Exploration and mining in the Southeast Region, British Columbia

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1. Introduction

The Southeast Region, in the southeast corner of the province (Fig. 1), offers a variety of mining and exploration opportunities accessible by well-developed infrastructure. Five operating metallurgical coal mines in the Elk Valley account for most of Canada's coal production and exports. Several mines produce industrial minerals including silica, magnesite, gypsum, graphite, and phosphate. Placer mining occurs throughout the region, and several small operations produce aggregate, sand and gravel, and dimension stone. The region also hosts the historic lead-zinc-silver Sullivan Mine, which operated from 1909 to 2001, and produced more than 7.9 Mt of zinc, 8.4 Mt of lead, and 298 Moz of silver. The Trail smelter (Teck Resources Limited) is still in operation, and produces approximately 305,000 t of refined zinc, 99,000 t of refined lead, and up to 25 Moz of silver annually.

As in 2016, 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 and Young LLP. For the Southeast Region, exploration expenditures were estimated at $43.4 million and exploration drilling was estimated at approximately 69,450 m (Clarke et al., 2018; Ernst & Young LLP, in press).

2. Geological overview

The Canadian Cordillera has long been of interest to the exploration industry for the mineral resources it contains. It has witnessed a history spanning more than 1.8 billion years during which time diverse plate tectonic and metallogenetic processes generated the equally diverse deposit types that contribute to the mineral endowment of British Columbia (Nelson et al., 2013).

The Southeast Region (Figs. 1, 2) contains autochthonous and parautochthonous 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 Quesnellia and its basement (Okanagan subterrane), which are entirely exotic to North America (Nelson and Colpron, 2007; Nelson et al., 2013). By mid-Jurassic, the emerging Canadian Cordillera had been transformed from a set of loosely connected arc and pericratonic terranes, to a progressively thickening and complexly structured accretionary wedge. Some magmatic rocks (Fig. 3) 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, Cretaceous, and Cenozoic), are related to subduction, crustal thickening, and post-orogenic 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 five mines in the Elk Valley, and continues to be an important source of industrial minerals such as gypsum, magnesite, silica sand, phosphate, mineral wool, dolomite, limestone, graphite, flagstone, railroad ballast, rip rap, smelter slag and aggregate (Fig. 1).

3.1. Metal mines

In 2017, no metal mines operated in the Southeast Region.

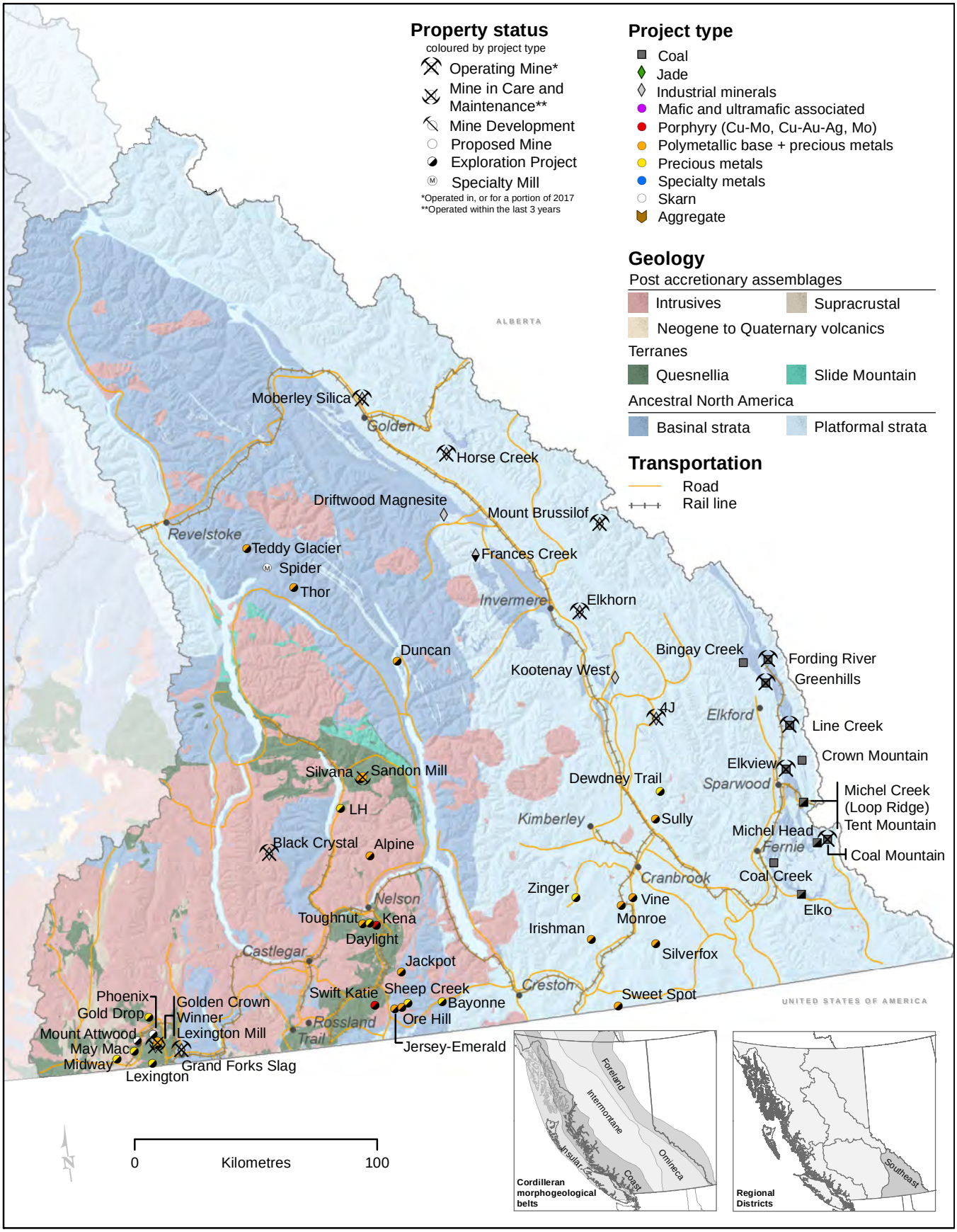

Fig. 1. Mines and selected exploration projects, Southeast Region, 2017. Terranes from Cui et al. (2017).

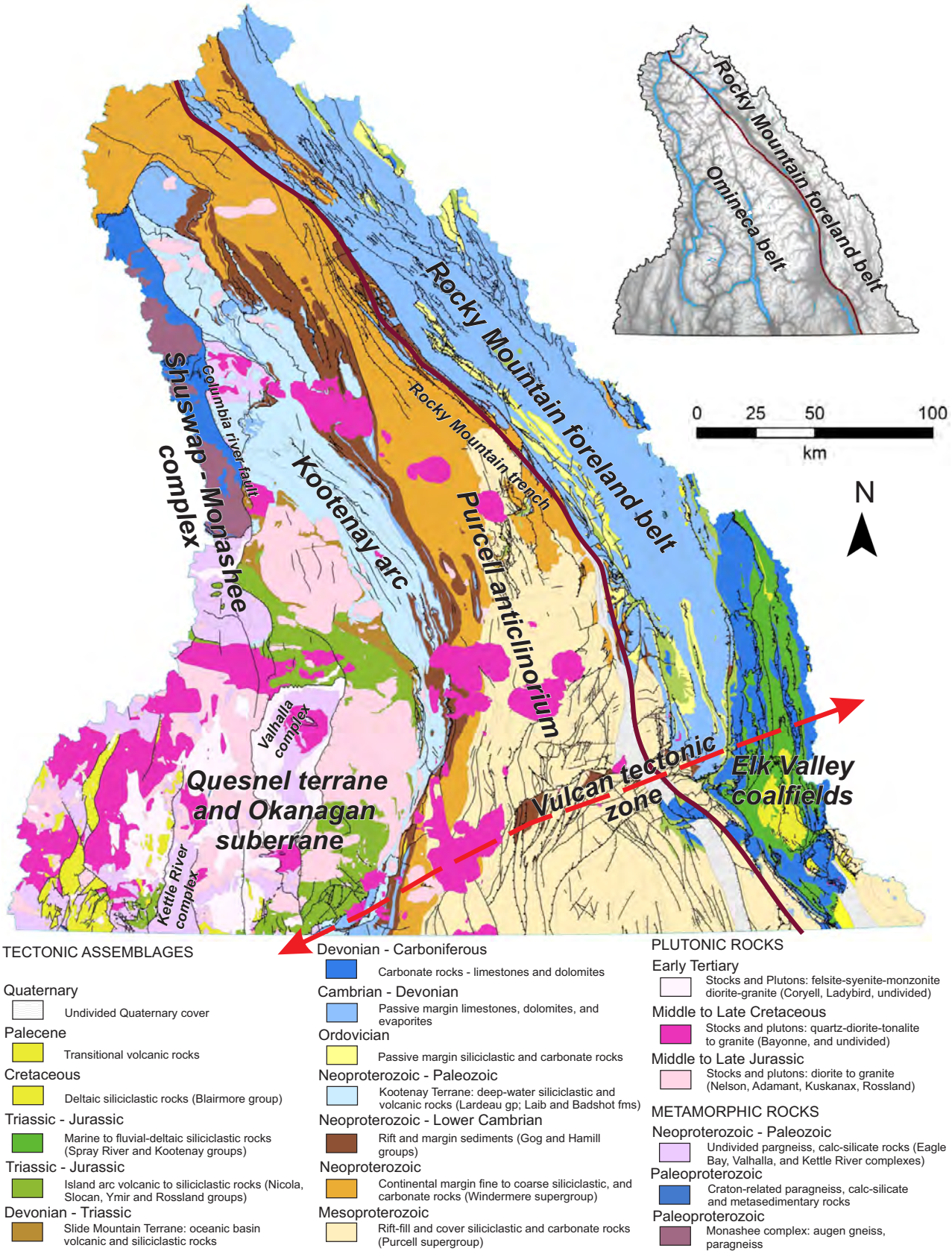

Fig. 2. Geology and physiographic belts of the Southeast Region. Physiographic belts after Nelson et al. (2013). Bedrock units are after Wheeler and McFeely (1991) and Cui et al. (2013) and generalized to highlight temporal and lithological differences in the region. Vulcan tectonic zone is after McMechan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

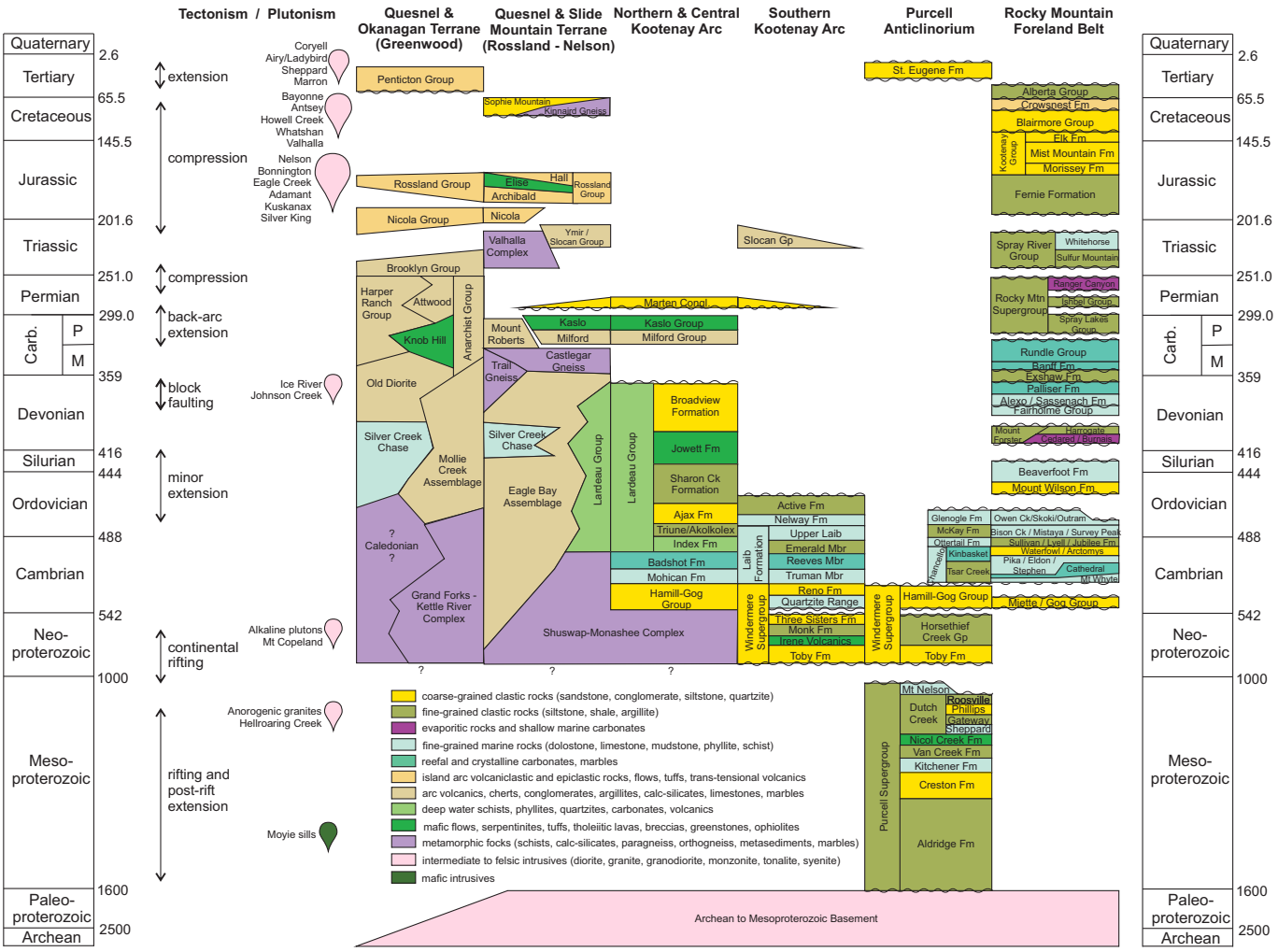

Fig. 3. Generalized stratigraphy Southeast Region. Tectono-stratigraphic events modified from Nelson et al. (2013). Selected stratigraphy and approximate ages derived from Fyles (1967, 1990), Norford (1981), Stott (1984), Monger et al. (1991), Warren and Price (1992), Grieve (1993), Sevigny and Parrish (1993), Höy and Dunne (1997), Logan (2002), Colpron and Nelson (2009), Hein and McMechan (2012), McMechan (2012), Poulton et al. (2012), Price (2012), and Slind et al. (2014). Geological timescale from Walker and Geissman (2009).

3.2. Coal mines

Southeastern British Columbia has a long history of coal mining that dates back to the 1800s, with reports of coal discovered in the Elk Valley around 1845. Today, Teck Coal Limited operates five large open-pit mines in the Elk Valley area (Table 1; Figs. 1, 4), from coal seams in the Mist Mountain Formation (Jurassic; Fig. 3). The main product is metallurgical coal (85%), with some thermal and pulverized coal injection (PCI) coal (15% combined). Teck Coal Limited's mines in the Southeast Region account for more than 70% of Canada's annual coal exports.

Coal prices continued to recover from lows in 2015-2016, and remain strong in 2017. Teck's 2017 Q3 report forecasted a quarterly benchmark price of $185 USD/tonne, which is up from an annual average of $93 USD/tonne in 2015, and the low of $81 USD/tonne in Q1 2016. The coal mines in the Southeast Region remained open during the 2015-2016 down turn by reducing costs and optimizing processes. In the latter half of 2016, Teck ramped up production in response to a rapid commodity price increase in November 2016, when coal peaked briefly around $300USD/tonne. Record production levels were achieved in late 2016, and continued into 2017, with Q1 realized prices of $285 USD/tonne (Teck, 2017a, b).

In 2017, total annual production from the mines in the Southeast Region was approximately 28 Mt of clean metallurgical coal. Approximately 95% of sales are transported by rail and shipped westward to Asia (75%), and to other international customers (20%), while approximately 5% is shipped via rail eastward through Thunder Bay (with a small amount through Coutts, Alberta), to North American customers (Teck, 2017a).

In recent years, environmental assessment approval of major mine projects in the Elk Valley has been conditional on developing a regional watershed management plan. In November, 2014, Teck received approval from the British

Table 1. Coal mines, Southeast Region.

Mine	Operator; Partner	Commodity	Forecast 2017 Production (based on Q1-Q3)	Reserves (as of December 31, 2016)	Resource (as of December 31, 2016)	Comments
Fording River	**Teck Coal Limited (100%)**	HCC	9.1 Mt	**HCC** P: 169 Mt, Pr: 220.5 Mt	**HCC** M: 486.7 Mt, I: 945.8 Mt, Inf: 789 Mt	EA approval of Swift expansion (2015); permit amendments to align mine design with improved efficiencies; exploration drilling in active pits; coal quality testing in expansion areas.
Greenhills	**Teck Coal Limited (80%)**; POSCAN (20%)	HCC	6.2 Mt	**HCC** P: 25.4 Mt, Pr: 147.9 Mt	**HCC** M: 220.1 Mt, I: 269.5 Mt, Inf: 182.6 Mt	Cougar Pit Expansion (CPX) approved in 2016; coal quality testing.
Line Creek	**Teck Coal Limited (100%)**	HCC, TC	3.7 Mt	**HCC** P: 3 Mt, Pr: 61.7 Mt **TC** P: 1.2 Mt, Pr: 9.5 Mt	**HCC** M: 320.6 Mt, I: 419.4 Mt, Inf:: 413.4 Mt **TC** M: 4.8 Mt, I: 4 Mt, Inf: 2.7 Mt	Burnt Ridge Extension (BRX) approved in 2016; pre-stripping on Mount Michael begun (Line Creek Phase II expansion); Commissioning of West Line Creek water treatment facility (February, 2016), with process and design optimization underway; Annual production records set in 2016.
Elkview	**Teck Coal Limited (95%);** Nippon Steel & Sumitomo Metal Corp. (2.5%), POSCO (2.5%)	HCC	6.3 Mt	**HCC** P: 11.2 Mt, Pr: 254.8 Mt	**HCC** M: 432.5 Mt, I: 157.5 Mt, Inf: 246 Mt	Baldy Ridge Extension (BRE) approved in 2016; pre-stripping at BRE; exploration drilling in active pits; development progressing in new approved mining areas; Annual production records set in 2016.
Coal Mountain	**Teck Coal Limited (100%)**	PCI	2.7 Mt	**PCI** P: 2.7 Mt	M: 56.1 Mt, I: 23.1 Mt, Inf:4.9 Mt	Mineable resource at CMO is nearing depletion and expected mine shut down in early 2018; reclamation begun; facilities to be placed on Care and Maintenance; Coal Mountain Phase II (CMO2/ Marten Wheeler) would utilize facilities from CMO, but 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

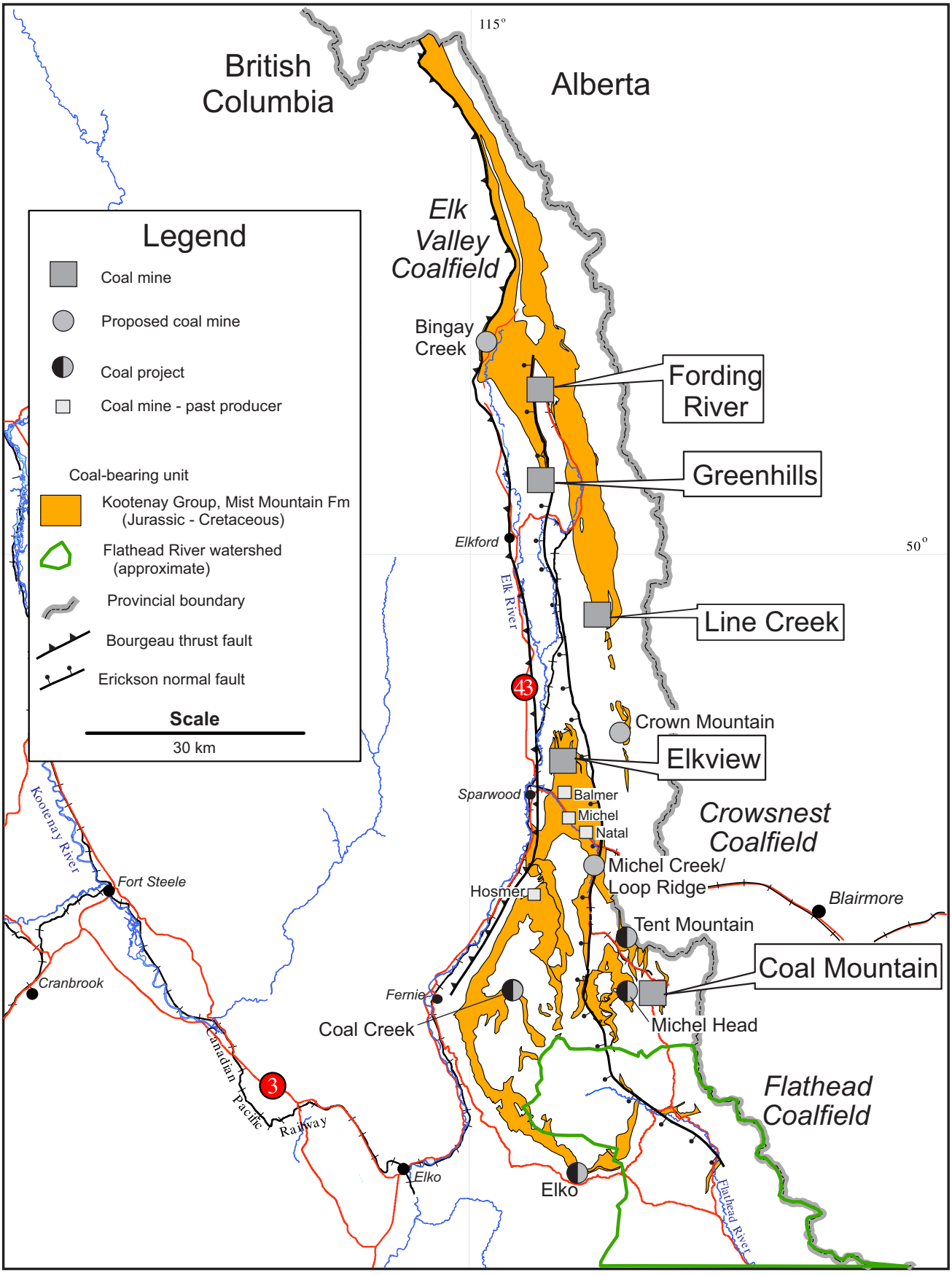

Fig. 4. Map of the Kootenay Group and East Kootenay Coalfields, including the major coal mines and projects in southeastern British Columbia.

Columbia Ministry of Environment for the Elk Valley Water Quality Plan which addresses the management of selenium and other substances released by mining activities. It is a public policy document that will guide future regulatory decisions about water quality and all mining in the Elk Valley. It includes statements about water diversion and treatment, and establishes water quality targets for selenium, nitrate, sulphate, cadmium, and calcite.

The selenium management plan was projected to cost about $600 million over five years, and $40 million to operate annually. In 2016, Teck spent approximately $40 million on mitigation measures and treatment facilities; in 2017, they estimate spending $100 million (Teck, 2017a). The West Line Creek water treatment facility (**Line Creek** mine), the first of six facilities planned for the Elk Valley has been operating since February 2016. Design and process changes since the beginning of its operation will be integrated into plans for the second water treatment facility, which will be constructed at **Fording River** (Fig. 4).

3.2.1. Fording River (Teck Coal Limited)

The **Fording River** mine (Fig. 4) 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 8.5 Mt; the preparation plant has a capacity of 9.5 Mt of clean coal. In 2017, production at **Fording River** was mainly from their Eagle Mountain pit, with a small amount of production from Lake, Swift-Lake, and Swift pits in their **Swift** expansion area (Fig. 5).

In September 2015, the **Swift** expansion received conditional environmental assessment approval, and construction and pit design has begun. Located west of the current mine area at **Fording River**, the project 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. The area is along strike and directly north of the **Greenhills** Cougar North project; eventually the two will merge and collectively become the **Swift**. Initial construction costs are approximately $88.5 million dollars and operating costs will be around $16.9 billion over the planned 25-year mine life. The open-pit project will use the existing Fording mine facilities and is expected to produce 175 Mt of clean coal. To meet specifications outlined in the Elk Valley Watershed Management Plan, construction of a selenium water treatment facility on site is expected to begin in 2018. The plant will incorporate design modifications that are currently being tested at the first facility that was constructed at **Line Creek**.

Fig. 5. Truck and shovel operations in the Swift expansion area.

Large diameter (9 inch) coring for coal quality testing was conducted in their new pits, and also 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 52 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. 4). 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 6.2 Mt of clean coal. Production is mainly from the Cougar pit area, and Proven and Probable reserves are projected to support another 39 years of mining at the current planned production rate.

The **Cougar Pit Extension (CPX)** project (Fig. 4) is the expansion area for Greenhills Operations and was approved in 2016. It lies immediately north of the existing operations, and has similar coal characteristics. At full development, the **CPX** project will merge with the Fording River **Swift** expansion. Drilling in 2017 focused mainly on active pits in order to determine seam thickness and structure, update the mine model, and improve coal quality definition. Large diameter (9 inch) core was also used to obtain bulk samples for coal quality and coke testing.

3.2.3. Line Creek (Teck Coal Limited)

The **Line Creek** mine (Fig. 4) 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** 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 2017, production was mainly from their Burnt Ridge extension (BRX), North Line Creek extension (NLX), and Mine Services extension (MLX) pits. Pre-stripping also began on Mount Michael in late Q2, in preparation for the next phases of mining. Exploration drilling focused mainly in active pits to design new reserve shells, and update geological modeling. Further exploration drilling is also planned on their Saddle Ridge area. Proven and Probable reserves at Line Creek are projected to support mining at planned production rates for a further 19 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 in 2017 focused on implementing design changes and adding an additional treatment process into the circuit, to mitigate an issue with selenium compounds found in the effluent. The effectiveness of these design changes is being monitored, and may delay the construction of the second facility at **Fording River**.

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

The **Elkview** mine (Figs. 4, 6) 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 both the mine and preparation plant are approximately 7.0 Mt of clean coal. Record production was achieved at the mine in 2016, with a total of 7.2 Mt of clean coal mined, and production in 2017 is forecasted at 6.2 Mt. Teck estimates a remaining reserve life of approximately 41 years at the current production rate. Production is derived primarily from the Baldy Ridge and Natal Ridge pit areas.

The **Baldy Ridge Extension (BRE)** received an Environmental Assessment Certificate in September 2016, and the company began pre-stripping in 2017. 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. New dump and tailings facility expansions are also included in the plan. Capital cost estimates for the project have been reduced from $600 million (over 5 years) to approximately $60 million, primarily by re-sequencing the mine plan to defer movement of critical site infrastructure to later in the mine life. The **BRE** expansion, expected to be brought on stream by 2018, will maintain production at Elkview at about 6.8 Mt per year, extending the mine life by approximately 25 years.

In 2017, mining occurred mainly in Baldy Ridge (BR1, BR2, and BR6), and in Natal (NP1 and NP2) pits. Drilling continued in active pits, and in their NP3 area for highwall design purposes. Exploration drilling for 2018 is currently being planned outside of the current permitted mine, for geological modeling and coal quality testing of future expansion areas.

3.2.5. Coal Mountain (Teck Coal Limited)

Coal Mountain (Figs. 4, 7) 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. Large-scale, open-pit mining didn't begin until 1970s, when large-scale equipment and hydraulic shovels were brought to the area. In 2004, the five Elk Valley mines consolidated into the Elk Valley Partnership and, in 2008, Teck Coal Limited acquired the majority of this partnership and began operating the mines.

The **Coal Mountain** mine is now nearing the end of its reserve life, and is expected to shut down in early 2018. **Coal Mountain Phase II (Marten Wheeler)** was designed to replace production after the resource at **Coal Mountain** is depleted, but the project was suspended in 2015 because of market conditions. With recently approved expansion areas at

Fig. 6. Dipping Mist Mountain Formation coal seams at the Elkview mine.

Fig. 7. Coal Mountain mine.

the other four operational mines in the Elk Valley, Teck Coal Limited intends to optimize and expand production and facility capacity at their other metallurgical coal mines to replace about 2.25 Mt of lost production.

Reclamation of the mine is well underway on the final lifts of the dry stacked tailings facility, and waste dump spoils, and will continue in 2018. With the possibility of **Coal Mountain Phase II** coming online, the current preparation plant and facilities at **Coal Mountain** (with an annual capacity of approximately 3.5 Mt) will be maintained operational, but on care and maintenance.

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 steeply dipping strata are easily mined. A variety of smaller mines and quarries exist throughout the region; graphite is mined from rocks of the metamorphic core complexes (Fig. 2; 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** (Fig. 8). The deposit was discovered in 1966, and the mine has been in production since 1982. The Mount Brussilof deposit is in Cambrian carbonate rocks of the Cathedral Formation (Fig. 3) that were originally deposited on the edge of the Cathedral escarpment, at the continental shelf edge. The deposit 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 pyrite) at the mine, suggests that hydrothermal fluid flow along fault structures of the Cathedral escarpment was episodic.

Sulphides (mainly pyrite) 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.

Fig. 8. Mount Brussilof mine.

3.3.2. Moberly Silica (Northern Silica Corporation)

In 2017, Northern Silica Corporation purchased the **Moberly Silica** operation from Heemskirk Canada Limited. The silica deposit is in regionally extensive orthoquartzites of the Mount Wilson Formation (middle to upper Ordovician; Fig. 3). 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. At Moberly, the unit is nearly vertical, about 200 m thick, extends along an 800 m strike length, and is de-cemented and friable. The deposit was mined from the early 1980s to 2008 for silica sand, glass making, and other 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. Phase I of the $25 million USD project began in 2015 and included redeveloping the current silica operations, redesigning and upgrading the haul roads, and constructing a new 300,000 tpy frac sand processing plant. The plant was commissioned in 2017, and the company resumed quarry operations and began processing saleable product. The plant has the potential for expansion to a 600,000 tpy capacity.

3.3.3. Horse Creek Silica (HiTest Sand Inc.)

At the **Horse Creek Silica** mine, HiTest Sand Inc. operates a seasonal quarry in Mount Wilson orthoquartzites (Fig. 3), producing a variety of industrial use and aggregate products. The Mount Wilson orthoquartzites are more consolidated than at Moberly. The company is also evaluating processes for the production of alternate products, including silicon metal.

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; Figs. 3, 9) were deposited in a restricted, shallow-marine embayment during the Middle Devonian, and later thrust upwards during the Mesozoic. Steeply dipping, mineable sections are 30 to 180 m thick (Butrenchuk, 1991). The **Elkhorn** mine, nearing the end of its reserve life, is expected to continue production for another 3 years. The company plans to replace gypsum production after mine closure with their new **Kootenay West** mine, which is currently under environmental assessment review.

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; Fig. 3). The company has been re-evaluating their mine design

Table 2. Selected industrial mineral mines and quarries, Southeast Region.

Mine	Operator	Commodity; deposit type; MINFILE	Forecast 2017 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	**Northern Silica Corporation**	Silica; industrial use silica, frac sand; 082N 001	78,000 t	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): 37.5 Mt at 70% frac sand + 11.3 Mt silica as frac sand residues (2016)	US $25M capital cost for Phase I plant construction and upgrades to existing facility (for frac sand operation); 300,000 tpy capacity; Phase II expansion to 600,000 tpy will cost an additional US $15M; Construction started on frac sand processing plant in 2015, commissioned in 2017.
Horse Creek Silica	**HiTest Sand Inc.**	Silica; industrial use, aggregate; 082N 043	na	na	Estimated: 3 Mt at 99.5% Silica (1987)	Variety of aggregate and industrial use products.
Elkhorn	**CertainTeed Gypsum Canada Inc.**	Gypsum; evaporitic bedded gypsum; 082JSW021	400,000 t	na	na	3 years mine-life remaining; the company will replace production by developing the Kootenay West mine (EA review period).
4J	**Georgia-Pacific Canada Limited**	Gypsum; evaporitic bedded gypsum; 082JSW009	na; Processing stockpiled ore	na	Estimated: 20 Mt	Processing stockpiles; updating mine expansion plans.
Black Crystal	**Eagle Graphite Corp.**	Graphite; metamorphic hosted flake graphite; 082FNW260, 082FNW283	na; Quarry on Care and Maintenance; company focused on process optimization	na	Regolith: M+I: 0.648 Mt at 1.83% fixed carbon; Calc-silicate: I: 4.765 Mt at 1.21% fixed carbon	Process optimization at plant; produced sample of 99.995% pure spheronized graphite from flake graphite; product suitable for Li-Ion battery specifications; research and development.
Winner; Friday Quarry	**Roxul Inc.**	Gabbro/basalt; crushed rock for mineral wool; 082ESE265	Quarrying to supply feed stock for mineral wool plant	na	na	Crushing, screening, stockpiling; environmental.
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.

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

Fig. 9. Bedded gypsum (dark layers) with interbedded mudstone (light) in the middle part of the Burnais Formation (Devonian).

for the next stages of pit expansion as they wait for commodity prices to improve, and producing mainly from stockpiled material for use in agricultural.

3.3.6. Black Crystal (Eagle Graphite Corp.)

Eagle Graphite Corp. operates the **Black Crystal** flake graphite operation where graphite ore is mined from the open-pit quarry on Hodder Creek and processed at a pilot 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. The graphitic horizon is 80 to 100 m thick. Carbon grades up to 6.95% in two zones: a 'hard rock' zone, and an overlying regolith zone. Most of the deposit, especially the regolith zone, is friable and blasting is not required. Sand and aggregate are produced as by-products during the mining and refining process. In 2017, the open-pit quarry was on care and maintenance, and efforts were focused on a research partnership with Queen's University to produce multi-layered graphene.

3.3.7. Winner and Friday quarries (Roxul Inc.)

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 Roxul 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.

3.3.8. 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 2017, 62 placer projects currently have active Mines Act permits that allow mechanized work, consisting of more than simple hand panning.

5. Mine development

With the exception of the coal mine expansion projects that are currently in construction phases (see above) no new mine development projects are under construction.

6. Proposed mines and quarries

The Southeast Region has four proposed coal mines (Table 3): **Michel Creek/Loop Ridge** (North Coal Limited, formerly CanAus Coal Limited), **Crown Mountain** (NWP Coal Canada Ltd.), **Coal Mountain Phase II** (on hold; Teck Coal Limited), and **Bingay Main** (Centermount Coal Ltd.). In addition, it has two proposed industrial mineral projects: **Kootenay West** (CertainTeed Gypsum Canada Inc.), and **Driftwood Magnesite** (MGX Minerals Inc.).

6.1. Proposed metal mines

There are currently no proposed metal mines in the region.

6.2. Proposed coal mines

6.2.1. Michel Creek/Loop Ridge (North Coal Limited, formerly CanAus Coal Limited)

In October 2015, North Coal Limited, a wholly owned subsidiary of CoalMont Pty Ltd., entered the pre-application phase of environmental assessment for their **Michel Creek** project. The project consists of licenses at **Loop Ridge, Loop South, Tent Mountain,** and **Michel Head** (Fig. 4). The company is focused optimizing all coal deposits for development and will be issuing an amended application in 2018. The company entered pre-application of environmental assessment in 2015. In 2017, work included testing for waste rock and developing water management strategies, and working on an updated project description. The project will use new techniques for managing waste rock to mitigate selenium, and ensure that targets identified in the Elk Valley Water Quality Plan can be met.

Exploration drilling in 2017 (8850 m; 61 holes) focused on the **Loop South** and **Tent Mountain** areas, and included 9 large diameter core holes for coking quality analysis. Results and coal quality testing from their 2016 drill program (**Loop Ridge** and **Michel Head**) were compiled and updated into 3D models for resource modeling and mine planning. Drilling identified 20 coal seams, between 5 and 20 m thick, and confirmed that coal is representative of typical Elk Valley hard coking coals

Table 3. Selected proposed mines and quarries, Southeast Region.

Project	Operator (partner)	Commodity; deposit type; MINFILE	Reserves	Resource	Comments
Michel Creek (Loop Ridge)	**North Coal Limited (formerly CanAus 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 (5212 m, 38 holes); 7 large diameter core holes for coal quality testing; environmental and baseline work; mine design; permitting; Pre-application of EA (2015); Coal quality testing indicates coal has similar characteristics to Elk Valley hard coking coal; drilling has identified 20 coal seams with cumulative thickness of 70 m (14% of a 504 m section in the Mist Mountain Fm).
Crown Mountain	**NWP Coal Canada Ltd. (Jameson Resources Limited)**	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)	Pre-application of EA (2014); nearing end of comment period for Application Information Requirements (AIR); 16-year mine life; 1.7 Mtpy; review of pre-feasibility study identified upside in lower capital costs for contract mining and additional resources in Southern Extension.
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, 082JSW020	na	North and South Quarries: Total 15 Mt (at average quality of 83-85%)	Entered 180-day review period of Environmental Assessment in March (2017); temporarily suspended the review in order to respond to comments and submit additional information; 400,000 tpy; 43-year mine life; blended product to market specifications.
Driftwood Magnesite	**MGX Minerals Inc.**	Magnesite; hydrothermal sparry magnesite; quarry; 082KNE068	na	M+I: 8.028 Mt grading 43.3% MgO (2016; using cutoff grade of 42.5% MgO)	Preliminary Economic Assessment; 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.

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

(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.

The site is considered a brownfields operation, with previous mining at the **Loop Ridge** area from the McGillvray Pit. In 1969, the Crow's Nest Pass Mining Company mined 60,000-100,000 t. A further 20,000 t was extracted in 1995 by McGillivray Mining Ltd., and then 30,000 t by Fording Coal Ltd. between 1996 and 2000. Fording dropped the asset in 2000 when it was merged into Teck Coal Limited.

6.2.2. Crown Mountain (NWP Coal Canada Ltd.)

The **Crown Mountain** property (NWP Coal Canada Ltd., a wholly owned subsidiary of Jameson Resources Limited)

is along strike with Line Creek, 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 is currently nearing the last round of comments for the application information requirements. In 2017, the company also began preliminary engineering design work, continued environmental baseline work, and worked on updating the mine plan. 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.

6.2.3. Coal Mountain Phase II (Teck Coal Limited)

At Teck Coal's **Coal Mountain Phase II** (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. 4). 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, which is scheduled to be shut down in early 2018. Facilities at **Coal Mountain** will be placed on care and maintenance, but maintained in a ready to operate state.

6.2.4. Bingay Main (Centermount Coal Ltd.)

Centermount Coal Ltd.'s Bingay Main is a proposal for an open-pit mine on the **Bingay Main** property (Fig. 4). 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.

6.3. Proposed industrial mineral mines

6.3.1. Kootenay West (CertainTeed Gypsum Canada Inc.)

CertainTeed Gypsum Canada Inc. continued to advance the proposed **Kootenay West** project. The project entered the 180-day review period of environmental assessment in March, 2017. The company temporarily suspended the review to submit additional technical information, and address comments from the Environmental Assessment Office, the Working Group, and First Nations. A decision is expected in June, 2018. The quarry would have two pits and target gypsum from a deformed hydrated evaporite layer 20-25 m thick, with beds of 75-95% gypsum in the Burnais Formation (Fig. 3). The mine would have an average production rate of 400,000 tpy, over a 43-year mine life. The total mineral reserve is estimated at 15 Mt, and product would be blended to a product specification of 83-85% gypsum for market. Gypsum would be drilled, blasted, and crushed, then transported by truck to Exshaw, Alberta or Washington State, or by rail to Vancouver. In 2016 and 2017, the company focused on environmental work and mine design. Phase 1 construction, with estimated capital costs of $20 million, is projected for 2018.

6.3.2. Driftwood Magnesite (MGX Minerals Inc.)

At the **Driftwood Magnesite** property, cliff-forming, steeply dipping beds of sparry magnesite (Fig. 10) are interlayered with dolostones and dolomitic limestones of the Mount Nelson Formation (Proterozoic; Fig. 3). The deposit is 100 to 300 m in width, to a depth of approximately 110 m, and has been traced along strike for 2000 m. In recent years, the company drilled and resampled both the East and West zones of the deposit. In 2016, they took a 100 tonne bulk sample from a zone near surface (up to 15 m depth). They released a NI 43-101 compliant resource estimate in September, 2016 with updated results from their 2014 and 2015 drill programs, and drilled additional holes in the fall of 2016 to test the depth and extend the known mineralization. They also acquired a pilot test mill, including a jaw crusher, ball mill, floatation cells, cyclone dewatering equipment, and tailings filtration system. The mill was used to process the bulk sample material to a high-purity magnesite ($MgCO_3$), and a silica by-product using reverse flotation techniques. In 2017, the company focused work on a preliminary economic assessment and continued environmental baseline studies for their quarry application.

Magnesium is a non-metallic alkaline earth metal that is 75% lighter than steel and 33% lighter than aluminum, with comparable strength-to-weight ratios. Magnesium oxide (MgO)

Fig. 10. Sparry magnesite at the Driftwood Magnesite project.

is also used to produce fire-retardant wallboard, fertilizer, and animal feed; and used for environmental water treatment and as a refractory material in the steel industry.

7. Selected exploration activities and highlights

Exploration continued in the Southeast Region in 2017 for a variety of targets, including base and precious metals, industrial minerals, and coal (Fig. 1; Table 4).

7.1. Selected precious metal projects

Dating back to the 1880s, exploration for precious metals is ongoing 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). In the West Kootenays and Boundary regions, precious metal exploration is also ongoing for vein (epithermal and mesothermal), porphyry, and skarn systems. Precious metals are explored for throughout the region.

7.1.1. Dewdney Trail (PJX Resources Inc.)

PJX Resources Inc. identified a new target area at their **Dewdney Trail** property in 2016, and continued mapping and sampling in 2017. The target is upstream from current and historic placer mining in the Wildhorse Valley. Heavy mineral stream samples collected from two previously unexplored drainage areas contained sharply angular visible gold. The company reported that scanning electron microprobe analysis found the grains to be fairly consistent in chemical composition, with gold as the major element followed by silver and trace quantities of copper and iron, suggesting a single bedrock source. In addition, the chemistry of sample residue material suggests that the gold 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, cut by Cretaceous, and possibly Tertiary, felsic to mafic intrusions (Fig. 3). 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. Past exploration efforts included prospecting, soil geochemistry, rock sampling, VLF-EM ground magnetic surveys, ground IP surveys, airborne geophysics, hand trenching, and diamond drilling. The best sample to date was collected from a 4 to 5 m wide altered syenite dike, which returned 1953 g/t Au. Other rock samples have yielded up to 18 g/t Au.

7.1.2. Zinger (PJX Resources Inc.)

In 2017, PJX Resources Inc. continued exploration on their **Zinger** property, where grab samples from multiple quartz veins have returned anomalous assays for gold. The quartz veins occur along a six to eight km trend, and are coincident with geophysical anomalies. The property is adjacent to the Perry Creek fault, and hosts gold mineralization in multiple NW-trending folds, veins, and shear zones. Host rocks are the Purcell Supergroup (Proterozoic; Fig. 3), predominantly metasedimentary quartzites, argillites, and siltstones of the Creston Formation, argillites of the Kitchener Formation, and gabbro sills and dikes. Quartz veins form stockworks and stringers with iron carbonate, sericite, and minor sulphides. Sulphide mineralization is mainly pyrite (weathered to limonite near the surface), galena, and chalcopyrite. Historic drilling intersected near-surface gold mineralization including 2.9 g/t Au over 2 m, within a broader interval of 0.50 g/t Au over 22.38 m. Soil sampling was carried out in 2016 on two grids. The eastern grid identified an anomaly approximately 100 m wide and more than 300 m long with gold in soil values ranging from 0.1 g/t to 4.94 g/t. Samples taken on the west grid returned anomalous gold values up to 0.743 g/t. Heavy mineral separation of soil samples discovered hackly gold grains that the company interpreted to be near their bedrock source (within 50 to 400 m). Further VLF and VTEM geophysical work in 2017 outlined dipping conductors that coincide with these soil anomalies at surface. The anomalous soil geochemical results and geophysical responses also coincide with the regional NW trend of folds and faults mapped on surface. The company plans follow-up work that includes both trenching and drilling.

7.1.3. Bayonne (Margaux Resources Ltd.)

Margaux Resources Ltd. began work on their **Bayonne** property in 2017 with mapping, rock sampling, and LiDAR. The Bayonne 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 limestones of the Horsethief Creek Group (Fig. 3). 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 (e.g., Fig. 11), focusing mainly on the areas between the Main vein, which extends for approximately 950 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, 46.6 g/t Au and 41.1 g/t Au from the Maggie Aikens vein, along with anomalous silver, zinc, lead and tungsten values. The company drill tested three main targets on the property (2089 m, 13 DDH), to test below the limits of historic mining, and previous undrilled areas. Results include 1.85 m grading 15.31 g/t Au, 1.0 m grading 12.7 g/t Au, and 0.32 m grading 18.2 g/t Au.

7.1.4. Sheep Creek and Ore Hill (Margaux Resources Ltd.)

Margaux Resources Ltd. acquired additional land under an option agreement with Yellowstone Resources, and continued further exploration for Late Jurassic orogenic gold on their

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	na	Mapping; sampling; drilling (1600 m, 11 DDH); re-sampling of historic core, includes: 1.5 m grading 11.8 g/t Au, 1.7 m grading 19.1 g/t Au, 1.4 m grading 38.0 g/t Au.
Bayonne	**Margaux Resources Ltd.**	Au+/-Ag-Pb-Zn-Cu; Au-quartz veins, polymetallic veins; 082FSE030, 031, 034, 025	na	LiDAR; mapping; grab and chip sampling; drilling (2089 m, 13 DDH); grab sample results include up to 27.5, 23.3, 18.1, 15.0 and 10.6 g/t Au, and chip sampling of 1.0 m grading 24.6 g/t from the Main vein, and grab samples of 51.6, 46.6 and 41.1 g/t Au from the Maggie Aikens vein; Drill intercepts of 1.85 m grading 15.31 g/t Au, 1.0 m grading 12.7 g/t Au, and 0.32 m grading 18.2 g/t Au.
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; resource evaluation; baseline studies; potential for an underground mine; review of the historical mine workings of Coal Creek colliery (operated from 1897 to 1958).
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; sharply angular gold grains indicate grains in stream samples near bedrock source.
Duncan	**Rokmaster Resources Corp.**	Zn-Pb-Ag; carbonate-hosted; 082KSE023, 022	na	Mapping; sampling; data compilation; re-logging historic drill core; results include 14.7 m grading 8.20% Zn+Pb, 13.4 m grading 8.00% Zn+Pb, and 12.2 m grading 8.31% Zn+Pb; drill permits received late in 2017.
Elko	**Pacific American Coal Limited**	Coal (HCC, PCI); 082GSE029	M: 19.2 Mt; I: 57 Mt; Inf: 181.3 Mt (JORC 2015)	Mine design and CAPEX study; environmental baseline studies and permitting; mapping of 5 coal seams over the property; 3 seams have hard coking coal quality, 2 seams have PCI coal.
Frances Creek	**Voyageur Minerals Ltd.**	Ag-Pb-Zn-Ba; Mississippi valley type, polymetallic vein breccia; 082KNE061	53,856 to 215,422 t grading 95.86% to 99.26% $BaSO_4$	Mapping, sampling, drilling (>1200 m, >17 DDH); drill intercepts include (true width) 36.03 m 19.47% $BaSO_4$, 11.86 m at 60.32% $BaSO_4$, 23.88 m at 27.05% $BaSO_4$, 18.7 m at 37.39% $BaSO_4$, 22.88 m at 23.94% $BaSO_4$, 14 m at 38.41% $BaSO_4$, 15.22 m at 37.65% $BaSO_4$.

Table 4. Continued.

Gold Drop/ C.O.D.	**GGX Gold Corp.**	Au; Alkalic intrusion-associated Au; 082ESE055, 150, 152, 153, 285, 286, 287	na	Rock sampling; trenching; channel sampling; drilling (27 DDH, 1449 m); option agreement with Ximen Mining Corp.; property hosts numerous low-sulphide, gold-bearing quartz veins; steeply dipping, and striking roughly northward; small scale historic production dates back to 1919. Drilling results included 0.3 m of 10.8 g/t Au, 123 g/t Ag and 16.3 m of 4.59 g/t Au, 38.64 g/t Ag.
Irishman/Panda/ Sweet Spot	**Teck Resources Limited**	Pb-Zn-Ag+/-Cu; SEDEX, polymetallic veins; 082FSE110, 082GSW077	na	Mapping, soil geochem; sampling; re-logging historic core; initial stages of exploration on the property identified fragmental units, alteration assemblages, and indicators of SEDEX-style mineralization.
Jackpot	**Margaux Resources Ltd.**	Pb-Zn-Ag+/-W, Au, Mo, Bi; stratiform replacement; 082FSW012, 013, 014, 015, 255, 256	na	LiDAR; rock and channel sampling; compilation of historical data into 3D model; drilling (1394 m, 9 DDH); mineralization exists along a 600 m strike length; grab sample results up to 30% Zn, with associated Pb, Ag, and Cd; chip sampling included 3.4 m grading 13.35% Zn, 2 m grading 15.58% Zn, and 3 m grading 8.97% Zn. Drilling results included 61.1 m grading 1.01% Zn, 49.2 m grading 1.04% Zn, 8.5 m grading 6.66% Zn, and 36.3 m grading 1.48% Zn.
Jersey-Emerald	**Margaux Resources Ltd.**	Pb-Zn-Ag+/-W, Au, Mo, Bi; stratiform replacement, skarn; 082FSW010, 009	**Emerald-Dodger** Tungsten: M+I*:* 3.071 Mt grading 0.34% WO_3, 0.028 Mt grading 0.1% Mo; Inf: 5.48 Mt grading 0.27% WO_3, 0.481 Mt grading 0.1% Mo (2006-2015) **Jersey**: I*:* 1.9 Mt grading 4.1% Zn, 1.96% Pb; Inf: 4.98 Mt grading 3.37% Zn, 1.95% Pb (2010)	Results from 2016 diamond drilling released in 2017 included 10.2 m grading 24.98 g/t Au, 0.65 m grading 68.3 g/t Au, and 0.25 m grading 59.1 g/t Au. Work in 2017, dewatering of underground workings at Emerald, rock and silt sampling, LiDAR surveys, data compilation and 3D geological modeling, re-logging of historic core, diamond drilling (1121 m in 6 holes). Drilling results included 6.1 m grading 2.61% Pb, 0.44% Zn, and 3.11 m grading 2.02% Pb, 0.48% Zn. Rock sampling from the Comet and Tungsten King showings returned results of 32.8% Zn, 1.2% Pb; and 2.69% Zn, 0.65% Pb, with elevated gold and bismuth. A 3500 kg sample of historic Emerald mine tailings was collected. A partnership agreement with CRONIMET Mining Group is in place to evaluate the economic viability to re-process historic tailings.

Table 4. Continued.

Kena-Daylight/ Toughnut	**Prize Mining Corporation (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	Mapping; soil geochem; rock sampling; ground magnetics and VLF; trenching; historical data compilation; 18 DDH (2695 m) at Kena-Daylight; 11 DDH (1730 m) at Toughnut; option agreement to acquire 80% in Kena-Daylight (Apex Resources Inc. owns 20%); option to acquire 100% in Toughnut; Rock sample results: 2.45 g/t Au, 33.4 g/t Ag; 20.6 g/t Au, 188 g/t Ag; 5.28 g/t Au, 2.85 g/t Ag; 6.25 g/t Au, 5.74 g/t Ag; 9.05 g/t Au, 8.6 g/t Ag; 5.58 g/t Au, 1.73 g/t Ag; 2.87 g/t Au, 8.59 g/t Ag; drill results pending.
LH	**Magnum Goldcorp Inc.**	Cu-Ag-Au; subvolcanic, skarn, Au-veins; 082FNW212	na	SP, magnetometer and EM surveys; drilling (ongoing late in the year); gold mineralization appears to be associated with pyrrhotite +/-arsenopyrite, providing conductive targets; identification of drill targets on ground geophysics.
May Mac/ Golden Crown/ Lexington/ Phoenix	**Golden Dawn Minerals Inc.**	Au-Ag-Pb-Zn+/-Cu; Cu-Au-Ag skarns, polymetallic veins, epithermal Au-veins, Porphyry; 082ESE041, 042, 032, 045, 020, 130, 116	**Golden Crown:** M+I: 163,000 t grading 11.09 g/t Au, 0.56% Cu (2016); **Lexington-Grenoble**: M+I: 372,000 t grading 6.4 g/t Au, 1.05% Cu (2016)	**May Mac** drilling (22 U/G DDH 3028 m; 8 surface DDH, 1886 m); **Golden Crown** drilling (31 DDH, 2954 m as of Dec. 4th); dewatering of **Lexington** underground; mapping; rock sampling; PEA released on Lexington-Golden Crown; NI 43-101 report; acquisition of Merit Mining assets in Greenwood area, including the historic Phoenix mine and surrounding claims; **May Mac** drill intercepts include 2.57 m grading 252.6 g/t Ag, 0.93 g/t Au, 9.9% Pb, 4.3% Zn, 3.71 m grading 246.0 g/t Ag, 2.69 g/t Au, 1.3% Pb, 0.9% Zn, 1.20 m grading 174.3 g/t Ag, 8.2 g/t Au, 3.7% Pb, 2.6% Zn. **Golden Crown** drill intercepts include 4.6 m grading 7.66 g/t Au, 0.13% Cu, and 7 m grading 5.14 g/t Au, 1.18% Cu; Engineering assessments of Lexington mill (C&M) suggest a cost estimates of $270,000 to put plant back in operation.
Monroe	**Highway 50 Gold Corp.**	Pb-Zn-Ag+/-Au, Cu; SEDEX; 082GSW069, 035, 041	na	Drilling (4 DDH; 4000 m) to follow up on 2015-2016 drill programs; encountered fragmentals, moderate to intense albitization; bedded pyrrhotite-sphalerite; disseminations and veinlets of sphalerite and galena.

Table 4. Continued.

Mount Attwood/ Midway	**KG Exploration (Canada) Inc.**	Au-Cu-Pb-Zn-Ag+/-Mo; Cu-Au-Ag skarn, polymetallic vein, Au-vein, porphyry; 082ESW022, 210, 034, 221	na	Drilling (1160 m; 7 DDH); detailed mapping of mineral zonation and alteration assemblages; option agreement with Grizzly Discoveries Inc. to gain 75% interest in 27,346 ha; fulfilled 2nd year agreement to drill; following up on targets identified in 2016 airborne, ground EM and magnetics, geological mapping and sampling; prospected new area.
Sheep Creek/Ore Hill	**Margaux Resources Ltd.**	Au+/-Ag, Pb, Zn; Au-quartz veins; 082FSW040, 048, 050, 051, 052, 053	na	LiDAR; mapping; soil geochem; sampling; drilling (2000 m, 6 DDH); historic Sheep Creek camp; veins are typically 10 cm to >2 m; grab samples returned up to 36.4, 21.8, and 12.8 g/t Au; other samples contained up to 1021 g/t Ag, up to 33.7% Pb, and up to13.6% Zn.; soil anomaly 450 x 100 m, averaging 2.95 g/t, with gold values of >5 g/t in 13 samples; Ore Hill rock sampling: 119 g/t Au, 105 g/t Au, 60.2 g/t Au, and 50.5 g/t Au.
Silver Fox	**Antofagasta plc (Kootenay Silver Inc.)**	Cu-Ag; Sediment-hosted copper; 082GSW070, 072, 073	na	Drilling (3000 m); mapping, sampling, ground geophysics; entered option agreement to earn 80%, with Kootenay Silver Inc.; 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.
Slocan Silver (Silvana)	**Klondike Silver Corp.**	Ag-Pb-Zn+/-Au; polymetallic veins; underground; 082FNW050, 013, 082KSW006	na	Rehabilitation of the 4625 portal at the Silvana; geological mapping, and sampling; compilation of historical data and underground workings into a 3D model; facility upgrades; environmental monitoring; mill on care and maintenance; work focused on identifying exploration targets; environmental baseline work.
Sully	**Kootenay Zinc Corp.**	Pb-Zn-Ag+/-Au; Gravity anomaly, sediment-hosted	na	Drilling (6 DDH; 1464 m); mapping; ground magnetic surveys and gravity; soil geochemistry; downhole magnetic and EM survey; geophysical modeling; mass models suggest two gravity anomalies may be stratiform sulphide mineralization in Aldridge formation; property lies at intersection of St. Mary-Boulder Creek fault and Rocky Mountain Trench fault with complex faulting on property, including overturned normal faults.

Table 4. Continued.

Swift Katie	**Valterra Resource Corporation**	Cu-Au-+/-Pb-Zn-Ag-Mo; 082FSW290, 291, 350	na	Released 2016 drill results (1954 m, 6 DDH); 2017 drilling (1392 m, 8 DDH); rock sampling; drill tested surface mineralization along a 1000 m strike length; results include 2.5 m grading 11.5 g/t Au and 6.7 g/t Ag, (including 0.8 m grading 30.9 g/t Au and 17.8 g/t Ag); and 8.6 m grading 3.1 g/t Au and 2.0 g/t Ag.
Teddy Glacier/ Spider Mine	**Jazz Resources Inc.**	Ag-Pb-Zn+/-Au; polymetallic veins; 082KNW069	Inf: 44,000 t grading 4.46 g/t Au, 7.94% Pb, 6.74% Zn (2007; non-compliant)	Bulk sample permitting; environmental baseline studies; Pb flotation concentrate with 62% Pb, 83% Au and 92% Ag; Zn flotation concentrate with 48.7% Zn; Permitting for a 5000 t bulk sample from the Teddy Glacier, to be processed at pilot mill and tailings pond at historic Spider mill.
Thor	**Taranis Resources Inc.**	Ag-Pb-Zn+/-Au; polymetallic veins and breccia, stratiform volcangenic massive sulphide; 082KNW030, 031, 060, 061	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)	VLF; trenching and channel sampling; test milling; channel sample results include 2.04 m grading 26.6 g/t Au, 1246 g/t Ag, 3.1% Pb, 4.3% Zn, and 0.55% Cu; extension of SIF gold zone; discovery of new mineralization between Great Northern and Broadview.
Vine	**PJX Resources Inc.**	Pb-Zn-Ag+/-Au; polymetallic vein, SEDEX; 082GSW050, 049, 035	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); geophysical and geological modeling; focus on East gravity anomaly; infilled gravity survey grid; detailed geophysical and geological model; drilling intersected sphalerite, as well as massive sulphide (pyrite, pyrrhotite) near Moyie fault zone.
Zinger	**PJX Resources Inc.**	Ag-Pb-Zn+/-Au; polymetallic veins; 082FSE122, 065	na	Geological mapping; 2 soil grids (East and West); East grid soil anomaly approximately 100 x 300 m, with Au ranging from 100 to 4941 ppb; hackly gold grains heavy mineral separation of soil samples suggest near bedrock source; VLF and VTEM; dipping VLF conductors coincident at surface with soil geochem anomalies.

M = Measured; I = Indicated; Inf = Inferred

Sheep Creek and **Ore Hill** properties in 2017. The company now holds 1200 ha of contiguous mineral tenure that includes 60 known veins and 34 past producers. Mineralization (pyrite with lesser amounts of pyrrhotite, chalcopyrite, galena, sphalerite and rare visible gold) is found in quartz veins along northeast trending faults that cut quartzites. 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).

The **Sheep Creek** showings are in a 7 x 1.2 km NNE-trending corridor, with veins concentrated at the crests of folds, and preferentially hosted in competent Neoproterozoic quartzite units. Veins are typically 10 cm to >2 m wide, strike ENE, and are steeply dipping to near vertical. Margaux Resources Ltd. sampled (rock and soil), conducted LiDAR, and began drilling late in the year (2000 m, 6 DDH) to test zones along strike from known veins. Drilling also tested the Kat vein (Fig. 12), which was newly discovered in Cambrian limestones (Laib Formation, Fig. 3) stratigraphically above the main quartzite host units. Surface grab samples of the Kat vein returned up to 36.4 g/t Au, with anomalous Ag, Pb, and Zn. Soil sampling also identified a 450 x 100 m anomaly, averaging 2.95 g/t, with gold values of >5 g/t in 13 samples in an area underlain by Laib limestones. At the **Ore Hill**, located at the southern end

Fig. 11. Oxidized mineralized quartz vein from the Bayonne. Photo courtesy of Margaux Resources Ltd.

Fig. 12. Mineralization at the Kat vein, Sheep Creek property. Photo courtesy of Margaux Resources Ltd.

of the Sheep Creek camp, gold veins also occur in Cambrian limestone. Rock samples returned 119 g/t Au, 105 g/t Au, 60.2 g/t Au, and 50.5 g/t Au.

7.1.5. Mount Attwood, and Midway (KG Exploration (Canada) Inc.)

KG Exploration (Canada) Inc. (a wholly owned subsidiary of Kinross Gold Corporation) continued to build on work done in 2015 and 2016 in the 27,346 ha of land optioned from Grizzly Discoveries Inc. The area is underlain by rocks of the Knob Hill and Anarchist groups (Paleozoic), Brooklyn Formation (Triassic), and Penticton Group syenites and andesites (Eocene; Fig. 3). 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. Kinross can earn a 75% interest by spending US$3 million over a five year period. The company focused on three key areas, including Tertiary rocks in the northern portion of the Toroda graben, pre-Tertiary rocks northwest of **Midway** (the 'Midway Window'), and pre-Tertiary rocks surrounding the historic Phoenix-Golden Crown-Lexington district (**Mount Attwood**), where a number of nearby geochemical anomalies with elevated Au-Ag-Bi-Sb-Hg-Mo-Te have been outlined.

In 2016, previously unrecognized epithermal quartz veins and precious metal mineralization were recognized in the **Attwood**-Overlander area, hosted in Permian limestone and siltstone of the Attwood Group (Fig. 3). Bands of sulphide mineralization in altered limestone yielded up to 9.27 g/t Au, with elevated Ag, Cu, Hg, Sb and Te. Rock grab samples from exposed epithermal veins, from 0.75 to 2 m wide, returned up to 29.8 g/t Au. Detailed mapping was conducted in 2017 to follow up on anomalies identified on airborne and ground electromagnetic and magnetic data, and to further understand vein and skarn zonation.

At **Midway**, surface sampling and mapping identified additional zones of alteration and veining. Pre-Tertiary rocks yielded a strong Au-Ag-As-Hg-Sb-Mo geochemical anomaly in the area of Ingram Creek that is spatially related to a northeast-trending structure, and potential precious metal epithermal and skarn mineralization.

Drilling in 2017 (1160 m, 4 DDH at **Attwood**, 3 DDH at **Midway**) intersected alteration and mineralized zones similar to those seen at surface in both areas. At March Creek, Bruce Creek, and Kerr Creek, stream-sediment samples were anomalous for precious metals and indicator minerals of a potential epithermal system. Triassic sediment-hosted VMS and skarn mineralization was also mapped and sampled on the Rads claim group, along the northern extension of the Republic graben.

7.1.6. May Mac, Golden Crown, Lexington, and Phoenix (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; Fig. 3); 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 focussed on acquiring and expanding their land package. In 2016, they acquired assets from Huakan International Mining Inc., including the

Lexington (Greenwood) mill, and the former **Lexington** and **Golden Crown** underground Cu-Au mines. In 2017, they acquired Kettle River Resources Ltd. from New Nadina Explorations Ltd., and an additional 11,000 ha, including the historic **Phoenix** mine, and surrounding claims and historic producers. They also signed a letter of intent to acquire the Lone Star, which is just across the border in Washington State, through the acquisition of BGP Resources Ltd..

The company has begun mapping and sampling and is compiling all historic records to evaluate and identify areas of focus. Drilling continued at the **May Mac** (polymetallic vein; Ag-Au-Pb-An-Cu; 3028 m in 22 underground DDH; 1886 m in 8 surface DDH), as a follow-up to work in 2015 and 2016. Underground and surface drilling extended the known mineralization down dip for an additional 250 m, and along strike for 215 m, and intersected multiple mineralized quartz vein zones with iron, lead, and zinc sulphides. Significant intersections include up to 1.2 m grading 174 g/t Ag, 8.2 g/t Au, 3.7% Pb, and 2.6% Zn. Historic production from the **May Mac (**1903 to 1983) is reported to be 4228 t averaging 5.35 g/t Au and 227 g/t Ag. Samples were also taken for metallurgical testing, and bulk sampling. Further underground drilling is planned for 2018. The company also drilled at the **Golden Crown** (2954 m, 31 DDH; ongoing late in the year), to test the deposit and extend zones of known mineralization. Initial results included 12.3 m grading 3.53 g/t Au, 0.11% Cu, and 7.0 m grading 5.14 g/t Au, 1.18% Cu.

Golden Dawn also began dewatering the **Lexington** mine late in the year, with plans for mapping and sampling of the underground workings. The 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. The mill (Fig. 13), which was built in 2007, is now on care and maintenance; the cost of putting the plant back in operation is estimated at $270,000.

Initial chip sampling and mapping was also conducted on the **Phoenix** group of properties, which includes several historic producers. The sampling program highlighted several gold-silver and gold-copper targets for future drilling at the Sylvester K, JD, Minnie Moore, Summit, Gilt Edge and Oro Denoro past producers and showings with several samples ranging between 8 and 25 g/t Au, and 0.1% to 0.4% Cu over intervals of 1 m.

Fig. 13. The 200 ton-per-day Lexington mill (gravity-flotation) and tailings facility. Golden Dawn Minerals Inc. has entered into a purchase agreement with Huakan International Mining Inc. to acquire both the Lexington mine and mill, as well as the nearby Golden Crown mine. Both mines are underground Cu-Au mines.

7.1.7. Gold Drop/C.O.D (GGX Gold Corp.)

GGX Gold Corp. entered and option agreement with Ximen Mining Corp. for 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 (Fig. 3). Gold-bearing veins in the area post-date the Nelson intrusives and pre-date the Coryell suite. The Gold-Drop-North Star veins are 10 cm to 2 m thick. North-trending, steeply dipping strike-slip and normal faults, and low-angle detachment faults post-date mineralization. The property hosts numerous low-sulphide, gold-bearing veins, and hundreds of metres of historic underground workings. Between 1919 and 1941, the area saw small-scale production (Gold Drop, North Star, Amandy, and Rhoderick Dhu veins).

Trenching in 2015 at the North Star and Gold Drop vein systems returned a grab sample assay of 159 g/t Au, 744 g/t Ag, 70 ppm Cu, and 1.7% Pb. Near the **C.O.D** vein, on the Tel 2 occurrence, a 1988 grab sample from a quartz vein was reported to return 20.8 g/t Au and 115.6 g/t Ag. Historically, most samples that were elevated in Au also had elevated Ag, Pb, and Cu. In 2017, GGX Gold Corp. focused mainly on the southwest portion of the property and conducted rock sampling, trenching, channel sampling, and drilling (1449 m, 27 DDH), at the **C.O.D** vein. Drilling results included 0.3 m of 10.8 g/t Au, 123 g/t Ag and 16.3 m of 4.59 g/t Au, 38.64 g/t Ag. They also undertook prospecting, soil sampling, and rock sampling near the **Gold Drop** main vein, and southwest of the historic Dentonia mine.

7.1.8. LH (Magnum Goldcorp Inc.)

In 2017, Magnum Goldcorp Inc. continued work on their **LH** property, as a follow up to their drilling and geophysical programs in 2014 and 2015. Mineralization appears to follow an east-west trending zone of fracturing, faulting, and silicification in a roof pendant of what are interpreted as Slocan Group sedimentary rocks and Rossland Group metavolcanic rocks, in granodiorites of the Nelson batholith (Fig. 3). Gold occurs 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 2017, ground geophysical surveys were conducted to

expand their survey grid. One magnetic anomaly coincides with the surface projection of a gold-bearing pyrrhotitic vein system that was intersected in 2015 drilling. Additional anomalies are interpreted to represent potential sub-parallel and en-echelon veins. Multi-year drill permits were received late in 2017 and the company began drilling.

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.)

PJX Resources Inc. continued drilling in 2016 at the **Vine** property, 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 (Fig. 3). 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). Recent drilling on these targets identified disseminated and replacement sphalerite along fractures and associated with carbonate-rich beds. The West target lies parallel to the Vine vein, which is a shear-related vein system (Pb-Zn-Ag-Au) that was discovered in the late 1970s. Two holes drilled on the **Vin**e vein in 1990 and 1994 encountered thin zones of massive sulphides at depth. Additional geophysical work was conducted in 2017, and drilling (6000 m; 15 DDH) focused mainly on the East target. Drill holes intersected sulphide (sphalerite, pyrite, pyrrhotite) mineralization with chlorite and albite, typical of distal SEDEX mineralization in the Belt-Purcell basin, and complexly deformed massive sulphides in the Moyie fault zone.

7.2.2. Monroe (Highway 50 Gold Corp.)

Highway 50 Gold Corp. drilled at the **Monroe** property, targeting base metal sulphide mineralization in the Aldridge Formation (Fig. 3). 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 2017. Drilling intersected bedded pyrrhotite and sphalerite (Fig. 14) and pyrrhotite-biotite-chlorite-albite+/-chalcopyrite veins across intervals of more than 170 m. Drilling also intersected thickened sequences within the Aldridge Formation, albitized sedimentary and sulphide clast fragmentals, carbonate beds, and abundant sericite and chlorite alteration. One hole drilled a 40 m section of argillite with abundant pyrrhotite laminations, followed by 6 m of albitized rock, and underlain by a 40 m zone of sphalerite and galena in tension cracks and veinlets.

Fig. 14. Bedded sulphides in drill core on the Monroe property.

7.2.3. Irishman, Panda, Sweet Spot, and DD (Teck Resources Limited)

Teck Resources Limited continued work on their properties in the Purcell anticlinorium. The company staked claims in 2015 and has optioned other surrounding claims for SEDEX mineralization. Teck 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. A recent study by Cook (2017) indicates that magnetotellurics could highlight conductive subsurface horizons and provides another tool for SEDEX targeting.

In 2016, the company re-logged core, mapped, and sampled over their claims, and identified target areas. In 2017, their focus was on geophysics. Using magnetotellurics, they ran a test line to determine the signature surrounding the Sullivan deposit, and ran three other lines across their target areas between Moyie and Creston. The company hopes to identify areas for drilling in 2018.

7.2.4. Silver Fox (Antofagasta plc)

Antofagasta plc entered into an option agreement with Kootenay Silver Inc. to acquire 80% interest in the **Silver Fox** property (Fig. 1). 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. Mineralization is thought to be penecontemporaneous, formed by hot, metal-enriched brines moving through porous sediments before lithification, with metals deposited at redox interfaces.

The property lies along the northern extension of the Western Montana copper belt, where copper-silver is hosted in three main deposits (Troy-Spar Lake, Rock Creek, Montanore; averaging 1.45 oz/ton Ag, 0.65% Cu, <2% sulphides) in the Revett Formation (Creston Formation equivalent).

Mapping and prospecting at the **Silver Fox** has identified strata-bound copper mineralization, with chalcopyrite and malachite, and accessory galena, arsenopyrite, bornite and pyrite occurring as disseminations, fracture fillings, and/or blebs in quartzites, calcareous siltstones, and sericite-altered siltstones. Three 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. Pyrolusite and jarosite alteration are associated with the mineralization. Between 2007 and 2013, Kootenay Silver completed mapping and sampling, ground electromagnetic and magnetic surveying, a 500 line km airborne magnetic survey, and a 500 line km seismic survey. In 2017, Antofagasta plc, together with Kootenay Silver Inc., delineated five main targets with further mapping, sampling, and ground geophysics, and drilled (3000 m).

7.2.5. Sully (Kootenay Zinc Corp.)

Kootenay Zinc Corp. continued work on their **Sully** property in 2017, where two subsurface gravity anomalies in the Aldridge Formation were identified. Previous drilling intersected traces of Pb-Zn-Cu sulphide mineralization, sericite alteration, and complex faulting. Overturned strata and low-angle faults have been mapped at surface and intersected in drilling. The low-angle faults, which have an apparent thrust sense, are considered to have originated as normal faults that were rotated during later deformation (Ransom et al., 2017). Minor zinc mineralization has been located in outcrop. Geological and geophysical model interpretations suggest the gravity anomalies may represent fault repetition of an overturned, near-vertical stratabound sulphide horizon in the Aldridge Formation.

In 2017, the company expanded their ground magnetic and gravity survey coverage, conducted additional soil geochemistry, and drilled (1464 m; 6 DDH). Downhole magnetics and EM were run in two drill holes to better understand the geology and update the geophysical model

7.2.6. 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 acquired the property in 2006 and 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). Their 2016 drill program encountered stacked zones of mineralization beneath the Great Northern, and as step-out mineralization in previously undrilled areas. Additional work identified other targets that appear as VLF conductors and gossans, and the company expanded their VLF grid further in 2017. They followed up several targets with trenching, expanded the known mineralization at their SIF zone, and discovered new mineralization beyond the Great Northern. Channel sample results include 2.04 m grading 26.6 g/t Au, 1246 g/t Ag, 3.1% Pb, 4.3% Zn, and 0.55% Cu. A portable test mill was used to produce a heavy minerals concentrate with gold. The company has updated their 3D modeling of the deposit to identify peripheral targets, and plans to update the resource after drilling in 2018.

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. 3). 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 (Fig. 15).

7.2.7. Teddy Glacier and Spider mill (Jazz Resources Inc.)

The **Teddy Glacier** property lies at the northern end of the Kootenay Arc (Fig. 2) and has been intermittently explored since the 1920s. The property is underlain by tightly folded and sheared limestones, carbonaceous phyllites, and grits of the Index and Jowett formations (Lardeau Group; Fig. 3). Mineralization occurs as irregular Ag-Pb-Zn±Au polymetallic veins, and stratabound massive galena-pyrite-chalcopyrite in silicified limestones.

Samples from **Teddy Glacier** assayed from 0.082-1.88 oz/ton Au, 7.23-22.9 oz/ton Ag, 8.86-27.5% Pb, and 5.11-22.1% Zn. The company has been moving towards rehabilitating the

Fig. 15. Quartz breccia on the Thor property.

historic **Spider mill** site, and moved a pilot mill on site. The company plans to collect a 5000 t bulk sample from **Teddy Glacier** and process it at the **Spider mill.**

In 2017, the company continued environmental baseline studies, upgraded the historic tailings facility, and worked on mitigation plans to obtain permits for the site.

7.2.8. Slocan Silver (Klondike Silver Corp)

Klondike Silver Corp's **Slocan Silver** project consists of 25,000 ha with more than 68 past producers, in the silver-rich historic Slocan (Ag-Pb-Zn) mining camp, 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; Fig. 3). Ag-Pb-Zn mineralization is 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. Considerable underground work, including rehabilitating old workings, extending exploration drifts, underground drilling and sampling, and bulk testing and processing of ore was done by Klondike Silver until 2013. The company's mill at Sandon is a 100 tpd flotation mill that operated at an average rate of 40 tpd that is currently on care and maintenance. The company has been sampling, mapping, and compiling all the historic data into a 3D model, including all underground workings, mined stopes, faults, geology, and drill hole data (~1150 underground and surface holes).

In 2017, LiDAR was flown over the area, and the company began rehabilitating the 4625 ft mine level portal of the **Silvana**, and the 5480 and 6100 ft mine levels of the Carnation, in preparation for further underground work. Access road upgrades have also begun to the Ruth-Hope and Silversmith. Environmental work and engineering upgrades to the tailings facility, mill, and underground structures are ongoing.

7.2.9. Jersey-Emerald (Margaux Resources Ltd.)

Margaux Resources Ltd. continued work at **Jersey-Emerald**. The property lies at the south end of the Kootenay Arc, and is underlain by interstratified carbonates and pelites of the Laib (Cambrian) and Active (Ordovician) formations (Figs. 2, 3). Coarse-grained marble to garnet-pyroxene skarn occurs in the Truman and Reeves members at contacts with small Cretaceous biotite granite stocks, Nelson intrusions (Jurassic to Cretaceous), and pegmatitic stocks. The main structure is a NNE-trending anticline known locally as the Jersey anticline. The property contains: stratiform lead-zinc-silver mineralization; tungsten (with minor molybdenum and copper) skarn mineralization; quartz veins, silicified limestone, and greisen-type alteration with gold, bismuth, cadmium and barium; and molybdenum porphyritic stocks. The **Emerald** Tungsten mine has stratabound Pb-Zn mineralization in the Reeves member, and a W-skarn zone in the Truman member. The **Jersey** mine has stratiform Pb-Zn mineralization at the base of the Reeves member (Fig. 16). The surrounding historic Dodger, Invicible, and Feeny mines also display tungsten mineralization.

In 2016, Margaux completed LiDAR over the property, worked on dewatering the underground workings at the Emerald, and compiled all the available historical data (including surface and underground mapping and surveys, over 5300 drill collars, logs, and assay data). They began expanding their 3D modelling, and drilled late in the year focussing on higher grade gold-bismuth targets and lead-zinc targets. Drill results were released early

Fig. 16. Stratiform mineralization in the Reeves Member (Cambrian) at the Jersey mine.

in 2017, with 10.2 m grading 24.98 g/t Au, 0.65 m grading 68.3 g/t Au, and 0.25 m grading 59.1 g/t Au, with gold strongly associated with bismuth and tellurium. They also discovered an historic drift, along strike with the Pb-Zn **Jersey** mine that was 12.8 m long, with continuous galena-rich mineralization. Further drilling in 2017 (1121 m, 6 DDH) was done to follow up on gold, and lead-zinc targets, with 6.1 m grading 2.61% Pb and 0.44% Zn, and 3.11 m grading 2.02% Pb, 0.48% Zn. Further follow-up work included geological mapping and sampling on the property, along with re-logging and sampling historical drill core. Silt sampling near the tungsten skarn mill site, which was not designed to recover gold, revealed that the skarn mineralizing system contains a previously unidentified gold component. Rock sampling from the Comet and Tungsten King showings returned results including 32.8% Zn, 1.2% Pb; and 2.69% Zn, 0.65% Pb, with elevated gold and bismuth.

Margaux Resources Ltd. has entered into a partnership agreement with CRONIMET Mining Group to evaluate the potential to re-process tailings from the historic **Emerald** tungsten mine (1942-1943, operating intermittently until 1973). At the time of operation, the mine was the second most productive tungsten mine in North America, and mined 1.077 Mt averaging 0.86% WO_3. In 2017, the company excavated and shipped approximately 3500 kg of material for testing, and will move to a more comprehensive bulk sampling proposal pending technical and economic viability of the project.

7.2.10. Jackpot (Margaux Resources Ltd.)

Margaux Resources Ltd. entered into an option agreement in 2016 to acquire 100% of the **Jackpot**/Oxide property, 17 km north of their **Jersey** property. The Jackpot orebodies are currently thought to be Kootenay Arc-type carbonate-hosted syngenetic deposits. The orebodies are concentrated in complex fold structures in dolomitized limestones of the Laib Formation (Lower Cambrian), Reeves member (Fig. 3). Several historic Pb-Zn showings occur in the Laib formation, and historic work includes two exploration drifts (1858 m; two levels), and 143 surface and underground drill holes. Grab sample results from late in 2016 include up to 30% Zn, with associated Pb, Ag, and Cd.

In 2017, the company compiled all historical data into a 3D model, identifying a zone of mineralization along a 600 m strike length. They also conducted a LiDAR survey, sampled outcrops, re-sampled historic drill core, and identified several targets for drilling. Results of chip sampling included 3.4 m grading 13.35% Zn, 2 m grading 15.58% Zn, and 3 m grading 8.97% Zn. Their drill program (1397 m, 9 DDH) targeted an area of 500 x 1000 m and three main zones, including the Jackpot Main, Lerwick, and Jackpot East, and included results of 61.1 m grading 1.01% Zn, 49.2 m grading 1.04% Zn, 8.5 m grading 6.66% Zn, and 36.3 m grading 1.48% Zn. Mineralized core is shown in Figure 17.

Fig. 17. Zinc-lead mineralized drill core from the Jackpot property. Photo courtesy of Margaux Resources Ltd.

7.2.11. Kena/Daylight/Toughnut (Prize Mining Corporation)

Prize Mining Corporation 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; Fig. 3). 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, Prize Mining Corporation mapped, sampled (rock and soil), conducted ground based magnetic and VLF surveys, and trenched. Soil sample results yielded samples up to 1 g/t Au, and one sample at 8 g/t Au. Results from the soil grid were combined with historical data. Rock samples yielded results up to 33 g/t Au, with one sample at 188 g/t Au. Based on the initial exploration program, 41 targets were prioritized. Later in the year, they drilled (2695 m, 18 DDH) at the **Daylight-Kena,** and also began a drill program late in the year at the **Toughnut** (1730 m, 7 drill pads). Environmental baseline water quality surveys were also undertaken in preparation for further exploration.

7.2.12. Swift Katie (Valterra Resource Corporation)

In 2017, Valterra Resource Corporation released results of their 2016 drill program (1954 m, 6 DDH), and continued drilling on their **Swift Katie** project (1392 m, 8 DDH). Results included 2.5 m grading 11.5 g/t Au and 6.7 g/t Ag, (including 0.8 m grading 30.9 g/t Au and 17.8 g/t Ag); and 8.6 m grading 3.1 g/t Au and 2.0 g/t Ag. One of the holes is offsetting a 2014 hole that assayed 3.5 m grading 13.3 g/t Au, 201 g/t Ag and 0.33% Cu. Drilling tested three areas along a 1000 m strike length that has been traced on surface by rock and soil sampling, and historical trenching.

The property is underlain by volcanic and synvolcanic intrusive rocks of the Elise Formation (Early Jurassic), Nelson intrusions (Jurassic to Cretaceous), Eocene intrusive rocks (Coryell), and Tertiary felsic to mafic and lamprophyre dykes. Historically the property was explored as two separate mineralizing systems. The northern claims host the **Katie** alkalic Cu-Au porphyry target, with pyrite, chalcopyrite, bornite, pyrrhotite, sphalerite, tetrahedrite and chalcocite. Polymetallic (Pb-Zn-Ag±Au,Cu) shear-hosted quartz-calcite veins cut the deposit. Alteration consists of a potassic core, with elevated copper and gold, surrounded by a broad propylitic zone. Drilling on the **Katie** identified zones of copper-gold mineralization along a 1800 m strike length, with numerous other untested soil anomalies. The southern claims host the **Swift** Au-Ag vein targets, in highly deformed and strongly quartz-sericite-pyrite-altered rocks of the Elise Formation, and at the contact between andesite and a diorite intrusion. Vein mineralization is mainly pyrite-pyrrhotite-chalcopyrite, with elevated copper and lead.

7.2.13. Alpine (Braveheart Resources Inc.)

Braveheart Resources Inc.'s **Alpine** property is underlain by Nelson intrusions (Jurassic to Cretaceous). Mineralization (Au-Ag-Pb-Zn) is found in shear zone-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 082FNW127). In 2017, they mapped, sampled, and drilled (1600 m, 11 DDH) on the property to test the extension and continuity of mineralization within quartz veins on the property. Drill intersections include: 1.5 m grading 11.8 g/t Au, 1.7 m grading 19.1 g/t Au, and 1.4 m grading 38.0 g/t Au.

7.2.14. 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 (Fig. 3), but include 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, within 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, and suggest that mineralization is open along strike. The company received drilling permits late in the year, and intends to begin drilling in early 2018.

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. Frances Creek (Voyageur Minerals Ltd.)

At the **Frances Creek** property, barite is found in fault-controlled breccia cutting dolomitic rocks of the Mount Nelson Formation (Mesoproterozoic; Purcell Supergroup; Fig. 3).

Voyageur Minerals Ltd. continued drilling late into the year (more than 1200 m, >17 DDH) targeting barite in a brecciated vein. Drill results indicate barite mineralization extends over a 20.37 m width, for 60 m along strike, averaging 30.57% $BaSO_4$. Drilling is ongoing and designed to extend the strike length farther, and test mineralization to a depth of about 60 m. Purity testing indicates that the barite, in addition to being used for drilling in the oil and gas industry, may qualify for the pharmaceutical market. The company plans for bulk sampling.

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 geological

modeling, environmental baseline studies, engineering review, resource, 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 potential. 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 has been working on their **Elko** project since 2015, when they began mapping, sampling, and compiling historical geological data, including drill locations, and historical adits. In 2017, the company updated their geological model, outlined drill locations, and conducted environmental baseline work. Permitting is currently underway for drilling in 2018.

The project is in the Crowsnest Coal field, targeting Mist Mountain Formation (Fig. 3) 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 of the project indicates the potential for a small open cut operation, with potential development of a larger underground operation. The company released a JORC resource estimate of 181.3 Mt Inferred, 57 Mt Indicated, and 19.2 Mt Measured (2015), and has been working to get drill permits in place for 2018.

8. Selected geological research

Ransom et al. (2017) released a study highlighting that some of the normal faults related to extension along the Rocky Mountain trench fault in the Hughes Range were rotated during later deformation and now have an apparent thrust sense. Cook (2017) is using magnetotellurics to image structures and subsurface conductors in the Purcell anticlinorium. In the West Kootenays, Allan et al. (2017) released a study on orogenic gold systems in the Cariboo, Cassiar, and Sheep Creek camps, and Webster et al. (2017) has been studying polyphase metamorphism and deformation between Nelson and Creston. In the Boundary region, updated geological mapping is being done in 082E/7, 082E/8, 082E/9 and 082E/10 (Höy et al., 2016). Mackay et al. (2017) studied reducing the amount of chemicals used in cleaning coal by using a water-based jig.

9. Summary

In 2017, exploration and mining continued in the region. Major mine development, expansion plans, and projects in the East Kootenay coalfields continue to advance. Several mine development projects for industrial minerals continue to move forward. Exploration for SEDEX-style base metals in the Purcell Anticlinorium, and base and precious metal mining projects in the region remain active. Commodity prices were up in 2017, and activity in the region was increased. Several late drill programs continued late into the year throughout the region.

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