

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 2019 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.

Exploration slowed in 2019 relative to 2018. Drilling continued at some projects that have been active in the last several years and started at a few new projects. Mine expansion and exploration continued at the coal mines in the Elk Valley and grassroots exploration took place on several projects, and for assessment work.

Estimates for exploration expenditures, drilling programs, and other metrics were captured in the British Columbia Mineral and Coal Exploration Survey, a joint initiative of the Province of British Columbia Ministry of Energy, Mines and Petroleum Resources, the Association for Mineral Exploration in British Columbia, and EY LLP. For the Southeast Region, exploration expenditures were estimated at \$45.0 million and exploration drilling was estimated at approximately 117,700 m (Clarke et al., 2020; EY LLP, 2020).

2. Geological overview

The Canadian Cordillera has long been of interest to the exploration industry. It is a collage of allochthonous terranes, parautochthonous terranes, and autochthonous basement, containing diverse rocks and structures. Metallogenic

processes generated the varied deposit types that contribute to the mineral endowment of British Columbia (Nelson et al., 2013).

The Southeast Region (Fig. 1) 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: 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 mines in the Elk Valley, and continues to be an important source

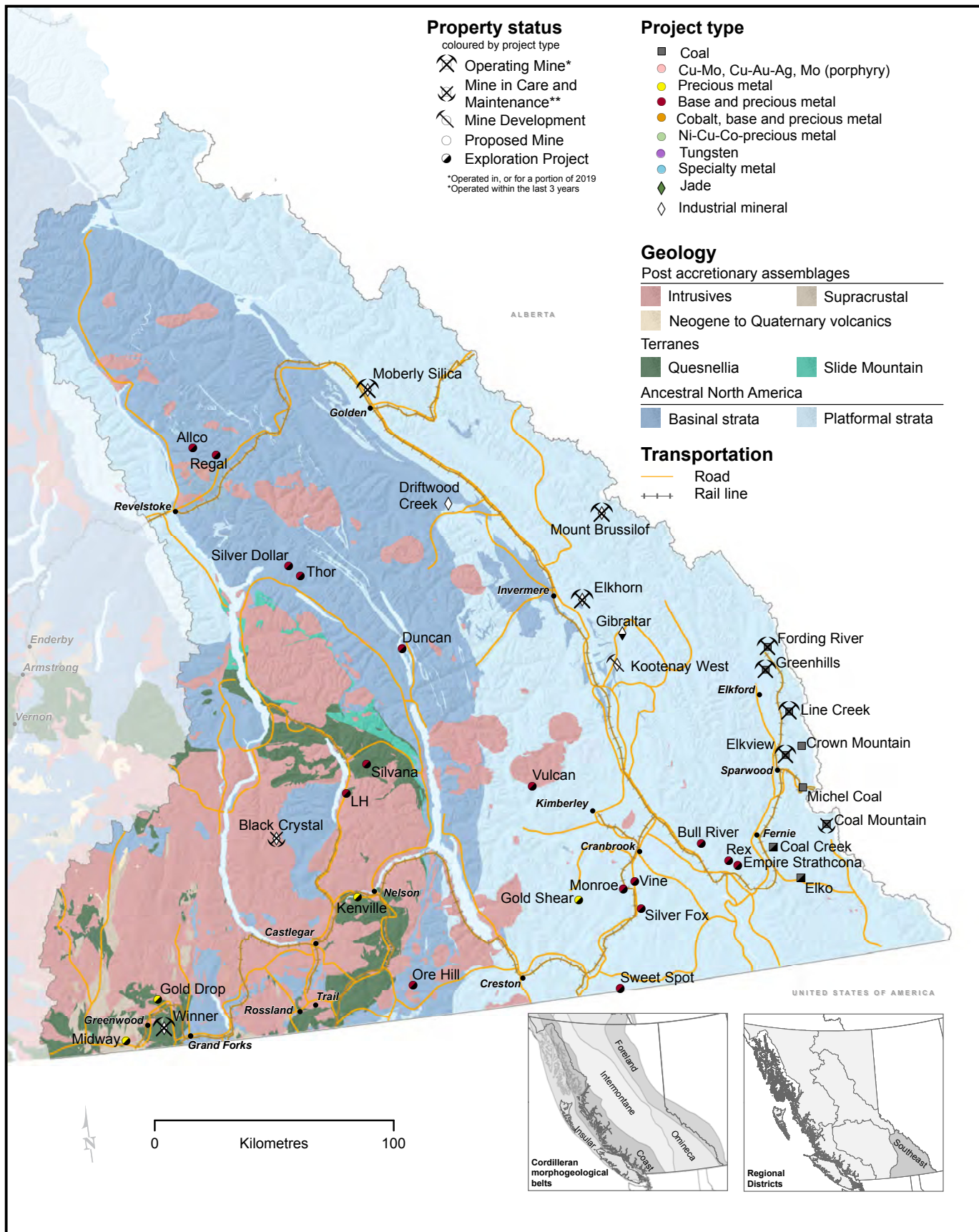


Fig. 1. Mines and selected exploration projects, Southeast Region, 2019.

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 2019, 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, 2). Today, four open pit mines are operated by Teck Coal Limited in the Elk Valley (**Fording River**, **Greenhills**, **Line Creek**, and **Elkview**). A fifth mine (**Coal Mountain**) reached the end of its reserves life and produced intermittently until Q2 of 2019. The pit operations are now suspended, though the plant and load out facilities continued to process coal into Q3.

With a history that dates to the 1800s, several underground coal mines operated in the region 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. The main product is metallurgical coal (85%), with some thermal and pulverized coal injection (PCI) coal (15% combined). In 2019, total annual production from the mines in the southeast region was approximately 25.5 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 in the Elk Valley. 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. All producing and proposed mine projects are engaged in research to improve technologies for active water treatment facilities and develop alternative and passive treatment methods.

Since its approval, the water quality objectives in the Plan have undergone criticism, and continue to be the focus of ongoing discussions between provincial, federal, and trans-border working groups. Draft changes to the objectives are expected to be announced early next year and may affect the current targets and limits of the Elk Valley Water Quality plan.

Under the current plan, Teck Coal Limited has committed to constructing five active water treatment facilities. The first facility has operated at the **Line Creek** mine since February 2016, and a second treatment step was successfully added in 2018. Construction on the facility at **Fording River** began in 2019, with the design modifications used at the **Line Creek** facility. At least four more facilities may be needed to meet water quality objectives. Passive water treatment trials have

also been underway to reduce the reliance on, and increase the effectiveness of, active water treatment. The first saturated rock fill pilot project was constructed at **Elkview** in 2018. It uses biological processes enhanced by the addition of nutrients (methanol and phosphoric acid) to remove nitrate and selenium from the water. This technique is reported to almost completely remove nitrate and selenium from water at processing rates of 10 million litres per day. In 2019, Teck received approvals to expand this project (Teck, 2019). Capital costs of a saturated rock fill facility are approximately 20% of those of an active water treatment facility, and annual operating costs are approximately 50%. Total capital spending by Teck Coal Limited on water treatment in 2019 was estimated at approximately \$235 million, making efficiencies in treatment techniques an attractive option. Other water quality trials are underway, including capping and reclamation techniques and methods for calcite management (Teck, 2019). Jameson Resources Ltd. (**Crown Mountain**) and North Coal Ltd. (**Michel Coal**) are also actively involved in independent design and test work for their proposed mine projects.

3.2.1. Fording River (Teck Coal Limited)

The **Fording River** mine (Fig. 2) 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 2019, production at **Fording River** (Fig. 3) was mainly from their Eagle Mountain, **Swift**, and Lake areas. Exploration drilling and large diameter core drilling (103 RC holes, 33,059 m; 15 LDC holes, 2510 m) to test seam extensions and coal quality, occurred in their producing pits and their Castle Mountain area. The company also conducted geotechnical drilling and environmental baseline work in their producing pits and extension areas.

West of the current mine area at **Fording River**, the **Swift** expansion area comprises both previously mined (last in the 1990s) and unmined zones. 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**. Future expansions would include highwall pushback at the Turnbull and Henretta pits and expansion at their Castle Mountain and Greenhills Ridge areas. Proven and Probable reserves at the mine are from the Eagle Mountain, Swift, Turnbull, and Castle Mountain areas, and are projected to support a further 43 years at planned production rates.

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. 2). Coal seams generally grade in rank from

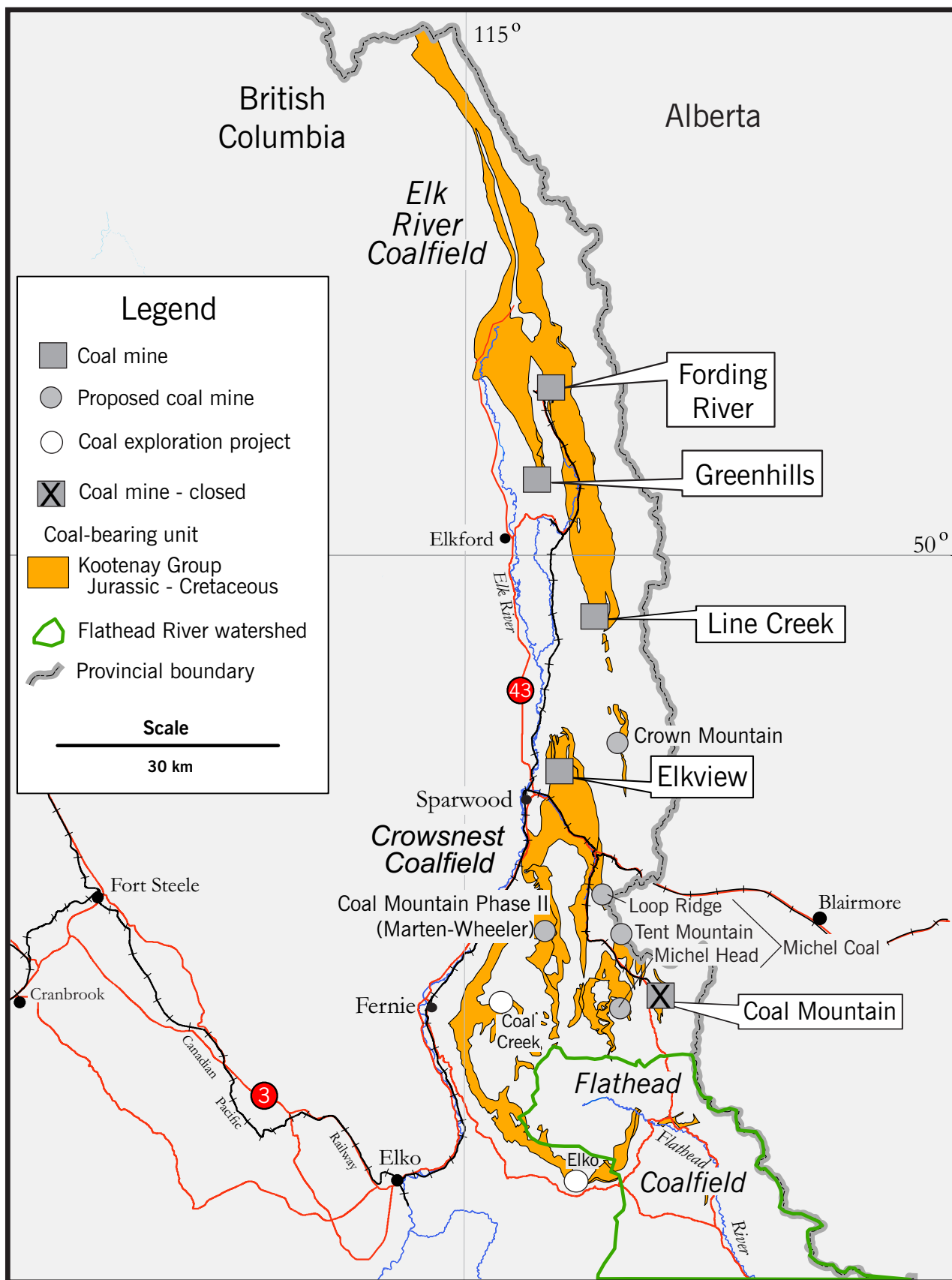


Fig. 2. Map of the Kootenay Group and East Kootenay coalfields, including the major coal mines and selected projects in southeastern British Columbia. From British Columbia Geological Survey (2020).

Table 1. Coal mines, Southeast Region.

Mine	Operator; Partner	Commodity	Forecast 2019 Production (based on Q1-Q3)	Reserves (as of December 31, 2018)	Resource (as of December 31, 2018)	Comments
Fording River	Teck Coal Limited (100%)	HCC	2019: 8.15 Mt clean	HCC P: 166.4 Mt Pr: 221.5 Mt	HCC M: 407.6 Mt I: 925.5 Mt Inf: 775.6 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 43 years of mining at current production rate.
Greenhills	Teck Coal Limited (80%); POSCAN (20%)	HCC	2019: 6.1 Mt clean	HCC P: 9.7 Mt Pr: 155.3 Mt	HCC M: 162.2 Mt I: 247.2 Mt Inf: 177.1 Mt	Cougar Pit Expansion (CPX) approved (2016); exploration drilling in expansion areas; coal quality testing; P+Pr reserves are projected to support another 28 years of mining at current planned production rates.
Line Creek	Teck Coal Limited (100%)	HCC, TC	2019: 3.95 Mt clean	HCC P: 2.4 Mt Pr: 57.8 Mt TC P: 0.4 Mt Pr: 10.1 Mt	HCC M: 312.2 Mt I: 406.5 Mt Inf: 372.8 Mt TC M: 1.7 Mt I: 1.9 Mt Inf: 1.8 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 Corporation (2.5%), POSCO (2.5%)	HCC	2019: 7.1 Mt clean	HCC P: 6.8 Mt Pr: 258.3 Mt	HCC M: 223.0 Mt I: 156.7 Mt Inf: 205.6 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 38 more years at current production rate.
Coal Mountain	Teck Coal Limited (100%)	PCI	2019: 0.2 Mt clean	na	PCI M: 56.8 Mt I: 22.9 Mt Inf: 4.8 Mt	Mineable reserves at CMO depleted in Q3 2018; reclamation begun; facilities also processed coal trucked from Elkview mine; facilities to be placed on care and maintenance; Coal Mountain Phase II (CMO2, Marten Wheeler) would use 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. 3. Truck and shovel operations at Fording River mine.

medium-volatile bituminous in the lower parts of the section, to high-volatile-A bituminous at higher intervals, with a small amount of thermal coal also produced. Currently, the annual production capacity of clean coal is 5.9 Mt from the mine and 5.4 Mt from the preparation plant. Production is mainly from the Cougar pit area; Proven and Probable reserves are projected to support another 28 years of mining at planned production rates.

The **Cougar Pit Extension (CPX)** project (Fig. 2) 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. Exploration drilling in 2019 (8 RC holes, 2401 m; 16 LDC holes, 844 m) included both in-pit drilling to update structural and seam quality models, and further step-out drilling in their permitted extension areas for the next phases of mining. Additional geotechnical drilling was conducted, and environmental baseline work continued.

3.2.3. Line Creek (Teck Coal Limited)

The **Line Creek** mine (Fig. 2) 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.

In 2019, production was mainly from the Burnt Ridge extension (BRX), Mount Michael (MTM), and Mine Services extension (MSX) pits. Further exploration and coal quality testing were done in 2019 to prepare for the next phases of mining. Exploration drilling (59 RC holes, 12,239 m; 9 LDC holes, 744 m) occurred in producing pits and on their Burnt Ridge North extension area to update geological models and for coal quality test work. Additional drilling was completed for geotechnical assessments, and environmental baseline

studies are ongoing. 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, with additional design changes in 2018.

3.2.4. Elkview (Teck Coal Limited 95%; Nippon Steel Corporation 2.5%; POSCO Canada Limited 2.5%)

The **Elkview** mine (Fig. 2) 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 38 years at the current production rate. In 2019, drilling continued in their active pits and expansion areas (32 RC holes, 7348 m; LDC holes, 1200 m), and production was primarily from the Baldy Ridge, Natal Ridge, Adit Ridge expansion areas.

In 2019, **Elkview** received approval to expand their saturated rock fill project after successful trials. The project uses biological processes to sequester selenium and other substances and will be used as another step in the water treatment process at Teck's mine sites in the Elk Valley.

3.2.5. Coal Mountain (Teck Coal Limited)

Coal Mountain (Fig. 2) 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. The historic underground workings at the mine posed challenges to mining operations and, in 2018, the mine neared the end of its reserves life. The mine produced a small amount in the first half of 2019.

The plant and load out facilities at **Coal Mountain** continued to process coal until Q3 2019, including a small amount of coal that was trucked from the **Elkview** mine. Reclamation of the mine is well underway on the final lifts of the dry stacked tailings facility, and waste dump spoils. The wash plant (with an annual capacity of approximately 3.5 Mt) and load out facilities will be kept operational, but on care and maintenance. Teck Coal Limited plans to maintain production levels by optimizing and expanding production at their other metallurgical coal mines, and from recently approved expansion areas.

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

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	MgO, and MgOH; sediment-hosted sparry magnesite.
Moberly Silica	HCA Mountain Minerals Limited (Northern Silica Corporation)	Silica; Industrial use silica, frac sand; 082N 001	na	20 to 140 mesh frac sand (dry) 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)	Drilling (7 DDH, 1900 m); mapping, sampling, thin section work; design modifications to processing plant.
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).
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.

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

in Cambrian carbonate rocks of the Cathedral Formation. 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) suggest episodic flow of hydrothermal fluids. 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.

3.3.2. Moberly Silica (HCA Mountain Minerals Limited)

HCA Mountain Minerals Limited (Northern Silica Corporation) continued work on their **Moberly Silica** project. The deposit has been mined since the early 1980s for silica sand, glass making, and other industrial uses. The silica deposit is in regionally extensive orthoquartzites of the Mount Wilson Formation (Middle to Upper Ordovician). At Moberly Mountain, the formation is ~ 99% SiO₂, partially de-cemented,

and friable along a fault zone. At the mine, the unit is nearly vertical, about 300 m thick, and extends along strike for 800 m. Sand grains in the orthoquartzite are well rounded, making it a suitable product for the frac sand industry. Redevelopment of the current operation and processing plant (300,000 tpy) began in 2015. In 2019, the company drilled (7 DD holes, 1900 m) to further test homogeneity along strike, and better characterize stratigraphy. Thin section work is being conducted to try to determine the controls on the selective dissolution of primary cements. The company also continued to work on design modifications at their plant to improve separation of different size fractions and products.

3.3.3. 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. 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 5.1), which received conditional approval through environmental assessment in January 2018.

3.3.4. 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 naturally fire-retardant.

4. Placer operations

Placer mines have operated in southeastern British Columbia since the gold rush began in 1864. Although activities were not tracked in 2019, 58 placer projects currently have active Mines Act permits that allow mechanized work, consisting of more than simple hand panning.

5. Mine development

In addition to the coal mine expansion projects that are currently in construction phases, one new gypsum mine, **Kootenay West** (CertainTeed Gypsum Canada Inc.), was granted an Environmental Assessment Certificate in 2018, with construction beginning in 2019 (Table 3).

5.1. 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 has been 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 43 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 2019, the company focussed on environmental work and modifications to the mine design. Phase 1 construction, with estimated capital costs of \$20 million, also began in 2019. The mine will replace production after the Elkhorn mine is depleted.

6. Proposed mines and quarries

The Southeast Region has three proposed coal mines (Table 4): **Michel Coal** (North Coal Ltd.), **Crown Mountain**

(Jameson Resources Ltd.), and **Bingay Main** (Centermount Coal Ltd.). An industrial mineral mine, **Driftwood Creek** (MGX Minerals Inc.), is also proposed.

6.1. Proposed metal mines

There are currently no proposed metal mines in the region.

6.2. Proposed coal mines

The Southeast Region has several proposed coal mines in various phases of environmental assessment (Fig. 2). Each must demonstrate how they will meet the guidelines set out in the Elk Valley Water Quality Plan. Only **Michel Coal**, which includes **Loop Ridge**, **Tent Mountain**, and **Michel Head**, and **Crown Mountain** are described below.

6.2.1. Michel Coal (North Coal Ltd.)

North Coal Ltd., a wholly owned subsidiary of CoalMont Pty Ltd., entered the pre-application phase of environmental assessment for their **Michel Coal** project in 2015. With subsequent 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. 2), and submitted a revised project description in September 2018. The expanded plan will give them more flexibility in blending product from different areas to specification for clients. The project is expected to produce between 2.3 and 4 Mt annually, with a 30-year mine life.

In 2019, work continued on their environmental baseline, permitting, and 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. Drilling has 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 (ca. 6:1) strip ratio. In 2018, the company released an updated 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.

6.2.2. Crown Mountain (NWP Coal Canada Limited 80%; Bathurst Resources Limited 20%)

The **Crown Mountain** property is along strike with **Line Creek** (Fig. 2), 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 application information requirements from the Environmental Assessment Office in April 2018. In 2019, Bathurst Resources Limited earned an additional 12% interest in the project, bringing their interest up to 20%. Bathurst could become a 50/50 joint venture partner after exercising all tranches in the terms of the agreement, with an investment totaling \$121.5M.

Table 3. Selected mine development projects, Southeast Region.

Project	Operator (partner)	Commodity; deposit type; MINFILE	Reserves	Resource	Comments
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; construction began in 2019; 400,000 tpy; 43-year mine life; blended product to market specifications.

Table 4. Selected proposed mines, Southeast Region.

Project	Operator (partner)	Commodity; deposit type; MINFILE	Reserves	Resource	Comments
Michel Coal	North Coal Ltd.	Coal (HCC and PCI); Open-pit and underground; 082GSE050	na	HCC M: 44.6 Mt I: 42.5 Mt; open-pit and underground (2015)	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 Limited 80% (Bathurst Resources Limited 20%)	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, with ability to earn 50% with investment of \$121.5 M; Pre-application of EA (2014); Application Information Requirements (AIR) received in April (2018); coal quality test work; water quality and treatment studies involving passive biological treatment; engineering studies and mine design; bankable feasibility study; 16-year mine life; 1.7 M tpy.
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 rock-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.

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

Results released in 2019 from coal quality test work indicate a premium hard coking coal in the north pit, and a low-volatile hard coking coal in the south pit. Coal quality test work indicates that approximately 84% of the coal is hard coking coal, the remainder PCI coal. Environmental baseline work and geotechnical drilling continued, as did engineering work on spoil pile design and water treatment, including the use of biological reduction of nitrate and selenium by naturally occurring microbes in waste piles. A feasibility study for the project is in progress and includes an open-pit mine with an estimated production capacity of 1.7 Mtpy of clean coal and a 16-year mine life. In 2014, the company completed a resource estimate of 74.9 Mt (Measured + Indicated).

6.3. Proposed industrial mineral mines

MGX Minerals Inc.'s **Driftwood Creek** project is a proposed magnesite mine. The **Black Crystal** graphite quarry (Eagle Graphite Corp.) is on care and maintenance while the company focusses on research and development for their product. Several small quarries and pits for dimension stone, flagstone, and sand and gravel are not considered here.

6.3.1. 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 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. In 2019, the company continued environmental baseline studies and obtained permits for additional infill drilling.

6.3.2. Black Crystal (Eagle Graphite Corp.)

Eagle Graphite Corp. operates the **Black Crystal** flake graphite open-pit quarry on Hodder Creek and a processing plant 10 km west of Passmore. In the Kootenay terrane, the property is underlain by Paleozoic upper amphibolite-grade gneisses that were 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 m². At the quarry location, the graphitic horizon is 30–40 m thick, immediately underlying 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 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 are by-products during the mining and refining process. In 2019, the company continued research into processing techniques and received a \$290,000 grant from CleanBC toward advancing lithium-ion graphite.

7. Selected exploration activities and highlights

Exploration continued in the Southeast Region in 2019 for numerous targets, including base and precious metals, industrial minerals, and coal (Fig. 1; Table 5).

7.1. 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 (Höy, 1982; McMechan, 2012; Seabrook, 2015).

7.1.1. Gold Shear (PJX Resources Inc.)

PJX Resources Inc. continued work at their **Gold Shear** property in 2019. 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), and trend SW-NE, parallel to the Perry Creek fault zone. The David zone, a gold-mineralized quartz vein, was discovered in 1990 (British Columbia MINFILE 082FSE108) and has since been traced along strike for 1600 m and 150 m downdip, along with several other splays and veins. Drilling on the property between 1990 and 1996 intersected 0.8 m that graded 196.69 g/t Au, associated with weak to moderately conductive sulphides. 2018 VLF ground geophysics done by PJX identified a large conductive target area down-dip of the David Gold Zone, below the depth of historical drilling. In 2019, the company drilled (9 DD holes, 750 m) to test this target.

7.1.2. Ore Hill (Apex Resources Inc.)

The **Ore Hill** property is in the historic Sheep Creek gold mining camp, where Late Jurassic gold mineralization (133 Ma; pyrite with lesser amounts of pyrrotite, chalcopyrite, galena, sphalerite and rare visible gold) is found in steeply dipping quartz veins along northeast-trending structures. Between 1906 and 1940, a total of 3335 t of ore was mined and 115,671 grams of gold (34.7 g/t), 202,307 grams of silver (60.7 g/t), and 93,985 kilograms of lead and 88,639 kilograms of zinc were recovered (British Columbia MINFILE).

In 2017 and 2018, the property was under option to Margaux Resources Ltd. Margaux carried out mapping and sampling along a gold soil geochemical anomaly and identified gold mineralization in a 10 m wide breccia zone along a north-trending fault. The soil anomaly traced the fault for more than 1500 m across the Summit and Ore Hill claims, and rock sample results included 119 g/t and 105 g/t Au collected across an area 950 by 150 m. In 2019, Apex Resources Inc. compiled historic data, and identified two linear, north-trending magnetic anomalies from an airborne Heliogeotem survey that was flown in 2009. The western anomaly coincides with the soil and rock

Table 5. Selected exploration projects, Southeast Region.

Project	Operator (partner)	Commodity; Deposit type; MINFILE	Resource (NI 43-101 compliant unless indicated otherwise)	Comments
Bull River mine	Braveheart Resources Inc.	Cu-Ag-Pb-Zn+/-Au; Polymetallic veins; 082GNW 002, 6, 15	I: 1.51 Mt grading 1.91% Cu, 0.41 g/t Au, 15.6 g/t Ag at 1% CuEq cut-off Inf: 0.34 Mt grading 1.58% Cu, 0.36 g/t Au, 10.7 g/t Ag at 1% CuEq cut-off	Exploration drilling at Empire Strathcona (14 DD holes, 1389 m) and Rex (11 DD holes, 1697 m); Condemnation drilling on mine property for stockpiles (6 DD holes, 618 m); sampling and assay of the ore stock piles; mine planning; environmental baseline studies; updating mine plan and permitting.
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.
Duncan	Rokmaster Resources Ltd.	Zn-Pb-Ag; Carbonate-hosted; 082KSE023, 22	na	Mapping; sampling; soil geochemistry; historic drill core results include 7.5 m grading 6.2% Zn + 6.3% Pb, 4.8 m grading 11.4% Zn + 0.8% Pb, and 6.9 m grading 7.1% Zn + 4.6% Pb.
Elko	Pacific American Coal Limited	Coal (HCC, PCI); 082GSE029	M: 117.6 Mt I: 93.2 Mt Inf: 92.3 Mt (JORC 2019)	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	Drilling (5 DD holes, 200 m); metallurgical test work results indicated suitability for medium quality feedstock for metallurgical-grade silicon; sampled 97.8 to 99.9% SiO ₂ .
Gold Drop	GGX Gold Corp.	Au; Alkaline intrusion-associated Au; 082ESE055, 150, 152, 153, 285, 286, 287	na	Drilling (48 DD holes, 2284 m on C.O.D vein; 10 DD holes, 685 m on North C.O.D. vein); rock sampling; trenching; channel sampling; airborne magnetotelluric survey.
Gold Shear / David	PJX Resources Inc.	Au, Cu, Pb, Zn; Vein; 082FSE108	na	Drilling (9 DD holes, 750 m); drill targets identified from VLF survey to test down-dip extensions of the vein, below the level of historic working; historic chip sampling returned 0.4 m grading 144 g/t Au.
Kenville	Ximen Mining Corp.	Ag-Au-Cu+/-Pb, Zn, Cd, W; Au-veins, polymetallic veins, porphyry; 082FSW086, 87, 85, 254, 354	M: 3312 t grading 31.72 g/t Au I: 21,312 t grading 18.84 g/t Au Inf: 522,321 t grading 23.01 g/t Au (2009; non-compliant)	Option agreement; data compilation; surface work; permitting for underground decline, drilling, and bulk sampling; ML/ARD test work; environmental baseline; agreement for toll milling at Lexington (Greenwood) mill.
LH	Magnum Goldcorp Inc.	Cu-Ag-Au; Subvolcanic, skarn, Au-veins; 082FNW212	na	Drilling (4 DD holes, 250 m); results included 5.58 m grading 4.068 g/t Au, including 0.27 m grading 22.8 g/t Au.
Midway	KG Exploration (Canada) Inc.	Au-Cu-Pb-Zn-Ag+/-Mo; Cu-Au-Ag skarn, polymetallic vein, Au-vein, porphyry; 082ESW022, 210, 34, 221	na	Option agreement with Grizzly Discoveries Inc. to gain 75% interest in 27,346 ha; continued mapping and sampling at the Midway, Bruce Creek, and Kerr Creek. 2018 drilling (4 DD holes) encountered epithermal-style mineralization with low-grade, anomalous Au.

Table 5. Continued.

Monroe	Highway 50 Gold Corp.	Pb-Zn-Ag+/-Au, Cu; SEDEX; 082GSW069, 35, 41	na	Mapping, modelling; Drilling (2 DD holes, 1450 m) encountered fragmentals, moderate to intense albitization; bedded pyrrhotite-sphalerite; disseminations and veinlets of sphalerite and galena; thickened isopach sequences within the Aldridge Formation, suggesting sub-basin development.
Ore Hill	Apex Resources Inc.	Au+/-Ag, Pb, Zn; Au-quartz veins, polymetallic veins; 082FSW040, 48, 50, 51, 52, 53, 082FSE030, 31, 34, 25	na	Data compilation, mapping, rock sampling; 2 magnetic anomalies coincident with soil geochem anomalies and historic production; Drilling (600 m DD program) late in the year; visible gold in drill core.
Regal	Affinity Metals Corp.	Ag-Pb-Zn+/-Au; Polymetallic veins, SEDEX; 082N 004, 3, 16	Regal: 590,703 t grading 71.6 g/t Ag, 2.66% Pb, 1.26% Zn, 1.1% Cu, 0.13% Sn, 0.015% W (1982; non-compliant)	Drilling (1846 m; Regal: 10 DD holes, Allco: 11 DD holes); data compilation; 2011 ZTEM airborne geophysical survey; grab sampling (22 samples at Allco) with results up to 4420 g/t Ag, 2.27% Cu, 26.4% Zn, >20% Pb, and 5.68 g/t Au.
Silvana	Klondike Silver Corp.	Ag-Pb-Zn+/-Au; Polymetallic veins; underground; 082FNW050, 13, 082KSW006	-	Underground drilling (10 DD holes); facility upgrades; environmental monitoring; mill on care and maintenance; environmental baseline work.
Silver Dollar	Mariner Resources Corp. (Explorex Resources Ltd.)	Ag-Pb-Zn+/-Au, Cu; Polymetallic veins; 082KNW101, 127, 40, 46, 136	na	Option agreement; helicopter-borne high resolution magnetic and radiometric survey (621 line-km).
Silver Fox	Kootenay Silver Inc.	Cu-Ag; Sediment-hosted copper; 082GSW070, 72, 73	-	Drilling (6 DD holes, 3600 m); mapping, sampling; 3 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; drill results pending.
Sweet Spot	Teck Resources Ltd.	Pb-Zn-Ag+/-Au; Polymetallic vein, SEDEX; 082GSW077	na	Drilling (2 DD holes, 1371 m); mapping; sampling; re-logging historic core; petrophysics; short wave near infrared spectral analysis; initial stages of exploration identified fragmental units, alteration assemblages, and indicators of SEDEX mineralization.
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, 3.2% Zn (2013)	Data compilation; update of geological model; environmental baseline studies; permitting for 10,000 t bulk sample.
Vine	PJX Resources Inc.	Pb-Zn-Ag+/-Au; Polymetallic vein, 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 on Vine vein; non-compliant)	Drilling (12 DD holes, 4925 m); geophysical and geological modeling; drilling on magnetotelluric anomaly intersected 5.5 m zone of massive sulphide (pyrite, pyrrhotite, sphalerite).
Vulcan	Eagle Plains Resources Ltd.	Pb-Zn-Ag+/-Au; Polymetallic vein, SEDEX; 082FNE103, 101, 102, 104, 093, 160	na	Mapping, sampling, soil geochemistry, geophysical (IP and MT) survey; chip sample 1.6% Pb+Zn, and 10g/t Ag for 1.5 m.

M = Measured; I = Indicated; Inf = Inferred

geochemical anomaly, whereas the eastern anomaly coincides with historic production from the Queen mine at its northern end. Apex mapped and sampled to confirm grades from the previous work and late in the year began a 600 m drill program, which encountered visible gold (Fig. 4).



Fig. 4. Visible gold in drill core (NQ size). Photo courtesy of Apex Resources Inc.

7.1.3. Kenville (Ximen Mining Corp.)

Ximen Mining Corp. optioned the **Kenville** property in 2019. The company began surface work and the permitting process for underground work, which proposes a new decline, bulk sampling, and underground drilling. The area is mainly underlain by mafic volcanic rocks of the Eagle Creek plutonic complex (Jurassic) which may be co-magmatic with volcanic rocks of the Elise Formation (Rosslund Group). Nelson granodiorites (Late Jurassic), and Tertiary intrusive rocks are common in the immediate area. The predominant regional structural features are broad, north-trending and east-verging folds. The original past-producing **Kenville** mine, also known as the Granite-Poorman mine (Au-Ag-Pb-Zn-Cu), is classified as a gold-quartz vein deposit (Fig. 5) and consists of five north-northwest trending veins that can be traced for at least 500 m with an average thickness of 0.6 m. It was the first underground lode gold mine in British Columbia and operated intermittently between 1890 and 1954. Historic production totalled 180,740 t averaging 9.07 g/t Au and 3.96 g/t Ag. In total, the mine produced 65,236 oz of gold, 27,686 oz of silver, 51,782 lbs of lead and 33,393 lbs of zinc. Exploration of the property since 1992, includes soil sampling, airborne EM geophysics, and both surface and underground drilling to test the southern extension of the veins and to define new targets.

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

KG Exploration (Canada) Inc. (a wholly owned subsidiary of



Fig. 5. Quartz veins in the underground workings at the Kenville mine.

Kinross Gold Corporation) continued work in the Greenwood area in 2019. Kinross is targeting epithermal, skarn, and VMS mineralization in the northern extensions of the Republic and Toroda graben, on a land package optioned from Grizzly Discoveries Inc. At **Midway**, the target area is underlain by hydrothermally brecciated and intensely argillic-altered volcanic-sedimentary sequences interpreted to be part of the Marron Formation (Eocene). A silicified zone at the base of the Eocene unconformity in outcrop contains multiple narrow (to 0.5 m) chalcidonic quartz (+/-quartz breccia) veins. A soil geochemistry grid was completed on the property, and anomalies coincide with mineralization at surface. 2018 drilling (4 DD holes) encountered epithermal style mineralization with sporadic sulphides and low-grade, anomalous gold and silver in all 4 holes. Work in 2019 included detailed mapping and rock sampling at the Bruce Creek, **Midway**, and Kerr Creek areas to outline further targets for drilling in 2020.

7.1.5. 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, distributed along steeply dipping strike-slip and normal faults. The veins post-date the Nelson intrusions, 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.

GGX Gold Corp. has been drilling at the Gold Drop, Everest

and C.O.D veins since 2017. Mapping, sampling and trenching has also identified several other veins, with values of 81.8 g/t Au and 630 g/t Ag in grab sample at the Everest vein, and up to 6.98 g/t Au and 38.6 g/t Ag at the Silent Friend and Ken veins. In 2019, the company continued to drill both the C.O.D. (48 DD holes, 2248 m) and C.O.D. North veins (10 DD holes, 685 m). The company also completed an airborne magnetotelluric survey and identified additional deeper drill targets for late 2019.

7.1.6. 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. The company has been drilling the property in the past few years, with intersections including 8.5 m grading 7.10 g/t Au. Gold mineralization appears to be associated with pyrrhotite+/-arsenopyrite, which provide conductive targets that are coincident with ground geophysics magnetic anomalies. In 2018, the company expanded their magnetic grid, and obtained orthophotos using drones. In 2019, they completed a helicopter-supported drill program (4 DD holes, 250 m) to follow up on 2015 drilling, and on the western end of a magnetic anomaly. Present and historic drilling has identified at least two mineralized intervals 1 to 8.75 m thick. Highlight results from 2019 include 5.58 m grading 4.068 g/t Au, with 0.27 m grading 22.8 g/t Au.

7.2. 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.

7.2.1. Vine (PJX Resources Inc.)

The **Vine** property lies immediately north of the Moyie fault, a northeasterly trending structure, and a small north-trending graben. It 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). A 3D magnetotelluric grid completed over the East anomaly late in 2018 highlighted a conductive zone that correlates with the gravity high. In 2019, PJX drilled (12 DD holes; 4925 m) and encountered anomalous zinc, copper, lead, and silver in two holes and a 5.5 m zone of massive sulphides. The zone is in the same horizon as a historic

hole 700 m to the south that graded 5.6% Zn, 2.7% Pb and 1.2 oz/t Ag for 3.4 m. Below the sulphide zone, the drilling also encountered a zone of granofels, bearing resemblance to the SEDEX deposit model of the historic Sullivan mine where granofels are adjacent to the main vent pipe.

7.2.2. Monroe (Highway 50 Gold Corp.)

Highway 50 Gold Corp. drilled (2 DD holes, 1450 m) 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, 2010).

The company has been drilling since 2015, as a follow up on geochemical soil anomalies and geophysics. 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.

7.2.3. Silver Fox (Kootenay Silver Inc.)

Kootenay Silver Inc. continued working at the **Silver Fox** property in 2019. 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. Antofagasta plc dropped their option agreement on the property after 2018, but Kootenay Silver followed up on anomalies from sampling and ground geophysics and drilled 6 DD holes (3600 m) in 2019. Grab samples include grades up to 0.55% Cu, 14 g/t Ag, and 0.208 g/t Au.

7.2.4. Sweet Spot (Teck Resources Ltd.)

Teck Resources Ltd. continued work at the **Sweet Spot** property in 2019. 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.

Cook (2017) indicated that magnetotellurics could highlight conductive subsurface horizons, providing another tool for SEDEX targeting.

In the last several years, the company has re-logged core, mapped, and sampled and identified target areas. They conducted additional geophysical work, including magnetotelluric studies to delineate targets, and in 2019 they drilled (2 DD holes, 1371 m). They also continued mapping, conducted petrophysical studies, and used short wave near infrared spectral analysis tools in their work.

7.2.5. Vulcan (Eagle Plains Resources Ltd.)

Eagle Plains Resources Ltd. continued work on their **Vulcan** property in 2019. The property is underlain by argillites and quartzites in the lower and middle parts of the Aldridge Formation, and hosts numerous showings. A high-resolution VTEM airborne geophysical survey was flown in 2005, and several anomalies were defined. Historic drilling (Cominco, 1985) reported pyrite/pyrrhotite laminations and “pervasive albite-tourmaline alteration and fracture/vein-controlled Pb/Zn mineralization”. The company compiled the data, mapped, sampled and completed soil geochemistry on the property to further constrain targets. A chip sample from the main mineral occurrence (Hilo 3; MINFILE 082FNE103) returned 1.6% Pb+Zn and 10 g/t Ag along 1.5 m. In 2019, the company completed a ground IP and scalar magnetotelluric survey along approximately 3.0 line-kilometres.

7.2.6. Bull River mine, Empire Strathcona, and Rex (Braveheart Resources Inc.)

Braveheart Resources Inc. purchased the **Bull River mine** in 2019, which has been on care and maintenance since 2009. The property is in fault-bounded blocks of the Aldridge Formation. Cu-Ag mineralization is in a network of east-trending, near-vertical, sulphide-bearing quartz-carbonate veins, in sheared and brecciated host rocks. The main vein structure and stringer zones range from a few cm to 30 m wide. Mineralization occurs as pyrite, pyrrhotite, and chalcopyrite, with minor galena, sphalerite, arsenopyrite, cobaltite, and traces of tetrahedrite and native gold. The historic Dalton mine operated between 1971 and 1974, and produced 7260 t of Cu, 6354 kg of Ag, and 126 kg of Au from 471,900 t milled (MINFILE) from open pits. The property has existing infrastructure, including a 750 tpd conventional mill, assay and metallurgical laboratories, tailings impoundment, waste dumps, and two open pits. Currently stockpiled on surface are 165 kt grading 1.7% CuEq. In 2019, the company completed condemnation drilling (6 DD holes, 618 m) on the mine property for planning purposes and environmental baseline work. In addition, they completed exploration drilling at the **Empire-Strathcona** (14 DD holes, 1389 m) and **Rex** properties (11 DD holes, 1697 m), which are to the southeast of the main mine property. Currently updating their major mines permit and working towards restart, the company plans to use the mill to process ore from their Alpine property.

7.2.7. 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 Thor property is underlain by a thick succession of folded and faulted sedimentary and volcanic rocks of the Badshot Formation and Lardeau Group. Parallel horizons of massive and disseminated galena, chalcopyrite, pyrite, and sphalerite (Ag-Pb-Zn-Au-Cu) 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 2019, the company obtained a collection of maps, cross-sections, and logs from Granby Consolidated Mining, Smelting and Power Company Ltd. for the underground workings at the True Fissure and Blue Bell mines. The files were for work conducted between 1930 and 1970. They compiled the data into their geologic model, and re-mapped and re-interpreted host structures to better understand the controls on mineralization and identify new targets. They also continued environmental baseline work for a 10,000 t bulk sample permit and a drill permit application at the Ridge target.

7.2.8. 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 veins, and as replacement in Slocan Group limestones. Klondike’s holdings include 68 past producers, such as the Sandon, Hewitt, Silverton Creek, Cody Creek, Payne, and Jackson Basin camps, and the Silvana, Wonderful and Hinckley. 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). Data compilation and 3D modeling of the past-producers in the Sandon camp suggests mineralized potential between the mined zones of the historic producers, offset by late-stage post-mineral faulting.

In 2017, the company began rehabilitating the 4625-foot portal at **Silvana**, and began drifting (80 m). In 2019, they began underground drilling (10 DD holes; Fig. 6) to test unmined zones and encountered sphalerite and galena in every hole. 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



Fig. 6. Underground drilling at the Silvana project.

mill at Sandon is a 100 tpd flotation mill that operated at an average rate of 40 tpd and has been on care and maintenance since 2003.

7.2.9. Duncan (Rokmaster Resources Corp.)

The **Duncan** property has been intermittently explored since the 1950s. The property is 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 bodies, on the east limb of the Duncan anticline.

Rokmaster previously compiled historic data and resampled historic drill core. Results include 7.5 m grading 6.2% Zn + 6.3% Pb, 4.8 m grading 11.4% Zn + 0.8% Pb, and 6.9 m grading 7.1% Zn + 4.6% Pb. New forestry cutblocks on the property in 2019 exposed additional outcrops, and additional mapping, soil geochemistry, and rock sampling was done. The company also conducted environmental baseline work, and drill permits were received late in the year.

7.2.10. Regal, Allco (Affinity Metals Corp.)

Affinity Metals Corp. has been working on the **Allco** and **Regal** properties, which are underlain by lower Paleozoic quartzites, argillites, and limestones of the Badshot Formation and Lardeau Group. Galena, sphalerite, chalcopyrite, tetrahedrite, and pyrite are in numerous showings as stratiform bodies, replacements, and veins. The **Regal** property hosts several past producing mines including Regal, Allco and Snowflake, which operated intermittently between 1936 and 1953, following vein structures. Reported reserves (1982;

non-compliant) were 590,703 t grading 71.6 g/t Ag, 2.66% Pb, 1.26% Zn, 1.1% Cu, 0.13% Sn and 0.015% W (MINFILE). A minor amount of ore was shipped between 1934 and 1937.

In 2011, Northaven Resources Corp. completed 1354 line-km of airborne geophysical work over the area and identified linear magnetic and conductive anomalies that are coincident with historic MINFILE showings. In 2018, Affinity Metals Corp. optioned the property, compiled historic data, and did additional mapping. At the **Allco** property, 22 grab samples assayed up to 4420 g/t Ag, 2.27% Cu, 26.4% Zn, >20% Pb, and 5.68 g/t Au. Further interpretation was done on the 2011 geophysical survey, and helicopter-supported drilling was completed late in 2019 at **Allco** (10 DD holes), and **Regal** (11 DD holes).

7.2.11. Silver Dollar (Mariner Resources Corp.)

In 2018, Mariner Resources Corp. entered into an option agreement on the **Silver Dollar** property, with Explorex Resources Ltd. They can earn 75% by fulfilling the terms of the option agreement over a four-year period. The property is in the historic silver-lead-zinc Beaton-Camborne camp along a 40-km long mineralized zone that contains numerous past producers along the Camborne fault. The rocks are folded and faulted metasedimentary rocks of the Lardeau Group (Broadview and Jowett formations; lower Paleozoic). Argentiferous tetrahedrite, pyrite, galena, and sphalerite occur in mineralized veins and shear zones, along with lesser chalcopyrite, pyrrhotite, and minor amounts of gold. Drilling in 1984 returned 2.1 m grading 229 g/t Ag, 1.0 g/t Au, 10.95% Zn, 4.04% Pb, and 0.29% Cu. Chip sampling completed by Happy Creek Minerals in 2013 included 1.8 m grading 16.8% Zn, 3.9% Pb, 1.67 g/t Au and 241 g/t Ag. Soil geochemistry completed in 2018 defined an anomaly 1.4 km long and 350 m wide with elevated silver, lead, zinc, and antimony. Late in 2019, Mariner Resources Corp. completed a helicopter-borne high-resolution magnetic and radiometric survey over the property to delineate the Camborne fault zone.

7.3. 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.

7.3.1. Gibraltar (MGX Minerals Inc.)

In 2019, MGX Minerals Inc. continued to explore their silica projects. At the **Gibraltar** property, Mount Wilson Formation quartzite (Upper Ordovician) was quarried for a short time in 1967 (Red Cloud quarry; MINFILE). The only recorded production was a small trial shipment, which assayed 98.56% SiO₂. 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% SiO₂, and began an eight-hole drill program late in the year. In 2019, they drilled (5 DD holes, 200 m) to follow up on their 2018 work.

7.4. Selected coal projects

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

7.4.1. 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.

7.4.2. Elko (Pacific American Coal Limited)

Pacific American Coal Limited released results of their 2018 drilling, and continued work on their **Elko** project. The company began working on the project in 2015 and compiled all 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 First Nations engagement to receive permits for exploration.

In the 2018 drilling (RC and large-diameter; 3451 m), six coal seams were encountered in the Mist Mountain formation, ranging in thickness from 2.41 to 12.70 m. Geological modeling suggests that these seams are continuous across the property. Three additional seams were encountered in the overlying Elk Formation, and range in thickness from 1.77 to 2.60 m. Coal quality test results indicate seven of the nine seams are mid-volatile, low-ash coking coal. The bottom two seams are mid-volatile, semi-hard coking coal to PCI metallurgical coal, but more work needs to be conducted to determine characteristics of a blended product.

The project is in the Crowsnest coalfield, targeting Kootenay Group (Jurassic-Cretaceous) coal seams in the McEvoy syncline. Block modeling indicates potential for a small open-cut operation and a larger underground operation. In 2019, the company used 2018 drilling results to update their JORC resource estimate of 117.6 Mt Measured + 93.2 Mt Indicated + 92.3 Mt Inferred.

8. Geological research

Höy (2019) released updated maps in the Boundary region, Rioseco et al. (2019) studied the metamorphic evolution of the Purcell Anticlinorium and Kootenay Arc, and Kuppasamy and Holuszko (2019) are characterizing the Elk Valley coals for rare earth elements.

9. Summary

In 2019, exploration and mining continued in the region. Major mine development, expansion plans, and projects in

the East Kootenay coalfields continue to advance. Mineable reserves at the 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 on the project began in 2019. Exploration for SEDEX-style base metals continued in the Purcell anticlinorium, and for precious and base metals throughout the region. Several drill programs continued late into the year throughout the region because of late financing and permitting delays, and some programs were postponed until 2020.

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