canada Inc. continued to advance the proposed **Kootenay West** project. The project was approved through the Environmental Assessment Office in January 2018, and is currently working to fulfill conditions outlined in the approval. The quarry will have two pits, and mine gypsum from a deformed hydrated evaporite layer 20-25 m thick, with beds of 75-95% gypsum in the Burnais Formation. The mine is expected to produce 16.9 Mt of gypsum at an average blended quality of 83.2%, and 400,000 tpy at full production rate. The current projected mine life is 42 years. Gypsum would be drilled, blasted, and crushed, then transported by truck to Exshaw, Alberta or Washington State, or by rail to Vancouver. In 2016, through 2018, the company focussed on environmental work and modifications to the mine design. Phase 1 construction, with estimated capital costs of $20 million, is projected for 2019. It will replace production after the Elkhorn mine is depleted.

5.3.2. Driftwood Creek (MGX Minerals Inc.)

At the **Driftwood Creek** property, cliff-forming, steeply dipping beds of sparry magnesite are interlayered with dolostones and dolomitic limestones of the Mount Nelson Formation (Proterozoic). The deposit is 100 to 300 m wide, to a depth of approximately 110 m, and has been traced along strike for 2000 m. In 2016, the company took a 100 t bulk sample from a near surface (<15 m) zone, and released a NI 43-101 compliant resource estimate. They acquired a pilot test mill, which includes a jaw crusher, ball mill, floatation cells, cyclone dewatering equipment, and tailings filtration system. They used the mill to upgrade the bulk sample to a high-purity magnesite ($MgCO_3$) and a silica by-product using reverse flotation techniques. In 2018, the company released a Preliminary Economic Assessment for a 1200 tpd quarry operation. The mine would produce 169,700 t of MgO at an average grade of 43.27% MgO, with a 19-year mine life, and 2.4:1 strip ratio. The company continued environmental baseline studies, and drilled step out zones at both the East and West zones.

5.3.3. Black Crystal (Eagle Graphite Corp.)

Eagle Graphite Corp. operates the **Black Crystal** flake graphite open-pit quarry on Hodder Creek and processing plant 10 km west of Passmore. The property is in the central part of the Valhalla complex (Fig. 2) in the Valhalla dome, a structural complex of upper amphibolite-grade gneisses in Paleozoic rocks of the Kootenay terrane that was exhumed during Tertiary extension. Disseminated fine- to coarse-flake graphite is distributed along foliation in organic-rich calcsilicates and marbles, across an area of about 500 m^2. At the quarry location, the graphitic horizon is 30-40 m thick, immediately underlying the overburden, and dips sub-parallel to topography. Graphite is in 2 zones: a ‘hard rock’ zone, and an overlying ‘regolith’ zone. The regolith zone is the near-surface weathered zone that averages 2-4 m thick and has grades of up to 6.95% carbon. Most of the deposit is friable, and blasting is not required. Sand and aggregate were produced as by-products during the mining and refining process. In 2018, the company updated the resource estimate with results obtained in their 2016 drilling, and focussed efforts on research and development to upgrade the purity of their product for use in the energy storage industry.

6. Selected exploration activities and highlights

Exploration continued in the Southeast region in 2018 for numerous targets, including base and precious metals, industrial minerals, and coal (Fig. 1; Table 4).

6.1. Selected precious metal projects

Dating back to the 1880s, exploration for precious metals is ongoing in the Southeast Region for vein (epithermal and mesothermal), porphyry-related, and skarn systems, and in the East Kootenays along the Kimberley Gold trend, where fault and vein structures, and Mesozoic intrusions are coincident with deeper basement structures along the Vulcan low (Höy, 1982; McMechan, 2012; Seabrook, 2015).

6.1.1. Zinger (PJX Resources Inc.)

The **Zinger** property is underlain by Purcell Supergroup rocks (Proterozoic), predominantly quartzites, argillites, and siltstones of the Creston Formation, argillites of the Kitchener Formation, and gabbro sills and dikes. The property is adjacent to the Perry Creek fault, and multiple NW-trending faults hosting sericite-carbonate-quartz alteration, that crosscut NNE-trending folds. Mineralized breccias and tension veins occur within minor folds and structural intersections in the more competent quartzite units. In 2018, PJX Resources Inc. targeted gold in quartz veins with mapping, sampling, and drilling. Grab samples from multiple quartz veins returned anomalous gold assays along a 6 km trend, and are coincident with a 4 x 2 km airborne VTEM anomaly. VLF ground geophysics identified dipping conductors that coincide with soil anomalies at surface, and the company drilled (1224 m, 6 DDH) to test downdip extensions.

6.1.2. Dewdney Trail (PJX Resources Inc.)

PJX Resources Inc. continued mapping and sampling in 2018 at their **Dewdney Trail** property, and identified targets for drilling. Grab samples from a pervasively altered and fractured quartzite returned up to 18 g/t Au. The quartzite, 75 to more than 200 m in true width can be traced for more than 12 km. Heavy mineral stream samples contain angular visible gold. Chemical compositions are fairly consistent, and trace quantities of silver, copper and iron, suggest a single bedrock source that may be associated with felsic intrusive rocks and/or sericite alteration.

The property is underlain by folded, faulted, and altered Mesoproterozoic sandstones and argillites of the Fort Steele, Aldridge, Creston, and Kitchener formations that are cut by Cretaceous, and possibly Tertiary, felsic to mafic intrusions. The property contains several mineral showings, including: 1) large-tonnage sediment-hosted vein type gold prospects at the Spirit, Tac, and Lewis showings; 2) vein-type prospects at the Jack Leg showing; and 3) skarn and stockwork Cu-Au prospects at the Dew Drop showing.

6.1.3. Gold Shear (PJX Resources Inc.)

In 2018, PJX Resources Inc. entered into an option agreement to acquire 100% in the **Gold Shear** property. Steeply dipping north-northeast mineralized shear zones (pyrite, galena, chalcopyrite, sphalerite, and rare visible gold) on the property cut quartzites and siltstones of the middle Aldridge Formation (Mesoproterozoic; Purcell Supergroup). A mineralized quartz vein was first discovered on the property in 1990, and assayed 144 g/t Au over a chip sample length of 40 cm. The David shear (BC MINFILE 082FSE108) has since been traced along strike for 1600 m, with mineralized splays. Drilling on the property between 1990 and 1996 intersected a 0.8 m zone that graded 196.69 g/t Au, within weak to moderately conductive sulphides. Several veins have been mapped on the property, and rock sampling in 2018 returned several samples with Au grades over 68 g/t, and up to 193.9 g/t Au. VLF ground geophysics has identified a large conductive target area down-dip of the David Gold zone, and below the depth of historical drilling. The company has begun compiling all historical data on the property to better identify the structural controls on mineralization and identify targets.

6.1.4. Gold Hill (American Creek Resources Ltd.)

American Creek Resources drilled at their **Gold Hill** property in 2018, targeting down-dip extensions of mineralization at the historic Midas occurrence (BC MINFILE 082GNW022). The area is underlain by Cambrian quartzites, argillites, and carbonates of the Eager Formation, and Cretaceous felsic (syenite/monzonite) intrusions. Mineralization (galena, tetrahedrite, pyrite, chalcopyrite, and rare visible gold) is best-developed in quartz-iron carbonate-pyrite-sericite veins in north-northeast trending shears and breccias. Locally, syenite dikes and host sedimentary rocks are also silicified and carry disseminated pyrite and galena (Fig. 11). Grab samples have assayed 22.32 g/t Au, and up to 442 g/t Au and 1660 g/t Ag. Drilling (2400 m, 4 DDH) began late in the year.

Fig. 11. Galena and pyrite mineralization, Gold Hill property.

6.1.5. Sheep Creek Gold District (Margaux Resources Ltd.)

Margaux Resources Ltd.'s Sheep Creek Gold District project includes the **Bayonne** and **Sheep Creek** properties, where late Jurassic orogenic gold mineralization (133 Ma; pyrite with lesser amounts of pyrrhotite, chalcopyrite, galena, sphalerite and rare visible gold) is found in steeply dipping quartz veins along northeast-trending structures. On the **Bayonne** property additional mapping, rock sampling, and drilling was carried out. The property hosts several high-grade, steeply dipping gold-bearing orogenic quartz veins in a granodiorite roof-pendant of the Bayonne batholith (Mine stock; Middle Jurassic, 171 Ma) that cuts Neoproterozoic argillaceous quartzites and

Table 4. Selected exploration projects, Southeast Region.

Project	Operator (partner)	Commodity; deposit type; MINFILE	Resource (NI 43-101 compliant unless indicated otherwise)	Comments
Alpine	**Braveheart Resources Inc.**	Au-Ag-Pb-Zn; mesothermal Au and polymetallic veins; 082FNW127, 257, 292	Inf: 268,000 t grading 16.52 g/t Au, using a cutoff grade of 5 g/t (2018)	Mapping; sampling; drilling (1500 m); resampling of historic core; STEINERT ore density sorting testing: a 72 kg run of mine sample was upgraded from 14.7 g/t to 20.3 g/t Au, with 92.8% Au recovery and 32.7% waste rejection, and a 128 kg composite sample was upgraded from 25.4 g/t to 43.2 g/t Au, with 81.3% recovery and 52.1% waste rejection.
Barnes Lake/ Marten	**Fertoz International Inc.**	Phosphate; upwelling; 082GSE051, 082GNE027	na	Mapping, sampling, environmental baseline studies; application for bulk sample permits.
Coal Creek	**Crowsnest Pass Coal Mining Ltd.**	Coal (HCC and PCI); underground; 082GSE035	HCC+PCI: 616 Mt in the upper 3 near-surface seams (2014)	Prefeasibility studies; geological modeling, baseline studies.
Dewdney Trail	**PJX Resources Inc.**	Au; Au-veins; 082GNW094	na	Geological mapping; heavy mineral stream sampling; sampling; following up on heavy mineral stream sediment survey from 2016; angular gold grains indicate grains in stream samples near bedrock source.
Duncan	**Rokmaster Resources Ltd.**	Zn-Pb-Ag; carbonate-hosted; 082KSE023, 22	na	Mapping; sampling; soil geochemistry; historic drill core results include 14.7 m grading 8.20% Zn+Pb, 13.4 m grading 8% Zn+Pb, and 12.2 m grading 8.31% Zn+Pb; grab sample results up to 23 g/t Ag, 12.5% Pb, and 21.4% Zn; drill permits received late in 2018.
Elko	**Pacific American Coal Limited**	Coal (HCC, PCI); 082GSE029	M: 19.2 Mt I: 57 Mt Inf: 181.3 Mt (JORC 2015)	Drilling (8 RC, 1 large-diameter core; 3451 m); environmental baseline studies and permitting; mapping of five coal seams; 3 seams have hard coking coal quality, 2 seams have PCI coal.
Gibraltar	**MGX Minerals Inc.**	Si; silica sandstone; 082JSW001	na	One tonne sample sent for metallurgical test work; results indicated suitability for medium quality feedstock for metallurgical-grade silicon; sampled 97.8 to 99.9% SiO_2; began drilling late in the year (8 DDH).
Gold Drop	**GGX Gold Corp.**	Au; alkalic intrusion-associated Au; 082ESE055, 150, 152, 153, 285, 286, 287	na	Rock sampling; trenching; channel sampling; drilling at the C.O.D. (71 DDH, 14,500 m); drill results include: 2.05 m grading 50.1 g/t Au; 1.47 m grading 54.9 g/t Au; and 16.03 m grading 4.59 g/t Au; trenching at the Everest, Gold Drop, Silent Friend, and Ken veins.
Gold Hill	**American Creek Resources Ltd.**	Au, Pb, Zn, Cu; vein; 082GNW022	na	Drilling (2400 m, 4 DDH); sampling.

Table 4. Continued.

Gold Shear/ David	**PJX Resources Inc.**	Au, Cu, Pb, Zn; vein; 082FSE108	na	VLF ground geophysics; mapping; rock sampling; several grab samples assayed 68 g/t, and up to 193.9 g/t Au; drill targets identified on VLF to test down-dip extensions of the vein, below the level of historic working; historic drilling returned 0.9 m grading 169.96 g/t Au.
Goldsmith	**Black Tusk Resources Ltd.**	Au, Pb, Zn, Cu; veins; 082KSW088	na	Mapping, trenching, sampling; historic workings and trenches along a 2 km strike length.
Greenwood (Lexington/ Golden Crown)	**Golden Dawn Minerals Inc.**	Au-Ag-Pb-Zn+/-Cu; Cu-Au-Ag skarns, polymetallic veins, epithermal Au-veins, porphyry; 082ESE041, 42, 32, 45, 20, 130, 116	**Golden Crown:** M+I: 163,000 t grading 11.09 g/t Au, 0.56% Cu (2016); **Lexington**: M+I: 372,000 t grading 6.4 g/t Au, 1.05% Cu (2016)	**Golden Crown** drilling (33 DDH, 3121 m); drill intersections include 1.74 m grading 11.11 g/t Au, 0.23% Cu, 7 g/t Ag; 1.66 m grading 15.20 g/t Au, 1.37% Cu, and 20.1 g/t Ag; 12.3 m grading 3.53 g/t Au, 0.11% Cu; and 6.95 m grading 6.77 g/t Au, 1.18% Cu; surface mapping and sampling. **Lexington** dewatering and rehabilitation of underground; mapping; rock sampling; results included: 3.9 m grading 13.41 g/t Au, 2.08% Cu; 2.3 m grading 26.67 g/t Au, 1.77% Cu; 1.8 m grading 30.18 g/t Au, 4.93% Cu; 1.4 m grading 22.2 g/t Au, 4.32% Cu; and 2.6 m grading 17.04 g/t Au, 3.42% Cu; surface mapping and sampling.
Irishman/ Panda/DD	**Teck Resources Ltd.**	Pb-Zn-Ag+/-Cu; SEDEX, polymetallic veins; 082FSE110, 082GSW077	na	Mapping, magnetotellurics, drilling (1 DDH, 1425 m); soil geochemical sampling.
Iron Range	**Eagle Plains Resources Ltd.**	Pb-Zn-Ag+/-Cu, Au; vein, breccia, IOCG; 082FSE014, 15, 16, 17, 18, 19, 20, 21, 22, 23	na	Mapping, sampling, soil geochemistry, stream sampling, IP geophysics; drilling (2 DDH, 997 m).
Jackpot	**Margaux Resources Ltd.**	Pb-Zn-Ag+/-W, Au, Mo, Bi; stratiform replacement; 082FSW012, 13, 14, 15, 255, 256	na	Boulders at Big Zinc target grading up to 44% Zn. Re-logged historic core; updated geologic model.
Kena	**Prize Mining Corp.** (Apex Resources Inc.)	Au-Cu+/-Pb-Zn-Ag; porphyry, Au-veins, polymetallic veins; 082FSW379, 173, 174, 175, 294	**Kena**: I*:* 24.89 Mt grading 0.6 g/t Au; Inf: 85.79 Mt grading 0.48 g/t Au	Released results of 2017 drilling (3425 m, 29 DDH); results include **Daylight**: 0.9 m grading 62.7 g/t Au, 0.5 m grading 20.9 g/t Au, 0.5 m grading 7.36 g/t Au; **Toughnut:** 0.7 m grading 7.3 g/t, 1.0 m grading 25 g/t Au, and 2.0 m grading 5.58 g/t Au. 2018 drilling (3386 m, 20 DDH) at Toughnut; results include 4.37 g/t Au over 6.0 m and 14.3 g/t Au over 0.84 m.
Koot	**MGX Minerals Inc.**	Si; silica sandstone; 082JSW025	na	Mapping, sampling, drilling (782 m, 10 DDH); 97.61 to 99.9% SiO_2.

Table 4. Continued.

Ledgend	**Cardero Resources Corp.**	Ni, Co, Cu; syngenetic massive sulphide; 082KSE092	na	Airborne magnetic survey, trenching, mapping.
LH	**Magnum Goldcorp Inc.**	Cu-Ag-Au; subvolcanic, skarn, Au-veins; 082FNW212	na	Drone-survey magnetics; released 2017 drill results including 8.5 m grading 7.10 g/t Au; gold mineralization appears to be associated with pyrrhotite+/-arsenopyrite; drone magnetic survey and orthophotos.
Monroe	**Highway 50 Gold Corp.**	Pb-Zn-Ag+/-Au, Cu; SEDEX; 082GSW069, 35, 41	na	Drilling (4 DDH; 4000 m) to follow up on 2015-2017 drill programs; encountered fragmental rocks, moderate to intense albitization; bedded pyrrhotite-sphalerite; disseminations and veinlets of sphalerite and galena; thickened isopach sequences within the Aldridge Formation.
Midway	**KG Exploration (Canada) Inc.**	Au-Cu-Pb-Zn-Ag+/-Mo; Cu-Au-Ag skarn, polymetallic veins, Au-vein, porphyry; 082ESW022, 210, 34, 221	na	Drilling (1420 m; 4 DDH); option agreement with Grizzly Discoveries Inc. to gain 75% interest in 27,346 ha; fulfilled 3rd year agreement to drill; following up on targets identified in airborne, ground EM and magnetics, geological mapping, sampling, and 2017 drilling; continued mapping and sampling at the Rads claim group.
Rossland Gold	**Currie Rose Resources Ltd.**	Au+/-Ag,Cu,Pb,Zn; Au-quartz veins; 082FSW093, 195, 102, 135	na	Mapping, sampling, compilation of historic data; community engagement; identified eight target areas; permitting for drilling.
Sheep Creek Gold District	**Margaux Resources Ltd.**	Au+/-Ag, Pb, Zn; Au-quartz veins, polymetallic veins; 082FSW040, 48, 50, 51, 52, 53, 082FSE030, 31, 34, 25	na	**Bayonne**: mapping; drilling (3308 m, 13 DDH); drill intersections of 1.40 m grading 39.43 g/t Au, and 131.2 g/t Ag; 0.88 m grading 16.88 g/t Au, and 60.2 g/t Ag; and 1.14 m grading 10.85 g/t Au, 23.7 g/t Ag; drilling targeted areas below historic mining and step-out. **Sheep Creek:** mapping; sampling; compilation of historic data into 3D model using lidar acquired in 2017; sampling of historic Reno and Nugget mine dumps (historic grades of 19.2 g/t Au); dump samples sent to research facility to test ore sorting method.
Silvana	**Klondike Silver Corp.**	Ag-Pb-Zn+/-Au; polymetallic veins; underground; 082FNW050, 13, 082KSW006	na	Rehabilitation of the 4625 portal at the Silvana; phase 1exploration program included 80 m of drifting, and drilling (1030 m, 13 DDH); updated their 3D geological model; facility upgrades; environmental monitoring; mill on care and maintenance; environmental baseline work.
Silver Fox	**Antofagasta plc** (Kootenay Silver Inc.)	Cu-Ag; sediment-hosted copper; 082GSW070, 72, 73	na	Drilling (1 DDH, 500 m); mapping, sampling; three rock samples assayed 0.104% Cu and 2.9 g/t Ag; 0.127% Cu and 9.9 g/t Ag; and 0.55% Cu, 14 g/t Ag, and 0.208 g/t Au.

Table 4. Continued.

Thor	**Taranis Resources Inc.**	Ag-Pb-Zn+/-Au; polymetallic veins and breccia, stratiform volcanogenic massive sulphide; 082KNW030, 31, 60, 61	I: 640,000 t grading 0.88 g/t Au, 187 g/t Ag, 0.14% Cu, 2.51% Pb, and 3.51% Zn; Inf: 424,000 t grading 0.98% Au, 176 g/t Ag, 0.14% Cu, 2.26% Pb, and 3.2% Zn (2013)	Drilling (1983 m; 30 DDH); downhole magnetics; ground geophysics, including resistivity, magnetics, and VLF; processed a 600 t sample using a pilot test mill, with recoveries of ~25.3% of the Au; extension of SIF gold zone.
Tungsten Tailings	**Margaux Resources Ltd.**	W; tailings; 082FSW010, 9	Estimated: 1.4 Mt grading 0.11% WO_3 (non-compliant)	Evaluating economic viability to reprocess tailings from historic Emerald mine; 3500 kg sample sent to CRONIMET for testing; 84 samples tested 0.11% WO_3; environmental baseline studies; permitting for 10,000 t bulk sample.
Vine	**PJX Resources Inc.**	Pb-Zn-Ag+/-Au; polymetallic veins, SEDEX; 082GSW050, 49, 35	1.3 Mt grading 2.2 g/t Au, 3.12% Pb, 36.3 g/t Ag, 3.12% Zn (1990; non-compliant)	Drilling (6000 m; 15 DDH); magnetotelluric survey; geophysical and geological modeling; focus on East gravity anomaly; infilled gravity survey grid; detailed geophysical and geological model; drilling intersected sulphides (pyrite, pyrrhotite, sphalerite) near Moyie fault zone.
Wonah	**MGX Minerals Inc.**	Si; silica sandstone	na	Mapping, sampling; 98.9 to 99.9% SiO_2; quartzite exposed along strike for 850 m, steeply dipping; received permits for drilling and began road construction.
Zinger	**PJX Resources Inc.**	Ag-Pb-Zn+/-Au; polymetallic veins; 082FSE122, 65	na	Drilling (1224 m, 6 DDH); Geological mapping; East grid soil anomaly approximately 100 x 300 m, with Au ranging from 100 to 4941 ppb; VLF and VTEM; dipping VLF conductors coincident at surface with soil geochemical anomalies.

M = Measured; I = Indicated; Inf = Inferred

limestones of the Horsethief Creek Group. Historic production (1936-1942) was mainly from the Main vein and a splay known as the A vein. The mine produced 81,782 t, at an average grade of 16 g/t Au and 45.9 g/t Ag.

In 2017, the company mapped 10 veins, focusing mainly on the areas between the Main vein, which extends for approximately 1000 m along strike, the A vein (a splay off the Main vein; 550 m strike length), and the Maggie Aikens vein (100 m strike length). Grab sample results include 27.5, 23.3, 18.1, 15.0 and 10.6 g/t Au from the Main vein, and 51.6 g/t Au and 46.6 g/t Au from the Maggie Aikens vein, along with anomalous silver, zinc, lead and tungsten values. Drilling in 2018 (3308 m, 13 DDH) followed up on results from 2017, and focussed on the Main and A veins in areas beneath the historic workings, and step-out areas. Vein intersections included 1.40 m grading 39.43 g/t Au, and 131.2 g/t Ag; 0.88 m grading 16.88 g/t Au, and 60.2 g/t Ag; and 1.14 m grading 10.85 g/t Au, 23.7 g/t Ag. Bulk tonnage results on drilling also included up to 1.14 m grading 10.85 g/t Au, and 23.7 g/t Ag, and copper mineralization increased with depth. The eastern extension of the vein system is splayed and horsetail veinlets occur in a broader zone of alteration and elevated gold mineralization.

The company now also holds 1200 ha of contiguous mineral tenure that includes 60 known veins and 34 past producers at their **Sheep Creek** property. The showings are in a 7 x 1.2 km NNE-trending corridor. Mineralized veins are typically 10 cm to >2 m wide, strike ENE, and are steeply dipping to near vertical. They are concentrated at the crests of folds, and preferentially hosted in brittle units in the metasedimentary package and pre-orogenic intrusions. Historic production from the camp (1899-1951) totalled 736,000 oz Au, 356,000 oz Ag, 377,000 lbs Pb, and 312,000 lbs Zn (with an average grade of 13 g/t Au; Allan et al., 2017; Matthews, 1953).

Drilling identified new zones of mineralization in Cambrian limestones (Laib Formation, Fig. 3) stratigraphically above the main quartzite host units. In 2018, the Margaux compiled historic data into a 3D model using lidar. Surface workings identified on the lidar survey were used to rectify the locations of historic workings, and also identified new workings that had no information. The historic dumps of the Reno and Nugget mines, with historical grades that averaged 19.2 g/t Au (Mathews, 1953) were also sampled. Dump samples were sent

to an independent research facility for sensor-based sorting testing to determine if waste rock grades could be upgraded and processed. Their planned drill program was delayed due to forest fires until 2019.

6.1.6. Midway (KG Exploration (Canada) Inc.)

KG Exploration (Canada) Inc. (a wholly owned subsidiary of Kinross Gold Corporation) drilled at the **Midway** project in 2018. As part of an option agreement with Grizzly Discoveries Inc. signed in 2015, Kinross can earn a 75% interest in 27,346 ha in the Greenwood area. The area is just north of their Kettle River mill (1800 tpd), and land package in Washington State. The area is underlain by rocks of the Knob Hill and Anarchist groups (Paleozoic), Brooklyn Formation (Triassic), and Penticton Group syenites and andesites (Eocene). Jurassic, Cretaceous, and Eocene intrusions occur throughout the area. Exploration targets include epithermal gold, skarn, and VMS mineralization in the northern extensions of the Republic and Toroda graben. At **Midway**, surface sampling and mapping identified additional zones of alteration and veining. A silicified zone at the base of the Eocene unconformity in outcrop contains multiple narrow (to 0.5 m) chalcedonic quartz (+/-quartz breccia) veins in a broader zone of silicification. A soil geochemistry grid was completed on the property, and anomalies coincide with mineralization at surface. Drilling in 2018 (1,420 m, 4 DDH) followed up on alteration and mineralized zones intersected in 2017. Mapping and sampling continued on other claims in the land package, including the **Rads** claim group, where Triassic sediment-hosted VMS and skarn mineralization occurs along the northern extension of the Republic graben.

6.1.7. Greenwood (Golden Dawn Minerals Inc.)

Golden Dawn Minerals Inc. has been evaluating several historic mineralized areas near their Greenwood project, including the **May Mac**, **Golden Crown**, and **Lexington**. The area is underlain by rocks of the Knob Hill and Anarchist groups (Paleozoic), the Brooklyn Formation (Triassic), and the Penticton Group (Eocene); Jurassic, Cretaceous, and Eocene intrusions occur throughout the area. Mineralization includes: Cu-Au-Ag skarn; Au-Ag epithermal, Ag-Pb-Zn±Au shear hosted, carbonate replacements, stockworks, and breccias, and alkalic porphyry Cu-Au-Ag.

In 2016 and 2017, Golden Dawn acquired assets from Huakan International Mining Inc., including the **Lexington (Greenwood) mill**, and the former **Lexington** and **Golden Crown** underground Cu-Au mines, and an additional 11,000 ha from New Nadina Explorations Ltd..

The company continued compiling all historic data to evaluate and identify areas of focus.

Drilling that began late in 2017 at the **Golden Crown** (3121 m, 33 DDH), continued in 2018. Mineralization (pyrrhotite, pyrite, chalcopyrite, arsenopyrite, and gold) occurs in veinlets and as disseminated sulphides in the host rocks (meta-diorite, greenstone and serpentinite). Drill intersections included: 1.74 m grading 11.11 g/t Au, 0.23% Cu, 7 g/t Ag; 1.66 m grading 15.20 g/t Au, 1.37% Cu, and 20.1 g/t Ag; 12.3 m grading 3.53 g/t Au, 0.11% Cu; and 6.95 m grading 6.77 g/t Au, 1.18% Cu. Surface mapping and sampling identified mineralization 3 km along strike at the JD zone, with chip sample results ranging between 1.8 and 15.8 g/t Au.

Golden Dawn also began dewatering the **Lexington** mine late in 2017, and installed ventilation and rehabilitated some of the workings in 2018. They began mapping and sampling the underground workings to develop a 3D model and characterize the mineralization. Rock chip sample results included: 3.9 m grading 13.41 g/t Au, 2.08% Cu; 2.3 m grading 26.67 g/t Au, 1.77% Cu; 1.8 m grading 30.18 g/t Au, 4.93% Cu; 1.4 m grading 22.2 g/t Au, 4.32% Cu; and 2.6 m grading 17.04 g/t Au, 3.42% Cu. Surface mapping and chip sampling along strike, west of the underground **Lexington** yielded results of 4.5 m grading 14.5 g/t Au.

The **Lexington** mine produced 5486 oz of Au, 3247 oz of Ag, and 860,259 lbs of Cu from April to December 2008. The ore was processed 17 km away, at the **Lexington (Greenwood) mill,** a 200 ton per day gravity-flotation facility (Fig. 12). The mill was built in 2007, and is now on care and maintenance; the cost of putting the plant back in operation is estimated at $270,000.

Fig. 12. The 200 tpd Lexington mill (gravity-flotation) and tailings facility.

6.1.8. Gold Drop (GGX Gold Corp.)

GGX Gold Corp. continued drilling and trenching at the **Gold Drop** property. The property is underlain by metamorphic rocks of the Knob Hill complex (Paleozoic) that have been intruded by granodiorite and diorite of the Nelson Plutonic suite and by biotite syenite and diorite/andesite dikes of the Coryell suite. The property hosts numerous north-trending, easterly dipping gold-bearing veins that are 10 cm to 2 m thick, and occur within steeply dipping strike-slip and normal faults. The veins post-date the Nelson intrusives, pre-date the Coryell suite, and are truncated by low-angle detachment faults. Between 1919 and

1941, the area saw small-scale production (Gold Drop, North Star, Amandy, and Rhoderick Dhu veins), from underground workings.

In 2017, GGX Gold Corp. conducted rock sampling, trenching, channel sampling, and drilling at the C.O.D vein, and near the Gold Drop main vein. The Everest vein was discovered to the southwest of C.O.D., and returned values of 81.8 g/t Au and 630 g/t Ag in grab sample. Drilling continued in 2018 (14,500 m, 71 DDH), on infill locations and extensions of the C.O.D. and Everest veins. Drill results include 2.05 m grading 50.1 g/t Au; 1.47 m grading 54.9 g/t Au; and 16.03 m grading 4.59 g/t Au. The company also mapped, sampled, and trenched at the Silent Friend and Ken veins, to follow up on grab sample results of 6.98 g/t Au and 38.6 g/t Ag, and 4.47 g/t Au and 23.0 g/t Ag from the historic workings. They also trenched extensions of the Gold Drop vein.

6.1.9. Rossland Gold (Currie Rose Resources Inc.)

Currie Rose Resources Inc. entered into an agreement to option approximately 2230 ha at the **Rossland Gold** property in 2018. The company has begun compiling historical information, and they mapped, sampled, and evaluated geophysics to identify drill targets. The Rossland area is underlain by Upper Paleozoic (Mount Roberts Formation) and Lower Jurassic (Rossland Group, Elise Formation) volcanic and sedimentary rocks, which are variably metamorphosed and cut by Early Jurassic to Eocene intrusive rocks (Rossland monzonite, Rainy Day pluton, Trail pluton, and Coryell suite; lamprophyres and serpentinites). With numerous historical producers, the Rossland camp produced more than 84,000 kg of gold and 105,000 kg of silver between 1894 and 1941. Three main deposit types occur within the camp: 1) copper-gold veins with minor lead and zinc in fracture zones; 2) gold veins in high-grade shoots; and 3) molybdenum-tungsten, in fractures of the Trail pluton on Red Mountain (Fyles, 1984). The company identified eight priority targets and plans to drill in 2019.

6.1.10. LH (Magnum Goldcorp Inc.)

Gold mineralization at the **LH** property appears to follow an east-west trending zone of fracturing, faulting, and silicification in a roof pendant of Rossland Group metavolcanic rocks (Lower Jurassic; Elise Formation) and early Jurassic subvolcanic equivalents. Gold is in a structural zone up to 13.7 m wide that contains mesothermal quartz lenses and veins 30 to 60 cm wide, and in silicified breccias and stockworks in hornfelsed volcanic rocks. Both styles of mineralization have elevated sulphides, including pyrite, pyrrhotite, arsenopyrite, and chalcopyrite. In 2018, the company released results from a helicopter-supported drill program that began late in 2017 (659 m, 5 DDH) on magnetic anomalies. Intersections included 8.5 m grading 7.10 g/t Au. Gold mineralization appears to be associated with pyrrhotite+/-arsenopyrite, providing conductive targets that are coincident with ground geophysics magnetic anomalies. In 2018, the company expanded their magnetic grid, and obtained orthophotos using drones. The company has plans for further follow-up drilling in late 2018.

6.1.11. Goldsmith (Black Tusk Resources Inc.)

Black Tusk Resources Inc. optioned in on the **Goldsmith** property in 2017, and began exploration work on the claims. The property is underlain mainly by mafic volcanic rocks (chlorite schist, greenstone) and argillaceous metasedimentary rocks of the Lardeau Group (lower Paleozoic). The strata are variably altered (chlorite+/-sericite+/-quartz-carbonate) and contain from 5-40% carbonate. Historic mine workings and trenches occur in areas of quartz veining, over a 2 km strike-length on the property. Grab samples from these workings assayed up to 29.89 g/t Au. In 2018, Black Tusk compiled historic information on the property and reprocessed airborne electromagnetic and magnetic data from 2006. Linear anomalies appear coincident with the geologic grain of the area, while several features also crosscut the structural grain. The company mapped, sampled, and trenched along an 800 m mineralized corridor. Sulphides and local visible gold (Fig. 13) occurs in quartz veins in a shear system.

Fig. 13. Visible gold in quartz veinlet, Goldsmith property.

6.2. Selected polymetallic base and precious metal projects

Base metals are explored for throughout the Omineca belt as SEDEX, VMS, manto and replacement deposits, and along structures in vein and fault systems.

6.2.1. Vine (PJX Resources Inc.)

PJX Resources Inc. continued drilling in 2018 at the **Vine** property, conducted magnetotelluric surveys, and updated their geological-geophysical model. The property lies immediately north of the Moyie fault, a northeasterly trending structure in the Vulcan tectonic zone (Fig. 2), and a small north-trending graben. The property is underlain by argillites and quartzites in the middle part of the Aldridge Formation. Historic trenching and drilling at the Vine vein revealed disseminated and bedded sulphides (pyrite, sphalerite, and galena) along a strike length

of more than 1000 m, and to a depth of more than 700 m.

Gravity surveys identified two target areas (East and West) that are interpreted to have potential for massive sulphide mineralization (Pb-Zn-Ag±Au). Drilling in 2017 and 2018 mainly focussed on the East Gravity zone, which is more than 180 m thick, 400 m wide, and extends for more than 700m along the Moyie fault zone. Right-lateral oblique thrust movement along the fault has folded sequences that include: a silicified and sericite altered breccia that is locally cut by massive iron sulphide veins; phyllitic sedimentary rocks that contain disseminated pyrite, pyrrhotite, sphalerite, and chalcopyrite; and a chloritized and silicified zone that contains disseminated and massive sphalerite in veins and veinlets. The thick package of hydrothermally altered sedimentary rocks is typical of distal SEDEX mineralization in the Belt-Purcell basin, but the disseminated sulphides encountered to date are insufficient to account for the gravity anomalies. A 3D magnetotelluric grid completed over the East anomaly late in the year highlighted a conductive zone that correlates with the gravity high. The company updated their 3D model and further constrained drill targets for January, 2019.

6.2.2. Monroe (Highway 50 Gold Corp.)

Highway 50 Gold Corp. drilled at the **Monroe** property, targeting base metal sulphide mineralization in the Aldridge Formation. The property lies in a structural corridor at the intersection of two major fault zones, with numerous other showings, vent and breccia complexes, and abundant sericite, albite, chlorite, garnet and biotite alteration. Isopach variations, hydrothermal alteration, and distal-style mineralization may indicate proximity to growth faults and SEDEX mineralization in the Belt-Purcell basin (Lydon, 2007; Lydon, 2010).

The company has been drilling since 2015, as a follow up on geochemical soil anomalies and geophysics, with an additional four holes (4000 m) in 2018. They have intersected thickened sequences in the Aldridge Formation, albitized and tourmalinized zones, fragmental units, carbonate beds, and abundant sericite and chlorite alteration. Mineralization occurs as disseminations, bedded and laminated pyrrhotite and sphalerite, pyrrhotite-biotite-chlorite-albite+/-chalcopyrite veins, sphalerite and galena in tension cracks and veinlets, and sulphide-clast fragmental rocks.

6.2.3. Irishman/Panda/DD (Teck Resources Ltd.)

Teck Resources Ltd. continued work on their properties in the Purcell anticlinorium. The company has optioned surrounding claims for SEDEX mineralization and has the option to acquire 75% of the nearby **DD** property from PJX Resources Inc. The area is underlain by Purcell Supergroup rocks, with extensive stratabound and discordant fragmental units and widespread albite-tourmaline-chlorite-sericite alteration. Recent focus in the Purcell anticlinorium has been on geophysical methods to further identify structures and thickness variations in the Aldridge Formation that may indicate sub-basin development and potential SEDEX mineralization. In 2018, the company continued mapping and sampling work on their properties, and drilled (1425 m, 1 DDH) on a magnetotelluric anomaly at the **DD** late in the year.

6.2.4. Silver Fox (Antofagasta plc)

Antofagasta plc entered into an option agreement with Kootenay Silver Inc. to acquire 80% interest in the **Silver Fox** property. The area is underlain by sedimentary rocks of the Purcell Supergroup (Mesoproterozoic); mainly rusty weathering argillites in the upper part of the Aldridge Formation and quartzite, siltstone and argillite of the Creston Formation. Stratabound copper mineralization is in the Creston Formation and includes chalcopyrite and malachite with accessory galena, arsenopyrite, bornite and pyrite as disseminations, fracture fillings, and/or blebs. Pyrolusite and jarosite alteration appear associated with the mineralization. Mineralization is thought to be formed by hot, metal-enriched brines moving through porous sediments before lithification, with metals deposited at redox interfaces. In 2018, Antofagasta followed up on their 2017 work with additional mapping, sampling, and ground geophysics, and drilled one hole (500 m). Grab samples include grades up to 0.55% Cu, 14 g/t Ag, and 0.208 g/t Au.

6.2.5. Iron Range (Eagle Plains Resources Inc.)

The **Iron Range** property consists of 70,472 ha over a deep-seated regional fault (Iron Mountain fault) in the Purcell anticlinorium. The Aldridge Formation hosts Ag-Pb-Zn±Au,Cu mineralization along the Iron Mountain fault zone, which consists of a number of north-trending faults along a 90 km strike length. Along the fault zone are brecciation, tourmalinization, albitization, fragmental rocks, and intense hydrothermal alteration, including: chloritization, silica flooding and replacement, hematite-magnetite-albite, sericite-carbonate overprinting and intense argillic alteration. The property is also underlain by felsic intrusive rocks. Some showings display hematite, albite and chlorite, and characteristics of precious metal enriched iron oxide copper gold (IOCG) mineralization (BC MINFILE; Duncan, 2014). The company has identified three main target zones: the Talon/Canyon, O-Ray, and Car. In 2018, Eagle Plains Resources Inc. drilled two diamond drill holes (997 m) to test IP anomalies, and down-dip extensions of surface mineralization The holes returned several intersections of anomalous but not economic Au-Ag.

6.2.6. Thor (Taranis Resources Inc.)

Taranis Resources continued work at the **Thor** property, which has several targets, and showings, including the True Fissure, Great Northern, Broadview, and Blue Bell past-producing mines. The company released a NI 43-101 resource estimate in 2013 based on 152 holes that were drilled between 2007 and 2008 at three main zones (Broadview, Great Northern and True Fissure; Fig. 14). The Thor property lies at the northern end of the Kootenay arc (Fig. 2), and is underlain by a thick succession of folded and faulted sedimentary and volcanic rocks of the Badshot Formation and Lardeau Group.

Fig. 14. Drill core, Thor property.

Stratiform sulphide mineralization (Ag-Pb-Zn-Au-Cu) predates folding and faulting and is interpreted as primary, possibly of volcanogenic massive sulphide origin. Parallel horizons of massive and disseminated galena, chalcopyrite, pyrite, and sphalerite extend along a 2 km strike length of a sheared, northwesterly trending anticline. The zone of mineralization is commonly intercalated with tuffaceous pyroclastic rocks. Drilling encountered foliated quartz-feldspar porphyry, which is considered to pre-date structures and possibly be related to the mineralizing event. High-grade gold is also found in late quartz veins and breccia zones that flank the main zone of sulphide mineralization.

In 2018, the company continued drilling (1983 m, 30 DDH) southeast of the Great Northern zone, as a follow up to their 2016 drilling, which encountered stacked zones of mineralization, and step out mineralization. Each hole was surveyed using downhole magnetics. They also conducted resistivity, ground magnetics, and VLF surveys over portions of the property to better define structures and identify new targets. Surveys identified an extension to the northwest of the SIF zone with quartz vein and iron-oxide alteration similar to SIF. The company also processed a 600 t sample from the SIF zone using a pilot plant to test gold grades and recovery methods. In the field, it was estimated that the plant was only able to recover 25.3% of the gold as a result of a loss of the finer fractions and inefficiencies of using a hammer mill. Future work would include the use of a ball mill to obtain a finer grind size and improve recoveries by liberating more gold. The company has applied for a 10,000 t bulk sample permit, and began collecting environmental baseline data and information required for permitting. The company also plans to update their geological model and update the resource with results from 2018.

6.2.7. Silvana (Klondike Silver Corp.)

Klondike Silver Corp's **Silvana** project consists of 25,000 ha with more than 68 past producers, in the silver-rich historic Slocan mining camp (Ag-Pb-Zn), with production that dates back to 1891. The area is underlain by sheared and brecciated metasedimentary rocks of the Slocan Group (Late Triassic) that are cut by granodiorite and quartz monzonite dikes and at the edge of the Nelson batholith (Middle Jurassic). Ag-Pb-Zn mineralization occurs in a series of east to northeast-trending, shear zone-hosted polymetallic quartz-carbonate veins, and as replacements in Slocan Group limestones. Klondike's holdings include the Sandon, Hewitt, Silverton Creek, Cody Creek, Payne, and Jackson Basin camps, and the Silvana, Wonderful and Hinckley past producers. The main vein at **Silvana** is in an eight km-long structure that yielded about 242 t Ag, 28,691 t Pb, 26,299 t Zn and 72 t Cd from 510,964 t mined between 1913 and 1993, at an average grade of 13.87 oz/t Ag, 5.62% Pb, and 5.15% Zn (Hedley, 1952).

In 2017, the company began rehabilitating the 4625 portal at **Silvana**, and the 5480 and 6100 portals at the Carnation, in preparation for further underground work. In 2018, the company upgraded rock bolts, began phase 1 of drifting (80 m), and underground drilling (1030 m, 13 DDH) to test unmined zones. Environmental baseline work, monitoring, and engineering upgrades to the tailings facility and mill are ongoing as the company updates their mine plan and permit. The company's mill at Sandon is a 100 tpd flotation mill that operated at an average rate of 40 tpd has been on care and maintenance since 2003.

6.2.8. Tungsten Tailings (Margaux Resources Ltd.)

Margaux Resources Ltd. continued work on their **Tungsten Tailings** project, where they are evaluating the potential for recovering metals from tailings of the historic Emerald tungsten mine with concurrent site remediation. The historic mine operated from 1942 to 1943, and intermittently until 1973. The amount of tailings is currently unknown, but historic records document 1.077 Mt averaging 0.86% WO_3, and up to 1.45 Mt averaging 0.76% WO_3 with mill recovery rates of about 82% (BC MINFILE; Lawrence, 1974). The mine produced from a garnet-pyroxene skarn in the Truman Member (Laib Formation; Cambrian) at the contact with Nelson intrusions (Jurassic).

In 2017, Margaux Resources Ltd. sampled separate areas of the tailings facility, and a total of 84 samples assayed an average of 0.11% WO_3. They entered into an agreement with CRONIMET Mining Processing AG, and shipped approximately 3500 kg of material to their lab for testing, to characterize the tailings and determine processing options. Margaux is also in the application process for a 10,000 t bulk sample and on-site pilot processing facility to further test the economic viability of the project. Margaux has partnered with the Salmo Watershed Streamkeepers Society, which is a charitable, non-profit community-based organization focussed on stewardship and awareness of the Salmo River watershed. They hope to showcase the tailings project as an opportunity to generate revenue from industrial activities, while also benefiting the environment, and are drawing on the organization for expertise in collecting environmental baseline data.

6.2.9. Jackpot (Margaux Resources Ltd.)

Margaux Resources Ltd. continued mapping and sampling at the **Jackpot** property. The property is underlain by folded dolomitized limestones of the Reeves Member of the Laib Formation (Lower Cambrian). The Jackpot orebodies are currently thought to be Kootenay arc-type carbonate-hosted syngenetic zinc-lead deposits. Historic showings and workings on the property include two exploration drifts (1858 m; two levels), and 143 surface and underground drill holes.

In the northern part of the property, discontinuous pods and lenses of high-grade zinc oxide mineralization occur at the Big Zinc target in boulders along the 'Oxide fault', with grades of up to 16.3% Zn over 5.8 m reported, and grab samples up to 44% Zn. The boulders are interpreted to be displaced from their bedrock source, and enriched through surface weathering processes. Mapping also identified laminated sulphides in the Active Formation (Ordovician). The company re-logged historic core and continued compiling all historical data into a 3D model.

6.2.10. Kena-Daylight (Prize Mining Corp.)

Prize Mining Corp. entered into two separate option agreements in 2017, to acquire an 80% interest in the Kena and Daylight gold-copper properties (20% owned by Apex Resources Inc.), and 100% of the adjoining **Toughnut** claims. The area is underlain by sheared and highly schistose augite basalt flows and subvolcanic intrusions of the Elise Formation (Rossland Group), and Silver King intrusions (Late to Middle Jurassic). Porphyry style gold and copper-gold mineralization is low grade, bulk tonnage. In addition, bonanza-grade gold mineralization has four distinct settings: a high-grade corridor, associated with volcanic and intrusive rocks; volcanic-intrusive contact areas; bonanza shoots; and bulk tonnage haloes around shoots. Northwest-trending shears also host quartz veins with sulphides. Shear-zone mineralization occurs as vein, stockwork, and porphyry-style Au and Au-Cu. Historic production includes the Starlight, Victoria, Daylight, and Great Eastern mines, which operated intermittently from 1937 to 1949 and produced mainly gold, silver, and copper.

In 2017, the company mapped, sampled, trenched, and conducted ground-based magnetic and VLF surveys to identify targets. Late in the year, they drilled at the **Toughnut** (1730 m, 11 DDH) and Daylight (2695 m, 18 DDH), and they released results in early 2018. Mineralization at the Daylight occurs within vuggy quartz-carbonate veins and swarms, and in altered intervals of the Silver King porphyry (Jurassic) and mafic volcanic rocks. High-grade intervals in veins (quartz+pyrite+chalcopyrite) included intersections of 0.9 m grading 62.7 g/t Au, 0.5 m grading 20.9 g/t Au, 0.5 m grading 7.36 g/t Au, and low-grade intervals of up to 74.28 m grading 1.09 g/t. At the **Toughnut**, high-grade mineralization occurs in sheeted quartz veins and sulphide mineralized shears at contacts between the porphyritic intrusions and mafic volcanic rocks. Results include 0.7 m grading 7.3 g/t, 1.0 m grading 25 g/t Au, and 2.0 m grading 5.58 g/t Au. The company followed up in 2018 with further drilling at the **Toughnut** (3386 m, 20 DDH) across an area of 1000 x 450 m in the Silver King shear system targeting the Gold Eagle showing, where mineralization extends for a strike length of more than 750 m, and the Toughnut Crown Grant workings, where historical grab samples returned up to 32.8 g/t Au, 212.5g/t Ag, 2.6% Pb, and 5.9% Zn from quartz veins in volcanic host rocks. Results from the 2018 drilling include 4.37 g/t Au over 6.0 m and 14.3 g/t Au over 0.84 m.

6.2.11. Alpine (Braveheart Resources Inc.)

At the **Alpine** property, Braveheart Resources Inc. continued to follow up on their 2017 exploration program. The property is underlain by the Nelson intrusions (Jurassic to Cretaceous), with mineralization (Au-Ag-Pb-Zn) in shear-hosted mesothermal quartz veins. Numerous small adits exist on the property, and intermittent production from the historic Alpine mine from 1915 to 1988 totalled 16,810 t containing 222 kg Ag, 356 kg Au, 49,329 kg Pb, and 17,167 kg Zn (BC MINFILE). The 2017 drill program tested the extension and continuity of vein, with drill intersections of up to 1.6 m grading 33.6 g/t Au. Historic core from 1989 drilling was also re-sampled. The helicopter-supported drill program in 2018 (1500 m), was to further test zones of extension. A NI 43-101 compliant resource estimate was released early in 2018, with an Inferred Resource of 268,000 t, grading 16.52 g/t Au, using a cut-off grade of 5 g/t.

Material from the **Alpine** mine was also sent to STEINERT US Inc. in Walton, Kentucky, to test a density ore sorting method and determine if material could be upgraded on site before trucking and processing. A 72 kg run of mine sample was upgraded from 14.7 g/t to 20.3 g/t Au, with 92.8% gold recovery and 32.7% waste rejection, and a 128 kg composite sample was upgraded from 25.4 g/t to 43.2 g/t Au, with 81.3% recovery and 52.1% waste rejection.

6.2.12. Duncan (Rokmaster Resources Corp.)

The **Duncan** property has been intermittently explored since the 1950s. The property is along the Kootenay arc (Fig. 2), and underlain mainly by the Mohican and Badshot formations, but includes the upper part of the Hamill Group and lowermost rocks of the Index Formation (Lardeau Group). Structures are mainly tight, asymmetric, and overturned folds, and steeply dipping faults. Mineralized zones consist of pyrite, sphalerite, galena and minor pyrrhotite disseminated in dolomite and siliceous dolomite of the Badshot Formation.

Drilling by Cominco between 1989 and 1997 outlined zinc-lead mineralization along a 650 m strike length. Several zones of mineralization exist on the property as steeply dipping, stratiform, tabular bodies, separated by high-angle fault zones, on the east limb of the Duncan anticline.

In 2017, Rokmaster compiled historic data and re-sampled historic drill core. Results include 14.7 m grading 8.2% Zn+Pb, 13.4 m grading 8% Zn+Pb, and 12.2 m grading 8.31% Zn+Pb. Additional mapping, soil geochemistry and rock sampling was done on the property in 2018 across an area of 4.5 km,

and to the south of the planned drill program. Elevated silver, lead, and zinc anomalies occurred over a distance of 1.3 km. Elevated grab sample results up to 23 g/t Ag, 12.5% Pb, and 21.4% Zn were returned from an area of recent logging. The company also conducted environmental baseline work, and drill permits were received late in the year.

6.2.13. Ledgend (Cardero Resources Corp.)

Cardero Resources Corp. optioned in on five nickel-cobalt massive sulphide prospects as part an agreement totalling 8,000 ha in the Kootenay region, and continued to work on their main project at the **Ledgend** in 2018. The property is underlain by highly deformed metamorphic rocks of the lower Index Formation (Lower Paleozoic), including black, carbonaceous and calcareous phyllite, argillaceous limestone, minor quartzite and mica schist. Structural and lithological trends are oriented generally north–northwest with abundant evidence of isoclinal folding and polyphase deformation. Mineralization in interpreted as syngenetic, and occurs locally as a manganiferous-rich exhalite with banded metacherts, nickel-bearing massive sulphides and lesser values of cobalt, copper, zinc, and gold. Selected samples have assayed from 0.3 to 0.75% Ni and 0.06 to 0.9% Co. Talc-tremolite schists, listwanites, silicified zones of chromium mica (fuchsite), and spessartine (manganiferous) garnets occur locally.

In 2018, the company continued mapping and sampling on the property. Chip samples include 4 m grading 0.22% Ni and 0.028% Co at the discovery showing, and 0.84% Ni, 0.025% Co in the central showing. Two soil geochemistry grids identified several northwesterly trending linear anomalies that are interpreted to be folded repetitions of the mineralized horizon. The company completed a 90 line-km drone airborne magnetometer survey over the North soil grid and to the west. They also trenched (775 m) three targets identified on the North soil grid, and located disseminated oxides after sulphides in interlayered actinolite-tremolite and talc-carbonate schists. These are interpreted as the altered remnants of high Ni-Co ultramafic rocks that cut calcareous sedimentary rocks, and likely host and source the mineralization. XRF analysis highlighted anomalous Ni-Cu-Zn, with values averaging >1000 ppm Ni along a strike length of more than 800 m.

6.3. Selected industrial mineral projects

Industrial minerals are explored for throughout the region, including graphite, gypsum, magnesite, silica, rip rap, dimension stone, sand and gravel, limestone, dolomite, tufa, smelter slag, basalt, gabbro, marble, and phosphate.

6.3.1. Koot silica / Gibraltar / Wonah (MGX Minerals Inc.)

In 2018, MGX Minerals Inc. continued to explore their three silica projects, evaluating them for silicon metal potential, and possibly as feedstock for solar panel silicon. At the **Koot silica** property, siliceous quartzite, grit and pebble conglomerate, and sandstones (Cranbrook Formation; Lower Cambrian) outcrop at surface. Drilling in 1981 by Cominco outlined a mineralized zone approximately 400 m long of high purity quartzite, with results of 97.3 to 99.3% SiO_2 in core. The company drilled in 2018 (782 m, 10 DDH), reporting quartzites 36 to 105 m thick with 97.9 to 99.0% SiO_2.

At the **Gibraltar** property, Mount Wilson Formation quartzite (Upper Ordovician) was quarried for a short time in 1967 (Red Cloud quarry; BCMINFLE 082JSW001). The only recorded production was a small trial shipment, which assayed 98.56% SiO_2. In 2018, MGX shipped a one-ton sample to an independent lab in Germany (Dorfner Anzaplan) for testing. Results indicated that the material could be suitable as medium quality feedstock for metallurgical-grade silicon metal production. They mapped and sampled on the property, reporting assay results between 97.8 and 99.9% SiO_2, and began an eight-hole drill program late in the year.

At the **Wonah** property, the Mount Wilson quartzite is steeply dipping and exposed along a strike length of 850 m. Geological mapping and sampling was done on the property in 2018; 11 chip samples were assayed between 98.9 and 99.9% SiO_2. The company received drill permits and began road construction, and plans to drill in 2019.

6.3.2. Barnes Lake/Marten (Fertoz International Inc.)

Fertoz International Inc. continued to work on their phosphate projects in 2018, and have staked additional claims in the Elk Valley and Crowsnest Pass areas. They are targeting phosphoritic beds at the base of the Fernie Formation (Jurassic), and marketing their rock phosphate product as an organic agriculture product that meets the requirements of the Canadian Organic Standards (COS) and the USDA National Organic Program. The company mapped and sampled at their **Barnes Lake** project, where historic grades tested 22.4% P_2O_5 (BC MINFILE). Environmental baseline work is ongoing, and the company is currently applying for bulk sample permits at both their **Barnes Lake** and **Marten** projects. At the **Marten**, phosphoritic beds have been mapped for more than 1200 m along strike, with grades of 24-27% P_2O_5 tested by handheld XRF.

6.4. Selected coal projects

Coal exploration is ongoing in the Elk Valley, Crowsnest, and Flathead coalfields.

6.4.1. Coal Creek (Crowsnest Pass Coal Mining Ltd.)

Crowsnest Pass Coal Mining Ltd. continued environmental baseline studies, engineering, and pre-feasibility work at their **Coal Creek** property. The project is underlain by 11 coal zones 2 to 20 m thick. The company is evaluating three near-surface seams in the uppermost part of the Mist Mountain Formation that dip gently to the east for underground room-and-pillar mining. Drilling in 2012 indicated high-quality hard coking and PCI coal in the upper seams.

6.4.2. Elko (Pacific American Coal Limited)

Pacific American Coal Limited drilled on their **Elko** project

in 2018 (8 RC, 1 large-diameter core; 3451 m). Coal quality results are pending, but correlation of geophysical drill logs suggest seam continuity, and will be used to update the geological model. The company began working on the project in 2015, and compiled all the historical data into a model to outline the drill locations. Operating near the Flathead area, the company also has conducted extensive environmental baseline work, and engagement with the First Nations to receive the necessary permits for exploration.

The project is in the Crowsnest Coal field, targeting Mist Mountain Formation coal seams in the McEvoy syncline. Five seams outcrop on the property, with thicknesses of ca. 2.6 to 5.0 m, and quality ranging from hard coking coal to PCI coal. Block modeling indicates potential for a small open cut operation, with potential development of a larger underground operation. In 2015, the company released a JORC resource estimate of 181.3 Mt Inferred+57 Mt Indicated+19.2 Mt Measured, and will use the drill results to update the resource.

7. Geological research

Höy (2017) continued updating maps in the Boundary region and Rioseco et al. (in press) studied the metamorphic evolution of the Purcell Anticlinorium and Kootenay Arc. Work continues on: how to better reduce the amount of chemicals used in cleaning coal by using a water-based jig (Mackay et al., 2017); the Purcell anticlinorium and thickened sections of the Aldridge Formation using seismic and magnetotellurics (Cook, 2017); and carbonatites in the Rocky Mountain Foreland belt (Simandl and Paradis, 2018).

8. Summary

In 2018, exploration and mining continued in the region. Major mine development, expansion plans, and projects in the East Kootenay coalfields continue to advance. The reserves at Coal Mountain mine are depleted, and reclamation has begun to move the mine to closure, though the processing plant and facilities will remain operational. The Kootenay West gypsum mine was granted an Environmental Assessment certificate early in 2018, and construction is expected to begin in 2019. Exploration for SEDEX-style base metals continued in the Purcell anticlinorium, and for precious and base metals throughout the region. There was an increase in exploration for industrial minerals such as silica, which are targeting grades suitable for the production of silicon metal. A silicon smelter proposed at Newport, Washington to process product from mines in the Southeast Region is entering the beginning stages of public consultation and environmental assessment. Overall, exploration activity and spending in the region was increased relative to 2017. Several drill programs continued late into the year throughout the region because of late financing, permitting delays and closures due to forest fires, and some programs were postponed until 2019.

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