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Exploration and Mining in British Columbia, 2014



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Information Circular 2015-02



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**Ministry of Energy and Mines
Mines and Mineral Resources Division
British Columbia Geological Survey**

Front Cover: Claim post at past-producing Emerald Glacier Ag-Pb-Zn±Au mine. View south from southern flank of Sweeney Mountain; Hazelton Mountains in background. En-echelon quartz veins (up to 3 m wide) were mined intermittently between 1951 and 1968. Omineca Region. **Photo by Travis Ferbey.**

Back Cover: Deep drilling to SEDEX target in Gunsteel Formation shale (Upper Devonian), through overlying thrust sheet of Ordovician and Silurian shale and limestone (Road River Group) at the Cirque deposit (Teck Resources Limited and Korea Zinc Company, Ltd.). Omineca Region. **Photo by John DeGrace.**

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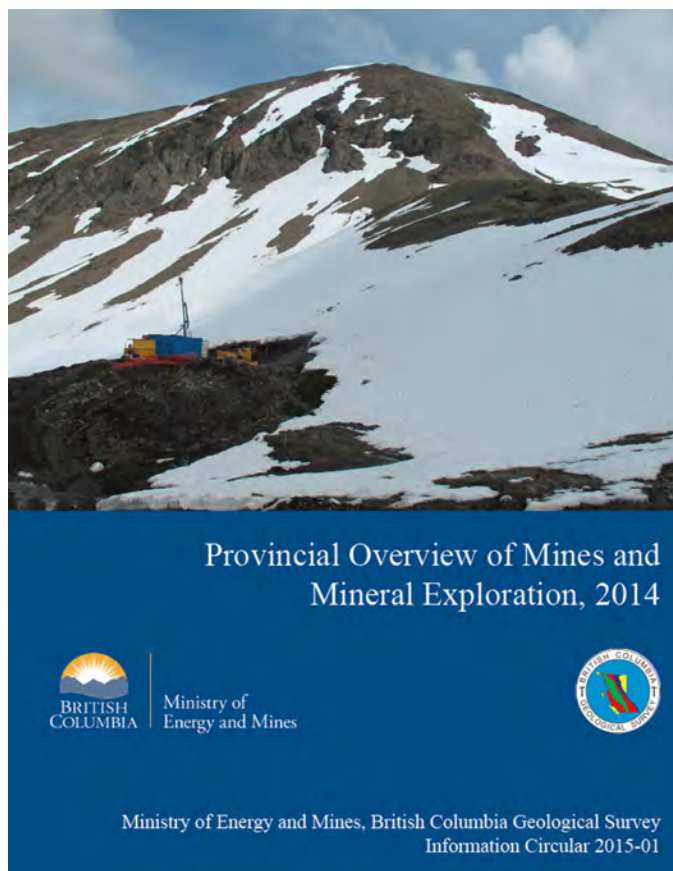
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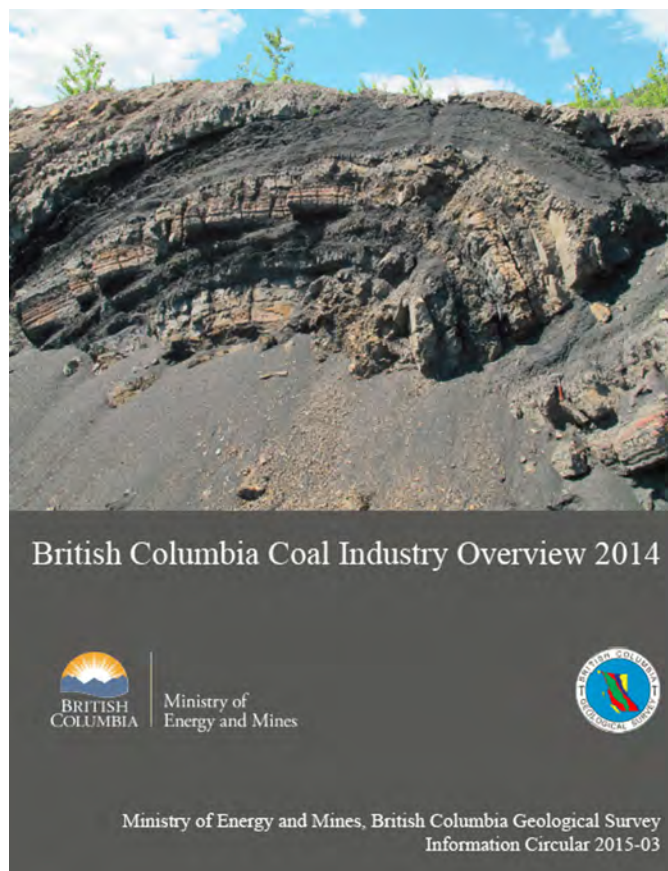
January 2015

Foreword

This volume is the latest in a series of annual reviews that dates back to 1874, when the first Annual Report of the Minister of Mines was published. Detailing significant projects region-by-region, the volume is a companion to the Provincial Overview of Mines and Mineral Exploration, 2014 (British Columbia Geological Survey Information Circular 2015-1) and the British Columbia Coal Industry Overview (British Columbia Geological Survey Information Circular 2015-3).



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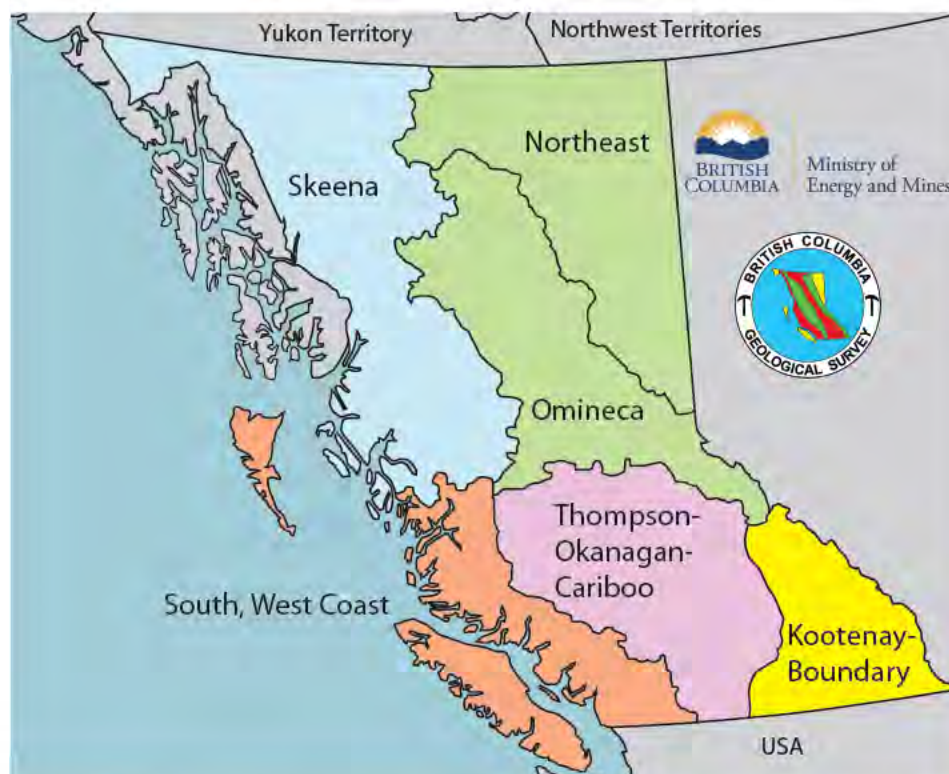
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Based in five communities, the Regional Geologists represent the British Columbia Geological Survey across the province. They monitor exploration and mining activities and provide geological expertise to support investment, land-use processes, First Nation capacity building, and public outreach. Coordinated by the Mineral Development Office, the Regional Geologists prepare annual documents that summarize current exploration and mining activities.

To prepare this volume, the Regional Geologists visit project sites to view outcrops and drill core and to discuss results. A significant amount of information is gleaned from corporate press releases, websites and reports. Late in the year, the Regional Geologists conduct informal phone and email surveys. Exploration expenditure estimates, rounded to the nearest \$1 million, are broken down by category: grassroots exploration, early-stage exploration, advanced exploration, mine evaluation, and mine lease exploration.

- Grassroots exploration commonly does not require permitting, and the activities and expenditures assigned to this category are less likely to be reported because they are typically below Mines Act permit thresholds.
- Early-stage exploration includes activities such as geophysics, geochemistry, trenching, and drilling.
- Advanced-stage exploration is concerned with resource definition, emphasizing drilling and bulk sampling. It may include baseline environmental studies, economic pre-feasibility work, and secondary target exploration.

- Mine evaluation begins with a commitment to develop a resource. It usually coincides with an application to government to open a mine and concentrates on the environmental, social, engineering, and financial assessments of a project.
- Mine lease exploration represents work on a mining property beyond known reserves. It may have characteristics of early-stage or advanced exploration.



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Kootenay-Boundary	Cranbrook	Fiona Katay	250-426-1758	Fiona.Katay@gov.bc.ca
South Coast and West Coast	Vancouver	Bruce Northcote	604-660-2713	Bruce.Northcote@gov.bc.ca
Mineral Development Office	Vancouver	Gordon Clarke	604-660-3332	Gordon.Clarke@gov.bc.ca

Founded in 1895, the British Columbia Geological Survey integrates historical data with active research programs and, drawing on continuously advancing concepts and technologies in the Earth sciences, supports the mineral and coal industries. The British Columbia Geological Survey preserves, archives, and provides free web-based access to over a century's worth of geoscience information. For details visit www.em.gov.bc.ca/geology.

We appreciate the information and access to project sites provided by industry representatives and thank George Owsiacki of Total Earth Science Services for desktop publishing.

Gordon Clarke
Director, Mineral Development Office
British Columbia Geological Survey
January, 2015

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Exploration and mining in the Omineca and Northeast regions, British Columbia

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Recommended citation: Jago, C.P., 2015. Exploration and mining in the Omineca and Northeast regions, British Columbia. In: Exploration and Mining in British Columbia, 2014. British Columbia Ministry of Energy and Mines, British Columbia Geological Survey, Information Circular 2015-2, pp. 1-27.

1. Introduction

The Omineca Region is prospective for metals including niobium, rare-earth elements (REE), molybdenum, nickel, copper, zinc, lead, silver and gold, whereas coal is of primary focus in the Northeast Region (Fig. 1).

The main deposit types explored for in the Omineca region (Figs. 1, 2) were epithermal gold-silver (Nechako Plateau), porphyry copper-gold (Nechako Plateau, Quesnel Trough and Toodoggone area) and stratiform zinc-lead-silver (Kechika Trough). Total exploration expenditure in 2014 is estimated at \$42 million (Fig. 3), mainly from mine evaluation-stage and advanced-stage projects, about 59% less than in 2013 (Fig. 4). At 42,000 m, drilling was 48% less than in 2013 (Fig. 5). In 2014,

- ramp-up activities continued at the **Mt. Milligan** mine (Thompson Creek Metals Company Inc.)
- a final feasibility study was released for **Blackwater** (New Gold Inc.), and pre-feasibility study completed for **Aley** (Taseko Mines Limited)
- an Environmental Assessment Certificate application was submitted for **Blackwater**, and Project Descriptions (initiating the environmental assessment process) were submitted for **Kemess Underground** (AuRico Gold Inc.) and **Aley**
- updated resource estimates were provided for **Capoose** (New Gold Inc.), **3Ts** (Independence Gold Corp.), **Aley**, and **Blackwater**
- drilling programs were undertaken for porphyry copper-gold at **Kemess East** (AuRico Gold Inc.), **Col-Later** (Pacific Empire Minerals Corp.), **Blackwater South** and **Key** (New Gold Inc.); low-sulfidation epithermal or vein gold-silver at **Fawn** and **Van Tine** (New Gold Inc.), **3Ts** (Independence Gold Corp.) and **Green Gold** (0902744 B.C. Ltd.); SEDEX zinc-lead-silver at **Akie** (Canada Zinc Metals Corp.), and **Cirque** (Teck Resources Limited); and high-purity limestone at **Giscome** (Graymont Western Canada Inc.).

About 18% of the province's coal production comes from the Peace River Coalfield in the Northeast Region (Figs. 1, 6). Metallurgical coal has been British Columbia's biggest mineral export commodity in recent years, representing about

46% of mineral production in 2014. The low-ash, low-sulphur bituminous coal in the region is internationally recognized for producing high-quality coke, a key ingredient in steel making. In concert with international oversupply and price decreases, coal production and exploration decreased in 2014. Total exploration expenditure was \$50 million (Fig. 3), mainly from mine evaluation-stage and advanced-stage projects, a 39% drop from 2013 (Fig. 4). Drilling (25,500 m) decreased 53% from 2013 levels (Fig. 5). In 2014,

- the second component of the Mines Act Permit Amendment was granted for the **Roman Mountain** expansion, fully permitting the combined **Trend-Roman** operation (Anglo American plc)
- the final two permit requirements for the **Quintette (Babcock)** mine (Teck Coal Limited) were granted, fully permitting the proposed mine
- the decline at **Murray River** (HD Mining International Ltd.) was driven beyond 740 m, proceeding toward the length for collecting a bulk sample
- feasibility-level exploration work began at **Sukunka** (Glencore)
- drilling programs were undertaken at **EB** and **Hermann** (Walter Energy, Inc.), **Roman Mountain**, **Roman Northwest**, and **Waterfall** (Anglo American plc), **Sukunka** (Glencore), and **Dunlevy** (Jameson Resources Limited)
- trenching and bulk sampling continued at **Wapiti East** (Fertoz International Inc.) and a small mine application was submitted.

Ridley Terminals Inc., the main port servicing the Peace River Coalfield, continued its Capacity Realization Project, which aims to double the annual terminal capacity to 24 Mt. However, by mid-year the project was curtailed pending recovery of the coal market. As of September 30, outlay for the project was \$15.1 million.

2. Geological overview

The Omineca-Northeast region is underlain by: cratonic basement rocks of ancestral North America (Laurentia); Neoproterozoic and Paleozoic sedimentary and carbonate successions deposited on the western flank of ancestral North

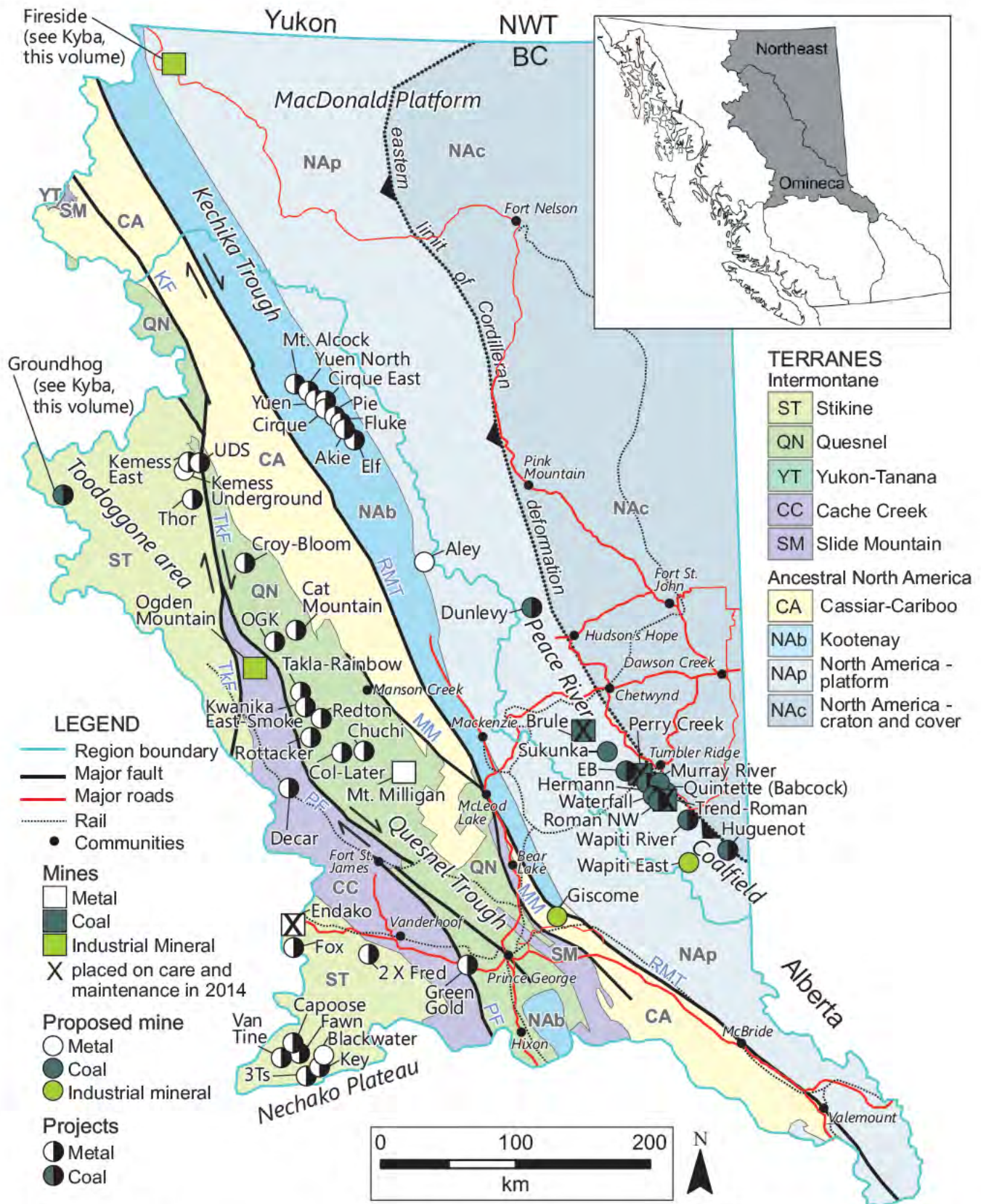


Fig. 1. Mines and selected exploration projects, Omineca and Northeast regions, 2014. Terranes from Nelson et al. (2013). Fault abbreviations: KF = Kechika fault, MM = Manson-McLeod fault system, PF = Pinchi fault, RMT = Rocky Mountain trench, TkF = Takla-Finlay-Ingenika fault system.

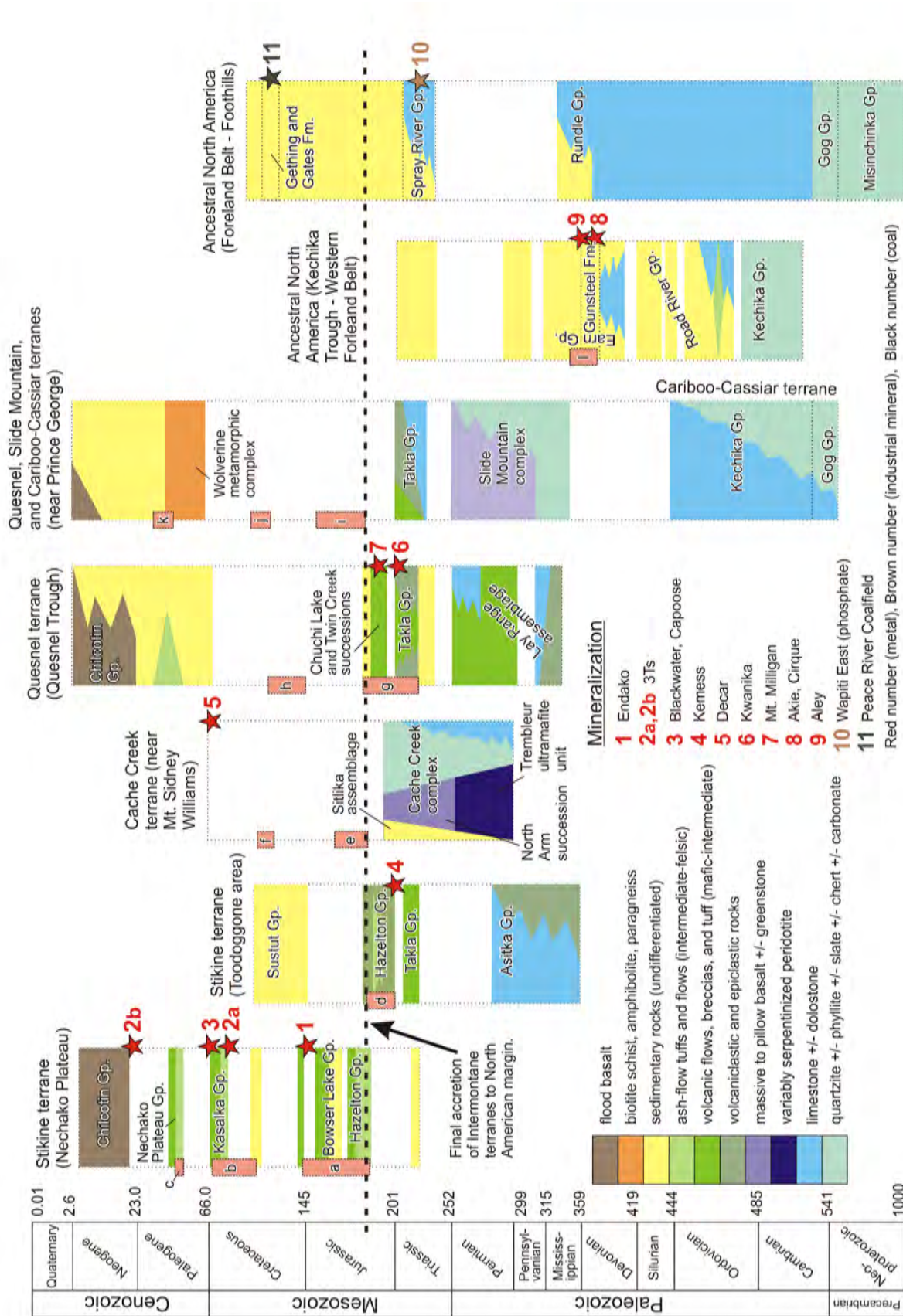


Fig. 2. Generalized stratigraphy, Omineca and Northeast regions. Selected intrusive rocks: a) Endako batholith and Laidman batholith; b) Capoose batholith and Auro pluton (Blackwater pluton); c) Chu pluton; d) Black Lake plutonic suite; e) Spike Peak intrusive suite; f) granodioritic plutons (unnamed suite); g) Hogen plutonic suite (Triassic-Jurassic); h) Hogen plutonic suite (Cretaceous) and Germansen Batholith; i) Ste. Marie plutonic suite; j) Bayonne Range plutonic suite; k) Wolverine Range plutonic complex. Mineralization ages at 3Ts are represented by the microdiortite sill (2a) and hydrothermal quartz breccia vein at the margin of the Johnny vein (2b). Unit ages from Stott (1975), Diakow et al. (1993, 1997), Nelson and Bellefontaine (1996), Ferri (1997), MacIntyre (1998), and Schiarizza and MacIntyre (1998). Mineralization ages from Andrew (1988), Pell (1994), McLeish (2013), Logan and Mihalynuk (2014), New Gold Inc. (2013), David Pawliuk (personal communication, 2014) and Ron Britton (personal communication, 2014). Geologic timescale from International Commission on Stratigraphy (2014).

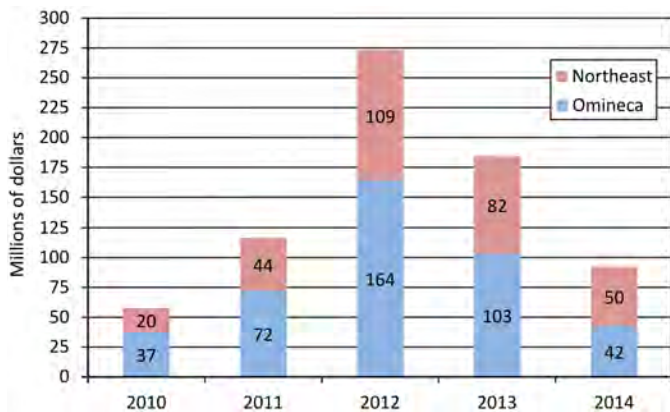


Fig. 3. Annual exploration spending estimates in millions of dollars for the Omineca and Northeast regions from 2010 to 2014. A total of \$92 million for the combined regions in 2014 was down 50% from 2013.

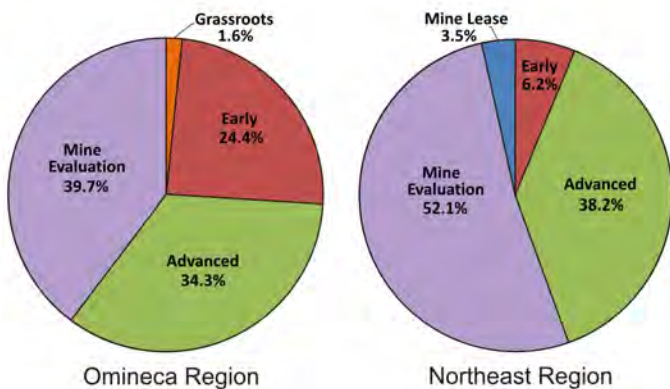


Fig. 4. Exploration expenditures in 2014 by exploration stage for the Omineca and Northeast regions.

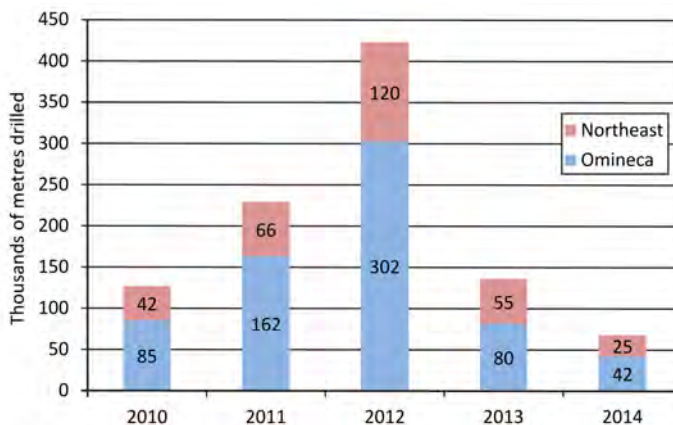


Fig. 5. Annual exploration drilling estimates in thousands of metres for the Omineca and Northeast regions from 2010 to 2014. A total of 67,200 m for the combined regions in 2014 was down 50% from 2013.

America; the Quesnel and Stikine island arc terranes, which formed outboard of ancestral North America starting in the Late Paleozoic and were accreted in the Middle Jurassic; the

Slide Mountain and Cache Creek oceanic terranes, which intervene between Quesnellia and Stikinia and formed in the Late Paleozoic to Mesozoic; post-accretionary rocks; and younger cover rocks (Figs. 1, 2).

2.1. Ancestral North America

In the Omineca and Northeast regions, Laurentian basement is unconformably overlain by Neoproterozoic to Early Paleozoic continental, shelf, and deep-water marine siliciclastic and carbonate successions that were deposited on the western margin of ancestral North America during protracted rifting and breakup of the supercontinent Rodinia (Fig. 2, see Nelson et al., 2013 for review). Local units of the Windermere Supergroup (Neoproterozoic) include predominantly siliciclastic rocks and their metamorphic equivalents (Misinchinka and Ingenika groups; Ferri et al., 1994). The Gog Group (Lower Cambrian) unconformably overlies the Windermere Supergroup and consists mainly of sandstone, granulestone, and conglomerate. In the Northern Rocky Mountains, Early to Middle Paleozoic sedimentation is represented by units containing mainly carbonate rocks, such as the Kechika Group (Cambrian), and the Road River Group (Middle Devonian).

2.2. Cassiar, Kootenay, and Slide Mountain terranes

In Devonian to Mississippian time, subduction of oceanic crust eastward beneath ancestral North America led to back-arc extension and opening of the Slide Mountain ocean. Subsidence from attenuation of the continental margin generated the Cassiar-Cariboo and Kootenay pericratonic terranes (Nelson et al., 2013). The Cassiar-Cariboo terrane is underlain by the same Neoproterozoic to Cambrian successions as ancestral North America. The Kechika Trough (Kootenay terrane) is the southeastern extension of the Selwyn Basin of the Yukon and Northwest Territories, which hosts prolific Ordovician to Early Devonian sedimentary exhalative (SEDEX) deposits. The trough is in the Northern Rocky Mountain fold and thrust belt, bounded to the west by the Rocky Mountain trench and to the east by the Macdonald Platform (Fig. 1). Siliceous and carbonaceous shale of the Upper Devonian Gunsteel Formation (Earn Group) hosts barite-bearing SEDEX deposits including those at **Akie** and **Cirque**. The host shales are preserved in a series of Cretaceous to Early Tertiary northwest-trending thrust sheets and synclinal keels (MacIntyre, 1998). The **Aley** carbonatite complex (Late Devonian-Early Mississippian) also lies in the fold and thrust belt. It is hosted by Cambrian to Ordovician carbonate and siliciclastic rocks near the transition between shelf deposits of the Macdonald Platform and deep-water deposits of the Kechika Trough (Mäder, 1986; McLeish, 2011).

2.3. Quesnel terrane

Volcanic island-arc rocks that originated outboard of ancestral North America in the Late Triassic to Early Jurassic (Nelson et al., 2013; Logan and Mihalynuk, 2014) extend along strike for 660 km in the Omineca Region. The Quesnel arc developed in

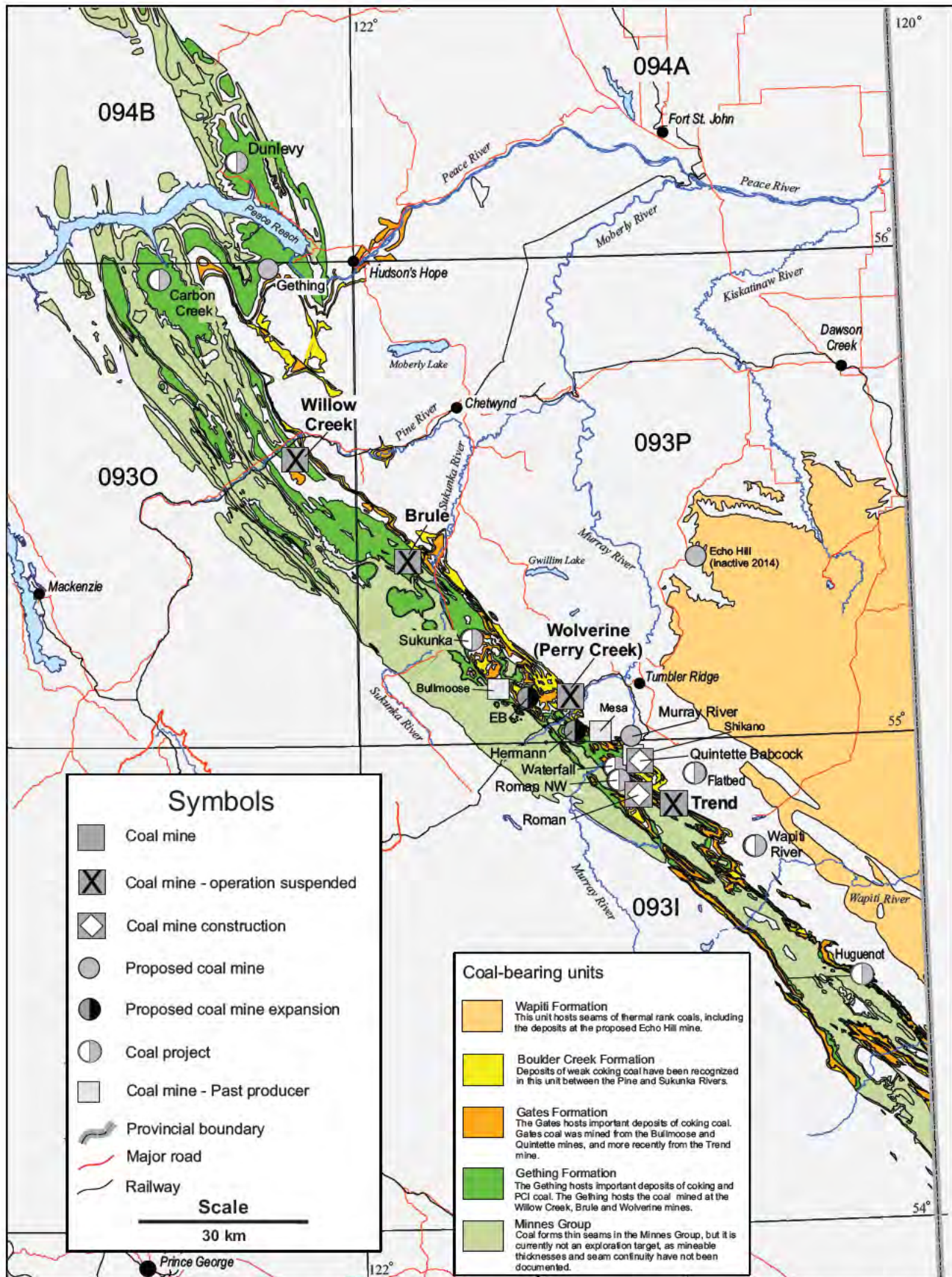


Fig. 6. Coal mines and exploration projects, northeastern British Columbia 2014. From British Columbia Geological Survey (2015).

two-phases above Late Paleozoic basement rocks (Nelson and Bellefontaine, 1996). The Takla Group (Late Triassic) phase comprises basal sedimentary rocks that are overlain by mafic and intermediate volcanic successions. These rocks are locally overlain by partially subaerial intermediate volcanic rocks, including the Chuchi Lake and Twin Creek successions (Early Jurassic), which were emplaced on a more mature arc. Coeval with the Takla Group, the Hogem Intrusive complex and its peripheral offshoots hosts porphyry copper-gold \pm silver \pm molybdenum deposits such as **Kwanika** and **Mt. Milligan**. The Hogem Intrusive suite generally evolved from more alkaline compositions in the Early Mesozoic to more subalkaline in the Cretaceous (Garnett, 1978), with the exception of Early Jurassic alkaline bodies such as the Duckling Creek syenite complex (Bath et al., 2014; Devine et al., 2014). Regional northwest-trending strike-slip faults bound the northern Quesnel terrane on its eastern (Manson-McLeod fault system) and western (Pinchi fault) margins.

2.4. Stikine terrane

The Stikine terrane shares ancestry with the Quesnel terrane (Logan and Mikalynuk, 2014). Both are thought to have been part of a larger arc complex lying offshore of ancestral North America in Late Permian to Triassic time. Accretion of the terranes is thought to have resulted from westward subduction of oceanic crust beneath Stikinia and eastward subduction beneath Quesnellia (Diakow et al., 1993, Nelson et al., 2013). The Stikine terrane underlies much of the Skeena region and the westernmost part of the Omineca region, particularly in the Toadoggonne (northwest) and Nechako Plateau (southeast) areas.

In the Toadoggonne area, bimodal volcanic and sedimentary rocks of the Asitka Group (Carboniferous-Permian) are unconformably overlain by mafic to intermediate volcanic rocks of the Takla Group (Late Triassic). Hazelton Group subaerial intermediate to felsic volcanic rocks (Toadoggonne Formation; Lower Jurassic) unconformably overlie the Takla Group. Coeval with Hazelton Group, quartz monzonitic to granodioritic rocks of the Black Lake suite form a 62-km long, north-northwest trending pluton that locally hosts porphyry mineralization. Intrusive rocks follow the margins of an elongate structural depression that was filled by voluminous Hazelton Group ash-flow tuffs particularly in the central part of the area (Diakow et al., 1993). A horst-and-graben fault system includes northwest-trending normal faults, northeast-trending cross faults, and shallow to moderately tilted monoclinical blocks. Porphyry copper-gold-silver-molybdenum deposits such as **Kemess Underground**, and epithermal gold-silver deposits of both low- and high-sulphidation type are known in the area. The Finlay-Ingenika fault system bounds the Toadoggonne area on the east.

In the Nechako Plateau area, Hazelton Group island-arc volcanic rocks predominate (Diakow et al., 1997) and are intruded by syn-accretionary monzogranitic rocks of the Endako and Laidman batholiths. The Endako Batholith is a

composite intrusive complex that extends for 95 km along a northwest trend at the northern end of the Nechako Plateau. The Endako subsuite (Late Jurassic) of the Francois Lake plutonic suite hosts the Endako low-fluorine porphyry molybdenum deposit (Pond, 2013).

2.5. Cache Creek terrane

The Cache Creek terrane is an oceanic fore-arc assemblage that formed outboard of the combined Stikine-Quesnel arc terrane and contains exotic fossils of Tethyan (Asian) affinity (Schiarrizza and MacIntyre, 1998; Nelson et al., 2013). In the Mt. Sidney Williams area the Cache Creek terrane consists of the Sitlika assemblage (Permian-Triassic) and the Cache Creek complex (Late Paleozoic to Early Jurassic). In the Sitlika assemblage, a lower unit of mafic and felsic metavolcanic rocks is overlain to the east by a siliciclastic unit. The Cache Creek complex includes an ophiolite sequence of variably serpentinized peridotite (Trembleur ultramafic unit), which hosts the **Decar** deposit, and an overlying unit of massive-to-pillowed basalts and mafic dikes and sills (North Arm succession). The ophiolite sequence is in thrust contact with a pelagic phyllite-chert unit; a massive limestone unit lies farther to the east. In the Ogden Mountain area, nephrite jade lenses are in high-pressure, low-temperature metamorphic rocks of the Cache Creek complex. Predominantly west-directed structural imbrication and obduction of oceanic rocks onto Stikinia occurred in Early-Middle Jurassic time during terrane accretion. The Sitlika rocks are considered to be part of a primitive oceanic arc complex, the Sitlika-Kutcho-Venables arc (Logan and Mikalynuk, 2014).

2.6. Post-accretionary rocks (Late Jurassic to Paleogene)

In Stikine terrane, non-marine sedimentary rocks of the Sustut Group (Lower to Upper Cretaceous), derived from the Omineca Belt to the east (Diakow et al., 1993), extend for over 100 km along the western margin of the Toadoggonne area, overlapping Upper Paleozoic to Lower Jurassic units.

In the Nechako Plateau area, Hazelton Group rocks are locally overlain by sedimentary and volcanic rocks of the Bowser Lake Group (Late Jurassic to Early Cretaceous), which formed in a foreland basin west of the obducted Cache Creek complex (Evenchick et al., 2007). By Late Cretaceous time, regional shortening and the development of a continental arc to the west led to an episode of granodiorite intrusion (Diakow et al., 1997; Nelson et al., 2013) that included the Capoose Batholith and Auro Pluton, which are spatially related to the **Capoose** and **Blackwater** deposits (Simpson and Rotert, 2014; Christie et al., 2014). Episodic volcanism continued with eruption of the intermediate Kasalka Group rocks (Late Cretaceous), which host the **Blackwater** deposit; and Eocene rocks of the Nechako Plateau Group, the Ootsa Lake Formation (felsic volcanic) and Endako Formation (intermediate volcanic). Eocene volcanism was concurrent with regional extension and horst-and-graben faulting. North- to northwest-trending faults and northeast cross faults are important controls on mineral showings developed

during Late Cretaceous to Eocene uplift and extension. The Nechako uplift, a northeast-trending horst, provides a window exposing Hazelton Group rocks beneath Miocene and younger cover.

In the Quesnel terrane, second-order strike-slip faults, fault splays, and releasing bends resulted in variably tilted structural blocks and triangular-shaped basins filled with Upper Cretaceous to Tertiary sedimentary and minor volcanic rocks (Nelson and Bellefontaine, 1996). The moderate tilt of the **Mt. Milligan** deposit may be related to motion along a splay of the Manson-McLeod fault zone. The Wolverine metamorphic complex, a core complex related to extensional and strike-slip tectonics, was rapidly exhumed in the Tertiary and comprises amphibolite-grade Neoproterozoic basement rocks (Ferri et al., 1994).

In northeastern British Columbia, the Peace River Coalfield extends nearly 400 km along the Northern Rocky Mountain inner foothills, from the Alberta border to the Pink Mountain area (Figs. 1, 6). Medium- to low-volatile bituminous coal seams of economic thickness and continuity are hosted in Lower Cretaceous sections of the Gething and Gates formations (Cunningham and Sprecher, 1992; Gibson, 1992). Coal-bearing cyclothems were deposited in deltaic and lagoonal settings along the western edge of the Western Canadian Sedimentary Basin during marine transgressions and regressions (Stott, 1984; Grieve, 1995). These rocks were shortened during the Laramide Orogeny (Late Cretaceous to Tertiary). Thrusts, northeast-vergent variably plunging asymmetric folds, box-folds, and triangle zones formed by back-thrusts generally trend northwest-southeast. Commonly, tight anticlines adjacent to thrust faults are bordered by broad synclines. Coals from both the Gething and Gates formations are relatively low in ash and sulphur (Grieve, 1995). In 2012, the Government of British

Columbia estimated 4900 Mt of potentially mineable resources in the Peace River Coalfield.

2.7. Neogene to Quaternary cover rocks

Tertiary fluvial deposits were deposited in large braided and meandering systems (Levson and Giles, 1993) such as the north-flowing ancient Peace River (Turner et al., 2010). Chilcotin Group flood basalts (Miocene and younger) outcrop locally. Quaternary glacial, glaciofluvial, fluvial, and colluvial deposits are extensive in the southern part of the Omineca region, and bedrock is exposed mainly at higher elevations.

3. Operating mines and quarries

3.1. Metal mines

3.1.1. Endako mine

The Endako molybdenum mine (Figs. 1, 2; Thompson Creek Metals Company Inc., operator and 75% owner; Sojitz Moly Resources, Inc., 25% owner) is one of many porphyry deposits that extend discontinuously along the length of Stikinia (Logan, 2013; Logan and Mihalynuk, 2014). The orebody is hosted by the Endako quartz monzonite (Fig. 2; Late Jurassic) and consists of subparallel or en-echelon quartz-molybdenite-pyrite veins, and stockworks (Pond, 2013). Open-pits (Fig. 7) extend across four structural blocks separated by south southwest-trending faults that appear to be offset as a series of Tertiary listric normal faults (Lowe, 2001). Pond (2013) summarized the geology of the deposit and provided operational updates. Although mining of in situ and stockpiled ore continued in 2014 (Table 1), the mine was placed on temporary suspension, effective December 31.

3.1.2. Mt. Milligan mine

The Mt. Milligan mine (Thompson Creek Metals Company

Table 1. Metal mines, Omineca and Northeast regions.

Mine	Operator	Commodity; deposit type; MINFILE	Forecast production (estimate based on Q1-Q3)	Reserves (Proven and Probable)	Resource (Measured and Indicated)	Near-mine exploration	Website
Endako	Thompson Creek Metals Company Inc. (75% share)	molybdenum; porphyry; 093K 006	4309 tonnes (9.5 Mlbs) molybdenum oxide	65.8 Mt at 0.052% molybdenum; containing 34,382 tonnes (75.8 Mlbs) molybdenum	109.4 Mt at 0.051% molybdenum - additional to reserves	N/A	http://www.thompsoncreekmetals.com/s/home.asp
Mt. Milligan	Thompson Creek Metals Company Inc.	copper, gold, silver; porphyry; 093N 194	28,395 tonnes (62.6 Mlbs) copper; 5645 kg (181,500 oz) gold	477.5 Mt at 0.199% copper and 0.388 g/t gold; containing 951,637 tonnes (2098 Mlbs) copper and 185,066 kg (5.95 Moz) gold	226.2 Mt at 0.14% copper and 0.204 g/t gold - additional to reserves	ground IP survey (31.2 line-km)	http://www.thompsoncreekmetals.com/s/home.asp



Fig. 7. Mining in the southeast corner of the Endako pit, Endako mine.

Inc.) is a near-surface, alkalic copper-gold porphyry deposit in central Quesnellia (Figs. 1, 2; Logan, 2013; Logan and Mihalynuk, 2014). It is hosted by mafic-intermediate volcanic rocks of the Witch Lake succession (Takla Group) and by Early Jurassic monzonite stocks (Fig. 2). Copper-gold mineralization occurs as sulphide disseminations, fracture fills, and lesser veinlets in the monzonitic stocks, their brecciated margins, and hornfelsed and altered volcanic country rocks.

The deposit is a moderately dipping, tabular, ca. 2.5 x 1.5 km body that extends to a depth of 400 m (Mills et al., 2009). A core zone of magnetite-rich potassic alteration and copper-gold mineralization (MBX sub-zone; Fig. 8) transitions peripherally to gold-only mineralization and carbonate-rich phyllic to intermediate argillic alteration (66 sub-zone) suggestive of an alkalic lithocap (Holliday and Cooke, 2007). An oxidized zone with weak supergene enrichment contains native copper extends to depths of 70 m along faults.



Fig. 8. Blast-hole drilling for Phase 2 mining in the MBX pit, Mt. Milligan mine.

Commissioned in October 2013, the mine saw its first full-year of operations in 2014. Ramp-up activities, including mechanical and electrical maintenance, and adjustments to mining and milling continued throughout 2014. Commercial production, defined as mill operation at 60% throughput capacity for 30 days, was reached in mid-February. Milling operations are expected to be consistently near 80% of design capacity by the end of 2014. Nine shipments of approximately 10,000 dry tonnes of copper and gold concentrate were made by October. About 328 people worked at the mine in 2014.

Near mine exploration in 2014 consisted of a ground IP geophysical survey northeast of the mine on a claims block underlain by volcanic rocks and limestone of the Takla Group, and biotite schist and paragneiss of the Wolverine metamorphic complex.

3.2. Coal mines

The year began with three open-pit coal mines operating in the Northeast Region (Fig. 6): the **Trend** mine of Peace River Coal Inc., wholly owned by Anglo American plc; and the **Perry Creek** (Wolverine) and **Brule** mines of Western Coal Corp., wholly owned by Walter Energy, Inc. The Trend and Perry Creek mines produce mainly hard coking coal (HCC), whereas the Brule mine produces only pulverized coal injection (PCI) coal, a high-rank thermal coal used to sustain blast furnace temperatures in steelmaking. In mid-April, Walter Energy announced that coal mining in the region would be suspended due to low prices. Mining at Perry Creek was suspended immediately, but operations continued at Brule until mid-late June. In September, Anglo-PRC announced that it would be suspending operations at the combined **Trend-Roman** mine by the end of 2014.

3.2.1. Trend

At the **Trend** mine (Table 2) HCC of medium-volatile bituminous rank is being mined from seams in the Gates Formation along the steeply dipping northeast limb of the Waterfall anticline. The Roman Mountain expansion lies 1.5 km to the southwest, in the Murray syncline. Coal seams, have been followed over a 3 km strike length; the cumulative thickness of Gates Formation seams is about 18 m. Seams in the Gething Formation have a cumulative thickness of 7.5 m and can be blended with Gates Formation coals. Metallurgical coal production for the first three quarters was 1.30 Mt, down slightly (2%) from 2013.

At the end of March, the second component of the Mines Act Permit Amendment was granted for access and start of mining on Roman Mountain, making the combined Trend-Roman operation (Fig. 1) fully permitted. The remaining effluent permit has also been received. Construction projects continuing into 2014 included ditching for runoff management, two sedimentation ponds, and a selenium treatment test plant that was commissioned in the first half of the year. A causeway was constructed to provide better access to Roman Mountain (Fig. 9). The expansion will comprise 5 km of linear open-cuts in

Table 2. Coal mines, Omineca and Northeast regions.

Mine	Operator - mine status	Commodity; deposit type; MINFILE	Forecast production (estimate based on Q1 to Q3)	Reserves (Proven and Probable)	Resource (Measured and Indicated)	Near-mine exploration	Website
Trend	Anglo American plc (Peace River Coal Inc.) Placed on care and maintenance, Dec. 2014	metallurgical coal; 093I 030	1.71 Mt	10.0 Mt saleable (excluding Roman Mountain)	27.7 Mt mineable in situ (exclusive of reserves, excluding Roman Mountain)	N/A	http://www.angloamerican.com/
Perry Creek	Walter Energy, Inc. (Western Coal Corp.) Placed on care and maintenance, Apr. 2014	metallurgical coal; 093P 025	564,000 t	9.4 Mt saleable; Proven	N/A (28.0 Mt in situ, March 31, 2010)	N/A	http://walterenergy.com/
Brule	Walter Energy, Inc. (Western Coal Corp.). Placed on care and maintenance, June 2014	metallurgical coal; 093P 007	1.02 Mt	17.5 Mt saleable; Proven	N/A (28.0 Mt in situ, December 31, 2011)	N/A	http://walterenergy.com/

**Fig. 9.** Looking southeast down the completed open-cuts Trend Mine. The causeway was constructed to access Roman Mountain (Trend-Roman mine).

three phases to capture the Middle Gates coal seams on Roman Mountain, and satellite pits for the Upper Gething coal seams (Peace River Coal Inc., 2007). Once in operation, the mine will require 450 full-time employees. The combined Trend-Roman operation will extend the life of the existing Trend mine by 16 years. The decision to suspend mining affected 360 mine employees and about 30 contractors.

3.2.2. Perry Creek mine (Wolverine)

At Walter Energy's **Perry Creek** mine (Wolverine Project; Fig. 1, Table 2) medium-volatile bituminous HCC is being mined from seams in the Gates Formation. In mid-April the company announced it would immediately idle production, but continue operating the wash plant to process coal already in inventory. A care and maintenance crew is to remain on site once coal processing is complete. Layoffs affected 415 employees.

3.2.3. Brule mine

Walter Energy's **Brule** mine (Figs. 1, 10; Table 2) mine

produces PCI coal from three, 3.0-4.6 m thick seams in the lower part of the Gething Formation. The mine forms part of the Brazion Group of properties that includes the Willow Creek mine. Production of about 2.2 Mt of run-of-mine coal was targeted for the year, but the mine was placed on idle status at the end of June and 280 employees were laid off. Hauling of stockpiled coal for processing and rail load-out at the Willow Creek mine continued for the remainder of the year.

3.3. Industrial mineral mines and quarries

3.3.1. Nephrite jade

Nephrite and soapstone are metamorphic rocks derived from an ultramafic protolith that has undergone dynamothermal metamorphism and metasomatism near a subduction zone. The Ogden Mountain property is underlain by metamorphosed, thrust-faulted, and well-foliated ultramafic rocks, including serpentinite melange, of the Cache Creek complex. These rocks are locally intercalated with massive white calc-silicate rock (Simandl et al., 2000). Near the calc-silicate rocks, the ultramafic rocks appear to grade from serpentinite to nephrite



Fig. 10. Walter Energy, Inc. geologist looking southeast over the South Brule Pit, Brule mine.

to soapstone (talc schist). The nephrite forms lenses that pinch and swell along the regional fabric.

Green Mountain Gemstones Inc. continued work at the **Ogden Mountain** property (Fig. 1, Table 3), including placer trenching for alluvial jade boulders and excavation of in situ jade.

3.3.2. Dimension stone

Near Valemound (Fig. 1), construction and building stone projects continued in 2014 with limestone quarrying at the **Yellowjacket** project and continued stockpiling of talus-derived quartzite slabs at **Hunterstone Quarries**.

4. Mine development and proposed mines

4.1. Metal projects

4.1.1. Kemess Underground (KUG)

The Kemess Underground deposit (Figs. 1, 2; Table 4; AuRico Gold Inc.) is centered on the Kemess North pluton, a quartz monzodiorite of the Black Lake intrusive suite that follows a south-dipping thrust fault. The fault separates Takla Group basaltic-andesites from a barren wedge of Toodoggone Formation (Hazelton Group) dacitic lapilli tuffs to the north, and cuts off the pluton and mineralization at depth. An 80 m thick oxidized sulphate leach zone of clay-rich hematite-stained broken rock overlies the deposit. Subjacent phyllic alteration with pyrite-anhydrite/gypsum veining is predominant in the Takla volcanic rocks; at depth, quartz-magnetite \pm biotite alteration becomes prevalent. Auriferous chalcopyrite-pyrite mineralization with trace molybdenite occurs as disseminations, fracture fills and quartz \pm magnetite veins in the pluton, and less so in hangingwall Takla Group volcanic rocks.

In February, AuRico submitted a Project Description to initiate environmental assessment. An underground block cave operation is proposed that would use infrastructure at the Kemess South mine (now on care and maintenance; Witte et al., 2013). Annual production would be approximately 3266 kg (105,000 oz) of gold and 19,958 tonnes (44 Mlbs) of copper. The operation would run for 12 years with mining from a single

extraction level. Construction is expected to take five years, employing up to 400 people for the first four years.

4.1.2. Blackwater

The **Blackwater** deposit (Figs. 1, 2; Table 4; New Gold Inc.) is interpreted as an intermediate sulphidation epithermal gold-silver system hosted by Kasalka Group rocks (Late Cretaceous; Christie et al., 2014). The volcanic section includes andesite flows, lapilli tuffs, and volcanic breccias, flow-banded and tuffaceous rhyodacites, heterolithic breccia containing altered fragments of other units, and silicified hydrothermal breccias. Alteration and mineralization define a 1300 x 950 m west-trending, shallowly north-plunging deposit. A fragmental zone with average vertical extent of 350 m tapers down to 600 m in a low-grade core. It contains pervasive muscovite-illite \pm silica, smectite, biotite, and chlorite alteration accompanied by disseminated and replacement pyrite-sphalerite-marcasite-pyrrhotite \pm chalcopyrite, galena, and arsenopyrite. Native gold and electrum as micron-scale grains (ranging from about 30 μ m up to 200 μ m) are spatially associated with sulphide and silicification. Local Mn-rich spessartine garnet, an important indicator mineral, occurs with pyrrhotite-bearing potassic alteration in the western part of the deposit. Steep, north-plunging higher-grade ore shoots are thought to be related to subvertical fault intersections. Highest grades (up to 47.49 g/t Au over 15 m) are along the margins of silicified breccia bodies. Illite and rare buddingtonite alteration suggests a late volatile phase common to shallow hydrothermal systems (Krohn et al., 1993).

In January 2014, New Gold Inc. released the NI 43-101 technical report. It describes an open-pit mining operation with 60,000 t/d processing plant and a mine life of 17 years. Life-of-mine average annual production would be 12,846 kg (413,000 oz) of gold and 54,182 kg (1.74 Moz) of silver. Total metal production would be 217,724 kg (7.0 Moz) of gold and 920,663 kg (29.6 Moz) of silver. New Gold worked to advance the project through permitting, which required additional engineering studies on the transmission line, tailings storage

Table 3. Industrial mineral mines and quarries, Omineca and Northeast regions.

Mine	Operator	Commodity; deposit type; MINFILE	Production	Reserves	Resource (Measured and Indicated)	Near-mine exploration	Website
Ogden Mountain	Green Mountain Gemstones Inc.	nephrite jade; jade; 093N 156, 165	less than 5 tonnes raw; 8 tonnes high-grade from stockpiles	N/A	N/A	placer trenching and in situ mineral exploration	http://gmgemstone.ca/
Yellowjacket	Private individual	limestone	1000 tonnes	N/A	N/A		N/A
Hunterstone Quarries	Private individual	quartzite slabs	200 tonnes	N/A	N/A		http://www.hunterstonequarries.com/

Table 4. Mine development and proposed mines, Omineca and Northeast regions.

Mine	Operator	Commodity; deposit type; MINFILE	Reserves (Proven and Probable)	Resource (Measured and Indicated)	Work program	Significant results	Website
Kemess Underground (KUG)	AuRico Gold Inc.	copper, gold, silver; porphyry; 094E 021	100.4 Mt at 0.28% copper, 0.56 g/t gold, 2.0 g/t silver; containing 280,842 tonnes (619.2 Mlbs) copper, 56,142 kg (1.8 Moz) gold, 205,532 kg (6.6 Moz) silver	65.4 Mt at 0.24% copper, 0.41 g/t gold, 1.8 g/t silver; containing 157,191 tonnes (346.5 Mlbs) copper, 26,562 kg (854 Koz) gold, 118,535 kg (3.8 Moz) silver (excluding reserves)	Environmental Assessment, care and maintenance (Kemess South)	Project Description to initiate Environmental Assessment submitted	http://www.auricogold.com/
Blackwater	New Gold Inc.	gold, silver; epithermal (intermediate sulfidation); 093F 037	344.4 Mt at 0.74 g/t gold, 5.5 g/t silver; containing 254,115 kg (8.17 Moz) gold, 1891 tonnes (60.8 Moz) silver	396.9 Mt at 0.74 g/t gold, 5.5 g/t silver; containing 295,483 kg (9.50 Moz) gold, 2181 tonnes (70.13 Moz) silver (including reserves)	Engineering studies for Environmental Assessment	Feasibility study released. Environmental Assessment application submitted	http://www.newgold.com/
Aley	Taseko Mines Limited	niobium; carbonatite- hosted; 094B 027	83.8 Mt at 0.50% Nb ₂ O ₅ ; containing 292.9 Mkg* of niobium *calculated by author	258.8 Mt at 0.37% Nb ₂ O ₅ ; containing 669.4 Mkg* of niobium (including reserves) *calculated by author	Pre-feasibility study, metallurgical testing, mineralogical, engineering and baseline studies	Achieved +50% recovery of niobium in test processing. Pre- feasibility study released	http://www.tasekomines.com/home
Roman Mountain	Anglo American plc (Peace River Coal Inc.)	metallurgical coal; 093I 030	26.6 Mt saleable	4.2 Mt mineable in situ (additional to reserves)	percussion drilling (7735 m)		http://www.angloamerican.com/
Quintette (Babcock)	Teck Coal Limited	metallurgical coal; 093I 011	41.1 Mt clean coal	124 Mt raw coal (excluding reserves)	detailed engineering, 50,000 tonne saleable coal test sample		https://www.teck.com/
Murray River	HD Mining International Ltd.	metallurgical coal; 093I 010	261.6 Mt (proven mineable)	314.2 Mt (in Plot-1 area)	Decline construction, drilling (330 m), engineering and environmental studies.	Decline to 742 m in October. Environmental Assessment application submitted (under review)	http://www.hdminingintl.com/

Table 4. Continued.

Mine	Operator	Commodity; deposit type; MINFILE	Reserves (Proven and Probable)	Resource (Measured and Indicated)	Work program	Significant results	Website
EB (Mt. Spieker)	Walter Energy, Inc. (Western Coal Corp.)	metallurgical coal; 093P 015	15.6 Mt clean coal	N/A	core drilling (860 m), auger drilling (180 m); test pitting		http://walterenergy.com/
Hermann	Walter Energy, Inc. (Western Coal Corp.)	metallurgical coal; 093I 031	9.1 Mt clean coal	N/A (30.6 Mt in situ, including reserves, March 31, 2010)	infill core drilling (999 m)		http://walterenergy.com/
Sukunka	Glencore. Glencore is operator with 75% interest. JX Nippon Oil & Energy Corporation has 25% interest.	metallurgical coal; 093P 012	N/A	140 Mt in situ	drilling (exploration, geotechnical, hydro- geological), 10 tonne bulk sample, trenching, coal quality testing, feasibility studies		http://www.glencore.com/
Giscome	Graymont Western Canada Inc.	limestone 093J 041	N/A	+100 Mt of limestone (>95% calcium carbonate, <5% magnesium carbonate) in situ - Indicated	infill drilling (1854 m), oriented core drilling, auger drilling, test pitting, Environmental Assessment		http://www.graymont.com/
Wapiti East	Fertoz International Inc.	phosphate; 093I 008	N/A	1.54 Mt at 21.6% P ₂ O ₅ (Inferred)	trenching, bulk sample (1250 tonnes of 20 Kt permitted)	1.2 - 2.5 m width of 13 - 27% P ₂ O ₅ in mineralized zone	http://www.fertoz.com/

facility, and water management. In early October, the final application for an Environmental Assessment certificate was submitted. The proposed mine would require 1200-1500 jobs during construction, and a permanent workforce of over 500 employees.

4.1.3. Aley

The **Aley** niobium project (Figs. 1, 2; Table 4, Taseko Mines Limited), the second largest in the world, is hosted by the Aley Carbonatite complex (Devonian-Mississippian). The complex is an alkalic-ultramafic intrusion that is ovoid in plan-view (2.8-2.0 km) and consists mainly of dolomite carbonatite (80-95%), with lesser calcite carbonatite (McLeish, 2011). An upper zone extending to about 200 m depth consists of multi-phase carbonatite with dense cumulate bands of magnetite-apatite-calcite-phlogopite-zircon-columbite \pm olivine, baddeleyite (ZrO_2), and pyrite that have been fragmented and disseminated within the intrusive. A lower zone of silico-carbonatite contains sodic-amphibole and extends to roughly 300 m depth. Niobium occurs in the minerals pyrochlore, fersmite and columbite. The latter two are alteration products of primary pyrochlore and may be related to dolomitization of calcite carbonatite. Pseudomorphs and relict textures of early carbonatite phases are in the dolomitic phase, and pyrite is more abundant. The fenitized aureole with abundant sodic-amphibole is cut by carbonatite dikes or sills and extends for over 500 m into the host rock beyond the brecciated carbonatite margin.

In the first half of 2014, Taseko Mines Limited continued metallurgical test work. Engineering and environmental studies also continued, as did upgrading the March 2012 resource estimate. In September, the company released the results of a pre-feasibility study and submitted a Project Description to initiate a formal environmental assessment. The company proposes an open-pit mine with a strip ratio of 0.5:1, and a 10,000 t/d processing plant. Average annual production over the 24-27 year mine life would be about 9000 tonnes (9 Mkg) niobium in the form of ferroniobium (annual production of about 14,000 tonnes FeNb). The proposed mine would require approximately 700 jobs during construction and 350 direct jobs at full operation. In November, it was announced that the project had been federally approved for a harmonized Environmental Assessment to be conducted by the province.

4.2. Coal projects

4.2.1. Roman Mountain

The **Roman Mountain** expansion project (Fig. 1, Table 4; Peace River Coal Inc.-Anglo American plc) is 1.5 km southwest of the Trend mine. Infill drilling in 2014 was designed to better define fold-fault structures.

4.2.2. Quintette (Babcock)

After delaying the restart of the **Quintette (Babcock)** mine (Fig 1. Table 4) in mid-2013, Teck Coal Limited continued detailed engineering work and completed the extraction of a saleable coal test sample. The final two permit requirements for

the mine were received in late summer. The mine is to reopen the Windy (Big and Little Windy) and Window pits on the northern side of Mt. Babcock. The historic Quintette mine operated from 1982-2000 with development in 1998 of the open-cuts on Mt. Babcock producing about 2 Mt/y clean coal. The new operation would start mining on the northeast in the Window Pit area. The mine is expected to produce an average of 3.5 Mt/y clean coal over a 12 year mine life. In April, Teck announced that the project was being deferred until market conditions improve, and by July the site had transitioned to care and maintenance. The decision affected 80 employees at the site.

4.2.3. Murray River

The 35 km-long, 160 km² northwest-trending licensed area for the **Murray River** project (Fig 1., Table 4) of HD Mining International Ltd. (co-owned by Huiyong Holdings (BC) Ltd. and Canadian Dehua Lvliang Limited) is underlain by Lower to Upper Cretaceous successions above the Gates Formation. The main geologic structure is modeled as an open asymmetric syncline, with reverse faults bringing coal beds in the middle part of the Gates Formation to shallower depths. The Project Description (Rescan Environmental Services Ltd., 2012) identifies 5-6 underground workable Gates Formation seams about 2 to 5 m thick.

In 2014, an underground bulk coal sample project continued (Fig. 11) with driving of a decline starting in January. The decline is planned to be 1500 m long and extend to a depth of 400 m. Contingent on coal quality results of the bulk sample, the proposed mine would have a production rate of 4.8 Mt/y of saleable coal over a 25 year mine life at an estimated capital cost of \$668 million (ERM Rescan, 2014). Commissioning and first production is anticipated before 2018, subject to permitting approval. Over 450 direct jobs are anticipated for the three year construction phase and over 640 jobs during operations. The company plans to use nearly 480 skilled temporary foreign workers at the start of operations, but to replace them with



Fig. 11. Workers entering decline portal at the South Decline site, Murray River.

Canadian workers over ten years. An agreement with Northern Lights College has been signed to train Canadian workers. The company's Environmental Assessment certificate application was accepted in mid-September, and the project is under review.

4.2.4. EB (Mt. Spieker) and Hermann

Walter Energy, Inc continued preparatory work at Wolverine Group expansion projects about 10 km west (EB) and southeast (Hermann) of the Perry Creek mine (Fig. 1). Both projects are certified under the provincial Environmental Assessment. The **EB** project (Fig 1., Table 4) is in a 3.5 x 1.4 km north-northwest trending area that captures the Gates Formation coal sequence. Four gently-to-moderately dipping coal seams (12.6 m average cumulative thickness) of medium-volatile bituminous rank are targeted on the northeastern limb of the Spieker syncline. Start-up is anticipated as early as mid-2016. Production of 2 Mt/y is expected over a mine life of 8 years. A 14-hole drilling (core and auger) and test-pitting program was completed in 2014.

The **Hermann** property (Fig 1., Table 4) is divided into three prospects (Hermann North, Hermann Syncline, and Hermann Gething) with the Hermann North prospect having the best surface mining potential (Minnes, 2007). Five main coal seams in the middle part of the Gates Formation of medium volatile bituminous rank have a cumulative thickness of up to 12.5 m. The proposed mine would have production rate of about 1 Mt/y of clean coal with a 10 year mine life. Three open-pits are proposed, covering an area of 3200 x 490 m. A six-hole core drilling program was completed in 2014 in the Hermann North prospect area. The provincial Environmental Assessment certificate for the project was extended in 2013 for another 5 years.

4.2.5. Sukunka

Glencore's **Sukunka** project (Fig. 1, Table 4) lies in a broad asymmetric syncline with beds that generally dip gently to the southwest. Southwest-dipping thrust faults cut across the property. Three coal seams (1.5-4.5 m thick) in the upper part of the Gething Formation are on the property, including the mineable Skeeter and Chamberlain. Seams in the lower part of the Gething Formation seams have been described historically (COALFILE 669) and are being targeted. In February, feasibility stage assessment began and exploration continued. Drilling focused on two target areas: the Nose Pit area (Fig. 12, upper Gething seams), and a northwest target area (lower Gething seams). Geochemical and geotechnical drilling to collect environmental and slope stability data was also completed. In August, a bulk coal sample of the upper Gething seams was collected for quality, coking and washing tests. Test trenches were also excavated for geotechnical investigation. The proposed Sukunka mine (Stantec Consulting Ltd., 2013) is a combined surface and underground operation that would initially produce 1.5-2.5 Mt/y of clean coal from surface contour mining. Addition of the underground component would increase production to 6 Mt/y. Mine life is estimated at 20 years minimum. Workforce requirements are

estimated at 250 jobs during construction, and 700 employees during operations. The project has been federally approved for a harmonized Environmental Assessment to be conducted by the province and is in the pre-application stage.

4.3. Industrial mineral projects

4.3.1. Giscome

The **Giscome** property of Graymont Western Canada Inc., is underlain by basaltic volcanic rocks and fossiliferous limestones (Fig. 13) of the Slide Mountain Group. High quality limestone grades of about 98% CaCO_3 have been historically described in the area. In 2014, Graymont continued to move the project (Fig. 1; Table 4) through the pre-application stage of Environmental Assessment. In March, eleven infill holes of 300-400 m depth were drilled to better define the available resource. Geotechnical and hydrogeological studies were also completed. The company aims to start construction in mid-2015 with production in 2016. Mine life is estimated at a minimum 50 years. The mine would create 40-60 jobs during



Fig. 12. Skeeter seam in the Nose pit area, Sukunka.



Fig. 13. Coral clast-bearing limestone near the proposed Giscome project. Photo by John DeGrace.

construction and 15-20 full time jobs during operations.

4.3.2. Wapiti East

At the **Wapiti East** project (Fig 1., Table 4) of Ferto International Inc., pelletal and nodular phosphate-bearing units (Fig. 14) are interbedded with siltstones in folded and thrust rocks of the Whistler member (Sulphur Mountain Formation, Spray River Group; Butrenchuk, 1996). The main ore mineral is microcrystalline francolite, a carbonate-rich variety of fluoroapatite. In August, Ferto began a trenching and bulk phosphate sampling program after being delayed by forest fires. The raw bulk sample was to be used in trials by certified organic farmers. A resource estimate (inferred) was also released for an at-surface resource averaging 1m wide and 30 m deep over a strike length of 12.5 km in four target areas. Environmental baseline studies in support of a small mine application were also completed. In November, Ferto submitted an application to extract up to 75,000 t/y of phosphatic rock.

5. Exploration highlights

5.1. Nechako Plateau (Stikine terrane)

5.1.1. Epithermal gold-silver and porphyry copper-gold

In late May, New Gold Inc. resumed its **Blackwater Regional** exploration program, which includes the **Van Tine, Van Tine South, Capoose, Fawn, Fawnie, Emma, Blackwater South/East, Key, and Auro** properties (Figs. 1, 2; Table 5). At the **Key** property, exploration focused on ring-shaped magnetic anomalies and a known copper-molybdenum mineralized feldspar porphyritic intrusive. By August, two drills were on site coring to an average depth of 500 m, and ground IP surveys were completed. The property is underlain by Hazelton and Nechako Group volcanic and sedimentary rocks and is cut by three main northwest to north-northwest trending faults and a northeast-trending cross fault. At **Blackwater South**, drilling was to test the northwest side of the interpreted Auro Pluton for mineralized volcanic rocks in an area historically mapped as Ootsa Lake Formation. The property is underlain by Hazelton, Kasalka, and Nechako Group volcanic and sedimentary rocks in the northwestern part of a large (7 km diameter) ring-shaped magnetic anomaly south of the Blackwater deposit. In October, New Gold reported that drilling at Key and Blackwater South encountered a broad area of porphyry-style mineralization (gold, silver, copper and molybdenum) in intrusive host rock (Fig. 15). Surface reconnaissance work at **Van Tine** and **Fawn** identified epithermal and deeper intrusive-related alteration styles and local high gold grades over narrow widths in Hazelton Group volcanoclastic rocks. Only about 2.5 drill holes were completed at Van Tine and Fawn before drilling was suspended because of forest fires.

In May, New Gold released a NI 43-101 technical report on the **Capoose** project. The deposit is hosted by Late Jurassic sedimentary and mafic-to-intermediate volcanic rocks of the Bowser Lake Group (Simpson and Rotert, 2014). Quartz monzonite of the Capoose Pluton lies a kilometre to the west and is thought to dip eastward under the deposit area (Awmack

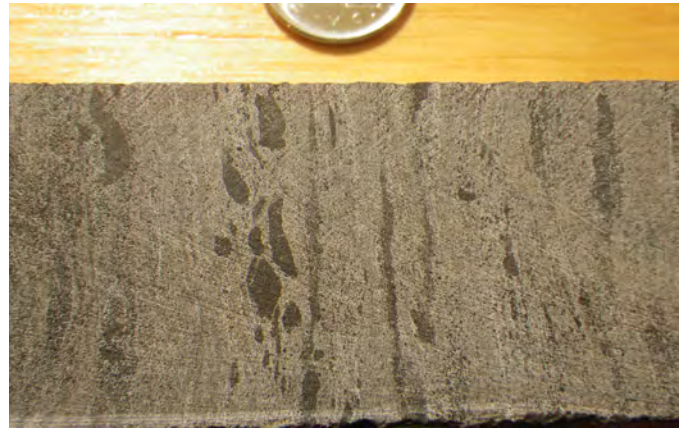


Fig. 14. Phosphate-rich intraclasts in Wapiti East drill core. Core size is AQ (27 mm wide). Photo by John DeGrace.

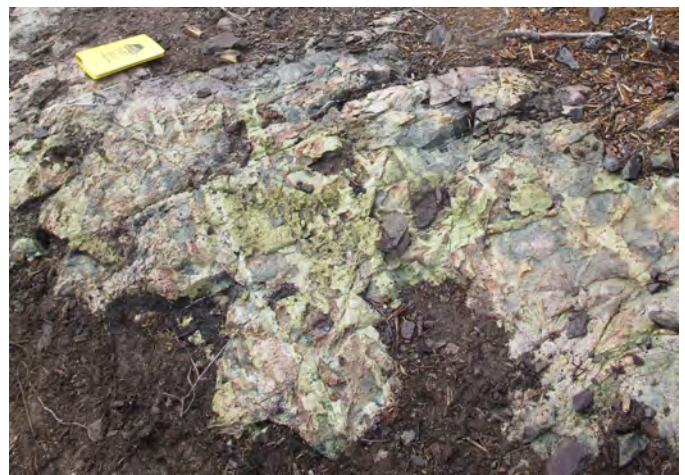


Fig. 15. Propylitically altered Hazelton Group andesite at the Key property.

et al., 2010). Fragmental rhyolite sills are the main host of mineralization and are pervasively altered with a quartz-sericite and garnet-bearing assemblage similar to the Blackwater deposit. Based on garnet geochemistry the sills are of similar age (Late Cretaceous) to the east margin of the Capoose Pluton (Andrew, 1987; Green and Diakow, 1993). Mineralization occurs as pyrite-sphalerite-marcasite-pyrrhotite \pm chalcopyrite, galena, arsenopyrite disseminations and garnet replacements. Quartz-garnet-sulphide veins and veinlets are less abundant. Native gold and electrum are spatially associated with pyrite, and silver with hessite (Ag_2Te) and argentite. High gold and silver grades are not always coincident and appear to be controlled by intrusive contacts and structural intersections. The mineralized zone (above 0.4 g/t AuEq.) is irregularly shaped and extends 825 x 715 m along a north-south trend, with a vertical extent of over 500 m.

The **3Ts** property (Figs. 1, 2, Table 5) of Independence Gold Corp. is underlain by Hazelton Group rhyolite tuffs and flows about 10 km south of Capoose Batholith quartz monzonite (Diakow et al., 1997). The 3Ts project is a low-sulfidation

Table 5. Exploration, Omineca and Northeast regions.

Property	Operator	MINFILE	Commodity; deposit type	Resource (NI 43-101 compliant unless indicated otherwise)	Work program	Significant results	Website
Blackwater Regional (Van Tine, Van Tine South, Fawn, Blackwater South, Key)	New Gold Inc.	093F 037, 43, 45, 50, 52, 53, 56, 69	gold, silver, zinc, lead, copper, molybdenum; epithermal, porphyry, skarn	20.3 Mt at 0.50 g/t gold and 22.4 g/t silver; containing 9953 kg (320,000 oz) gold and 454,733 kg (14.62 Moz) silver - Indicated	drilling (11,045 m; 23 drill holes), ground geophysics (IP, VLF-EM, magnetics) at Key, Fawn and Van Tine	Broad area of porphyry-style mineralization at Key and Blackwater South; epithermal and deeper intrusive-related alteration styles at Van Tine and Fawn	http://www.newgold.com/
Capoose	New Gold Inc.	093F 040	silver, gold (zinc, lead, copper); epithermal	5.45 Mt at 2.52 g/t gold, 71.5 g/t silver; containing 13,717 kg (441,000 oz) gold and 390,038 kg (12.54 Moz) silver (Inferred)	NI 43-101 technical report	Updated resource estimate incorporated 2013 drilling program	http://www.newgold.com/
3Ts	Independence Gold Corp.	093F 055, 68	gold, silver; epithermal	5.45 Mt at 2.52 g/t gold, 71.5 g/t silver; containing 13,717 kg (441,000 oz) gold and 390,038 kg (12.54 Moz) silver (Inferred)	drilling (2683 m)		http://www.ingold.ca/s/Home.asp
Fox and 2 X Fred	Kootenay Silver Inc.	N/A	gold, silver; epithermal	N/A	48 grab samples (Fox) and 175 composite vein samples (2 X Fred)	32.6 g/t gold and 6049 g/t silver peak values (Fox); 0.34 g/t gold average value and 4.31 g/t gold peak value (2 X Fred)	http://www.kootenaysilver.com/s/home.asp
Decar	Cliffs Natural Resources Inc. (60%), First Point Minerals Corp. (40% and 1% NSR)	093K 039, 41, 72	nickel; ultramafic-hosted	1159.5 Mt of 0.124% nickel (Davis Tube Recovered, DTR); containing 1,438 Mt (3169.7 Mlbs) nickel Indicated	Bench scale market test		http://www.cliffsnaturalresources.com/EN/PaPag/default.aspx http://www.firstpointminerals.com/s/Home.asp
Green Gold	0902744 B.C. Ltd.	093G 032	Gold; vein		drilling (388 m)	23 m at 1.64 g/t Au, including 8 m at 4.0 g/t Au (Discovery trench, 2011)	N/A
Cat Mountain	Rift Valley Resources Corp.	094C 069	copper, gold, silver; porphyry		geochemical sampling (rock chip and grab), blasting, trenching	1.2 m of 72.7 g/t gold, 11.45 g/t silver, 0.33% copper; grab samples up to 278 g/t gold, 22.92 g/t silver; 0.27% copper (No. 1 Magnetite Vein)	http://www.riftvalley.ca/Welcome_to_Rift_Valley_Resources_Corp.html

Table 5. Continued.

Property	Operator	MINFILE	Commodity; deposit type	Resource (NI 43-101 compliant unless indicated otherwise)	Work program	Significant results	Website
OGK	Blackeagle Development Corp.	094C 097, 170, 093N 176	copper, gold		mapping and sampling (rock, soil)		
Takla-Rainbow	Manado Gold Corp.	093N 082	gold, silver; epithermal, porphyry	Non NI 43-101 compliant resource estimate of 291,298 tonnes (321,101 tons) at 8.57 g/t (0.25 oz/ ton) gold; inferred and potential (Imperial Metals Corporation, 1988)	drilling (late 2013), mapping, prospecting, geochemical sampling (rock, till)	24.52 m (drilling length) of 0.18% copper, 2.01 g/t gold, 2.0 g/t silver (TR-13-88); 5 m chip sample of 0.292% copper, 0.553 g/t gold and 10.9 g/t silver; historic core samples up to 0.811% copper, 4.51 g/t gold, 10.9 g/t silver	http://www.manadogold.com/
Croy-Bloom	Serengeti Resources Inc.	094D 019, 25, 105	gold, copper, iron, magnetite; porphyry		geochemical sampling (historic drill core)	0.97% copper; 3.1 g/t gold (core sample); three grab samples at 0.38%, 0.84%, and 0.93% copper	http://www.serengetiresources.com/s/Home.asp
Rottacker	Serengeti Resources Inc.	093N 098, 093N 073 (Kwanika)	copper, gold, silver; porphyry	Kwanika Central Zone: 243.6 Mt at 0.23% copper, 0.21 g/t gold, 0.69 g/t silver; containing 559,279 tonnes (1233 Mlbs) copper, 51,632 kg (1.66 Moz) gold, and 167,959 kg (5.4 Moz) of silver; indicated	geochemical sampling (rock)	6.7% copper, 5.9 g/t gold and 464 g/t silver	http://www.serengetiresources.com/s/Home.asp
Kwanika East-Smoke	Serengeti Resources Inc.	093N 152, 168	copper, molybdenum; porphyry	N/A	ground IP survey		http://www.serengetiresources.com/s/Home.asp
Redton (Halobia)	Kiska Metals Corporation	093N 167	copper, molybdenum; porphyry		ground geophysics (11 line-km; magnetics, IP), geochemistry (soil)	N/A	http://www.kiskametals.com/s/Home.asp
Chuchi	Chlormet Technologies Inc., Kiska Metals Corporation	093N 159	copper, gold; porphyry	Non NI 43-101 compliant resource estimate of 50 Mt at 0.21% Cu, 0.21 g/t gold; inferred (Digger Resources Inc., 1991)	ASTER satellite survey (Chlormet), field review, rock sampling (Kiska)	N/A	http://www.kiskametals.com/s/Home.asp=00022839

Table 5. Continued.

Property	Operator	MINFILE	Commodity; deposit type	Resource (NI 43-101 compliant unless indicated otherwise)	Work program	Significant results	Website
Col-Later	Pacific Empire Minerals Corp.	093N 101	copper, gold, silver; porphyry	Non NI 43-101 compliant resource estimate of 1.81 Mt at 0.6% copper; indicated (Kookaburra Gold Inc., 1989)	drilling (848 m), ground IP survey	N/A	www.pencorp.ca/ Welcome_to_Pacific_ Empire_Minerals.html
Thor	Copper North Mining Corp.	094D 064, 5	copper, gold, silver; porphyry		ground IP survey (80 line-km)	N/A	http://www. coppertonmining. com/s/Home.asp
Kemess East	AuRico Gold Inc.	094E 021	copper, gold, silver; porphyry		drilling (16,877 m), mapping, geochemistry (rock), airborne geophysics (VTEM, 1111 line- km), metallurgical studies	768 m of 0.442 g/t gold and 0.392% copper (KH- 14-04); 304 m of 0.557 g/t gold and 0.421% copper (KH-14-09); 601 m 0.500 g/t gold and 0.391% copper (KH-13-08)	http://www.auricogold. com/
UDS	Serengeti Resources Inc.	094E 070, 115, 117, 120, 121, 244	gold, silver, copper, zinc, lead; porphyry, epithermal	N/A	mapping, geochemical sampling (rock, soil, silt)	10 samples between 0.1 - 0.7% copper (August 30 target); skarn sample 0.26% copper, 1.0 g/t gold	http://www. serengetiresources. com/s/Home.asp
Akie	Canada Zinc Metals Corp.	094F 031	zinc, lead, silver; sedimentary exhalative	12.7 Mt at 8.4% zinc, 1.7% lead and 13.7 g/t silver; containing 1.07 Mt (2352.3 Mlbs) zinc, 214,000 tonnes (471.8 Mlbs) lead, and 174,024 kg (5.6 Moz) silver indicated	drilling (2855 m), geophysics (airborne gravity)	9.44 m of 8.93% zinc, 1.25% lead, 10.54 g/t silver (A-14-111); 7.87 m of 5.97% zinc, 0.94% lead, 8.02 g/t silver (A-14-12); 8.42 m of 7.43% zinc, 1.19% lead, 10.72 g/t silver (A-14-115); 5.72 m of 5.45% zinc, 0.94% lead, 8.49 g/t silver (A-14-117)	http://www. canadazincmetals.com/
Kechika Regional (Yuen North, Mt. Alcock)	Canada Zinc Metals Corp.	094F 013, 15	zinc, lead, silver; sedimentary exhalative	N/A	airborne gravity survey (940 line- km), geochemical sampling (soil) at Yuen North	zinc-lead-barite anomaly expanded to 4500 x 500 m at Yuen North	http://www. canadazincmetals.com/

Table 5. Continued.

Property	Operator	MINFILE	Commodity; deposit type	Resource (NI 43-101 compliant unless indicated otherwise)	Work program	Significant results	Website
Cirque	Teck Resources Limited	094F 008	zinc, lead, silver; sedimentary exhalative	Non NI 43-101 compliant resource estimate of 24.7 Mt at 8.5% zinc, 2.3% lead and 50.8 g/t silver; indicated (Curragh Resources Inc., 1991)	drilling (5200 m), airborne VTEM survey, airborne gravity survey	N/A	https://www.teck.com/
Kechika Regional (Elf, Fluke, Pie, Cirque East, Yuen)	Teck Resources Limited	094F 008, 9, 11, 13 23	zinc, lead, silver; sedimentary exhalative	N/A	airborne VTEM survey, airborne gravity survey (840 line-km), re-logging and sampling historic core (3500 m), geochemical sampling (rock), mapping, prospecting	N/A	https://www.teck.com/
Wapiti River	Canadian Dehua International Mines Group Inc.	093I 013	metallurgical coal;	201.9 Mt (coal seam thickness >1.0 m); Measured and Indicated	feasibility study, baseline studies	N/A	http://www.dehua.ca/
Roman Northwest	Anglo American plc (Peace River Coal Inc.)	N/A	metallurgical coal;	N/A	percussion drilling (2121 m), core drilling (1535 m), trenching	N/A	http://www.angloamerican.com/
Waterfall	Anglo American plc (Peace River Coal Inc.)	N/A	metallurgical coal;	N/A	percussion drilling (1410 m), core drilling (360 m), trenching	N/A	http://www.angloamerican.com/
Huguenot	Colonial Coal International Corp.	093I 014	metallurgical coal;	132.0 Mt (surface), 145.7 Mt (underground) in situ; Measured and Indicated	carbonization testing, coal washing studies, baseline studies	N/A	http://ccoal.ca/
Dunlevy	Jameson Resources Limited (Dunlevy Energy Inc.)	094B 023, 25	metallurgical coal;	N/A	drilling (1302 m)	clean coal intersections up to 1.52 m thick; unoxidized samples indicate high- volatile A bituminous coals	http://www.jamesonresources.com.au/

epithermal vein system with more than a dozen subvertical, north-striking mineralized veins up to 900 m long and 20 m wide that appear to have formed by open space filling along faults (Fig. 16). The veins have quartz-calcite \pm sericite-adularia-amethyst gangue encompassing wall rock fragments, and feature crustiform banding and comb crystal textures. Fragments of breccia in the veins indicate multiple pulses of vein formation. Sparse sulphide mineralization occurs as pyrite and Cu-Ag sulphosalt(?) disseminations and sooty hairline veinlets, with accessory chalcopyrite, sphalerite, and galena. An 80 m thick Late Cretaceous (73.8 Ma, U-Pb zircon; Friedman et al., 2001) microdiorite sill crosscuts the veins. However, an Early Miocene (21.2 Ma Re-Os; David Pawliuk, personal communication, 2014) hydrothermal quartz breccia vein above the sill implies a protracted mineralizing history. In early May, an updated NI 43-101 compliant inferred resource estimate was released that incorporates data from 2012 and 2013 drilling programs. Drilling of new targets started in late May, but was suspended in late August after samples from 18 holes failed to return significant gold values.

In April, Kootenay Silver Inc. announced discovering two high-level epithermal systems resulting from grassroots exploration near their Copley (MINFILE 093F 070) property. The **Fox** property (Fig. 1, Table 5) features two northeast-trending mineralized zones, 400 m apart, near a 3 km long magnetic low. Subvertical, open-space quartz-sulphide veins and breccia fills have been identified in zones of quartz-sericite-pyrite alteration. The area is underlain by Ootsa Lake Formation felsic volcanic rocks and feldspar porphyry. At **2 X Fred** (Two Times Fred; Fig. 1, Table 5), gently west-dipping chalcadonic and banded quartz veins, stockwork, and breccia fill were found across a 2.5 x 1.75 km area in Endako Formation volcanic rocks. Veins are centered on a coincident airborne EM and magnetic high anomaly. The magnetic anomaly has intersecting north-south and northeast-trending components. Sampling of quartz

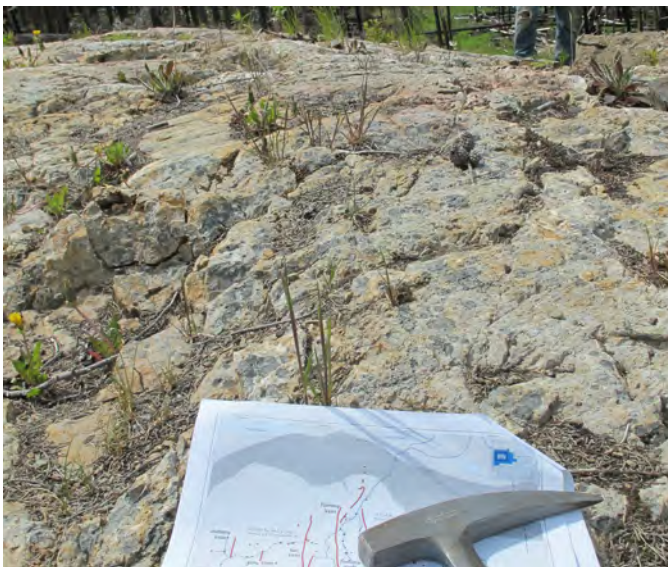


Fig. 16. Johnny vein at the 3Ts property.

vein material returned anomalous gold and silver values.

In 2014, Geoscience BC continued the Targeting Resources through Exploration and Knowledge project (TREK; Clifford and Hart, 2014), which covers part of the Nechako Plateau and includes mineral discoveries made during regional mapping by Diakow et al., (1997). Releases included results of geochemical and mineralogical surveys (Sacco et al., 2014), airborne magnetic data (Aeroquest Airborne Ltd., 2014; Geoscience BC), basal till geochemical and mineralogical data (Jackaman and Sacco, 2014), basal till potential maps (Sacco et al., 2014), and geologically constrained 3D Earth modeling of gravity and magnetic data (Mira Geoscience Ltd., 2014).

5.2. Cache Creek terrane

5.2.1. Ultramafic-hosted nickel

At the **Decar** project (Figs. 1, 2, Table 5), managed and operated by Cliffs Natural Resources Exploration Canada Inc., nickel occurs as a fine-grained, pervasively disseminated nickel-iron alloy (awaruite; Ni_{2-3}Fe) in serpentinized peridotites of the Trembleur ultramafic unit, an obducted ophiolite sequence (Schiarizza and MacIntyre, 1998). Typically, nickel is mined from magmatic Ni-sulphide or lateritic deposits and the Decar project is the first to assess the economic viability of awaruite. Two broad northwest-trending mineralized zones of awaruite and magnetite, alteration products of nickeliferous olivine, are recognized on the property. A near-vertical foliation is thought to parallel diffuse shear zones that developed prior to and during serpentinization. The age of mineralization is unknown, but is thought to be related to post-accretionary strike-slip faulting.

A recent NI 43-101 compliant technical report and preliminary economic assessment (McLaughlin et al., 2013) describes an open-pit mining operation with 114,000 t/d milling rate that would produce an average 37,369 tonnes (82.4 Mlbs) of nickel annually over a 24 year mine life. Although Cliffs elected to proceed with a pre-feasibility study in 2013, which was scheduled for completion in August 2015, their continued interest is uncertain. Activities in 2014 included First Nations engagement and baseline environmental studies. In April, First Point Minerals Corp. reported completing an initial market test for concentrate produced from the Decar project. The bench-scale tests indicate that Decar concentrate can be blended with laterite nickel as feedstock in ferronickel production, and as direct feed in stainless steel circuits.

5.2.2 Listwanite-associated lode gold

In October, private company 0902744 B.C. Ltd. completed a 4-hole diamond drilling program at the **Green Gold** property (Figs. 1, 17; Table 5) in the Pinchi fault zone west of Prince George. At the intersection of north-northwest and north-northeast trending faults, Cache Creek complex pelagic sedimentary rocks and limestones are juxtaposed against metabasalts, diabase, and metagabbro. Drilling encountered fine-to-medium grained intrusive rock with varying alteration assemblages including pervasive argillic (with chlorite and talc), quartz-sericite-pyrite, and pervasive silica. Secondary



Fig. 17. Core drilling at Green Gold.

biotite and fuchsite were identified as disseminations and vein components; and disseminated and veinlet-hosted pyrite and local crackle breccia were noted.

5.3. Quesnel trough (Quesnel terrane)

5.3.1. Porphyry copper-gold

The **Cat Mountain** property (Fig. 1, Table 5) of Rift Valley Resources Corp is a kilometre outside the east margin of the Hogen intrusive complex. It is underlain by mafic-intermediate volcanoclastic rocks of the Witch Lake succession (Takla Group; Upper Triassic) that host small syenitic intrusions. The intrusions appear to form a ring-dike complex along the summit of Cat Mountain, and are spatially associated with a 700 x 400 m variably altered and mineralized area (Macdonald, 2013). Steeply dipping, northwest- and north-trending magnetite-sulphide \pm quartz-calcite veins up to 0.6 m wide occur in an area of complex syn- and post-mineral faulting. Gold-copper \pm silver mineralization occurs in the magnetite veins, and as sulphide and secondary copper mineral disseminations and fracture fills. The deposit type appears to be transitional between shear-hosted vein and alkalic porphyry. Sampling was conducted in July 2014 to better determine the strike length of high-grade gold mineralization. A blasting and sampling program followed later in the season.

About 13 km to the west, the **OGK** property (Fig. 1, Table 5) is underlain by granodiorite to monzonitic rocks of the Hogen intrusive complex in its northern portion and by the Duckling Creek syenite complex, a multi-stage alkaline dike swarm, in its southern portion. Vein-hosted and disseminated copper sulphide, and secondary copper mineralization has been recognized. The property is under option to Blackeagle Development Corp. and a grassroots program of mapping and sampling was conducted in 2014.

The **Takla-Rainbow** property (Fig. 1, Table 5) of Manado Gold Corp. is in Twin Creek succession volcanic rocks (Takla Group) at the east margin of the Hogen intrusive complex. Sub-vertical auriferous quartz veins follow the east-southeast-striking Twin Creek Fault zone that cuts the contact between dioritic and volcanoclastic rocks. Sheared quartz syenite-to-granite porphyry dikes of probable Early Cretaceous age appear spatially related to mineralization. Mineralization occurs as fracture-controlled and disseminated sulphide and native gold with silica-carbonate alteration. The results of a 5-hole drilling program conducted in late 2013 were announced in January 2014. Several silicified, pyrite-bearing mineralized zones were intersected in two of the drill holes, including an interval over 24 m that ended in gold-silver-copper mineralization. Low-grade gold and silver mineralized intervals were returned in the other holes. A grassroots exploration program in mid-summer 2014 focused on identifying porphyry style mineralization in historic drill core. Geologic mapping and sampling covered four target areas, and historic drill collars were re-surveyed.

Serengeti Resources Inc. conducted grassroots exploration in 2014 at the **Croy-Bloom**, **Rottaker**, and **Kwanika East-Smoke** properties (Fig. 1, Table 5). At the historic Soup prospect on **Croy-Bloom** copper-gold mineralized microdiorite associated with a lens of magnetite skarn was sampled from historic drill core. The area is underlain by Takla Group volcanic rocks and a 700 m wide, northwest-trending monzodioritic pluton at the northern end of the Hogen intrusive complex. The target area comprises stratiform magnetite skarn exposed over a kilometre of strike length, and a 1000 x 600 m copper-gold soil anomaly. About 3 km to the south, composite grab samples of copper mineralized garnet-diopside skarn and chlorite schist were collected from the historic Kli showing, where copper soil anomalies are known. The **Rottaker** prospect is contiguous with the southern portion of the Kwanika property, for which a recent NI 43-101 compliant technical report and preliminary economic assessment was released proposing a 15,000 Mt/y combined open-pit and underground block cave operation with 13.4 year mine life and initial capital cost of \$364 million (Gray and Robillard, 2013). Two porphyry deposits at Kwanika, one copper-gold, the other copper-gold-silver-molybdenum are roughly a kilometre apart within the western margin of the Hogen intrusive complex near the Pinchi fault. At **Rottaker**, disseminated and vein sulphide has been identified in sheared, chlorite-sericite altered monzodiorite of the Hogen intrusive complex about 4 km east of the Pinchi fault. About 8 km northeast of the Kwanika camp, a reconnaissance IP survey was

completed at **Kwanika East-Smoke**. The property is underlain by Takla Group volcanic rocks (Twin Creek and Witch Lake successions) and monzodiorite of the eastern margin of the Hogem intrusive complex. The claims follow an east-northeast trending structure and the property contains a strong VTEM anomaly.

Kiska Metal Corporation undertook grassroots and early-stage work at the **Redton** and **Chuchi** properties (Fig. 1, Table 5) in 2014. At Redton (Halobia), an area underlain by altered intrusive rocks of the Hogem intrusive complex, ground based geophysics and soil sampling were completed to expand a 3 x 1 km copper-in-soil geochemical anomaly and define drill targets. At **Chuchi**, on the east end of the southeastern leg of the Hogem intrusive complex, a field review and rock sampling was completed ahead of a decision on an option agreement with Chlormet Technologies Inc. The property is underlain by a cluster of porphyritic monzonite stocks, dikes, and sills that cut Chuchi Lake succession (Takla Group) volcanic and hornfelsed sedimentary rocks. The central target area features gold, copper, and silver soil anomalies over a 1 x 3 km area of drilling-established copper-gold mineralization, and IP anomalies in the immediate vicinity. Geological relationships suggest that sedimentation, hypabyssal intrusions and mineralization were roughly coeval (Nelson and Bellefontaine, 1996).

The **Col-Later** property (Fig. 1, Table 5) of Pacific Empire Minerals Corp. covers the northern margin of the southeastern leg of the Hogem intrusive complex where it cuts alkaline volcanic rocks of the Chuchi Lake succession (Takla Group). Mineralization is hosted in altered monzonite, syenite, and andesitic rocks and occurs as disseminated and vein-hosted copper sulphide and secondary copper minerals in steeply dipping shear zones. The best mineralization has been identified in potassic and calc-potassic alteration suites. Mineralization with a higher bornite-chalcopryrite ratio appears to be controlled by the intersection of northwest- and northeast-trending fracture zones. Late in the year, a ground IP survey was carried out on the east side of the property and two drill holes were completed on the west side, where targets are covered by till.

5.4. Toodoggone area (Stikine terrane)

5.4.1. Porphyry copper-gold

The **Thor** property (Fig. 1, Table 5), under option to Copper North Mining Corp., straddles a north-trending fault that separates Sustut Group sedimentary rocks on the west from Asitka Group carbonate and volcanic rocks, Takla Group mafic volcanic rocks, and monzodioritic intrusive rocks (Early Jurassic) on the east. Regional magnetic data suggest that a large intrusive body underlies Sustut Group rocks and coincident IP chargeability anomalies are being targeted for porphyry style mineralization. Mineralization on the property occurs as sulphide disseminations, veins, and semi-massive pods in north- to northwest-trending silicified shear zones. A ground IP survey was conducted in 2014 to better define targets for drill testing.

The **Kemess East** (Fig. 1, Table 5) deposit of AuRico Gold

Inc. appears to be similar in size as KUG about two km to the west (see above). Mineralization is hosted primarily in a quartz monzonite body and, to a lesser degree, in Takla Group basaltic andesites. Gold is hosted in chalcopryrite in veins and disseminations; the highest copper-gold grades are associated with biotite alteration. Late calcite-zeolite alteration related to the Sovereign pluton appears to be grade destructive. Exploration drilling continued in 2014 with twelve steeply-inclined holes up to 1600 m long (Fig. 18). An airborne VTEM geophysical survey was flown and metallurgical test work completed.

The **UDS** property (Fig. 1, Table 5) of Serengeti Resources Inc. is also underlain by Takla Group and Toodoggone Formation volcanic rocks, and intrusive rocks of the Black Lake plutonic suite. Grassroots exploration in 2014 identified two target areas with potential porphyry copper-gold signatures. Copper mineralized outcrops and phyllic alteration is associated with felsic dikes that occupy a faulted contact between Black Lake intrusive and Takla Group volcanic rocks. Mineralized skarn occurrences were identified nearby. Several MINFILE occurrences in the area describe epithermal style polymetallic mineralization in northwest-trending, shear-hosted, brecciated quartz-calcite-barite veins.

5.5. Kechika trough and Rocky Mountain Trench area (ancestral North America)

5.5.1. SEDEX zinc-lead-silver

At the **Akie** property (Figs. 1, 2, Table 5) of Canada Zinc Metals Corp., the Cardiac Creek deposit is a zone of baritic zinc-lead-silver SEDEX mineralization hosted in Gunsteel Formation shale (Earn Group; Upper Devonian). The moderate to steeply southwest-dipping tabular mineralized body is about 20 m thick and extends for a strike length of 1400 m. From bottom to top, mineralization defines a stratiform sequence of: 1) bedded to massive barite; 2) mottled sphalerite-galena-pyrite with decreasing barite-calcite; 3) grey-white sphalerite bands with thickly banded pyrite and minor galena and barite; 4) fine



Fig. 18. Newly drilled core (KH-14-02), Kemess East.

banded pyrite; 5) fine banded barite-pyrite; and 6) fine nodular barite. The mineralized zone is commonly interbedded with siliceous Gunsteel Formation shale, and underlain by marine turbidites of the Paul River Formation (Lower Devonian). An 8-hole drilling program in 2014 focused on the Cardiac Creek deposit (Fig. 19). Canada Zinc Metals has an approved exploration permit and completed engineering design for an underground drilling program. Environmental baseline studies are ongoing.

As part of the **Kechika Regional** project, soil samples were collected at the **Yuen North** property (Fig. 1, Table 5). The survey expanded historic soils data to cover the western panel of Gunsteel Formation on strike with Teck Resources' Cirque project, 17 km to the southeast, and confirmed a northwest-trending linear zinc-lead-barite anomaly. In November, a helicopter-borne FALCON™ gravity gradiometry and LIDAR survey was flown at 200 m line spacing over the **Akie**, **Yuen North** and **Mt. Alcock** properties.

The **Cirque** project (Figs. 1, 2, Table 5) is a joint venture between Teck Resources Limited and Korea Zinc Company, Ltd. that includes the **Cirque**, **Elf**, **Fluke**, **Pie**, **Cirque East**, and **Yuen** properties. As part of a multi-year exploration program searching for SEDEX mineralization in shales of the Gunsteel Formation, the 2014 program included drilling (Fig. 20), airborne VTEM and gravity surveys, re-logging and sampling of historic drill core, mapping and prospecting.

5.5.2. Carlin-type gold?

Prompted by recent Carlin-type gold and realgar discoveries in Proterozoic to Paleozoic strata of Selwyn basin in Yukon Territory, the British Columbia Geological Survey initiated a project to evaluate the potential of similar mineralization in Kechika trough, the southern continuation of Selwyn basin (Rukhlov et al., 2015). Robust statistical analysis of multi-element geochemical data from the National Geochemical Reconnaissance (federal) and Regional Geochemical Survey (provincial) surveys, document $\text{Au} \pm \text{As} \pm \text{Hg} \pm \text{Tl} \pm \text{Sb}$ enrichment in stream and lake sediments from Kechika trough and Selwyn basin. In both areas, anomalous values are spatially related to platform to deep-water basin transitions and to extensional structures that originated during basin subsidence and then reactivated as thrusts during regional shortening. These anomalies and geologic setting suggest that Kechika trough may hold potential for Carlin-type deposits (Rukhlov et al., 2015).

5.6. Peace River Coalfield

5.6.1. South of Tumbler Ridge

The **Wapiti River** property of Canadian Dehua International Mines Group Inc. (Canadian Dehua) lies 25 km southeast of the Trend mine (see above; Fig. 1). Canadian Dehua reports a total of 63 coal seams in the Gates and Gething formations. Seismic interpretations (2-D) show a gently-folded syncline-anticline pair cut by reverse faults. A feasibility study for the No. 1 mine at Wapiti River, completed in 2014 by Golder Associates



Fig. 19. Drilling at the Cardiac Creek deposit, Akie. Photo by John DeGrace.



Fig. 20. Drilling at the Cirque deposit. Photo by John DeGrace.

Ltd. and Snowden Mining Consultants Inc., proposes a three-level underground longwall mining operation with a clean coal production rate of 8.5 Mt/y and a mine life of 46.4 years. The study identified 14 mineable coal seams based on thickness, depth, geologic structure and coal quality. The mineable coal

seams have an average cumulative thickness of 30 m, lie at depths between 300-1200 m, are medium-to-high volatile bituminous in rank, and washable to a low ash (about 10%) clean coal product. Employment requirements are forecast at 600-800 direct jobs. In 2014, Dehua focused on permitting, making arrangements for rail and power lines, and continuing environmental baseline studies.

The Trend mine expansion projects **Roman Northwest** and **Waterfall** (Fig. 1, Table 5; Peace River Coal Inc.-Anglo American plc) lie northwest of Roman Mountain following the close-folded Murray syncline and Waterfall anticline fold pair. Winter drilling and trenching programs were completed at both projects from January through early April 2014. Additional drilling at Waterfall was to start in December 2014 to continue into 2015.

At the **Huguenot** project of Colonial Coal International Corp. (Fig. 1, Table 5) the average cumulative thickness of Gates Formation coal seams in three separate blocks is 15 to 19 m. A recent NI 43-101 compliant preliminary economic assessment study (Evenson, 2013) described a combined surface and underground longwall mining operation that would produce between 1.4 Mt-5.9 Mt/y, averaging 3.0 Mt/y of clean coal over 31 years. Total clean coal production over the life of mine would be 89 Mt. Carbonization testing and coal washing optimization studies were undertaken in 2014, and environmental baseline studies continued.

5.6.2. Hudson's Hope area

At the **Dunlevy** property (Fig. 1, Table 5) of Jameson Resources Limited, a 13-hole drilling program testing Gething Formation coal seams was completed in 2014. The work confirmed coal seams previously located by hand trenching, and found clean coal intersections up to 1.5 m thick. Dunlevy geologists consider that the thickest coal seam is one that has been mined elsewhere in the north Peace region (Grant seam). Unoxidized samples taken from several seams demonstrate that the property hosts high-volatile A bituminous coal. The company is targeting a single seam 1.5-2.5 m thick for potential underground extraction by longwall mining, and speculates that 100-150 Mt of metallurgical coal may be recoverable outside the Coal Land Reserves restricted area.

6. Outlook for 2015

Thompson Creek Metals Company Inc. will likely complete their second full year of production at the **Mt. Milligan** mine and approach full design throughput capacity and metal recoveries by the end of the year. New Gold Inc. will likely move **Blackwater** through the final stages of permitting for a mining operation. AuRico Gold Inc. will continue advancing **Kemess Underground** through Environmental Assessment and delineating the orebody at **Kemess East** with additional drilling. Taseko Mines Limited will optimize the economics and technical aspects of the **Aley** project as it moves through Environmental Assessment. Canada Zinc Metals Corp. and Teck Resources Limited will continue drilling at **Akie** and

Cirque, and exploring the southern portion of the Kechika Trough SEDEX belt. Teck may also have a drilling program less than 10 km northwest of the Serengeti Resources Inc. Croy-Bloom property at **Kliyul**, recently optioned from Kiska Metals Corporation. Private company 0902744 B.C. Ltd. will continue drilling at **Green Gold**. Graymont Western Canada Inc. will continue advancing the **Giscome** project through Environmental Assessment and final permitting approval.

In the Northeast region, Anglo-PRC will continue to explore expansion projects of the **Trend-Roman** mine. Walter Energy, Inc will continue evaluating and preparing the remaining Wolverine Group projects for replacement of the **Perry Creek** mine. HD Mining International Ltd's decline at **Murray River** will likely reach the target depth for extracting a bulk coal sample. Glencore will continue feasibility stage exploration at **Sukunka**. Canadian Dehua will conduct a 3-D seismic program to further characterize geology and structure for mine development at **Wapiti River**, and will continue working on infrastructure permits. Fertoz International Inc. will continue their bulk phosphate sample program at **Wapiti East** and may be granted a small mine permit.

Acknowledgments

The information in this report was derived from news releases, quarterly reports, MD&A reports, company websites, technical reports, MINFILE reports, COALFILE reports, Geological Survey of British Columbia publications, site visits and discussions with industry professionals and personnel. I thank the geologists and miners who were generous with their time and resources, and those who provided expenditure and related information. I also thank the Regional Geologists and the Mineral Development Office for additional support, and the skilled staff at the Ministry of Energy and Mines regional office in Prince George. Very special thanks to John DeGrace (P.Geo, P.Eng.) for acting as Regional Geologist for the better part of the field season, and for providing thoughtful review and editing of this chapter.

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Exploration and mining in the Kootenay-Boundary Region, British Columbia

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Recommended citation: Katay, F., 2015. Exploration and mining in the Kootenay-Boundary Region, British Columbia. In: Exploration and Mining in British Columbia, 2014. British Columbia Ministry of Energy and Mines, British Columbia Geological Survey, Information Circular 2015-2, pp. 29-65.

1. Introduction

The Kootenay-Boundary Region, in the southeast corner of the province (Fig. 1), offers a variety of mining and exploration opportunities, and is accessible by well-developed infrastructure. Five operating coal mines produce most of Canada's coal exports. The historic lead-zinc-silver Sullivan Mine is in the region, and exploration for base metals and precious metals continues to be a focus. Several mines produce industrial minerals including silica, magnesite, gypsum, and graphite.

In 2014, total exploration spending and drilling increased relative to 2013 (Fig. 2), with about \$50.4 million spent on exploration. Exploration drilling (approximately 125,000 m) increased for metals projects relative to 2013, whereas coal exploration drilling was scaled back. With lower coal prices, drill programs in the coal mines were cut, and spending was focused on mine development and mine evaluation projects (Fig. 3), mainly on Environmental Assessment requirements for mine expansions. Coal production increased from 25.6 Mt in 2013, and is expected to be close to 27 Mt for 2014. Highlights for 2014 include:

- approval of the Elk Valley Watershed Management Plan
- continued advances in major mine expansion plans at operating coal mines, with several projects in pre-application of Environmental Assessment (Elkview Baldy Ridge Extension, Line Creek Burnt Ridge Extension, Fording Swift) and the Greenhills Cougar Pit Extension nearing pre-application
- advances in new coal projects such as Crown Mountain (NWP Coal Canada Ltd.), which entered pre-application stages of Environmental Assessment, Coal Mountain Phase II (Teck Coal Limited), which is nearing pre-application, and continued exploration drilling at Michel Creek (CanAus Coal Limited)
- the Kootenay West gypsum mine (CertainTeed Gypsum Canada Inc.) entered pre-application of Environmental Assessment
- base metal exploration in the Belt-Purcell Basin in the East Kootenays (Vine, Sully, Ptarmigan)
- base and precious metal exploration in the West

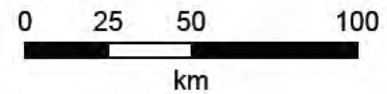
Kootenays (Jersey-Emerald, Jumping Josephine, Swift Katie, Thor, Willa, LH)

2. Geological overview

Plate tectonic processes have operated along the western margin of North America for over 2.5 billion years, and the tremendous mineral endowment of British Columbia is intimately linked to these processes (e.g., Nelson et al., 2013). The Canadian Cordillera is a collage of allochthonous terranes, parautochthonous terranes and autochthonous basement, containing diverse rocks and structures, and hence, metallogenic styles.

The Kootenay-Boundary Region (Fig. 1) 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, entirely exotic to North America, accreted to the continental margin in the middle Jurassic (Nelson et al., 2013).

Historically, the Canadian Cordillera has been divided into five northwest-trending physiographic belts. The Kootenay-Boundary Region includes two of these belts (Fig. 4), 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). The Omineca belt and the Rocky Mountain Foreland belt are separated by the Southern Rocky Mountain Trench (Fig. 4), which formed during Tertiary transtensional collapse (Monger et al., 1982; Nelson et al.,



Exploration and Mining in British Columbia, 2014. British Columbia Ministry of Energy and Mines, British Columbia Geological Survey IC 2015-2

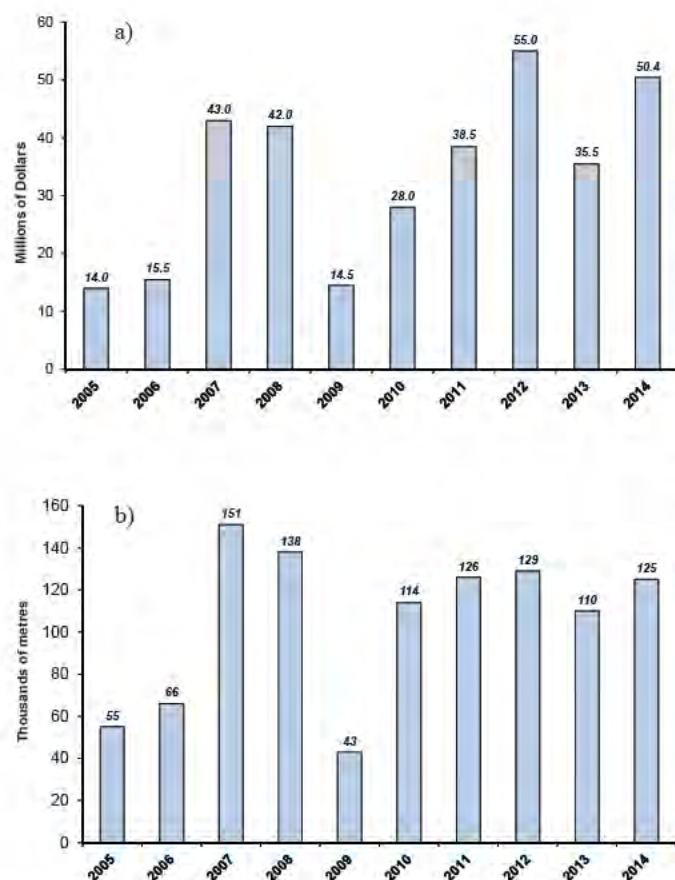


Fig. 2. a) Exploration spending and b) drilling in the Kootenay-Boundary Region, 2014.

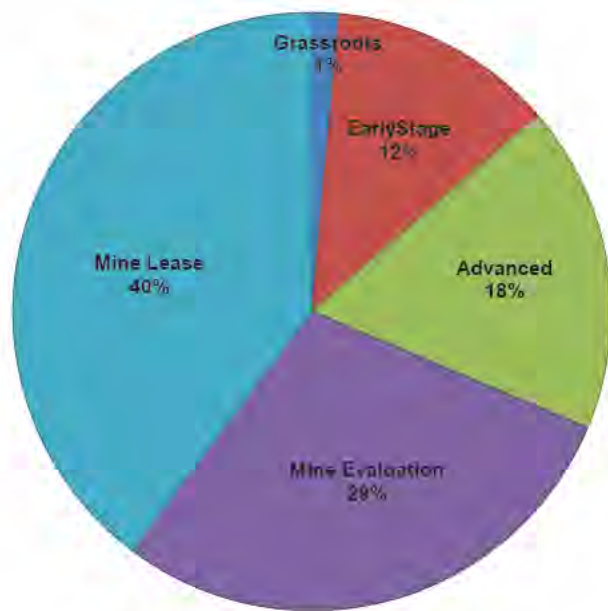


Fig. 3. Expenditures by exploration stage, Kootenay-Boundary Region, 2014.

2013). The Rocky Mountain Trench Fault is a normal fault on the eastern edge of the trench, with approximately 5 km of west-side-down displacement.

2.1. Tectonostratigraphic elements and terranes

2.1.1. Laurentian basement (ancestral North America)

Archean to Mesoproterozoic Laurentian basement rocks extend beneath the Cordillera west of the southern Rocky Mountain Trench (Fig. 5). Northeast-trending basement structures influenced both Cordilleran tectonism and metallogeny (e.g., McMechan, 2012; Nelson et al., 2013). For example, the Moyie-Dibble Creek fault has been interpreted by Price (1981) and McMechan (2012) as the surface expression of the Vulcan low (Fig. 5). Abrupt changes in thickness and facies in Proterozoic to early Paleozoic strata across northeast-trending structures along this trend suggest periodic reactivation of basement structures. In the West Kootenays, the southwestward shift in trend at the south end of the Kootenay Arc, and other structures indicate a deep structural influence that is also on trend with the basement Vulcan Low.

Although generally deeply buried, crystalline basement is locally exposed in structural culminations such as the Shuswap-Monashee complex (Figs. 4, 5). Located west of the east-dipping Columbia River fault (Fig. 4), the complex is bounded by early Tertiary normal faults, and was exhumed during Tertiary extension (Monger, 1999). Paleoproterozoic granitic and granodiorite gneisses are unconformably overlain by a Neoproterozoic to Paleozoic platformal paragneiss assemblage of calc-silicate gneiss, pelitic gneiss, psammitic gneiss, quartzite and marble. This paragneiss assemblage hosts stratabound lead-zinc deposits, including Ruddock Creek, Jordan River, and Big Ledge (Fyles, 1970; Höy 1982b), and flake graphite deposits.

2.1.2. Proterozoic basins on the western margin of ancestral North America

Following the Hudsonian orogeny (2.0-1.8 Ga), but before the breakup of ancestral North America (780-570 Ma), sedimentary successions accumulated in the Canadian Cordillera (Nelson et al., 2013). In the Kootenay-Boundary region, the Belt-Purcell basin (1.47-1.4 Ga), was a north-northwest trending intracratonic rift that extended into northern Idaho and Montana (Fig. 6). In Canada, the basin includes a 10-12 km section of turbiditic rocks (Aldridge Formation), and tholeiitic sills (Moyie sills; Lydon, 2007). Isopach variations along northeast-striking synsedimentary faults suggest that the basin was also affected by movement along transverse basement structures associated with the Vulcan low. The Belt-Purcell Supergroup hosts the Sullivan Pb-Zn-Ag SEDEX deposit (see Lydon, 2007).

By the end of the Mesoproterozoic (ca. 1.0 Ga), Laurentia was part of the supercontinent Rodinia. Rifting of this supercontinent occurred in at least two main episodes (Colpron et al., 2002). The earlier phase (ca. 723-716 Ma) in southern British Columbia resulted in deposition of the Windermere

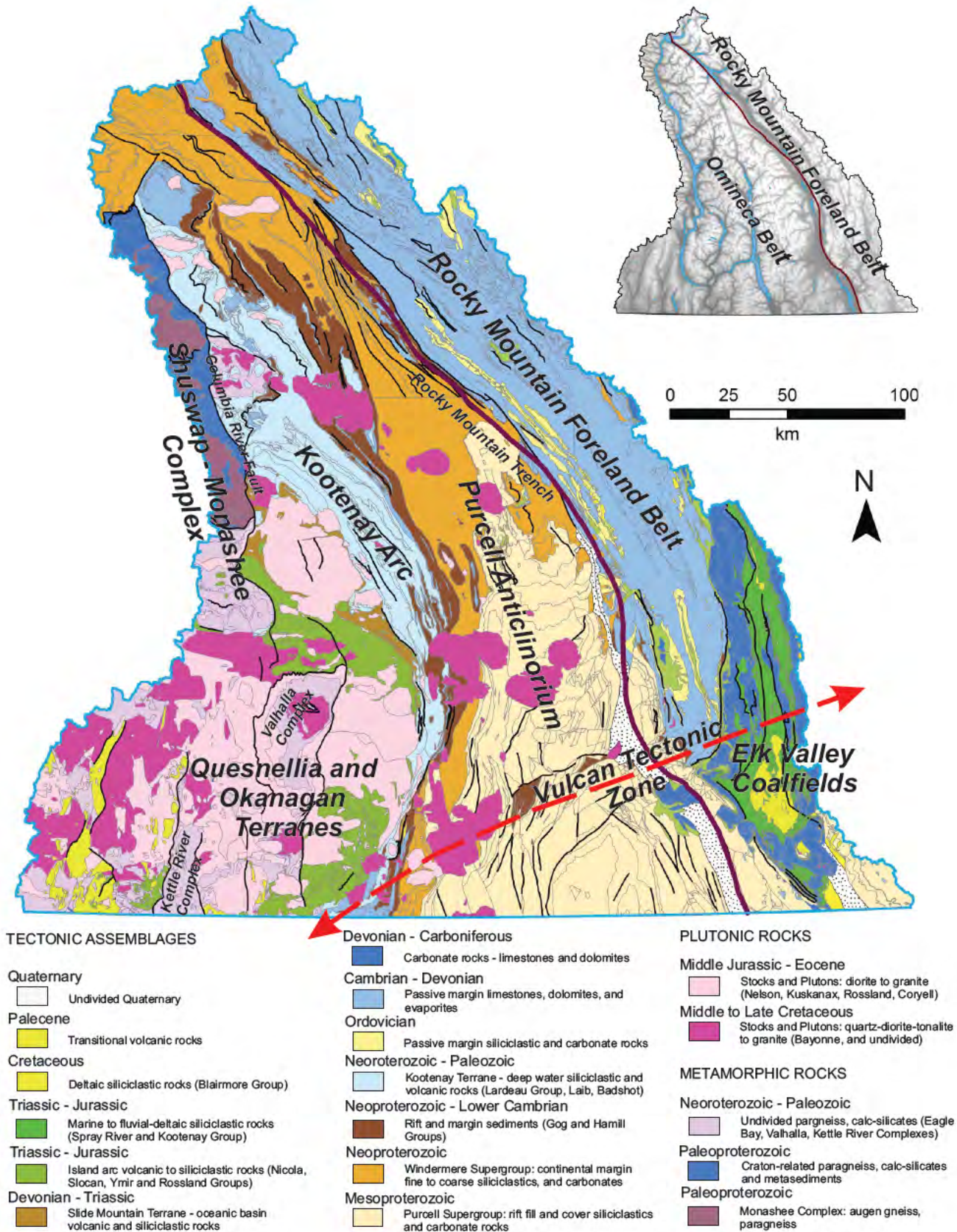


Fig. 4. Geology and physiographic belts of the Kootenay-Boundary region.

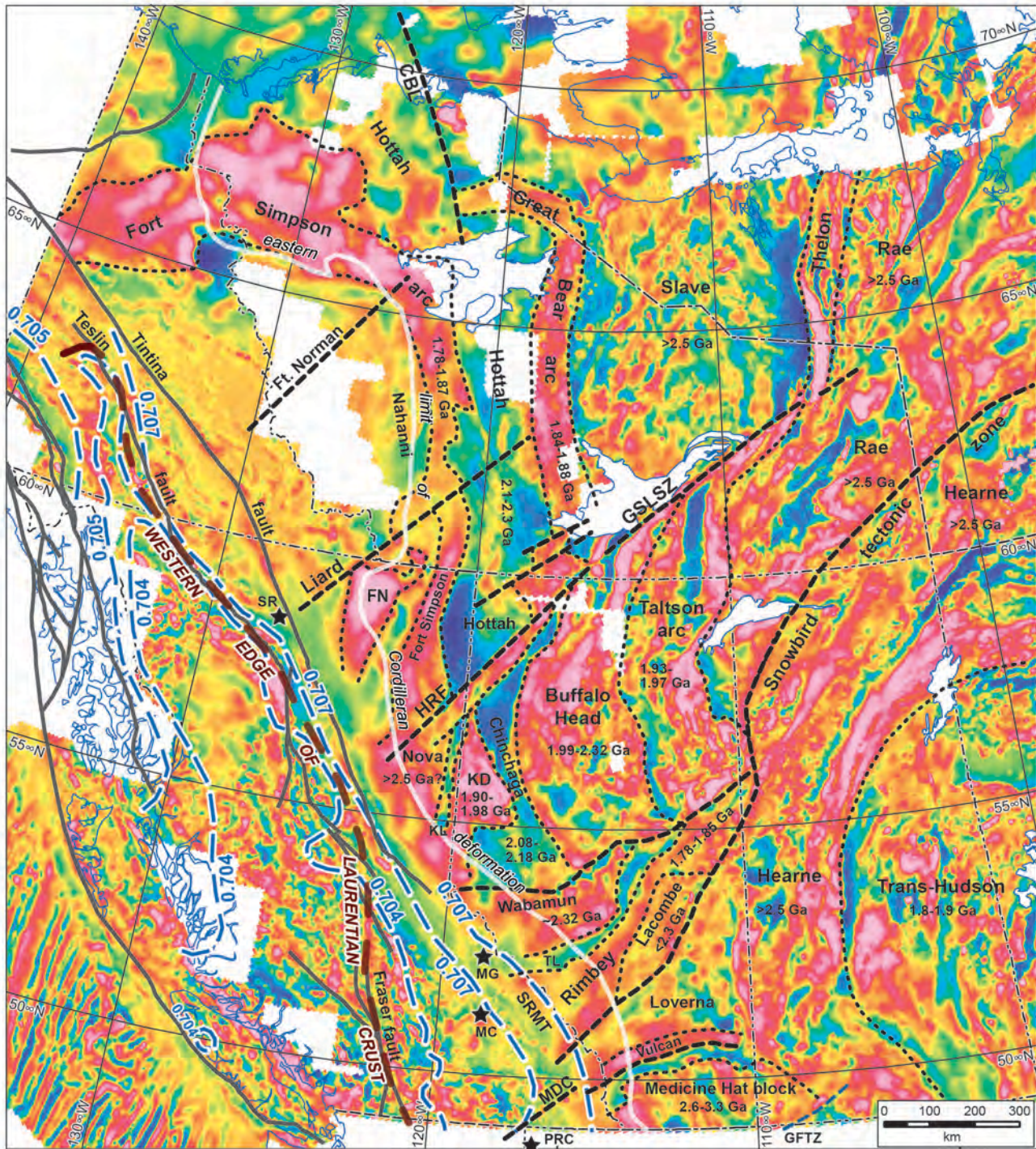


Fig. 5. Residual total field aeromagnetic map of western Canada, showing Precambrian basement domains of the western Laurentian craton with respect to the Cordilleran orogen (eastern limit of Cordilleran deformation indicated by white line). Precambrian basement domains are after Hoffman (1988), Ross et al. (1991), Villeneuve et al. (1993), Ross (2002), Hope and Eaton (2002), and Aspler et al. (2003). Precambrian domain boundaries are delineated by dotted lines; major basement structures are shown by short dashed lines. Some major structures extend beneath the Cordillera, including the Moyie-Dibble Creek fault (MDC) and related structures in the south (after McMechan, 2012), and the Liard and Fort Norman lines in the north (after Cecile et al., 1997). Stars show location of Precambrian basement exposures in the Omineca belt: MC = Monashee complex (1.86–2.10 Ga; Crowley, 1999); MG = Malton complex and Gold Creek gneiss (ca. 1.87–2.09 Ga; McDonough and Parrish, 1991; Murphy et al., 1991); PRC = Priest River complex (ca. 2.65 Ga; Doughty et al., 1998); SR = Sifton Ranges (ca. 1.85 Ga; Evenchick et al., 1984). Initial $87\text{Sr}/86\text{Sr}$ ratio isopleths for Mesozoic granitic rocks of the Cordillera (dashed blue lines) are after Armstrong (1988). Dashed brown line indicates inferred extent of North American orogen beneath the Cordilleran orogen from geophysical, geochemical, and geological. Other abbreviations: CBL = Cape Bathurst line, FN = Fort Nelson high, GFTZ = Great Falls tectonic zone, GSLSZ = Great Slave Lake shear zone, HRF = Hay River fault, KD = Ksituan domain, KL = Kiskatinaw low (1.90–1.98 Ga), LD = Lacombe domain, RDZ = Red Deer zone, SRMT = Southern Rocky Mountain trench, TL = Thorsby low (1.91–2.38 Ga). From Nelson et al. (2013).

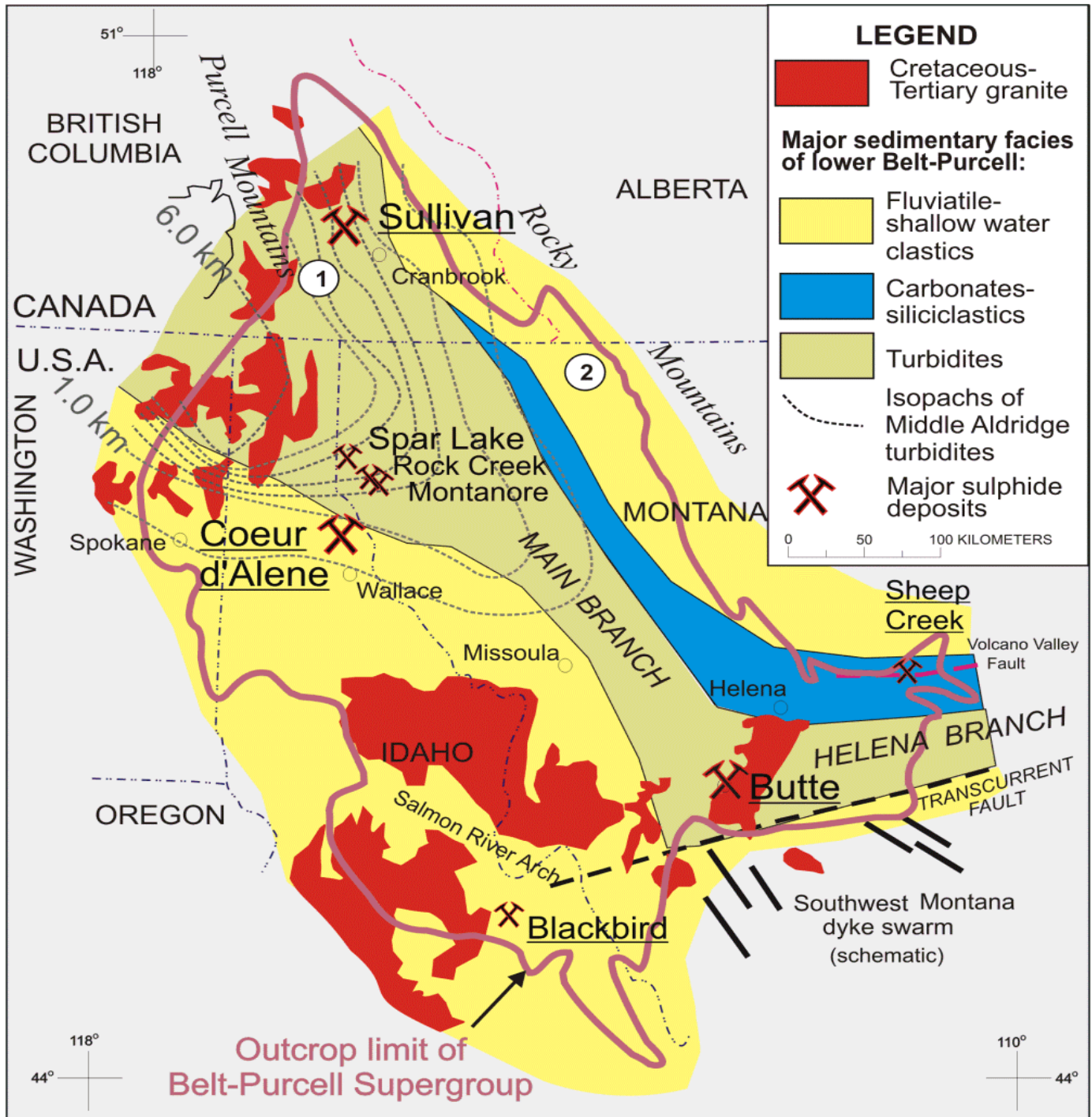


Fig. 6. Outcrop extent of the Belt-Purcell Basin, major mineral deposits, and simplified distribution of sedimentary facies in the lower part of the Belt-Purcell Supergroup (Aldridge and Pritchard formations and equivalents). From Lydon (2007).

Supergroup unconformably above the Purcell Supergroup (Fig. 7). Subsidence during the second phase (570-540 Ma) resulted in deposition of the Hamill-Gog Group unconformably over the Windermere Supergroup (e.g., Nelson et al., 2013). The Windermere Supergroup hosts limited syngenetic mineralization, and deposit types are mainly manto-style replacement, Mississippi Valley-type (MVT), and polymetallic veins.

2.1.3. Paleozoic to Cretaceous successions on the western margin of ancestral North America

Following the breakup of Rodinia, passive margin successions were deposited on the western flank of ancestral North America (Fig. 7). These rocks consist of Cambrian through Devonian siliciclastic, carbonate, and evaporitic rocks now exposed in the Purcell and Rocky mountains. In the Rocky Mountain Foreland Belt, these rocks host a number of industrial

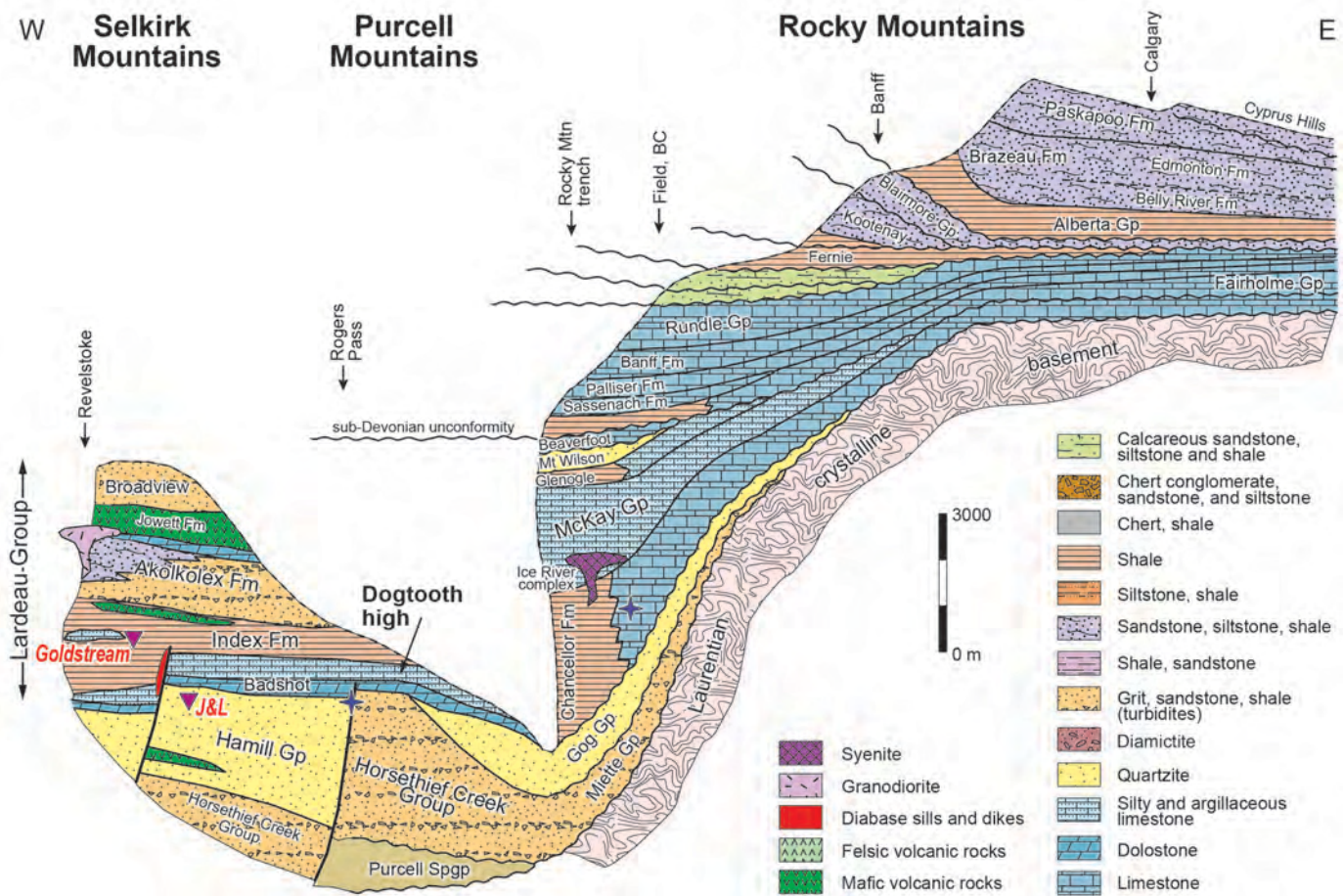


Fig. 7. Schematic stratigraphic relationships from the Rocky Mountains to the Selkirk Mountains for Neoproterozoic and younger strata of ancestral North American. Horizontal datum is the transition from marine to nonmarine Jurassic rocks, which is close to the transition from continental margin to foreland basin deposition. After Nelson et al. (2013).

mineral mines and quarries (silica, magnesite, and gypsum). Deep-water equivalents of these successions, now exposed in the Selkirk Mountains, were deposited outboard of the ancestral North American platform (Colpron and Price, 1995). These rocks consist of variably metamorphosed Neoproterozoic and Paleozoic strata, including the Badshot Formation (Lower Cambrian), and the Lardeau Group (Fig. 7; Logan and Colpron, 2006; Nelson, et al., 2013). Eastward subduction beneath the continental margin during the Devonian led to backarc extension and opening of the Slide Mountain ocean in the Pennsylvanian to Early Permian (285-300 Ma). Rocks of the Kootenay terrane represent remnants of the arc that remained on the continental side (Piercy et al., 2006; Nelson et al., 2006). The Badshot Formation hosts stratiform laminated to massive sulphides, and replacement-style mineralization, with characteristics similar to Irish-type deposits. In the Index Formation (Lardeau Group), basaltic and sedimentary units host a variety of Besshi-type, Cu-Zn-rich VMS deposits, and boron-enriched exhalative horizons (Nelson et al., 2013). Latest Devonian to Early Mississippian (ca. 360-340 Ma) carbonatites and associated alkalic intrusions in the western Rockies and Omineca belt are also related to

backarc extension, and include the Ice River and Fir showings in the Kootenay-Boundary Region.

During Mesozoic to Tertiary terrane accretion, strata of the passive margin were shortened and displaced northeastward, to create a classical thin-skinned fold-thrust belt, with eastward-vergent, eastward migrating, piggyback thrusts detaching along a basement-cover décollement (Fig. 8; e.g., Price and Fermor, 1985). Thrust loading led to foreland basin subsidence and synorogenic sedimentation of material derived from emerging thrust sheets. These Jurassic to Cretaceous foreland basin deposits include the coal-bearing successions that are mined in the region. Siliciclastic, carbonate, and evaporitic sequences in the Foreland Belt also host relatively easily mined industrial minerals such as gypsum, magnesite, and silica.

2.1.4. Slide Mountain terrane

Eastward subduction beneath the western flank of ancestral North America during the Devonian-Mississippian led to backarc extension and opening of the Slide Mountain marginal ocean basin (e.g., Nelson et al., 2006). In the Kootenay-Boundary Region, interbedded mid-ocean ridge basalts, cherts,

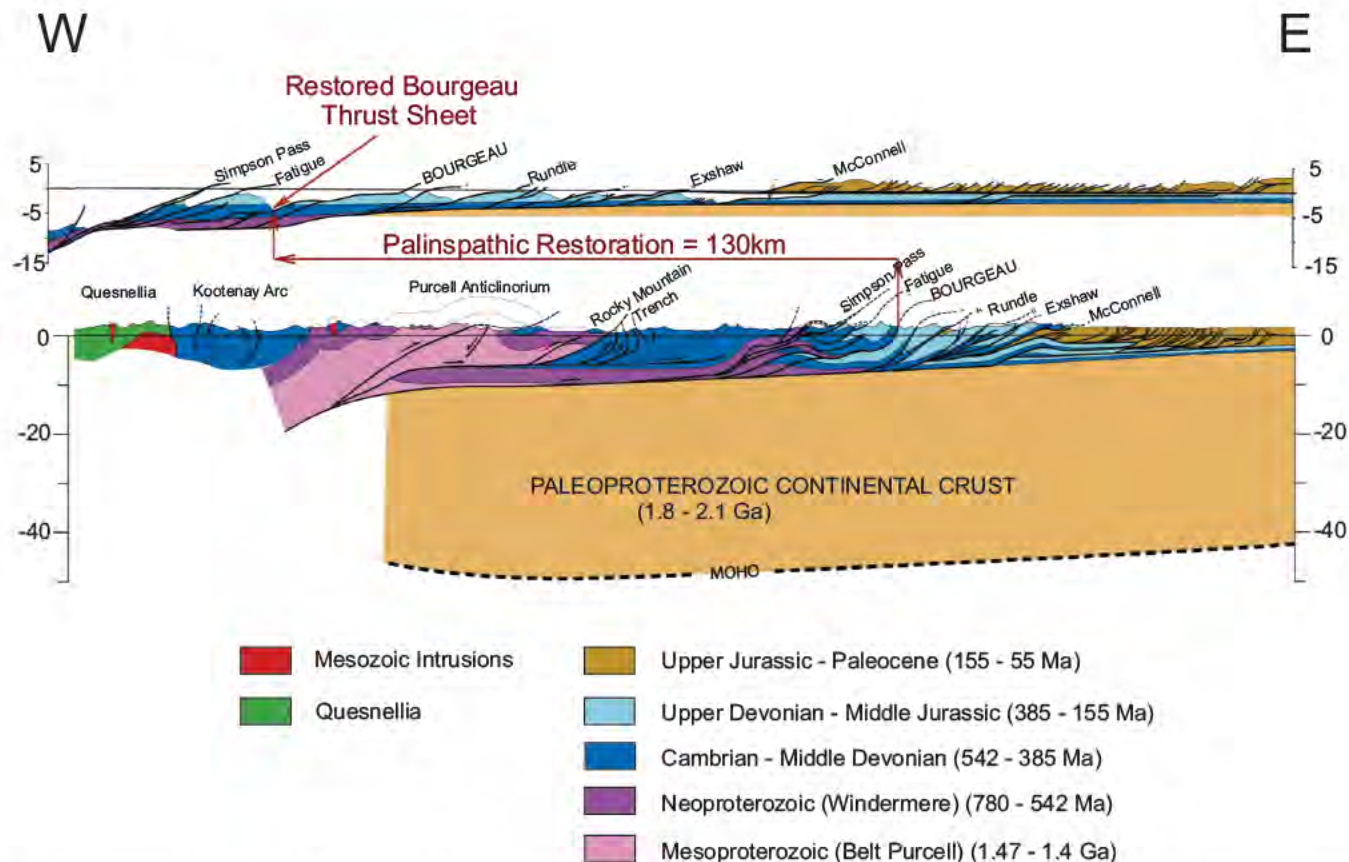


Fig. 8. Palinspastic restoration of the Rocky Mountain fold and thrust belt, southern British Columbia. Modified from Price and Fermor (1985).

sandstones and conglomerates imbricated between Quesnellia and ancestral North America represent remnants of the Slide Mountain ocean.

2.1.5. Quesnel terrane

By early to middle Permian, westward subduction beneath terranes outboard of North America consumed crust of the Slide mountain ocean, which closed by the end of the Triassic. Closing of the Slide Mountain ocean led to accretion of exotic arc terranes such as Quesnellia to the continental margin. Quesnel terrane consists of upper Devonian to Permian cherts, siliciclastic rocks, and basalts (Harper Ranch and Attwood Groups), coeval volcanoclastic rocks, pelites, and carbonates; and Upper Triassic to Lower Jurassic volcanic arc rocks (Nicola Group). Synorogenic siliciclastic rocks (Triassic Slocan Group) unconformably overlap the Slide Mountain and Quesnellia terranes, and were likely derived from uplift during accretion.

In southeastern British Columbia, Devonian and older units of southern Quesnellia differ significantly from coeval units to the north, and have been referred to as the Okanagan subterrane (Monger et al., 1991). These rocks form a roughly east-west trending belt, and constitute basement to Late Devonian and younger sequences of southern Quesnellia (Nelson and Colpron, 2009). Fragmentary evidence suggests that these rocks may originated in the Arctic realm (Massey et al., 2013;

Nelson et al., 2013). The Trail gneiss complex (paragneiss and orthogneiss), Knob Hill complex (chert, greenstone, and ultramafic ophiolitic rocks), and Anarchist group (argillite-phyllite, chert, carbonate, and greenstones) rocks may represent a primitive arc to back-arc assemblage, with MORB, island arc tholeiites, and associated facies (Nelson and Colpron, 2009).

2.1.6. Mesozoic to Tertiary magmatism

Renewed eastward subduction upon closing of the Slide Mountain ocean and terrane accretion led to Late Triassic to early Jurassic magmatism. By mid-Jurassic, the emerging Canadian Cordillera had been fundamentally transformed from a set of loosely connected arc and pericratonic terranes, to a progressively thickening and complexly structured accretionary wedge. During the Eocene, the tectonic framework was one of dextral transtension accompanied by extensional collapse of previously thickened crust. Exhumation of the Shuswap-Monashee and Valhalla metamorphic complexes (Fig. 4) is related to this regional extension (Vanderhaeghe, et al., 2003).

Metallogenic episodes in the Late Jurassic-Early Cretaceous, mid-Cretaceous, Late Cretaceous, and Paleocene-Eocene, and Late Eocene can be related to changing convergence rates, subduction geometries, and convective heat transfer. Shearing and deformation also created pathways for pluton emplacement, and mineralization. The metallogenic importance of this

is found in the suite of epigenetic deposits with increasing influence of continental sources of metals (eg. Mo, W), and increased precious metal enrichment (Nelson, et al., 2013). Major deposit types include porphyry Cu-Mo (\pm Au) and Mo, intrusion-related gold, Ag-Pb-Zn, tungsten, and structurally controlled epithermal and orogenic Au veins.

3. Coal

Coal is produced at five operating mines in the Elk Valley (Figs. 1, 9). These mines, operated by Teck Coal Limited, produce approximately 70% of Canada's total annual coal exports. Coal mining in southeastern British Columbia dates back to the 1800s, with reports of coal discoveries in the Elk Valley around 1845. The first underground mine, at Coal Creek, opened in 1897 and operated until 1958. In the early 1900s, and into the 1960s, several other underground mines operated intermittently. These included mines at Morrissey, Hosmer, Michel/Natal, and Corbin. All produced industrial steam coals and coke for the smelting industry. The Balmer mine was the first open pit strip mine in the Elk Valley. It opened in 1968, and was encompassed by the currently operating Elkview mine.

The main coal deposits in southeastern British Columbia are in the Rocky Mountain Fold and Thrust Belt, and extend along strike for 175 km, following the northwest-southeast trend of the Rocky Mountain Front Ranges. The coal seams are in sedimentary rocks of the Kootenay Group where structurally thickened and exposed sections permit open-pit mining. The Fernie Formation and Kootenay Group (Figs. 9, 10) consist of sandstones, shales, and coals that were deposited in the foreland basin adjacent to the uprising Canadian Cordillera, in the Jurassic to early Cretaceous. The foreland basin contains a series of clastic wedges that are genetically linked to terrane docking on the western margin of North America (Cant and Stockmal, 1989). Episodic thrusting and isostatic subsidence resulted in pulses of erosion, transport and deposition. Deposition of the Fernie-Kootenay coarsening-upward clastic wedge was the first of a series of these clastic wedges derived from uplift (Poulton, 1988; Stott 1984). Mineable coal seams are in the Mist Mountain Formation, and are considered to have been deposited in a coastal plain depositional system in which delta and interdelta deposits in the lower part of the section grade upward to fluvial deposits (Fig. 11).

The East Kootenay coalfields comprise three structurally separated fields (Fig. 9) including the Elk Valley, Crowsnest, and Flathead. The Elk Valley Coalfield is in the Alexander Creek and Greenhills synclines, and includes the **Fording River**, **Greenhills** and **Line Creek** operations, and the proposed **Crown Mountain** and **Bingay Main** projects. The Crowsnest Coalfield coincides with Fernie Basin, a broad north-trending synclinorium, and includes the current **Elkview** and **Coal Mountain** operations and the Michel Creek, **Coal Mountain Phase II** (Marten Wheeler), and **Coal Creek** projects. The Flathead Coalfield consists of four relatively small, isolated exposures of Kootenay Group rocks in the extreme southeast corner of the region. Provincial legislation prohibits subsurface

resource exploration and development in the Flathead Valley, so the Flathead Coalfield and part of the Crowsnest Coalfield are excluded from coal mining activity.

3.1. Operating mines

Mining operations, coal production, and expansion plans continued at all five mines in the Elk Valley and Crowsnest Coalfields (Table 1, Fig. 9). The main product is metallurgical coal (85%), with some thermal and pulverized coal injection (PCI) coal (15% combined). Total clean coal production from the Elk Valley in 2013 was approximately 25.3 Mt. Based on Teck's Q3 2014 forecasts, volumes for 2014 are expected to increase to almost 27 Mt. The mines directly employ over 4,500 people full-time.

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 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 decision making with respect to all water quality and mining in the Elk Valley. It includes water diversion and treatment, and establishes water quality targets for selenium, nitrate, sulphate, cadmium, and calcite.

The plan was developed with scientific advice from a Technical Advisory committee chaired by the British Columbia Ministry of Environment, and included representatives from Teck, the Ktunaxa Nation, the US Environmental Protection Agency, the State of Montana, Environment Canada and other agencies. Public consultation was also part of the process. A water treatment facility at Line Creek Operations is currently being commissioned, and is expected to be fully operational in 2015. The West Line Creek water-treatment facility is the first of six that Teck plans for the Elk Valley, including one at Fording River Operations for 2018. Together they are part of a selenium management plan that will cost a projected \$600 million over the next five years, and \$40 million to operate annually.

3.1.1. Fording River Operations

Fording River Operations produces mainly metallurgical coal from their Eagle Mountain, Turnbull, and Henretta Pits (Fig. 12). Exploration drilling was conducted in active pits, with plans for highwall pushback in Eagle and Turnbull pits. Henretta South drilling also revealed thick coal seams extending into the north side of Turnbull Mountain. Proven and Probable reserves are projected to support a 74-year mine life at the current production rate, and mine expansion plans are currently underway at both their **Henretta** and **Swift** areas. East of the current Henretta Pit footwall exploration drilling on the eastern limb of the Alexander Creek syncline is intended to demonstrate mineable coal reserves down section from the current footwall limit, and coals with standard Fording River

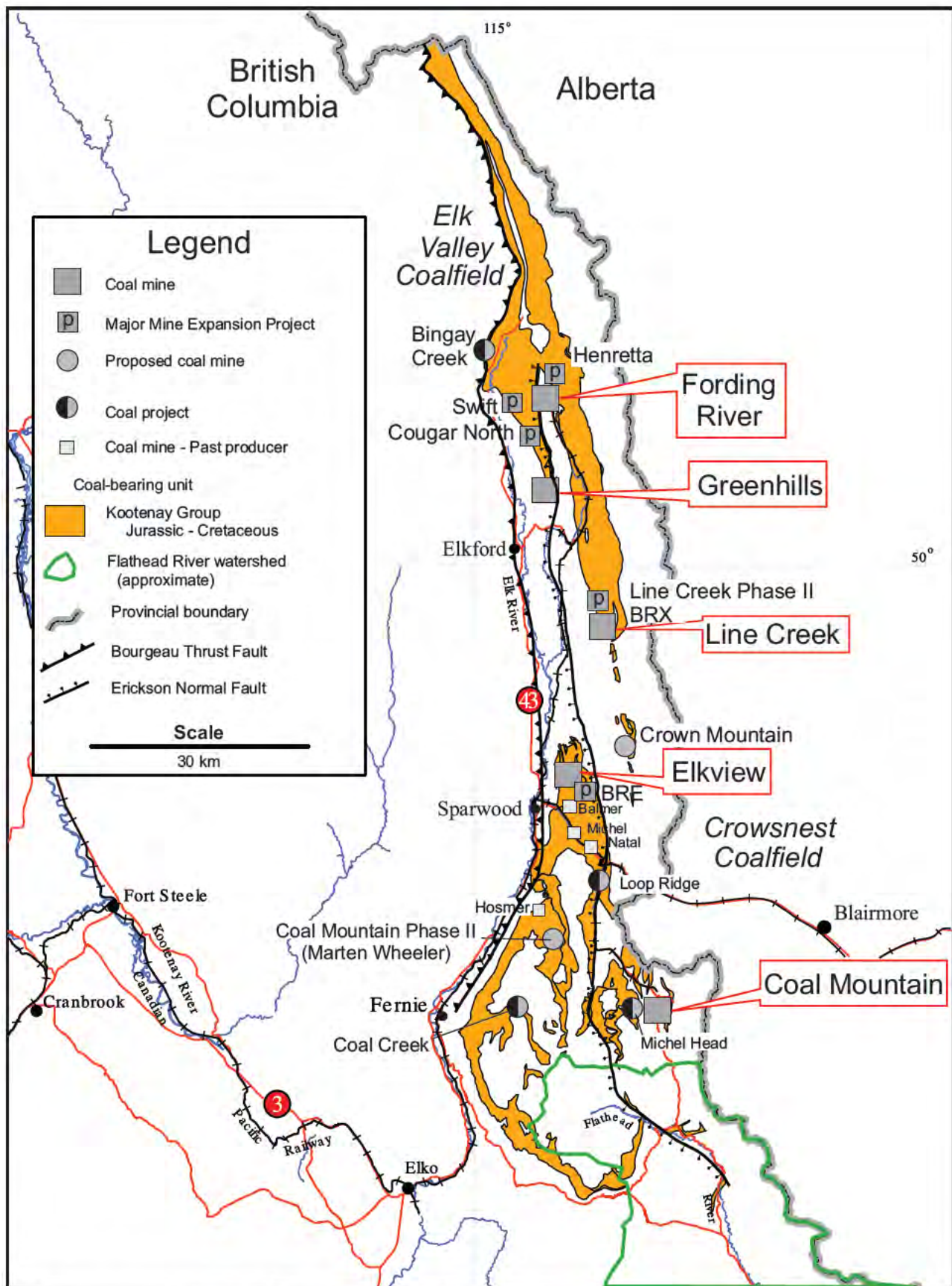


Fig. 9. Major mines and projects in the East Kootenay Coalfields.

Table 1. Operating coal mines, Kootenay-Boundary Region, 2014.

Mine	Operator; and Partners	Coal; Major Product	Forecast Production (based on Q1-Q3)	Proven + Probable Reserves of Clean Coal (as of December 31, 2013)	Resource (Meas. & Ind.)	Near-mine exploration; project highlights	Major Mine Expansion Projects	Website
Fording River	Teck Coal Limited (100%)	HCC, Thermal	8.97 Mt	628.6 Mt HCC; 4.6 Mt Thermal	1098 Mt HCC; 8.0 Mt Thermal	Drilling (24,295 m) at Eagle, Henretta, Turnbull; geological model for highwall pushback at Eagle and Turnbull pits	Swift entered pre-application stage of EA (2011); baseline and environmental studies	www.teck.com/coal
Greenhills	Teck Coal Limited (80%); POSCAN (20%)	HCC, PCI, Thermal	5.15 Mt	53.3 Mt HCC; 3.04 Mt PCI; 0.96 Mt Thermal	262.6 Mt HCC; 10.2 Mt PCI; 3.6 Mt Thermal	Drilling at Cougar pit (4,936 m); geological model; baseline studies	West Spoil Expansion approval (2014); Cougar Pit Extension (CPX) preparing to enter pre-application of EA (2015)	www.teck.com/coal
Line Creek	Teck Coal Limited (100%)	HCC, PCI, Thermal	3.40 Mt	55.7 Mt HCC; 3.4 Mt PCI; 8.3 Mt Thermal	761.7 Mt HCC; 0.5 Mt PCI; 9.2 Mt Thermal	Drilling (3,214 m) at Burnt Ridge Extension and North Line Creek Extension; geological model	Line Creek Phase II approval (2013); pre-stripping on Mt Michael and Burnt Ridge North; Burnt Ridge Extension (BRX) pre-application of EA (2014)	www.teck.com/coal
Elkview	Teck Coal Limited (95%); Nippon Steel & Sumimoto Metal Corp. (2.5%), POSCO (2.5%)	HCC	5.45 Mt	176.3 Mt HCC	731.8 Mt HCC	Drilling at BR1, NP1, BR2, NP2	Baldy Ridge Extension (BRE) entered pre-application of EA(2014)	www.teck.com/coal
Coal Mountain	Teck Coal Limited (100%)	PCI, Thermal	2.54 Mt	9.5 Mt PCI; 0.7 Mt Thermal	80.7 Mt PCI; 2.6 Mt Thermal	Drilling (2,445 m) at 37-pit and 6-pit; geological mapping	Possible pit extension of 6-pit	www.teck.com/coal

		SW Alberta and SE British Columbia	Lithology
Cretaceous	Lower	Blairmore Group	Upper Blairmore
			Cadomin
Jurassic	Upper	Kootenay Group	Elk Formation
			Mist Mountain Formation
			Morissey Fm.
	Middle	Ferne Formation	Passage Beds
			Upper Fernie Shale
			Green Beds
Triassic	Lower		Grey Beds Highwood
			Poker Chip Shale

Fig. 10. Jurassic – Lower Cretaceous stratigraphy of the Fernie and Kootenay groups. Modified from Poulton, et al (2012).



Fig. 11. Dinosaur tracks on a bedding plane, Mist Mountain Formation.

quality characteristics.

In September, 2011, the **Swift** project entered pre-application stages of Environmental Assessment for an open-pit project that is expected to produce 175 Mt of clean coal over 25 years.



Fig. 12. Fording River mine, looking toward Turnbull Mountain.

Located west of the Fording River in the northern part of the Greenhills Range, the project comprises both previously mined and unmined zones of the Fording property. The Swift Project expansion will be based on mining multiple coal seams on both limbs of the Greenhills Syncline. Mine development will

progress to the west from previous open pits. The project is along strike and directly north of the **Greenhills Cougar North** project (Fig. 13); and together, the two will become the **Swift**.

3.1.2. Greenhills Operations

Greenhills Operations is on the west limb of the Greenhills syncline (Fig. 13). 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. Proven and Probable reserves are projected to support another 14 years of mining from current pits at the current rate. The **Cougar Pit Extension (CPX)** project is the proposed expansion area for Greenhills Operations, and lies immediately north of the existing operations. At full development, the **Cougar North Extension** will merge with the Fording River Operations expansion. In 2014, Teck conducted further baseline work and mine planning to prepare to enter pre-application of Environmental Assessment in 2015. Exploration drilling (4,936 m) focused mainly on the active Cougar pit.

3.1.3. Line Creek operations

Line Creek Operations produces from the Burnt Ridge South, North Line Creek, and Horseshoe Pits (Fig. 14). Expansion plans are well underway with the **Line Creek Phase II**, which



Fig. 13. Greenhills mine, looking north toward Cougar Ridge North.



Fig. 14. Line Creek mine, Alexander syncline.

received conditional Environmental Assessment approval in 2013. This expansion will extend operations at Line Creek northward, and encompass the **Mount Michael** and **Burnt Ridge North** areas, adding approximately 59 Mt of clean coal, and 18 years of mine life to the mine. Coal seams are predominantly medium-volatile bituminous in rank, with some high volatile-A bituminous coals near the top of the section. In June, 2014, the **Burnt Ridge Extension (BRX)** project entered pre-application of Environmental Assessment. The project will connect the current Phase I operating area at **Line Creek Operations** to the recently approved **Phase II** area by pushing back the highwall of Burnt Ridge South pit to the north. It will add 8.3 Mt of clean coal to the mine. Drilling in 2014 focused on the Burnt Ridge and North Line Creek extension areas to update geological and geotechnical models. Pre-stripping on Mount Michael began, with pre-stripping on Burnt Ridge North to begin pending approval.

3.1.4. Elkview Operations

Elkview Operations produces mainly high-quality mid-volatile hard coking coal, and has a remaining reserve life of approximately 34 years at the current production rate. Production is mainly from their Baldy Ridge BR1 and Natal PH1 Pit. The mine received approval for expansion at **Baldy Ridge** in 2012, which is within their current mining area, and also for the Natal Phase 1 Pit Extension in 2013. Environmental baseline and other studies are being submitted to satisfy permit conditions. Exploration drilling in 2014 was directed at planning for the next phases of mining in the active Baldy and Natal pits. The **Baldy Ridge Extension (BRE)** entered pre-application of Environmental Assessment in June, 2014. 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 pit, and Natal Ridge NP2 pit, dump and tailings facility expansions.

3.1.5. Coal Mountain Operations

Coal Mountain Operations produces mainly PCI and thermal coal, with Proven and Probable reserves expected to support another 6 years of production at current rates. Coal is mainly produced from seams at **37-Pit** and **6-Pit**. Drilling in 2014 was focused on active pits to update geological modeling, with plans to expand **6-Pit** to the south. Additional geological mapping was conducted on the property, to expand the current mapping of the Mist Mountain Formation on the property.

3.2. Proposed coal mines and major projects

In addition to Teck Coal, four companies explored for reserves of hard coking coal in the East Kootenay coalfields in 2014: CanAus Coal Limited, NWP Coal Canada Ltd. (Jameson Resources Limited), CrowsNest Pass Coal Mining Ltd., and Centermount Coal Limited (Table 2, Fig. 9).

3.2.1. Crown Mountain

The **Crown Mountain** property (NWP Coal Canada Ltd., a wholly owned subsidiary of Jameson Resources Ltd.) is along strike with Line Creek Operations, and is considered an erosional outlier of the Mist Mountain Formation. The property contains seven major coal seams, with combined average thicknesses of 15 to 35 m. In October 2014, the project advanced to pre-application stages of Environmental Assessment. The project 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, with proposed construction beginning in 2016. NWP Coal completed a prefeasibility study; and updated coal resource estimates 74.9 Mt (Measured + Indicated). Coal quality test work indicates coal quality characteristics that are similar to the Elk Valley coking coals.

3.2.2. Coal Mountain Phase II

At Teck Coal's **Coal Mountain Phase II** (Marten Wheeler) project (MINFILE 082GNE006), 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. The seams range in rank from medium- to high-volatile bituminous coal. The project entered pre-application stages of Environmental Assessment in September, 2014. The mine will use infrastructure at the **Coal Mountain Operations**, and produce 76.5 Mt of clean coal over an estimated 34-year mine life, at a production rate of approximately 2.25 Mt per year. In 2014, Teck focused on environmental baseline, geotechnical, and mine design work.

3.2.3. Michel Creek

CanAus Coal Ltd., a wholly owned subsidiary of CoalMont Pty Ltd., drilled at their Michel Creek project (MINFILE 082GSE050), which consists of licenses at **Loop Ridge**, **Tent Mountain**, and **Michel Head**. Drilling identified twenty coal seams with an average cumulative thickness of 70 m in a 504 m section of Mist Mountain Formation. Geological modelling and correlation of drill data and coal quality data is

currently underway to better define stratigraphic and structural relationships and define a NI 43-101 Resource. Initial raw coal tonnage estimates from historic and current data indicate potential resources between 120 and 140 Mt of high quality, mineable coking coal. Drilling in 2014 focused on the Loop Ridge, Loop Ridge Phase 2, and Michel Head licenses.

3.2.4. Coal Creek

CrowsNest Pass Coal mining Ltd. continued geological modelling, resource, and pre-feasibility work at their **Coal Creek** property (MINFILE 082GSE035). The company has been testing the down-dip extensions of the uppermost coal seams of the historical underground Elk River and Coal Creek collieries, the latter of which closed in 1958. The project is underlain by 11 coal zones 2- >20 m thick. The company is evaluating three seams in the uppermost part of the Mist Mountain Formation for underground room-and-pillar mining potential. Drilling in 2012 indicated high-quality hard coking and PCI coal. Although the project remained on hold in 2014, environmental baseline studies, including water quality surveys, are ongoing.

3.2.5. Bingay Creek

Centermount Coal Ltd.'s **Bingay Main** is a proposal for an open-pit and underground coal mine on the **Bingay Creek** property (MINFILE 082JSE011). It entered pre-application of Environmental Assessment in early 2013, but the project was suspended on account of low coal prices, and remained on hold in 2014. The mine would produce 2 Mt of coal annually, and have a mine life of approximately 20 years, with a total resource of approximately 39 Mt of clean coal. At **Bingay Creek**, the coal-bearing Mist Mountain Formation is preserved in a tight, asymmetric syncline in the immediate footwall of the west-dipping Bourgeau thrust fault. Based on previous exploration results, coals at Bingay Creek are medium-volatile and high volatile-A bituminous in rank.

4. Industrial minerals

The Kootenay-Boundary Region continues to be an important source of industrial minerals such as gypsum, magnesite, silica sand, mineral wool, dolomite, limestone, graphite, tufa, flagstone, railroad ballast, rip rap, smelter slag, and aggregate (Table 3). The largest mines are on the western edge of the Rocky Mountain Fold and Thrust Belt, in Paleozoic carbonate and siliciclastic successions that were deposited on the passive margin of ancestral North America (Figs. 7, 8). Uplifting along thrust faults has exposed these deposits, enabling them to be easily mined.

4.1. Operating mines

4.1.1. Magnesite

Baymag Inc. produces high-quality magnesite throughout the year from its open-pit mine at **Mount Brussilof** (MINFILE 082JNW001). The deposit was discovered in 1966, and the mine has been in production since 1982. The Mount Brussilof

Table 2. Proposed coal mines and major coal projects, Kootenay-Boundary Region, 2014.

Mine	Operator	Commodity; deposit type	Reserves	Resource (Meas. & Ind.)	Work program	Significant results	Website
Crown Mountain (open-pit)	NWP Coal Canada Ltd. (Jameson Resources Limited)	Coal (HCC and PCI)	HCC: 42.60 Mt Proven + 4.91 Mt Probable; PCI: 7.13 Mt Proven + 1.19 Mt Probable (2014)	HCC + PCI: 68.9 Mt Measured + 6.0 Mt Indicated (2014)	Prefeasibility studies; environmental and baseline work; mine design; permitting	Pre-application of EA (2014); 16-year mine life; 1.7 Mt/yr	www.jamesonresources.com.au
Coal Mountain Phase II (Marten Wheeler)	Teck Coal Limited	Coal (PCI and Thermal)	N/A	PCI + Thermal: 117.09 Mt Measured + 100.97 Mt Indicated (2014)	Environmental and baseline work; mine design; permitting	Pre-application of EA (2014); total of 76.5 Mt; 34-year mine life; 2.25 Mt/yr	www.teck.com
Coal Creek (underground)	CrowsNest Pass Coal Mining Ltd.	Coal (HCC and PCI)	N/A	HCC + PCI: 616 Mt in the upper seams (2014)	Prefeasibility Study (PFS); geological modeling; resource evaluation; baseline studies	Optimization of the PFS; geological modeling	www.crowsnestpasscoal.com
Michel Creek (open pit)	CanAus Coal Limited	Coal (HCC and PCI)	N/A	120-140 Mt estimated	Drilling (RC: 18,892 m; 17 LD: 1,404 m; 12 DDH: 2,537 m; 2 LDRF: 237 m) at Loop Ridge, Loop Ridge Phase 2, and Michel Head; sampling; coal quality	Coal quality results; updated geological model; drilling has identified 20 coal seams with cumulative thickness of 70 m (14% of a 504 m section in Mist Mountain Fm)	www.coalmont.com.au
Bingay Main (open pit and underground)	Centremount Coal Limited	Coal (HCC)	N/A	42.43 Mt Measured + 52.9 Mt Indicated (2012)	On hold	Pre-application of EA (2012); 20-year mine life; 2 Mt/yr; total of 39 Mt HCC	www.centerpointcanada.com

Table 3. Industrial minerals, Kootenay-Boundary Region, 2014.

Mine	Operator	Commodity; deposit type	Production	Reserves (Proven + Probable)	Resource (Meas. & Ind.)	Near-mine exploration and project highlights	Website
Mount Brussilof	Baymag Inc.	Magnesite	180 Kt (MgO and MgOH)	50 Mt Proven	N/A	-	www.baymag.com
Moberly Silica	Heemskirk Canada Limited	Silica; industrial use silica and frac sand	-	20 to 140 mesh frac sand (dry): Proved 8.9 Mt @ 64% frac sand + Probable 4.6 Mt @ 64% frac sand; OR Silica for industrial (dry): 12.8 Mt Proved + 0.7 Mt Probable (Updated June 2014)	20 to 140 mesh frac sand (dry): 32.4 Mt @ 64% frac sand Measured and Indicated + 11.7 Mt silica as frac sand residues; OR Silica for industrial (dry): 43.2 Mt Measured + Indicated	\$26M capital cost for plant construction and upgrades to existing facility (for frac sand operation); 300,000 tonne per year capacity; Construction started on frac sand processing plant (2014)	www. heemskirkcanada. com
Horse Creek Silica	HiTest Sand Inc.	Silica; industrial use and aggregate	-	-	-	Variety of aggregate and industrial use products	www.hitestsand. com
Elkhorn (Elkhorn Quarry West Extension)	CertainTeed Gypsum Canada Inc.	Gypsum	400,000 tonnes annually	N/A	N/A	7 years mine-life remaining	www.certainteed. com
Kootenay West	CertainTeed Gypsum Canada Inc.	Gypsum	North and South Quarries: Total 15 Mt (at average quality of 83- 85%)	Estimated 15 Mt gypsum	N/A	Pre-application of EA (2014); 400,000 t/yr; 38-year mine life; environmental baseline work	www.certainteed. com
Winner; Friday Quarry	Roxul Inc.	Gabbro/Basalt (for mineral wool)	Quarrying to supply feed stock for mineral wool plant	N/A	N/A	Crushing, screening, stockpiling; environmental; bulk sample	www.roxul.com

Table 3. Continued.

Mine	Operator	Commodity; deposit type	Production	Reserves (Proven + Probable)	Resource (Meas. & Ind.)	Near-mine exploration and project highlights	Website
4-J	Georgia-Pacific Canada Limited	Gypsum	N/A	N/A	N/A	Care and Maintenance	www.gp.com
Marten Phosphate	Fertoz Limited	Phosphate; upwelling	N/A	N/A	N/A	Drilling (7 RC: 301 m), mapping; trenching; bulk sample (2,000 t); XRF of stockpiles: 24-27% P ₂ O ₅	www.fertoz.com
Zim Frac Sand	92 Resources Corp.	Silica; industrial use	N/A	N/A	N/A	Sampling; metallurgical testing: 98.3-99.0% SiO ₂	www.92resources.com
Black Crystal	Eagle Graphite Corporation	Graphite	N/A	Regolith: Measured + Indicated: 0.648 Mt @ 1.83% fixed carbon; Calc-silicate: Indicated: 4.765 Mt @ 1.21% fixed carbon	Surface work; mine design; permitting	Road and drill pad construction for exploration work	www.eaglegraphite.com
Mt Heimdal	Lithium Corporation	Graphite	N/A	N/A	Mapping; sampling	Graphitic horizon; up to 3.7% graphite	www.lithiumcorporation.com
Jumbo Graphite	Noram Ventures Inc.	082LSE 076, 77, 78	Flake graphite	N/A	Analytical drill results reported from Phase I (8 DDH: 1,295 m)	2013 Drill results released: 86.7 m grading 1.81% C; 40.9 m grading 2.49% C	www.noramventures.com
Driftwood Magnesite	MGX Minerals Inc.	082KNE 068	Magnesite	N/A	Drilling (8 DDH: 438 m); mapping; metallurgical testwork; re-assay of 2008 core	Recovery rates of 93.4% reverse flotation and removal of up to 70% silica and 30% calcium oxides	www.mgxminerals.com

deposit is in Cambrian carbonates of the Cathedral Formation (Fig. 15) that were originally deposited on the edge of the Cathedral escarpment, which formed at the shelf edge (Fig. 16). The deposit is a result of magnesium hydrothermal alteration, with characteristics similar to Mississippi Valley Type mineralization. Magnesite ore is transported by truck to the company's processing facilities in Exshaw, Alberta for production of magnesium oxide (magnesia or MgO) and magnesium hydroxide (MgOH). Production in 2014 is expected to remain flat at approximately 180 kt.



Fig. 15. Magnesite at the Baymag mine.

4.1.2. Silica

Silica is produced by Heemskirk Canada Limited at the **Moberly Silica** operation. The deposit is in orthoquartzites of the Mount Wilson Formation (middle to upper Ordovician) that continue for 300 km along the trend of the western Rocky Mountain Fold and Thrust Belt. 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, and extends along strike for an 800 m. The orthoquartzite (Fig. 17) is commonly de-cemented, rendering many exposures 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 a feasibility study to produce frac sand for the western Canadian oil and gas industry, conducted detailed engineering studies, and outlined a mine plan for a 400,000 tonnes per year at a 35-year mine life. In 2014, the company updated the feasibility study and the resource estimate specific to producing 20 to 140-mesh frac. Upgrades necessary to convert the current silica operation to produce frac sand include redesigning and upgrading the haul roads and constructing a new processing plant. Plant engineering is progressing, and construction of footings for the plant building began in late 2014.

At the **Horse Creek Silica** mine, HiTest Sand Inc. operates a seasonal quarry in Mount Wilson orthoquartzites for a variety of industrial use and aggregate products. The quarry is in an area where the formation is more consolidated than at Moberly,

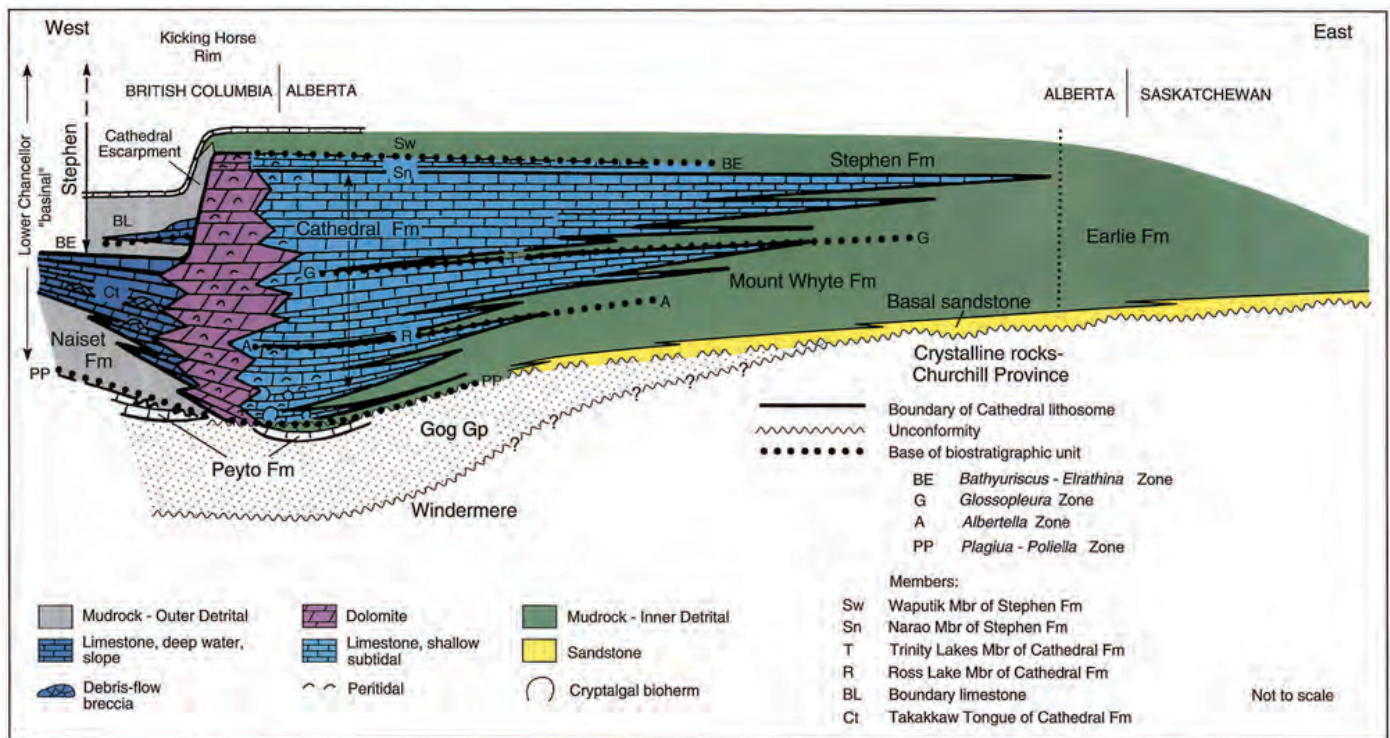


Fig. 16. Diagrammatic stratigraphic cross section of the Cathedral carbonate lithosome, a regional body of Middle Cambrian platformal carbonate rock that surrounded by siliciclastic mudrocks. The lithosome, (upper part of the Mount Whyte - Cathedral grand cycle) is abruptly terminated in the west, thins to the east, is diachronous at its base, and has a near-synchronous upper surface. From Slind, et al. (2014).



Fig. 17. Wave-rippled bedding surface, Mount Wilson Formation orthoquartzite, Moberly silica.

however, the company is also evaluating processes for the production of frac sand.

4.1.3. Gypsum

Gypsum is produced from an evaporite unit in the Burnais Formation (Middle Devonian; Fig. 18) that was deposited in a restricted shallow gulf. Gypsum-bearing strata are structurally disturbed, occurring as sections of steeply dipping, contorted rock gypsum, ranging in thickness from 30 to 80 m (Butrenchuk, 1991). CertainTeed Gypsum Canada Inc. operates the **Elkhorn** mine, which is expected to continue for another 7-12 years. The company also continues to advance the proposed **Kootenay West** mine, which entered the pre-application stages of Environmental Assessment in 2014. The quarry will target gypsum from a deformed hydrated evaporite layer, 5-40 m thick. The mine would have an average production rate of 400,000 tonnes per year, over a 38-year mine life. The total mineral reserve is estimated at 15 Mt and an average quality of 83-85% gypsum.

Georgia-Pacific Canada Limited operates the **4J** gypsum mine, also within Burnais Formation evaporites. The mine remained on care and maintenance in 2014.

4.1.4. Gabbro

Roxul Inc. seasonally operates two small quarries near Grand Forks. Gabbro is quarried from the **Winner** quarry, and basalt is quarried from the **Friday Quarry** (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, boards, blankets, and pipe covering.

4.2. Exploration projects

4.2.1. Phosphate

Fertoz Limited was active at their **Marten Phosphate** project (MINFILE 082GNE027), where thin phosphoritic beds are at the base of the Fernie Formation (Jurassic), immediately above



Fig. 18. Laminated evaporitic gypsum, Burnais Formation, Elkhorn mine.

the Spray River Group (Triassic; Fig. 10). Phosphoritic beds in the Fernie are thin oolitic sandstones. In 2014, the company conducted a drilling and trenching program, and extracted a bulk sample to test for agricultural use.

4.2.2. Silica

92 Resources Corp. sampled at the **Zim Frac** sand property. The property is along strike of the nearby Moberley silica project, in Mount Wilson orthoquartzites. Samples were tested for frac sand potential and metallurgical-grade silicon dioxide.

4.2.3. Graphite

Eagle Graphite Corp. operates the **Black Crystal** flake graphite (MINFILE 082FNW260) operation where graphite ore is produced from an open-pit quarry on Hodder Creek and processed at a pilot plant 10 km west of Passmore (Fig. 1). The property is in the central part of the Valhalla complex an upper amphibolite-grade gneiss dome in the Omineca physiographic belt (Fig. 4) that was exhumed during Tertiary extension. Disseminated fine- to coarse-flake graphite is distributed along foliation in organic-rich calc-silicates and marbles (Fig. 19), across an area of about 500 m². 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 byproducts during the mining and refining process. In 2014, the company focused on redeveloping the mine plan and expanding exploration and construction on the property.

In 2014, Lithium Corporation explored at the **Mt Heimdal** flake graphite property, which is approximately 10 km south of the Black Crystal quarry, and underlain by the same package of gneisses, graphite mineralized marbles, and calc-silicate rocks. The mapping and sampling program focused on flake graphite mineralization discovered in 2013, which assayed up to 3.7% flake graphite, and prospecting in other areas.



Fig. 19. Graphite at the Black Crystal property, formed from metamorphism of organic-rich calc-silicates.

In 2014, Noram Ventures Inc. release results from a 2013 drill program at their **Jumbo** flake graphite property. The property is underlain by Proterozoic to Paleozoic Monashee complex paragneiss and quartz-rich metasedimentary rocks that have undergone upper amphibolite-grade polyphase deformation. Three primary targets were identified by SkyTEM airborne surveys at the **Black Fly**, **South Limb**, and **Big Flake** areas. Analytical results from rock sampling indicated grades ranging from 0.5-7.3% graphite in tightly folded strata.

4.2.4. Magnesite

At the **Driftwood Magnesite** property (MGX Minerals Inc.) cliff-forming, upturned beds of sparry magnesite, 40-70 m thick, are interlayered with dolostones and dolomitic limestones of the Mount Nelson Formation (Purcell Supergroup, Fig. 20). The coarse-grained textures in the magnesite zone suggest that hydrothermal alteration and recrystallization of magnesite occurred during regional metamorphism (Kikauka, 2000). In 2014, the company drilled the **East** zone, and resampled 8 drill cores from drilling by Tusk Exploration Ltd. in 2008 at the **West** zone. The company is currently working on completing a NI 43-101 compliant resource, has filed for a mine lease application, and is moving towards development of a magnesite quarry.

5. Metals

Although metals were not mined in the Kootenay-Boundary Region in 2014, exploration continued in the Purcell Anticlinorium, the Kootenay Arc, Quesnellia, and the Okanagan sub-terrane (Figs. 1, 4; Table 4), with several projects evaluating the potential for rehabilitating historic underground workings.

5.1. Purcell Anticlinorium

The Purcell Anticlinorium is a broad, north-plunging structure in the Omineca Belt, between the Rocky Mountains

and the Kootenay Arc (Fig. 4). It is underlain by Proterozoic rift successions of ancestral North America (Fig. 7). Mineralization types include: sedimentary exhalative (SEDEX) deposits (bedded sulphide, feeder pipe, and vein); massive sulphide replacement deposits (Irish, Mississippi Valley, and manto); Mesoproterozoic intrusion and fault-related Ag-Pb-Zn and Cu-Ag veins; Mesozoic shear and vein gold, and associated placer deposits (Höy, 1993; McMechan, 2012).

The Purcell Anticlinorium formed during Mesozoic contraction, when imbricated thrusts carried up to 15 km of Belt-Purcell and Paleozoic margin sedimentary rocks eastward over a basement ramp (Cook and Van der Veelden, 1995). The Anticlinorium is transected by steep north-northwest longitudinal faults and northeast-trending transverse faults. The transverse faults may be related to the Vulcan low basement structure (Figs. 4, 5) and were likely reactivated repeatedly, including during Proterozoic Belt-Purcell Supergroup and Windermere Supergroup sedimentation (Höy, 1982a). The Vulcan low may also have influenced Mesozoic shear and vein gold along the Kimberley Gold Trend, which runs east-west through the historic gold rush town of Fort Steele.

The Belt-Purcell Supergroup (1.5-1.3 Ga) consists of up to 12 km of sedimentary rocks and tholeiitic sills that were deposited in an intracratonic rift (Figs. 6, 20). Sedimentary facies include rusty-weathering deep-water turbidites, shallow-water platform and fan-delta deposits at the margins of the rift and surrounding shelf, and shallow-water carbonates, mud flat, lagoonal, and alluvial deposits of the rift-cover succession (Fig. 21). Synsedimentary faulting during graben extension and sporadic tholeiitic to alkaline magmatism characterize lower units. Apparently, metal rich brines migrated along synsedimentary faults and interacted with sea floor boron and aluminous sediments to form stratabound massive sulphides. Exhalative-style indicators and alteration include tourmalinite (boron) horizons, sections of fragmental sediments, anomalous Pb-Zn-Ag-Sn-Cu, and indicator element geochemistry. Most exploration has focused on SEDEX Pb-Zn-Ag mineralization in the Aldridge Formation similar to that of the historic Sullivan mine at Kimberley (MINFILE 082FNE052). The mine operated from 1909 to 2001 and produced over 17.5 Mt of zinc, 18.5 Mt of lead, and 297 million ounces of silver. The contact between the lower and middle Aldridge members hosts the Sullivan Pb-Zn-Ag ore body (Fig. 21). Indicators of Sullivan-style mineralization are distributed throughout the Aldridge Formation, including disseminated sphalerite and galena. In addition to stratabound base metals, extensional tectonics also led to the development of vent and feeder pipe complexes and base metal vein deposits. Pb-Zn-Ag mineralization with characteristic tourmaline alteration is commonly localized at the intersections of north-northwest trending and northeast-trending faults, including the St Mary, Kimberley, and Moyie-Dibble Creek faults (Price, 1981; Höy et al., 2000; McMechan, 2012). These fault intersections have been the focus of exploration. The upper part of the Purcell Supergroup contains carbonate-hosted, stratiform replacement-

Table 4. Metals exploration, Kootenay-Boundary Region, 2014.

Property	Operator	MINFILE	Commodity; deposit type	Resource	Work program	Significant results	Website
Bul River (underground)	Purcell Basin Minerals Inc.	082GNW 002	Cu-Ag-Au+/-Pb-Zn; Cu-Ag veins	N/A	Permitting; environmental baseline; mine plan and mine design; ARD/ML	Proposed restart of Bul River Mine; draft project proposal	-
Findlay	MMG Limited	082KSE 041, 53, 60, 75	Pb-Zn-Ag+/-Cu; SEDEX, polymetallic vein	N/A	Drilling (2 DDH); mapping; geophysics; modelling	Failed to reach drill target due to poor ground conditions	www.mm.com
Sully	Santa Fe Metals Corp.	-	Gravity anomaly	N/A	Drilling (4 DDH); mapping; magnetics; geophysical and geological modeling	Drill hole correlations and geophysical modeling suggest two gravity targets in thrust repeat; sulphides and alteration halo intersected	www.santafemetals.com
Vine	PIX Resources Inc.	082GSW 050	Pb-Zn-Ag+/-Au; polymetallic vein, SEDEX	1.3 Mt grading 2.2 g/t Au, 3.12% Pb, 36.3 g/t Ag, 3.12% Zn (2011; non-compliant)	Drilling (1 DDH: 400 m); gravity survey; geophysical and geological modelling	Infilled gravity survey grid; detailed geophysical and geological model	www.pjresources.com
Iron Range	Santa Fe Metals Corp.	082FSE 014 to 28	Pb-Zn-Ag+/-Au-Cu; polymetallic veins and breccia; SEDEC; IOCG	N/A	Geological modeling; sampling	Prioritized targets	www.santafemetals.com
Zinger	PIX Resources Inc.	-	Au+/-Pb-Zn-Ag; veins	N/A	Mapping; soil sampling	Two soil grids; West grid: values up to 7 x baseline; East grid: soil values up to 4.9 g/t	www.pjresources.com
Parmigan	Silver Mountain Mines Inc.	082KSE 030, 36	Ag-Pb-Zn+/-Au-Cu; manto, polymetallic veins	N/A	Drilling (28 DDH: 3,690 m);	Extension of mineralized zones; 4.60 m grading 1.949 g/t Ag, 0.803 g/t Au, 0.72% Cu; 3.96 m grading 1.05 g/t Au, 260 g/t Ag, 0.14% Cu	www.silvermountainmines.com

Table 4. Continued.

Property	Operator	MINFILE	Commodity; deposit type	Resource	Work program	Significant results	Website
Iron Range	Santa Fe Metals Corp.	082FSE 014 to 28	Ag-Pb-Zn+/-Au-Cu; polymetallic vein, SEDEX, IOCG	N/A	Data compilation; mapping	Geological model	www.santafemetals.com
J & L (underground)	Huakan International Inc.	0825M 003	Ag-Pb-Zn+/-Au; SEDEX, Irish-type carbonate-hosted, polymetallic veins	Main Zone: 3.95 Mt grading 5.68 g/t Au, 56.5 g/t Ag, 1.94% Pb, 3.56% Zn (Measured+Indicated); Yellowjacket Zone: 1.0 Mt at 64.1 g/t Ag, 2.77% Pb, 9.08% Zn, 0.21 g/t Au (Indicated) (2011)	Engineering and baseline studies; metallurgical testwork	Care and maintenance; process optimization	www.huakanmining.com
Thor	Taranis Resources Inc.	082KNW 030, 31, 60, 61	Ag-Pb-Zn+/-Au; polymetallic veins, stratiform manto	Indicated: 640,000 t grading 0.88 g/t Au, 187 g/t Ag, 0.14% Cu, 2.51% Pb, and 3.51% Zn; Inferred: 424,000 t grading 0.98% Au, 176 g/t Ag, 0.14% Cu, 2.26% Pb, and 3.2% Zn (2013: potential open pit and underground)	Surface drilling (29 EW core, pack drill); trenching; mapping; panel sampling; metallurgical testwork; assessment of stockpiles to NI 43-101 standards	Extended gold-bearing zone at the SIF, including 30.59 g/t Au over 17.55 m; metallurgical testing at SIF shows 75% gravity recoveries for Au; discovery of SIF Carbon zone	www.taranisresources.com
Teddy Glacier / Spider Mine	Jazz Resources Inc.	082KNW 069	Ag-Pb-Zn+/-Au; polymetallic veins	Inferred: 44,000 t grading 4.457 g/t Au, 7.94% Pb, 6.74% Zn (2007; non-compliant)	Metallurgical testwork (flotation); ARD	Pb flotation concentrate with 62% Pb, 83% Au and 92% Ag; Zn flotation concentrate with 48.7% Zn; Permit for pilot mill and tailings pond at former Spider Mine to process bulk samples(2013)	www.jazzresources.ca
Jersey-Emerald	Margaux Resources Inc.	082FSW 010, 9	Pb-Zn-Ag+/-W-Au-Mo-Bi; stratiform, skarn	Measured and Indicated: 2,766 Mt grading 0.36% WO ₃ ; Indicated: 1,724 Mt 1.96% Pb, 4.1% Zn; Indicated: 25,000 t grading 0.098% Mo (2010)	Drilling (35 DDH: 6,319 m); mapping; sampling; geological modeling	Initial assay results indicated zones of 10-20 m width, grading 0.10 to 0.15% WO ₃ ; and >0.5% over 1-3 m; 10.2 m grading 24.98 g/t Au with elevated bismuth	www.margauxresources.com

Table 4. Continued.

Property	Operator	MINFILE	Commodity; deposit type	Resource	Work program	Significant results	Website
Slocan Silver (Silvana - underground)	Klondike Silver Corp.	082FNW 050, 13; 082KSW 006	Ag-Pb-Zn+/-Au; polymetallic vein	N/A	Engineering reports: underground mining structure and tailings storage facilities; mine emergency response plan update; dam safety inspection review; hydrological inspection of Carpenter Creek	Work identified in engineering reports to begin in early 2015	www.klondikesilver.com
Iron Range	Santa Fe Metals Corp.	082FSE 014 to 28	Ag-Pb-Zn+/-Au-Cu; polymetallic vein, SEDEX, IOCG	N/A	Data compilation; mapping	Geological model	www.santafemetals.com
Willa	Discovery Ventures Inc.	082FNW 070, 71	Ag-Pb-Zn +/-Au-Cu-Mo; subvolcanic breccia, polymetallic veins, porphyry Mo, Au-skarn	Measured and Indicated: Using a 3.5 g/t Au cutoff: 758,199 t grading 6.67 g/t Au, 0.85% Cu, 12.54 g/t Ag; Using a 2.5 g/t Au cutoff: 1,337,457 t grading 5.05 g/t Au, 0.74% Cu, 10.72 g/t Ag (2012)	Preliminary Economic Assessment; geological modelling; mine design; Dam safety inspection of MAX tailing facility; MAX mill upgrades; core re-sampling; Lidar survey; permitting	Acquisition of partial interest in MAX Mine and mill for processing; mill upgrades	www.discoveryventuresinc.com
LH	Magnum Goldcorp Inc.	082FNW 212	Cu-Ag-Au; subvolcanic, Au-veins	N/A	Drilling (4 DDH: 707 m); SP and IP/magnetometer survey	Two conductive anomalies were drilled; results pending	-
Daylight	Sultan Minerals Inc.	082FSW 175, 174	Ag-Pb-Zn+/-Au-Cu; polymetallic vein; porphyry	N/A	Mapping; sampling	Four new veins/silicified zones discovered; grab samples 80.4 g/t Au + 117.0 g/t Ag; 23.4 g/t Au + 7.8 g/t Ag	www.sultanminerals.com
Kennville	0995237 B.C. Ltd. (privately owned)	082FSW086	Au-Cu-Pb-Zn-Ag-W; Au-veins, Cu-Au alkali porphyry, intrusion-related Au, pyrrhotite veins	N/A	Permitting for surface and underground; surface work; mine planning; public consultation; mapping	Extension of powerline to site; plans for underground development and bulk sampling	-
Yankee-Dundee	Armex Mining Corp.	082FSW 067, 68, 082ESE 189	Ag-Pb-Zn+/-Au; polymetallic veins	Inferred reserve estimate: 872,000 t grading 10 g/t Au, 170 g/t Ag (1983: Non-compliant)	Permitting; mapping	-	-

Table 4. Continued.

Property	Operator	MINFILE	Commodity; deposit type	Resource	Work program	Significant results	Website
Swift Katie	Riverside Resources Inc.	082FSW 290	Cu-Au-Ag+/-Mo; porphyry	70.7 Mt grading 0.23% Cu, 0.22 g/t Au (2006; Non-compliant)	Drilling (5 DDH: 1,423 m); soil geochem; mapping	Precious metal and polymetallic zones encountered, including: 23.4 g/t Au, 0.62% Cu, and 435 g/t Ag over 1.5 m; 5.69 g/t Au, 0.13% Cu and 26.6 g/t Ag over 2 m;	www.rivres.com
Jumping Josephine	Orex Minerals Inc.	082ESE 275	Au-Ag; Au-quartz veins	JJ Main - Indicated: 363,000 t grading 2.95 g/t Au, with 34,000 oz contained (2011)	Drilling (25 DDH: 8,115 m); mapping; trenching	Drill results expected early 2015; trenching results included: 7 m grading 80.18 g/t Au, 706 g/t Ag; 8 m grading 6.34 g/t Au, 2.7 g/t Ag (coarse gold signature)	www.orexminerals.com
Rosland Gold	West High Yield (W.H.Y) Resources Ltd.	082FSW 119, 116, 117	Au-Ag-Pb-Zn, Mg; polymetallic veins, ultramafic-hosted talc-magnetite	N/A	Mapping; sampling	Four samples grading 70.3 g/t Au, 13.4 g/t Au, 17.9 g/t Au, and 52.0 g/t Au	www.whyresources.com
Gold Drop	Ximen Mining Corp.	082ESE 153, 152, 126	Au-Ag-Pb-Zn+/-Cu; vein, alkalic intrusion-associated Au	N/A	Trenching; mapping; sampling	Chip sample results up to 0.60 m grading 43.6 g/t Au, 141 g/t Ag; and 0.55 m grading 56.2 g/t Au, 259 g/t Ag; upper North Star vein extended along 315 m strike	www.ximenminingcorp.com
Lexington (Greenwood)	Huakan International Mining Inc.	082ESE 041, 32	Au-Cu-Ag+/-Pb,Zn; porphyry, epithermal, polymetallic veins	131,500 t grading 9.6 g/t Au, 1.48% Cu (1993; Non-compliant)	Re-acquired property; Care and maintenance; environmental	Permitted 200 t/d flotation mill and tailings facility	www.huakanmining.com

	Northern Purcell Mountains	Hughes Range	Lithology
Upper Prot.	Windermere Supergroup		Quartz-feldspar grit, conglomerate, sandstone, siltstone, shale, diamictite, local greenstone flows, breccia and tuff, limestone, dolomitic, pelite
Middle Proterozoic	Belt-Purcell Supergroup	Mount Nelson	Orthoquartzite, buff weathered/purple dolomite, argillite
		Rooseville	Dark grey to green argillite and siltstone, dolomitic sandstone
		Phillips	Pink-purple micaceous sandstone and siltstone
		Gateway	Light to dark, green-grey siltstones, sandstones, rare buff dolomitic beds
		Sheppard	Calcareous green-grey sandstones, siltstones, dolomitic limestones
		Nicol Creek	Grey-green amygdaloidal and phenocrystic basalt flows
		Van Creek	Light to dark green-grey argillites, sandstones, minor dolomitic siltstone
		Kitchener	Green-grey, limestone, dolomite, siltstones, fine-grained sandstones
		Creston	Green, mauve, and grey siltstone, argillite, and quartzite, local mudcracks
		Aldridge	Upper Aldridge: medium to dark-grey, rusty-weathering, siltstone, argillaceous siltstone, argillite, thinly laminated to thin bedded, turbidites Middle Aldridge: rusty-weathering, laminated, thinly-bedded to well-bedded, medium quartz arenite, wacke, siltstone, local conglomerate at contact with Lower Aldridge, turbidites Lower Aldridge: rusty-weathering, thin to medium-bedded, fine-grained quartz wacke and siltstone, fining-upwards, turbidites Moyie sills: gabbroic to diorite, hornblende and plagioclase phenocrysts
		Fort Steele	Cross-bedded to massive quartz arenite, feldspathic sandstone, siltstone

Fig. 20. Stratigraphy of the Belt-Purcell Supergroup. Modified from Hein, et al (2012).

style sulphide mineralization in dolomites of the Mount Nelson Formation (Fig. 20), and structurally related polymetallic Ag-Pb-Zn veins.

The Purcell Supergroup is unconformably overlain by the Neoproterozoic Windermere Supergroup (Fig. 22), which outcrops at the northern end of the Purcell Anticlinorium. Deposition of the Horseshoe Creek Group and the overlying Hamill-Gog Group appears to be related to two main phases of rifting, with 2-3 km of strata eroded from parts of the succession by the sub-Lower Cambrian unconformity (Aitken, 1969; Simony and Aitken, 1990). Deposition may have been locally affected by small- and large-scale structures, including the 'Windermere High', which was a northwest-trending offshore high that developed south of 53°N (Hein and McMechan, 2012). The Windermere Supergroup hosts limited syngenetic manto-style replacement, MVT, and polymetallic vein mineralization, mainly along north-trending faults.

The Geological Survey of Canada (GSC) is conducting a multi-year project in the area as part of the Targeted Geoscience Initiative (**TGI-4**). The main focus is to develop geoscience knowledge and techniques to better understand and model SEDEX mineral systems, and mineral potential in the Purcell

anticlinorium. Geological, geophysical, and geochemical data throughout the Purcell Basin are being compiled into a database, in order to generate a regional 3D digital model and maps over a large area of the Purcell anticlinorium, and give new perspectives and understanding on ore controls. The project is still underway, but preliminary releases include results of magnetic susceptibility studies and geophysical perspectives of the Purcell anticlinorium (Thomas, 2012; Thomas, 2013), a magnetic susceptibility study of the Moyie anticline (Thomas, in press), and magnetic contribution to 3D crustal modelling in the Purcell anticlinorium, (Thomas, et al., 2013). The geology and geochemistry of Ag-Pb-Zn veins (Païement, et al., 2012), and carbonate-hosted nonsulphide Zn-Pb mineralization (Paradis, et al., 2011), evaluations of SEDEX concepts in the Cordillera (Paradis and Goodfellow, 2012), and zircon ages from units on the western margin of the Purcell Basin (Lydon and van Breeman, in press) are also parts of this project. Preliminary interactive digital maps and data (Joseph, et al., 2011) have been released, along with concepts on 3D modelling and interpolation of geological surfaces (Hillier, et al., 2013) and strike and dip observations (Hillier, et al., 2013), which will contribute to concepts applied to the digital

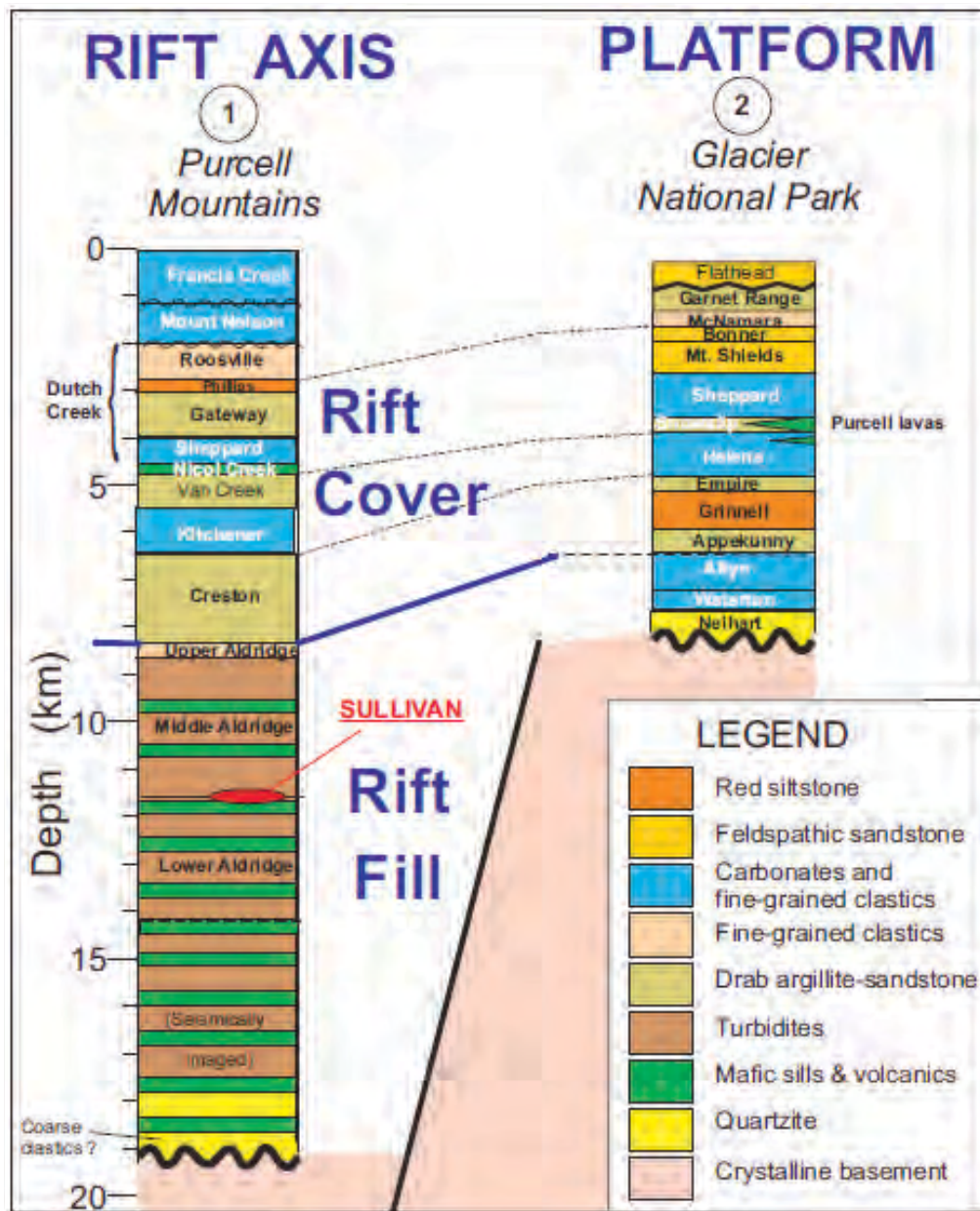


Fig. 21. Stratigraphic correlation and comparison of average thicknesses between units of the rift-fill, rift-cover, and platform successions in the Belt-Purcell Supergroup. From Lydon (2007).

modelling.

GeoscienceBC's **SEEK** project (Stimulating Exploration in the East Kootenays) is a partnership program with the East Kootenay Chamber of Mines focused on mineral potential in the Belt-Purcell Basin. Ground geophysical data have been compiled for the region into a single database (Sanders, 2012; Hartlaub, 2013), and in 2013 new data were added in the St. Mary Valley area, near Kimberley and the historic Sullivan mine (Sanders, 2013). In 2014, SEEK projects included a paleomagnetic study on structures in the Northern Hughes Range (Clifford, 2014; Ransom, in press), geological mapping and compilation along the Kimberley Gold Trend (Seabrook,

in press), and mapping of vent systems and sub-basins in the middle Aldridge Formation near Cranbrook (Kennedy, in press). Funding also supports the Fort Steele Drill Core Library Project, which is managed by the East Kootenay Chamber of Mines. The project aims to develop a secure repository to preserve some of the East Kootenay drill core, including core from the Sullivan mine.

5.1.1. Exploration projects in the Purcell Anticlinorium

Purcell Basin minerals Inc. is working to restart the **Gallowai Bul River** mine, which has been on care and maintenance since 2009. The property is hosted in fault-bounded blocks of

	Central Purcell Mountains		Southern Selkirk Mountains		Lithology
Lower Cambrian	Lardeau Group		Laib Formation	Emerald Mbr	Quarzite, feldspathic sandstone, phyllite, argillite, carbonate, tuff, basalt, chert, siliceous argillite
	Badshot			Reeves Mbr	Phyllite, calcareous grit, dolostone, siliceous phyllite, quartzite
	Mohican			Truman Mbr	
	Upper Proterozoic	Windermere Supergroup	Hamill Group	Reno Fm / Quartzite Range Fm	
Horsethief Creek Group (undivided)			Horsethief Creek Group	Three Sisters	Horsethief Creek Group: Clastic continental margin and marine sediments; quartz-felsdpar grit, conglomerate, sandstone, siltstone, shale, diamictite, local greenstone flows, breccia and tuff, limestone, dolomicrite, pelite
				Monk	
				Irene Volcanics	
				Toby Fm.	Toby Fm.
Middle Prot.		Purcell	Mt. Nelson	Mt. Nelson	

Fig. 22. Stratigraphy of the Windermere Supergroup. Modified from Hein, et al. (2012).

the Aldridge Formation. Cu-Ag mineralization is in a network of east-west trending, near-vertical, sulphide-bearing quartz-carbonate veins, in sheared and brecciated host rocks. The main vein structure and stringer zones range from a few cm to >30 m wide. Mineralization occurs as pyrite, pyrrhotite, and chalcopyrite, with minor galena, sphalerite, arsenopyrite, cobaltite, and traces of tetrahedrite and native gold. The historic **Dalton** mine operated between 1971 and 1974, and produced 7,260 t of Cu, 6,354 kg of Ag, and 126 kg of Au from 471,900 t milled (BC MINFILE) from open pits. The property has existing infrastructure, including a 750 ton per day conventional mill, assay and metallurgical laboratories, tailings impoundment, waste dumps, and two open pits. The company has been completing environmental baseline work and updating mine plans.

MMG Ltd. continued geological and geophysical work on the **Findlay** property, which is underlain by Purcell Supergroup rocks and Cretaceous intrusions. Targets include the contact between the lower and middle parts of the Aldridge Formation (Fig. 21) and other exhalative-style, stratabound mineralization and alteration, including tourmalinite (boron) horizons, sedimentary breccias, and anomalous Pb-Zn-Ag-Sn-Cu. This

part of the Purcell Basin is at the northern extent of the Sullivan-North Star structural corridor, a north oriented graben that hosts the Sullivan ore body (Price, 1981). The property also exhibits polymetallic veining, and hosts the historic Silver Key mine (MINFILE 082KSE053) which produced from structurally controlled polymetallic (Ag-Pb-Zn±Au) quartz veins in lower parts of the Aldridge Formation. In 2013, mapping, sampling and ground geophysics (AMT survey) was completed on the far west **Middle Fork Creek** and the northeastern **Phoenix** areas. The middle Fork Creek area hosts a thick fragmental package with disseminated syngenetic pyrrhotite, banded tourmaline, massive pyrrhotite, and sphalerite mineralization. Tourmaline-rich quartz veins crosscut Moyie sills and middle Aldridge Formation rocks. In 2014, two holes drilled at the **Phoenix** failed to reach the target due to poor ground conditions.

In 2014, Santa Fe metals Corp. drilled three holes on the **Sully** property (Fig. 23), and expanded their gravity and magnetic surveys. They targeted two subsurface gravity anomalies in the Purcell Supergroup that were identified using surface surveys and a 2012 downhole TDEM survey. Mass modeling of the anomalies is consistent with contrasting specific gravities of sulphide mineralization, relative to the country rocks. Recent



Fig. 23. Drilling at the Sully property.

mapping and drill-hole correlations suggest that the anomalies may represent fault repetition of an upturned stratabound horizon in the Aldridge Formation. Drilling has intersected traces of Pb-Zn-Cu sulphide mineralization and sericite alteration. The company intends to continue exploration in 2015 with further drilling and gravity and magnetic surveys.

PJX Resources Inc. continued work in 2014 at the **Vine** property, drilling one diamond drill hole, infilling their gravity grid, and updating their geological-geophysical model. The gravity modelling has identified two target areas that are interpreted to be massive sulphide mineralization (Pb-Zn-Ag±Au) in the Aldridge Formation. Close to the gravity targets is the shear-related **Vine Vein** (Pb-Zn-Ag-Au) occurrence, which was discovered in the late 1970s in middle Aldridge Formation argillites and quartzites. Historic trenching and drilling revealed vein-related and disseminated sulphides (pyrite, sphalerite, and galena) along a strike length of over 1000 m and at depths of over 700 m. Bedded massive sulphides were intersected 700 m deep in two historic drill holes at the Vine vein, and a more recent gravity survey identified a 2 x 4 km anomaly east of the two historic holes. This gravity anomaly has been the focus of work by PJX, who plan further drilling early in 2015.

Santa Fe Metals Corp. has begun work on the **Iron Range** property, where the Aldridge Formation hosts Ag-Pb-Zn±Au, Cu mineralization along the Iron Range fault zone, which consists

of a number of north-trending faults along a 90 km strike length. Intense hydrothermal alteration, brecciation, tourmalinization, albitization, and fragmental rocks along the fault zone suggest periodic reactivation. The property is also underlain by felsic intrusive rocks, and some showings display hematization of magnetite, albite and chlorite and possible affinities with iron oxide-copper-gold (IOCG) mineralization. In 2014, Santa Fe Metals Corp. began data compilation and geological modeling and sampled for heavy mineral concentrates under an option agreement with Eagle Plains Resources Ltd.

In 2014, PJX Resources Inc. continued mapping and geochemical sampling at the **Zinger** property. Purcell Supergroup quartzites, argillites, and siltstones (Creston Formation; Fig. 20), argillites of the Kitchener Formation, and gabbro sills and dikes host gold in northeast-trending veins and shear zones adjacent to the Perry Creek fault. Veins occur as quartz stockworks and stringers with iron carbonate, sericite, and minor sulphides, including pyrite, galena and chalcopyrite. Soil sampling on two separate grids in the Gold Run Lake area encountered highly anomalous soil results for gold.

The **Ptarmigan** property (Fig. 24; Silver Mountain Mines Inc.) includes the past-producing **Ptarmigan** and **Iron Cap** occurrences. Mineralization occurs along north-trending steeply dipping normal faults and in massive sulphide replacements in carbonates (mantos), and generally consists of pyrite, galena, sphalerite, and tetrahedrite. The Ptarmigan mine consists of a series of adits driven along the fault contact between the Mount Nelson Formation (Belt-Purcell Supergroup) to the west, and the Toby Formation (Windermere Supergroup) to the east. Late Cretaceous intrusions may have provided a heat source for hydrothermal fluid enrichment and contributed to metal zonation, with faults acting as the conduits for metal-bearing fluids. Gravity data acquired on the **Ptarmigan/Iron Cap**, **Horsethief** and **Gopher Creek**, and **Nip and Tuck** grids, surface geochemical sampling, and subsurface drill results



Fig. 24. Ptarmigan Basin, looking northwest, near the historic Ptarmigan underground mine.

have been used to update geological modelling and identify targets. In 2013, the newly discovered **Dunwalk** anomaly was targeted by 3-hole drill program and the company released a NI 43-101 report. In 2014, drilling focused on the Ptarmigan mine area, and extended zones of known mineralization.

5.2. Kootenay Arc

The Kootenay Arc is a 400 kilometre-long curved belt of sedimentary, volcanic, and metamorphic rocks that lies between the Purcell Anticlinorium to the east, and the Shushwap-Monashee complex and the Quesnel terrane (Fig. 4; Reesor and Moore, 1971; Reesor, 1973) to the west. Deflection of the arc to a southwest trend near its southern end may reflect reactivation of basement structures along the Vulcan low (Fig. 4; Price, 1981). The Kootenay Arc includes Paleozoic to Mesozoic rocks of the Kootenay terrane and parts of the North American platform. In the north, metamorphosed oceanic assemblages of the Slide Mountain terrane (Milford and Kaslo groups) overlie Neoproterozoic to Lower Paleozoic pericratonic successions of the Kootenay terrane (Fig. 25; Fyles, 1967). Deposits include stratiform, laminated to massive sulphides, replacement-style Irish-type, Besshi-type, Cu-Zn-rich VMS, and boron-enriched

exhalites (Nelson et al., 2013), and Mesozoic precious-metal and skarn mineralization. Some Pb-Zn deposits are Ordovician to Devonian, which is consistent with an epigenetic MVT rather than syngenetic origin (Simandl and Paradis, 2009). The Badshot Formation, a thick Cambrian carbonate unit, and its southern equivalent, the Reeves member (Laib Formation), host stratiform, laminated to massive sulphides, and replacement-style mineralization. The Laib Formation also hosts skarn mineralization in the Truman member. Overlying the Badshot Formation, the Lardeau Group (Middle Cambrian to Permian) comprises >3.5 km of graphitic phyllites, immature siliciclastic rocks, and mafic volcanic rocks, that are coeval with the shallow-water shelf deposits to the east (Logan and Colpron, 2006; Nelson, et al., 2013). Within the Lardeau Group, rift-basin, MORB, and OIB rocks host Besshi-type, Cu-Zn-rich VMS deposits, and boron-enriched exhalative horizons in the Index and Jowett formations (Nelson et al., 2013), and structurally hosted polymetallic breccias and veins.

5.2.1. Exploration projects in the Kootenay Arc

The **J&L** gold-silver-zinc-lead property remained on care and maintenance in 2014, but Huakan International Mining

	Northern and Central Kootenay Arc	Northern and Central Kootenay Arc Lithology	Southern Kootenay Arc	Southern Kootenay Arc Lithology
Mississippian to Permian	Marten Congl.	Rusty-weathering greenstone conglomerate		
	Kaslo Group	Ultramafic serpentinite, talc-schist, tholeiitic lava, flows, tuffaceous greenstone, cherty tuff		
	Milford Group	Chert, shale, argillite, limestone, conglomerate		
Ordovician to Mississippian	Lardeau Group	Broadview Fm		
		Jowett Fm		
		Sharon Creek Fm		
		Ajax Fm		
Mid to Upper Cambrian	Lardeau Group	Triune / Alkoklex Fm	Nelway Fm	Grey dolomite and limestone, argillaceous beds
		Index Fm		
		Badshot		
Lower Cambrian	Windermere	Mohican	Laib Formation	Grey / white limestone
		Hamill-Gog Group		
			Upper Laib	Grey dolomite and limestone, phyllite, quartzite
			Emerald Mbr	Black calcareous argillite, phyllite
			Reeves Mbr	Grey / white limestone
			Truman Mbr	Phyllite, argillite, limestone
			Reno Fm	Blocky quartzite, micaceous quartzite, grey / black phyllite
			Quartzite Range Fm	White / grey quartzite, green phyllite, limestone

Fig. 25. Stratigraphy of the Kootenay Arc. Modified from D.Grieve (pers. comm.).

Inc. continued pre-feasibility metallurgical test work (flotation, bio-oxidation, and pressure oxidation tests), baseline work, and mine design. The property is underlain by metasedimentary and metavolcanic rocks of the Hamill and Lardeau groups. Mineralization is hosted by the Hamill Group (Badshot and Mohican formations), which consists of sheared and intensely folded impure quartzites, quartz-sericite, sericite, and chlorite schists and phyllites, and banded carbonaceous limestones. The main Zone is a shear hosted, sheeted Au-Ag-Pb-Zn vein deposit that averages 2.5 m in thickness. Underground drilling and drifting has defined the zone over a 1.4 km strike length and 850 m down dip; on surface the zone has been traced for 1.6 km. The Yellowjacket Zone sub-parallel, and is in the immediate hanging wall of, the main Zone. Stratabound Ag-Pb-Zn is interpreted as a structurally controlled contact-related replacement deposit. An NI 43-101 resource estimate released in 2011 reported 722,000 ounces of gold in the Measured and Indicated categories.

The **Thor** property (Fig. 26; Taranis Resources Inc.) is underlain by a thick succession of folded and faulted rocks of the Badshot Formation and Lardeau Group, with potential for stratiform base metal sulphides (Ag-Pb-Zn-Au-Cu). Primary stratiform mineralization predates folding and faulting, and parallel horizons of galena, chalcopyrite, pyrite, and sphalerite extend along a 2 km strike length. High-grade gold is also found in late quartz veins that flank sulphide deposits. A number of targets have been identified on the property, including the **Scab**, **SIF**, **Gold Pit**, **Mega Gossan**, **West Limb**, and the **Ridge Target**, which appear as VLF conductors and gossans. In 2014, Taranis followed up on 2013 work with EW-sized core drilling at the **SIF** zone, where visible gold occurs in quartz-ankerite veins, and discovered mineralization at the **SIF Carbon** zone. An initial shaker table test from the **SIF Carbon** zone yielded a sulphide concentrate that graded 512.4 g/t Au and 540 g/t Ag. The company plans to conduct bulk sampling in 2015 at the **SIF** and **SIF Carbon** zones, and the **Broadview**, **Great Northern**, and **True Fissure** stockpiles. The NI 43-101 resource estimate (2013), based on drilling of 152 holes between 2007 and 2008, highlights both open-pittable (62% of the property) and underground mining projects. Historic production on the property was from the Silvercup, Triune, Nettie L. and True Fissure mines.

In 2014, Jazz Resources Inc. conducted metallurgical testwork at the **Teddy Glacier** property, which 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. 25). Mineralization occurs as a series of irregular Ag-Pb-Zn±Au polymetallic veins at the **Big Showing**, **East Vein**, **Dunbar Vein**, and **West Vein**. The **Vimy Ridge** stratabound zone exists as massive galena-pyrite-chalcopyrite in a silicified limestone at a schist-limestone contact (Shearer, 2007).

In 2014, Margaux Resources Ltd. released an NI 43-101 report and conducted a drill program at the **Jersey-Emerald** property (Fig. 27), targeting tungsten and gold mineralization



Fig. 26. Sampling at a gossan zone on the Thor property.



Fig. 27. Skarn mineralization at the Jersey Emerald.

at the **Emerald**. The property is underlain by interstratified carbonates and pelites of the Laib (Cambrian) and Active (Ordovician) formations (Fig. 25). Coarse-grained marble to garnet-pyroxene skarn occurs in the Truman and Reeves members at contacts with small Cretaceous granitic stocks, and Nelson (Jurassic) intrusions. The property contains: stratiform lead-zinc mineralization; tungsten (with minor

molybdenum) skarn mineralization; quartz veins, silicified limestone, and greisen-type alteration with Au, and Bi; and molybdenum porphyry. Exploration on the property dates back to the late 1800s, when gossanous outcrops were discovered by prospectors. The **Emerald** Tungsten mine is a stratabound Pb-Zn deposit with a tungsten skarn, and operated from 1942 to 1943, then intermittently until 1973. The **Jersey** mine is a stratiform Pb-Zn deposit that operated between 1949 and 1970.

5.3. Quesnel terrane, Okanagan sub-terrane, and Mesozoic intrusive suites

Exotic terranes that accreted to the western margin of North America are exposed in the southwest part of the Kootenay-Boundary Region. The area has a rich mining history that dates back into the 1800s (Fig. 28). Mineralization occurs as Ag-Pb-Zn±Au,Cu polymetallic vein; shear-hosted, stockwork and breccia deposits; replacement-type base metals; Cu-Au-Ag and base metal skarns; porphyry Cu-Mo; alkalic porphyry Cu-Au-Ag; Au-Ag epithermal vein; Zn-Pb bearing mesothermal quartz veins; and precious and base metal massive sulphides.

In the Kootenay-Boundary region, the Quesnel terrane and Okanagan sub-terrane (Figs. 1, 4, 29) consist of: upper Devonian to Permian cherts, siliciclastic rocks, and basalts (Harper Ranch, Attwood, and Mount Roberts groups) and

paragneiss, orthogneiss, cherts, siliciclastic rocks, phyllites, greenstones, ophiolites, and serpentinites (Trail Gneiss, Knob Hill, and Anarchist Group); coeval volcanoclastic rocks, pelites, and carbonates; Upper Triassic to Lower Jurassic volcanic arc rocks (Rossland and Nicola groups); Triassic siliciclastic rocks (Brooklyn and Slocan groups); and Mesozoic to Tertiary intrusions (Kuskanax, and Nelson batholiths; Bayonne magmatic suite; Coryell, Airy, and Ladybird intrusions).

In the Slocan, Nelson, and Rossland areas, Ag-Pb-Zn vein, polymetallic Ag-Pb-Zn±Au, breccia, shear-hosted, and replacement deposits are hosted by rocks of the Rossland, Slocan, and Ymir groups, and thought to be genetically related to the Kuskanax and Nelson intrusions (Middle to Late Jurassic). Mineralization commonly occurs at or near deformed contacts. The intrusions are predominantly granite and granodiorite in composition, but have local diorite, monzonite and syenite phases (Armstrong, 1988), commonly with local zones of intense deformation around their margins. The Middle to Late Jurassic intrusive suite comprises syn- to late-tectonic plutons that were emplaced during accretion of Quesnellia (Monger et al., 1982).

Cretaceous intrusions of the Bayonne magmatic belt (Fig. 4) were emplaced inboard of the main magmatic arc in continental margin rocks. They are generally intermediate to felsic alkalic to calc-alkalic, including peraluminous, subalkalic hornblende-biotite granodiorites, highly fractionated two-mica granites, aplites, and pegmatites. Mineralization related to the suite includes Mo-Au±W-quartz veins; W-Cu-Au skarns; Au-Ag-Bi-Cu-Pb fault-veins; and Pb-Zn-Au-As-Sb±W quartz-carbonate veins (Logan, 2002), with a low concentration of base metals and sulphides. At the southern end of the Bayonne magmatic belt, and along northeast-trending faults related to the Vulcan Low, are magmatic-hydrothermal mineral deposits (Fyles and Hewlett, 1959).

Intrusions emplaced during regional Tertiary extension include the Coryell suite of alkalic plutons (with local extrusive equivalents) and stocks of granite and augite-biotite syenite and monzonite. Alkalic intrusives have been the focus of considerable exploration for epithermal mineralization. Tertiary biotite, feldspar, hornblende and augite lamprophyre dikes are commonly along fractures, faults, or prominent foliation planes (L. Caron, pers comm, 2014). Some Tertiary faults expose Proterozoic crystalline basement (Kettle River and Valhalla metamorphic core complexes) in their footwalls.

5.3.1. Projects in the Quesnel terrane, Okanagan sub-terrane, and Mesozoic intrusive suites

Klondike Silver Corp.'s **Slocan Silver Project** (Fig. 1) consists of several past producers in a rich historic Ag-Pb-Zn mining area. The area is underlain by sheared and brecciated argillite and slates of the Slocan Group (Triassic; Fig. 29) that are cut by Nelson granodiorite and quartz monzonite dikes (Middle Jurassic; Fig. 4). Shear-hosted polymetallic veins contain Ag-Pb-Zn mineralization. Klondike's holdings include the Sandon, Hewitt, Silverton Creek, Cody Creek, Payne,



Fig. 28. Historic smelter near Greenwood.

	Greenwood	Greenwood / Rossland Lithology	Rossland	Nelson	Nelson Lithology
Jurassic			Hall Elise	Rossland Group Hall Elise	Fissile locally graphitic argillite, siltstone, quartzite, conglomerate Basalt flows, mafic to intermediate lapilli tuff, pyroclastic breccia, siltstone, congl.
Triassic	Brooklyn	Brooklyn: Fragmental greenstone, microdiorite, skarn, limestone, sandstone, siltstone, sharpstone congl.	Archibald	Ymir / Slocan Group	Ymir / Slocan: argillite, shale, siltstone, sandstone, impure limestone, grit conglomerate Archibald: argillite, siltstone, basalt to andesite flows, tuff
Permian				Marten Conglomerate	Rusty-weathering greenstone conglomerate
Carboniferous	Attwood	Attwood / Mount Roberts: Cherty siltstone, phyllite, argillite, limestone, andesitic volcanics, sharpstone congl.	Mount Roberts	Kaslo Group	Ultramafic serpentinite, talc-schist, flows, tholeiitic lava, tuffaceous greenstone, cherty tuff
	Knob Hill	Knob Hill: Cherty siltstone, phyllite, argillite, limestone, andesitic volcanics, serpentinite, greenstone		Milford Group	Chert, shale, argillite, limestone, conglomerate
	Anarchist	Trail Gneiss: bt-hbl quartz diorite gneiss, granodiorite gneiss, ophiolite	Trail Gneiss	Lardeau	Quartzite, phyllite, conglomerate, mica schist, feldspar chlorite schist, argillite, quartzo-feldspathic sandstone, limestone, volcanics, pyroclastic rocks, mafic flows
Devonian					
Proterozoic to Silurian	Silver Creek Chase (Caledonian)				

Fig. 29. Stratigraphy of Quesnel terrane and the Okanagan sub-terrane. Modified from Colpron et al. (2009).

and Jackson Basin camps, and the **Silvana**, **Wonderful** and **Hinckley** past-producers. The main vein at the **Silvana** is an 8 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, mainly as argentiferous galena and sphalerite. The company's mill at Sandon is a 100 t/day concentrator that operates at an average rate of 40 t/day. It was shut down in the latter half of 2013 as the company re-evaluated geological modelling and furthered exploration targets. In 2014, the mine and mill remained on care and maintenance, and the company focused on baseline environmental and engineering studies.

Discovery Ventures Inc. is proposing to reopen underground workings on the **Willa** property, and produce ore for processing at the **MAX** mill, 135 km to the west near Trout Lake. The **Willa** has been on care and maintenance since 2005. The deposit is in a roof pendant of the Nelson batholith, containing mafic volcanic rocks of the Rossland Group, intruded by felsic dikes. To the north are Slocan Group metasedimentary rocks that contain silver-lead-zinc mineralization. Lamprophyre dikes and faults post-date and crosscut the metavolcanics and intrusions. Mineralization (Pb-Zn-Ag-Au±Mo) is in structurally controlled silica-rich breccias, pipes and stockwork veins,

with local massive- to disseminated, replacement zones. The main copper-gold mineralization is hosted in a sub-volcanic breccia pipe at the centre of a hypabyssal complex of quartz and feldspar porphyritic intrusions, and has an alkalic porphyry signature. Chalcopyrite, pyrite, and magnetite mineralization comprise three zones in, and peripheral to, the breccia pipe (Ash, 2014). The resource was updated in 2012, and in 2014, the company continued mapping, sampling, metallurgical testwork, and environmental baseline work. They also acquired an interest in the **MAX** molybdenum mine and mill, which has been on care and maintenance since 2011, and began repairs, maintenance, and modifications. It is estimated that the mine life will be about 4.1 years at mining and milling capacity of 500 t/day.

Magnum Goldcorp Inc. entered into an option agreement with International Bethlehem at the **LH** property. Mineralization follows a zone of fracturing, faulting, and silicification in a roof pendant of Slocan Group sedimentary rocks and Rossland Group metavolcanic rocks, in granodiorites of the Nelson batholith. Gold mineralization is in structurally controlled mesothermal quartz lenses and veins that are 0.6 to 7 m wide and can be traced along strike for over 70 m., and in silicified

breccias and stockworks in hornfelsed volcanic rocks. Both styles of mineralization are associated with pyrite, pyrrhotite, arsenopyrite, and chalcopyrite. In 2014, the company completed SP and IP magnetometer surveys, and followed up with drill 4 holes. Results from the magnetometer survey suggest that the anomalies may indicate pyrrhotite, which has previously been correlated with elevated gold values in drilling.

In 2014, Sultan Minerals Inc. conducted a small mapping and sampling program on the **Daylight** property and discovered four new quartz veins and silicified zones carrying gold mineralization. The area is underlain by sheared and highly schistose augite basalt flows and subvolcanic intrusions of the Elise Formation (Rossland Group) that are cut by plagioclase-phyric rocks of the Silver King porphyry (Late- to Middle Jurassic). Northwest-trending shears host quartz veins with sulphides. Shear-zone mineralization occurs as vein, stockwork, and porphyry-style Au and Au-Cu. Quartz veins up to 0.9 m wide contain pyrite, chalcopyrite, with tetrahedrite and free gold. The property is 500 m north of the historic Silver King mine, which produced from the polymetallic Silver King Shear zone. Historic production on the Daylight property was from the Starlight, Victoria, and Daylight mines, which operated intermittently from 1937 to 1949 and produced mainly gold, silver, and copper.

In 2014, the **Kenville Gold** property was sold by Anglo Swiss Resources Inc. to a private company (0995237 B.C. Ltd.). Host rocks are the Eagle Creek plutonic complex (Jurassic) which may be co-magmatic with volcanic rocks of the Elise Formation (Rossland Group). Late Jurassic Nelson granodiorites, and Tertiary intrusive rocks are common in the immediate area. The property lies near the Silver King shear zone and hosts Au-Ag-Cu mineralization in a northwest-trending system of quartz veins, and Pb-Zn-Ag sulphide veins. An alkalic porphyry copper-gold signature may be associated with the intrusives. The principal mineralized veins found on the Kenville mine property strike northeasterly, average 0.6 m in thickness, and are traceable for at least 500 m. The past-producing Kenville mine, also known as the **Granite-Poorman** (Au-Ag-Pb-Zn-Cu), was the first underground lode gold mine in British Columbia, and operated intermittently between 1890 and 1954. In 2014, the company received permits for underground exploration work and drilling, began surface work, including a 3-phase power line extension to the site, and completed mapping and sampling. They have plans for bulk sampling and underground work.

Armex Mining Corp. optioned the **Yankee-Dundee** property from Duncastle Gold Corp. and began data compilation and geological mapping; drill permits are in place. The property includes numerous past-producing, high-grade mines including the two largest mines in the Rossland mining camp (Yankee Girl and Ymir). The property is underlain by Elise Formation volcanic rocks, and Ymir Group argillites and slates. Extending northeasterly through the central part of the property is a lobe of Nelson batholith granite with a diorite rind. Medium-grade metamorphism and hornfelsing of the sedimentary rocks

occurs at the intrusive contacts. The area is strongly faulted, and the metasedimentary rocks are internally tightly folded, with a prominent north-trending foliation. Mineralization (Ag-Pb-Zn-Au) is hosted in the Ymir Group and Nelson batholith diorites in northeasterly trending veins and can be traced for over a kilometer. Mining from the **Dundee** and **Yankee-Girl** polymetallic veins started in the early 1900s, reached a peak in the 1930s and ceased in the early 1950s (Höy and Dunne, 2001).

In 2014, Riverside Resources Inc. drilled the **Swift Katie** property under an option agreement with Valterra Resource Corp. The property is underlain by volcanic and synvolcanic intrusive rocks of the Elise Formation, Jurassic to Cretaceous (Nelson) intrusions, Eocene intrusive rocks (Coryell), and Tertiary felsic to mafic and lamprophyric dikes. The property contains alkalic porphyry Cu-Au mineralization, with pyrite, chalcopyrite, bornite, pyrrhotite, sphalerite, tetrahedrite and chalcocite, and polymetallic (Pb-Zn-Ag±Au,Cu) shear-hosted quartz-calcite veins. In 2014, Riverside conducted soil geochemistry and drilled on soil and resistivity anomalies identified over a 1 km² area at the **Swift** target. Drilling tested for porphyry Cu-Au and intersected zones of potassic alteration (biotite and magnetite) and hydrothermal alteration (epidote, chlorite, calcite, pyrite and magnetite). Drilling also identified 20-40 cm wide Au-Ag-Pb bearing veins with pyrite-pyrrhotite-chalcopyrite at the contact between andesite and a diorite intrusion.

In 2014, Orex Minerals Inc. merged with Astral mining Corp. and acquired 100% ownership of the **Jumping Josephine** property. The property is underlain mainly by several phases of the Nelson and Coryell intrusive suites, which cut metavolcanic and metasedimentary rocks of the Mount Roberts Formation (Fig. 29). Vein and shear-related gold mineralization is hosted in northeast-trending brittle shear zones in Middle Jurassic monzonitic plutonic rocks. Exploration has also revealed skarn mineralization. Historic production (pre-1940) includes gold-silver and minor copper, lead, and zinc from several workings. Airborne TEM surveys, soil geochemistry, drilling, and trenching have identified several zones of mineralization. A resource was compiled at the **JJ main** zone in 2011, where mineralization is hosted in sheeted and stockwork quartz veins. In 2014, Orex drilled at the **JJ main** to extend the mineral resource, and reconnaissance holes tested additional prospects and showings at the **JJ main Extension, Golden Crown, BZT, Borrow Pit, JJ West, and Hillside** zones. Some of the historic trenches at the JJ main were also located and resampled.

In 2014, West High Yield (W.H.Y.) Resources Ltd. sampled at their **Rossland Gold** property. The **IXL, Midnight** and **OK** claims straddle the north-dipping contact between a Permian serpentinized ultramafic body to the south, and Rossland Group (Elise Formation) volcanic rocks and Mount Roberts Formation sedimentary rocks to the north (Fig. 29). The volcanic rocks are hornfelsed, with irregular zones of disseminated magnetite, pyrite, pyrrhotite, and local tungsten mineralization. Gold mineralization occurs in quartz veins near

the ultramafic contacts. Veins are typically 0.1-0.6 m wide, extend along strike for up to 70 m, and consist of quartz with minor ankerite, pyrite, chalcopyrite and galena. Mineralization also occurs in local areas of pyrrhotite-pyrite bearing carbonate-talc-quartz alteration and carbonate veining (listwanite-type) in the serpentinites. Dikes and irregular bodies of Rossland monzonite, Coryell syenite and biotite lamprophyres cut both the ultramafic and the volcanic rocks, and some of these are silicified and contain gold. Sampling in 2014 focused on reject rock piles of several historic mines. The property is also being evaluated for potential for magnesium and nickel in the ultramafic rocks. The company released a Preliminary Economic Assessment for their **Record Ridge** magnesium project in 2013.

In 2014, Ximen Mining Corp. conducted an excavator trenching program on the **North Star** and **Gold Drop** veins. 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. Gold-bearing veins in the area post-date the Nelson intrusives and pre-date the Coryell suite. The Gold-Drop-North Star veins range in thickness from 10 cm to 2 m. North-trending, steeply-dipping strike-slip and normal faults, and low-angle detachment faults post-date mineralization (Caron, 2014)

Huakan International Mining Inc. re-acquired their **Greenwood** project (Au-Cu-Ag), which consists of the **Lexington-Grenoble** underground mine, the **Golden Crown** deposit, and the **Lexington** mill. The mill is a fully permitted 200 tonne per day gravity flotation mill and tailings facility for processing gold-copper mineralization from the Lexington underground mine. The project is currently on care and maintenance.

6. Outlook for 2015

Exploration and mining increased in 2014, and development is expected to continue on several of the larger and more advanced projects in 2015. Major mine development, expansion plans, and projects in the East Kootenay coalfields with long-term timelines will likely continue to advance, even as companies scale back exploration budgets in response to low coal prices. Base metal targeting in the Purcell Anticlinorium is expected to continue, with several drill projects planned for early in 2015, and base and precious metal mining projects around the Slocan remain active with some projects evaluating underground potential. Industrial minerals will remain a focus for the region.

Acknowledgments

Parts of this report are the result of a compilation and update of earlier reports and project files by previous Regional Geologists, British Columbia Geological Survey geologists, BC MINFILE data, Technical and Assessment Reports, and company news releases. Sincere thanks also go out to industry exploration and mining staff who provided updated information. The generous

co-operation of industry staff make it possible for the regional geologists to effectively monitor activities, trends, and results, and make the information available to the public. All errors and omissions in this report are the responsibility of the author.

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Exploration and mining in the Thompson-Okanagan-Cariboo Region, British Columbia

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Recommended citation: Britton, J., 2015. Exploration and mining in the Thompson-Okanagan-Cariboo Region, British Columbia. In: Exploration and Mining in British Columbia, 2014. British Columbia Ministry of Energy and Mines, British Columbia Geological Survey, Information Circular 2015-2, pp. 67-82.

1. Introduction

Thompson-Okanagan-Cariboo is an administrative region in south-central BC, established after the province reorganized its natural resource agencies in 2010. Mining predates Confederation and today, the region is home to five of BC's largest metal mines, several industrial mineral mines, and many small placer operations, gravel pits, and rock quarries. Mineral products include: copper; molybdenum; gold; silver; limestone; bentonite; zeolite; diatomaceous earth; high-alumina shale; precious opal; dimension stone; and aggregate. The region's diverse geology, natural endowment, infrastructure (road, rail, power), and skilled workers sustain the search for new deposits.

In 2014, the region saw one new gold mine open (Bonanza Ledge), one mine placed on care and maintenance after a breach in a tailings dam (Mount Polley), the installation of a new crusher (Copper Mountain), and the commissioning of a new mill (Highland Valley). Most projects in the pre-application stage of environmental review made progress. One project (New Prosperity) was rejected a second time by a Federal review panel.

A Supreme Court of Canada decision in favour of the Tsilhqot'in Nation created Canada's first Aboriginal title area. Subsequently, Tsilhqot'in Nation declared a Tribal Park over a large area in the centre of the region and released a draft mining policy intended to address present and future exploration and mining activities.

Exploration focused on defining or expanding porphyry and porphyry-related deposits (copper-gold; copper-molybdenum), gold deposits of various types, and stratiform base-metal deposits. The pace of exploration slowed in 2014, continuing a decline that started in late 2011. Many projects were inactive because operators were unable to raise venture capital or unwilling to spend it in the region. Exploration expenditures for the region were included in the provincial total (Clarke et al., 2015) but for confidentiality reasons, specific expenditures are not presented herein.

2. Geological overview

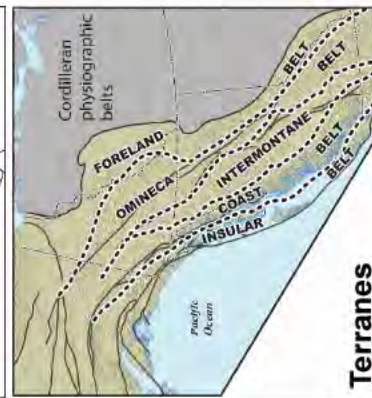
The tectonic and metallogenic evolution of the Canadian Cordillera are intimately linked (Fig. 1, e.g., Nelson et al.,

2013). The Thompson-Okanagan-Cariboo region straddles three of British Columbia's five morphogeological belts (from east to west: Omineca; Intermontane; Coast). The mid-Mesozoic and older geological framework is represented by cratonic and pericratonic rocks in the east, and a series of Late Paleozoic through mid-Mesozoic arc and oceanic terranes to the west (Fig. 1). Younger rocks, not shown on Figure 1, include Jura-Cretaceous siliciclastic and local volcanic rocks, Eocene volcanic rocks, Neogene and Quaternary basalt, and Middle Jurassic to Eocene granitic intrusions.

2.1. Cratonic and pericratonic terranes

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

Kootenay terrane comprises Neoproterozoic to mid-Paleozoic rocks that are interpreted as deep-water basin facies equivalents deposited west of the North American platform. Lower Cambrian and older rocks are similar to North American strata to the east, but the overlying lower Paleozoic succession is characterized by units of coarse siliciclastic and mafic volcanic rocks that may reflect intermittent extensional deformation (Colpron and Price, 1995). This belt also includes Devonian-Mississippian calc-alkaline to alkaline volcanic rocks and associated granitoid intrusions, found mainly in the Eagle Bay assemblage east and southeast of Clearwater (Schiarrizza and Preto, 1987), which reflect the initiation of east-dipping



subduction beneath the North American plate margin. These rocks host polymetallic volcanogenic massive sulphide occurrences, as well as the Harper Creek bulk tonnage copper deposit.

2.2. Arc and oceanic terranes

Slide Mountain terrane comprises the most inboard tract of oceanic rocks in the Canadian Cordillera. It includes the Fennell Formation, near Clearwater; the Antler Formation, near Wells; and in the intervening area, a narrow, discontinuous belt of rocks referred to as the Crooked amphibolite. The Fennell and Antler formations comprise thrust-imbricated sequences of mainly basalt, chert, diabase, and gabbro, ranging from early Mississippian to mid-Permian (Schiarrizza and Preto, 1987; Struik and Orchard, 1985). These rocks may be the remnant of a Late Paleozoic marginal basin that formed behind a westward-retreating volcanic arc in Quesnel terrane. The Fennell Formation hosts Cu-Mo massive sulphide mineralization at the Chu Chua occurrence.

Quesnel terrane is a Late Triassic to Early Jurassic magmatic arc complex that formed along or near the western North American continental margin (Mortimer, 1987; Struik, 1988a, b; Unterschütz et al., 2002). It also includes a Late Paleozoic arc sequence, represented by the Harper Ranch Group (Beatty et al., 2006) and, in the south, assemblages of oceanic rocks that include the Old Tom, Independence, and Shoemaker formations (Tempelman-Kluit, 1989). The Mesozoic rocks are represented mainly by Middle to Upper Triassic volcanic and sedimentary rocks of the Nicola Group, together with abundant Late Triassic to Early Jurassic calc-alkaline to alkaline intrusions (Preto, 1977, 1979; Mortimer, 1987; Panteleyev et al., 1996; Schiarizza et al., 2013). The Nicola Group consists mainly of volcanic and volcanic-derived sedimentary rocks, but also includes an eastern sedimentary facies of dark grey siltstone and slate intercalated with quartzite and limestone (Bloodgood, 1990; Schiarizza et al., 2013; Mihalynuk et al., 2015). The volcanic rocks are mainly augite-phyric shoshonitic basalts, but the western part of the group locally includes a belt of calc-alkaline volcanic rocks that includes substantial amounts of rhyolite and dacite (Mortimer, 1987; Preto, 1977, 1979). A younger stratigraphic component of Quesnel terrane comprises Lower to Middle Jurassic sedimentary rocks (Ashcroft Formation, Windy Mountain succession, Dragon Mountain succession) that overlie western parts of the Nicola Group unconformably or disconformably (Travers, 1978; Logan and Moynihan, 2009; Schiarizza et al., 2013).

Quesnel terrane is an important metallogenic province, particularly for porphyry deposits containing Cu, Au, and Mo (e.g., Logan, 2013; Logan and Mihalynuk, 2014). The plutons that host these deposits conform, in part, to a pattern defined by parallel belts of calc-alkaline or alkaline plutons that become progressively younger from west to east (Schiarrizza, 2014). The western (Late Triassic) calc-alkaline belt includes the Guichon Creek batholith, host to the Highland Valley Cu-Mo mines, and the Granite Mountain batholith, host to the Gibraltar Cu-Mo

mine. A well-defined belt farther east comprises younger, latest Triassic alkaline plutons, which host alkaline porphyry Cu-Au deposits, including producing mines at Copper Mountain, Afton and Mount Polley. A third belt, younger and farther to the east, is defined by several large, Early Jurassic calc-alkaline plutons, including the Bromley, Pennask, Wild Horse, Thuya and Takomkane batholiths (Fig. 2).

Cache Creek terrane, comprising Carboniferous to Early Jurassic chert, argillite, basalt, limestone, sandstone, gabbro and serpentinitized ultramafic rocks of the Cache Creek Complex, forms a belt to the west of Quesnel terrane in the central and northern parts of the region. It includes Late Triassic blueschists farther north (Ghent et al., 1996), and is interpreted, at least in part, as an accretion-subduction complex that was responsible for generating the Quesnel magmatic arc (Travers, 1978; Struik et al., 2001).

Cadwallader terrane, as interpreted by Schiarizza (2013), forms a belt that underlies parts of the Intermontane and eastern Coast belts, west of Cache Creek and Quesnel terranes. It includes a Late Permian-Early Triassic primitive oceanic arc complex, and an overlying Late Triassic-Middle Jurassic arc complex and associated siliciclastic apron. The older arc system includes bimodal volcanic rocks and associated intrusions of the Wineglass assemblage, southwest of Williams Lake, and Late Permian intrusive rocks within the Mount Lytton complex (Friedman and van der Heyden, 1992; Schiarizza, 2013). The younger arc system includes Upper Triassic volcanic and sedimentary rocks of the Cadwallader Group and Tyaughton Formation, Late Triassic intrusions in the western part of the terrane and in the Mount Lytton complex, and Lower to Middle Jurassic siliciclastic and local volcanic rocks of the Ladner Group (Schiarrizza, 2013, and references therein).

Bridge River terrane occurs in the eastern Coast belt, west of Lytton and Lillooet, where it is partially enveloped by Cadwallader terrane. It is represented mainly by the Bridge River complex, comprising structurally interleaved slivers of chert, argillite, basalt, blueschist, gabbro, serpentinite, limestone, and sandstone (Schiarrizza et al., 1997). Dated cherts and limestones range from Mississippian to late Middle Jurassic, and blueschist-facies metamorphic rocks yielded Middle to Late Triassic Ar-Ar ages (Cordey and Schiarizza, 1993; Schiarizza et al., 1997). The complex is interpreted as an accretion-subduction complex, possibly related to the Mesozoic arc volcanics of the adjacent Cadwallader terrane. Chert-bearing sequences are locally overlain by siliciclastic rocks of the Cayoosh assemblage (Journeay and Mahoney, 1994), which forms the youngest component of the terrane.

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

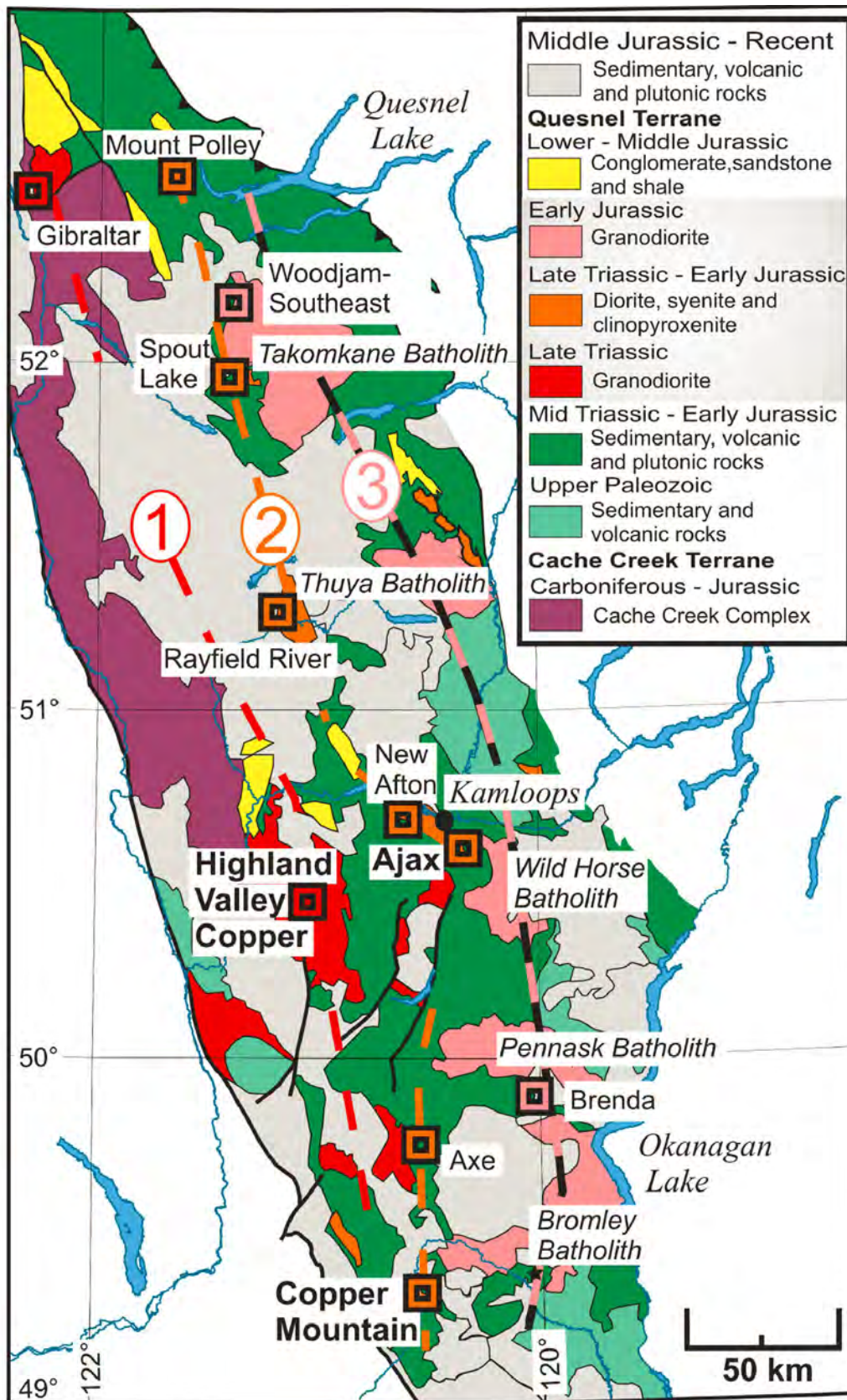


Fig. 2. Generalized geology of southern Quesnellia and Cu±Mo±Au deposits. Mesozoic arc plutons align along the length of southern Quesnellia to define three, north-trending, temporally distinct belts that get younger to the east: 1) Late Triassic; 2) Late Triassic-Early Jurassic; and 3) Early Jurassic.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

to the Mount Moore and Mosely formations, in the eastern Coast belt west of Chilko Lake, are also assigned to Stikine terrane (Rusmore and Woodsworth, 1991).

2.3. Late Jurassic and younger rocks

Older terranes are overlapped by younger stratigraphic units that, although not shown in Figure 1, cover large parts of the region. These include: Upper Jurassic to Upper Cretaceous siliciclastic rocks of the Tyaughton-Methow basin, which overlap Cadwallader and Bridge River terranes in the eastern Coast belt (Schiarizza et al., 1997); and mid-Cretaceous arc volcanic rocks of the Spences Bridge Group which form a northwest-trending belt that overlaps Quesnel and Cache Creek terranes in the Merritt-Lillooet area (Monger and McMillan, 1989), and continues westward across the Fraser River where it overlaps Cadwallader and possibly Stikine terranes (Mahoney et al., 2013). Eocene volcanic rocks are predominant in some locations, and Neogene basalt of the Chilcotin Group overlaps Quesnel, Cache Creek, Cadwallader and Stikine terranes throughout much of the central part of the region (Dohaney et al., 2010). Granitic plutons, ranging in age from late Middle Jurassic to Eocene, occur throughout the region, but are shown only in the southwest, where they form part of the Coast Plutonic complex (Fig. 1).

3. Operating mines and quarries

3.1 Metals

With five major operating mines, the Thompson-Okanagan-Cariboo region hosts roughly half of the province's metal mines (Fig. 1, Table 1). The Geological Survey of Canada and the British Columbia Geological Survey continue to develop surficial geology methods for detecting buried porphyry-style mineral deposits in drift-covered areas, conducting glacial dispersion, indicator mineral, and basal till geochemical studies near the Highland Valley, Gibraltar, and Mount Polley mines (e.g., Ferbey et al., 2014).

Three years after receiving all necessary permits, **Bonanza Ledge** mine began production in March (Fig. 3). Owned and operated by Barkerville Gold Mines Ltd., the mine is near Wells. It is an open pit, truck and shovel operation with a mine life of four years. Ore is processed at the company's mill at QR mine 100 km away. Ore consists of native gold in quartz veins within pyrite-bearing, carbonaceous and chloritic phyllite. Stated reserves (as of August 2009) include 130,724 tonnes grading 10.227 g/t Au in the proven category and 166,808 tonnes grading 8.114 g/t Au in the probable category.

New Afton gold-copper mine (Fig. 2) is a block cave operation owned by New Gold Inc. that opened in mid 2012 (Hall and May, 2013). Following tests of higher mining and milling rates in 2013, the company laid plans to increase mill capacity from a design rate of 11,000 t/d to 14,000 t/d. Construction of new facilities began late in 2014. Exploration drilling continued expand resources in the C zone, a down-plunge extension of the area now being mined. The deposit forms a high-grade keel beneath the past-producing Afton open pit mine, an alkalalic



Fig. 3. Bonanza Ledge, first gold pour in July, 2014. Courtesy of Barkerville Gold Mines Ltd.

porphyry in the Iron Mask batholith (Triassic).

Copper Mountain copper-gold mine, near Princeton (Fig. 2) has been producing since August 2011 (see Holbek and Joyes, 2013). It is operated by a partnership of Copper Mountain Mining Corporation (75%) and Mitsubishi Materials Corporation (25%). The rate of mining has met or exceeded guidance figures, but milling operations have struggled to achieve the targeted 35,000 t/d. A new secondary crusher, completed on budget and on schedule, processed its first ore on 4 August 2014 (Fig. 4). Quarterly mine production in 2014 has exceeded 2013's output by 9 to 27%. A multi-year exploration program seeks to upgrade resources, test ore depths and find mineralization outside the current mine plan. Results of recent British Columbia Geological Survey mapping in southern Quesnellia near Copper Mountain and north to Merritt can be found in Mihalynuk et al. (2013a, b, 2014, 2015).

The **Gibraltar** copper-molybdenum mine operated by Taseko Mines Limited and Cariboo Copper Corp., began



Fig. 4. Parts for new secondary crusher on the way to Copper Mountain mine. Photo courtesy of Copper Mountain Mining Corporation.

Table 1. Operating metal mines, Thompson-Okanagan-Cariboo Region, 2014 (listed alphabetically).

Mine	Operator	Commodity; deposit type; MINFILE	Production	Reserves/Resources	Near-mine exploration	Website
Bonanza Ledge (operations started March 2014)	Barkerville Gold Mines Ltd.	gold; vein; 093H 140	Not available	Reserves (as of 2009-08-17; cut-off 2.8 g/t Au): Proven: 130,700 tonnes grading 10.2 g/t Au (containing 43,000 oz Au); Probable: 166,800 tonnes grading 8.1 g/t Au (containing 43,500 oz Au)		www.barkervillegold.com
Bralorne	Avino Silver and Gold Mines Ltd.	gold; vein; 093JNE001	Not available	Reserve data not available. Resources (M+I as of 2012-08-31): 154,750 tonnes grading 9.11 g/t Au		www.avino.com/s/bralorne
Copper Mountain	Copper Mountain Mining Corporation, Mitsubishi Materials Corporation	copper, gold, silver; alkalic porphyry; 092HSE001	80.8 million lbs Cu; 22,100 oz Au; 456,800 oz Ag	Proven and probable reserves (as of 2013-12-31; 0.18% Cu cut-off): 145 million tonnes grading 0.34% Cu, 0.1 g/t Au and 1.38 g/t Ag; containing 1080 million lbs Cu; 0.54 million oz Au; 6.4 million oz Ag		www.cumtn.com
Gibraltar	Taseko Mines Ltd.	copper, molybdenum; calc-alkalic porphyry; 093B 012	144.5 million lbs Cu; 2516 thousand lbs Mo	Proven and probable reserves (as of 2013-12-31; 0.20% Cu cut-off): 682 million tonnes grading 0.30% Cu; 0.008% Mo; containing 4.5 billion pounds of copper; (4.0 billion pounds recoverable). (Molybdenum data not reported)		www.tasekomines.com/gibraltar
Highland Valley Copper	Teck Highland Valley Copper Partnership	copper, molybdenum; calc-alkalic porphyry; 092ISW012	122,700 tonnes Cu; 5 million lbs Mo	Proven and probable reserves (as of 2013-12-31; cut-off not stated): 663.4 million tonnes grading 0.29% Cu; 0.008% Mo. (Recoverable metal: 1,680,000 tonnes Cu; 30,000 tonnes Mo)	Drilling at Bethlehem; engineering studies	www.teck.com
Mount Polley (operations suspended August 2014)	Imperial Metals Corporation	Copper, gold, silver; alkalic porphyry; 093A 008	Production to August 2014: 24.5 million lbs Cu; 25,900 oz Au; 74,770 oz Ag	Proven and probable reserves (as of 2014-01-01; cut-off not stated): 86 million tonnes grading 0.295% Cu; 0.3 g/t Au; 0.6 g/t Ag; containing 559.5 million lbs Cu; 838,100 oz Au; 1.7 million oz Ag		www.imperialmetals.com/s/MountPolleyMine
New Afton	New Gold Inc.	copper, gold; alkalic porphyry; 092INE023	85.4 million lbs Cu; 102,700 oz Au; 244,200 oz Ag	Probable reserves (as of 2013-12-31): 48.8 million tonnes grading 0.56 g/t Au; 2.2 g/t Ag and 0.84% Cu; containing 879,000 oz Au; 3,500,000 oz Ag; 904 million lbs Cu	Drilling C-zone below current workings	www.newgold.com/properties/operations/new-afton
QR (mine on care and maintenance; mill operates)	Barkerville Gold Mines Ltd.	gold; skarn; 093A 121	Not available	QR deposit depleted. Mill processes ore from Bonanza Ledge mine near Wells		www.barkervillegold.com
Treasure Mountain (on care and maintenance)	Huldra Silver Inc.	silver, lead, zinc; vein; 092HSW016	Not available	Not available		www.huldrasilver.com

production in 1972 and completed its first full year of operation after modernization in 2013. The mine has met guidance of 85,000 t/d from combined mills. The mine was chosen the winner of the 2013 Mining and Sustainability Award by the Mining Association of BC and BC government. The mine is hosted by the Granite Mountain batholith (Late Triassic; see van Straaten et al., 2013 for detailed mine geology). Despite a long production history, the origin of the deposit has been contentious, and it has remained unclear if it formed in Cache Creek terrane or Quesnel terrane. New mapping, stratigraphic, geochronologic, and paleontologic studies by Schiarizza (2014, 2015) demonstrate that the Granite Mountain batholith cuts rocks characteristic of Quesnel terrane (Nicola Group) rather than Cache Creek terrane, and is part of a Late Triassic magmatic belt that includes the Guichon Creek batholith, which hosts the Highland Valley deposit (Fig. 2).

The **Highland Valley Copper** copper-molybdenum mine, operated by Teck Highland Valley Copper Partnership (97.5% Teck and 2.5% Highmont Mining Company Ltd.), is the largest base metal mine in Canada. Mine production focused on the Valley pit as pre-stripping continued for the Lornex pit extension. In March the company commissioned their new mill (Fig. 5). This \$475 million investment will help extend mine life to 2026. The company has achieved throughputs of 139,000 tonnes per day, exceeding its rated capacity of 130,000 tonnes per day. Following ground geophysical survey and drilling programs that started in 2012, Teck Highland Valley Copper Partnership continued to explore targets near the past-producing **Bethlehem** mine and their **Valley** pit. One hundred million tonnes of ore have been delineated at Bethlehem Phase 1. Engineering studies are underway. The company drilled 30 000 metres in 2014. A detailed description of the deposit may be found in Byrne et al. (2013).

Mining at the **Mount Polley** copper-gold-silver mine of Imperial Metals Corporation (Fig. 2) came to an abrupt halt on 4 August 2014 when a tailings dam failed (Fig. 6). Several million cubic metres of water, tailings and construction materials flowed into nearby Polley Lake, Hazeltine Creek and Quesnel Lake. Following this event, government commissioned a panel of experts to examine the cause of the failure and ordered a review of all tailings dams in the province. The panel will deliver its report in early 2015. Before shutdown, the mill had begun processing the first ore extracted from underground workings at the Boundary zone. The alkalic intrusive complex at Mount Polley has at least 8 discrete zones with a total resource inventory of ~411 million tonnes at 0.48% copper equivalent (Measured and Indicated; as of 1 January 2013). Rees (2013) provides a comprehensive review of the Mount Polley deposit.

The **QR** mine of Barkerville Gold Mines Ltd. has operated sporadically in recent years due to depleting ore. Early in 2014, the mill processed ore stockpiled in 2013. In March, QR mill began processing ore trucked in from Bonanza Ledge mine 100 km away.

The **Treasure Mountain mine**, 40 kilometres west of Princeton, was on care and maintenance in 2014 while its



Fig. 5. In March, Highland Valley Copper mine commissioned their new mill, shown here under construction in 2013. Photo courtesy of Teck Highland Valley Copper Partnership.



Fig. 6. Repairing the breached tailings dam at Mount Polley mine, September 2014. Photo courtesy of Imperial Metals Corporation.

owner, Huldra Silver Inc., restructured under the Companies' Creditors Protection Act. The Treasure Mountain deposit is described as a stacked series of high-grade silver-lead-zinc veins in Cretaceous sedimentary rocks of the Pasayten Group in the Methow terrane (Fig. 1). A resource estimate (indicated, non-NI 43-101 compliant) prepared in 2009 was 33,000 tonnes grading 828 g/t Ag, 4.16% Pb, and 3.8% Zn, at a 311 g/t Ag cut-off. Other targets near the mine have not been drilled but have returned high-grade grab samples. Huldra's mill is at the former Craigmont tailings facility, near Merritt.

Through most of 2014, the mill at **Bralorne** gold mine processed approximately 80 t/d from stockpiled and underground resources. In October, Avino Silver and Gold Mines Ltd. acquired Bralorne Gold Mines Ltd. and control of the mine. After takeover, Avino stated that it is reviewing operations and, although the mine has been operating steadily (producing 3842 oz Au in fiscal 2013), considers the mine still

in the exploration and evaluation stage. Ore comes from gold-bearing mesothermal quartz veins between three former mines (Bralorne, King and Pioneer).

3.2. Coal

The region's only coal mine was on care on maintenance in 2014, pending restructuring under the Companies' Creditors Protection Act. Coalmont Energy Corporation started production in June 2013 at their **Basin** mine (Table 2), 18 kilometres west of Princeton. The mine's initial production rate was 250,000 tonnes per year of thermal coal, but the company has permits to increase production to 350,000 tonnes per year. The mine uses a 250 tonne per hour Parnaby wash plant, which eliminates the need for a tailings pond. Cleaned coal moves by truck and barge to Texada Island for shipment to local and overseas markets. Production comes from Eocene rocks in a half graben; the Main seam is about 32 metres thick and has four coal units separated by thin layers of siltstone, tuff or ironstone. Twenty-seven metres below the Main seam is the Lower seam (7 metres thick), which remains an exploration target.

3.3. Industrial minerals

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

The **Kamloops** cement plant and **Harper Ranch** limestone quarry of Lafarge Canada Inc. continue to supply cement to meet demand in western Canada. Lafarge also draws materials from the **Falkland** gypsum quarry. **Buse Lake** quarry, which supplied alumina-silica rock to Lafarge, closed in 2013. A loess deposit near the plant provides suitable alternative material.

The **Decor** pit of Pacific Bentonite Ltd., 20 kilometres west of Cache Creek, supplies alumina-rich burnt shale to the Lafarge cement plant in Kamloops. The property also hosts a large bentonite deposit, which is being investigated for municipal engineering and tile manufacturing applications. Deeper in the same section is the Hat Creek coal deposit. A few kilometres farther west, Graymont Western Canada Inc. operates the **Pavilion** limestone quarry and lime plant. The operation produces quicklime, high-calcium limestone fines, screened high-calcium stone products, lime kiln dust and rip rap. Graymont has a forty-year lease with the Ts'kw'aylaxw First Nation to mine on their reserve, and most of the operation's employees are Ts'kw'aylaxw. Five kilometres east of Ashcroft, IG Machine and Fiber Ltd., a subsidiary of IKO Industries Ltd., operates the **Ashcroft** basalt quarry and roofing granule plant.

In January 2014 Craigmont Industries Ltd. started producing magnetite from their new recovery plant at **Mount Polley** mine. Operations halted in August due to the tailings dam failure. The plant captures magnetite from the mine's tailings stream and produces a dense media for coal washing operations.

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

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

Opal Resources Canada Inc. produces gem quality fire opal from the **Klinker** property, 25 kilometres northwest of Vernon. Opal forms fracture and vesicle-fillings in andesitic to basaltic lahars and breccias in the Kamloops Group (Eocene).

Decorative rock and dimension stone are produced at small quarries throughout the region. Kelowna Sand and Gravel mines gneiss, dacite ash, and basalt at the **Nipple Mountain, Kettle Valley, Canyon** and **Gemini** quarries and has been issued permits to explore other sites. Kettle Valley Stone Company of Kelowna processes this material to produce flagstone, ashlar, facing stone, and landscape rock. In 2010, Spectral Gold Corp. began developing the **Lady King Basalt** deposit, near Vernon, selling basalt columns as landscape rock.

3.4. Placer, aggregate, and rock

Fifty six quarries, 480 sand and gravel pits and 704 placer mines (701 surface operations and 3 underground) were 'active' in 2014. 'Active' refers to the status of the permit and therefore also includes mines undergoing reclamation and closure. Most of these operations are small, intermittent or seasonal, and lack production data.

4. Proposed mines

Five projects are in this category: **New Prosperity, Ajax, Ruddock Creek, Spanish Mountain** and **Harper Creek** (Fig. 1, Table 4).

The **New Prosperity** project of Taseko Mines Limited, 125 km southwest of Williams Lake, is described as a gold-copper porphyry with Proven and Probable reserves of 830 million tonnes grading 0.42 g/t Au and 0.23% Cu. In February, the Federal government announced it would not issue the

Table 2. Operating coal mine, Thompson-Okanagan-Cariboo region, 2014.

Mine	Operator	Commodity; MINFILE	Production	Reserves	Near-mine exploration	Website
Basin	Coalmont Energy Corp.	Thermal coal; 092HSE157	On care and maintenance in 2014	Not available	Not reported	coalmontenergy.com

Table 3. Industrial mineral mines, Thompson-Okanagan-Cariboo Region, 2014, (listed alphabetically).

Mine	Operator	Commodity; MINFILE	Production	Reserves/ Resources	Website
Ashcroft	IG Machine and Fibers Ltd. (IKO Industries Ltd.)	Basalt (roofing granules); 092INW104	350,000 t		www.iko.com
Bromley Creek (Zeotech)	Canadian Mining Company Inc.	Zeolite; 092HSE 243	On care and maintenance in 2014	Measured and Indicated Resources (2013-06-30): 550,000 t	www.canadianmining.ca
Bud	Absorbent Products Ltd.	Bentonite; 092HSE162	Not available		www.absorbentproductsltd.com
Decor	Pacific Bentonite Ltd.	Alumina, landscape rock; 092INW084	100,000 t		pacificbentonite.com
Falkland	Lafarge Canada Inc.	Gypsum; 082LNW001	6000 t		None
Harper Ranch	Lafarge Canada Inc.	Limestone; 092INE001	220,000 t		www.lafarge-na.com/wps/portal/na/en/2_8_3-OurPlants
Kettle Valley Quarries	Kelowna Sand and Gravel Ltd. / Kettle Valley Stone Company	Ashlar, flagstone, thin veneer: 082ENW109, 111, 112	Not available		www.kettlevalleystone.com
Klinker	Opal Resources Canada Inc.	Opal; 082LSW125	Intermittent operation		www.opalscanada.com
Lady King Basalt	Spectral Gold Corp.	Basalt columns; N/A	Intermittent operation		www.lady-king-basalt.com
Mount Polley Magnetite	Craigmont Industries Ltd.	Magnetite (recovered from tailings); 093A 008	Not available. Plant operated January-August 2014		www.craigmontmag.com
Pavilion	Graymont Western Canada Inc.	Limestone; 092INW081	190,000 t		www.graymont.com/en/locations/lime-plants/western-canada/lime-plant/pavilion
Red Lake	Absorbent Products Ltd.	Diatomaceous earth; 092INE081	Not available		www.absorbentproductsltd.com

authorizations needed for the project to proceed. Taseko is now seeking judicial reviews of the Federal decision.

KGHM International continued engineering and baseline studies to advance their **Ajax** porphyry copper-gold project, on the outskirts of Kamloops. The company expects to enter federal and provincial environmental review processes in the second quarter of 2015. Early in 2014 the company changed their mine plan to address concerns raised by residents of Kamloops. Dry tailings piles were replaced by conventional tailings ponds and some waste piles were moved farther from city limits. Late in the year the company released revised application information and environmental impact statements for public review. During the year, the company explored nearby deposits such as DM-Audra and Rainbow. All mineralization occurs in the Iron Mask

batholith, a multi-phase, alkaline intrusive complex (Fig. 2).

At the **Ruddock Creek** massive sulphide prospect, 75 kilometres northeast of Clearwater (Fig. 1), Imperial Metals Corporation focused on metallurgical testing of a new sample from the Upper E zone, and collecting environmental baseline data in preparation for future permitting requirements. In July, the Canadian Environmental Assessment Agency agreed that, for the environmental review of this project, the Province of BC's process is an appropriate substitute for the federal process. As a result, in October the BC Environmental Assessment Office formally established the scope, procedures, and methods for the forthcoming environmental review.

The project is owned by Imperial Metals Corporation (50%) and joint venture partners Mitsui Mining and Smelting

Table 4. Proposed mines, Thompson-Okanagan-Cariboo Region, 2014. Reserve categories are Proven and Probable, resource categories are Measured and Indicated.

Mine	Operator	Commodity; deposit type; MINFILE	Reserves and Resources	Work program	Significant results	Website
Ajax	KGHM Ajax Mining Inc.	Cu, Au; Alkalic porphyry 092INE 012, 13	Resources (M+I): 512 million tonnes grading 0.31% Cu; 0.19 g/t Au	Baseline and engineering studies; exploration and condemnation drilling	Revised mine layout; draft AIR and EIS reports.	www.ajaxmine.ca/
Harper Creek	Yellowhead Mining Inc.	Cu, Au, Ag; Stratiform, volcanic-hosted 082M 008, 9	Reserves (P+P; cut-off 0.14% Cu): 716 million tonnes grading 0.26% Cu; 0.029 g/t Au; 1.18 g/t Ag	Baseline and engineering studies	Revised resource estimate.	www.yellowheadmining.com
New Prosperity	Taseko Mines Ltd.	Cu, Au; Calc-alkalic porphyry; 092O 041	Reserves (P+P; cut-off not stated): 831 million tonnes grading 0.23% Cu and 0.41 g/t Au; containing (recoverable) 3.6 billion lbs Cu; 7.7 million oz Au	Legal review of Federal EA decision	Pending.	newprosperityproject.ca
Ruddock Creek	Ruddock Creek Mining Corporation	Pb, Zn, Ag; Monashee-type sediment-hosted massive sulphide; 082M 082	Resources (M+I; cut-off 4.0% Pb+Zn): 6.2 million tonnes grading 6.50% Zn, 1.33% Pb	Baseline and engineering studies; design of review process	Government support for streamlined review process.	www.imperialmetals.com
Spanish Mountain	Spanish Mountain Gold Ltd.	Au, Ag; Sediment-hosted gold; 093A 043	Resources (M+I; cut-off 0.20 g/t Au): 237.8 million tonnes grading 0.46 g/t Au; 0.69 g/t Ag; containing 3.5 million oz Au; 5.28 million oz Ag	Reverse circulation drilling; baseline and engineering studies	Improved data for resource evaluation.	www.spanishmountaingold.com

Co. Ltd. (30%) and Itochu Corporation (20%). The operator and manager of the joint venture is the Ruddock Creek Mining Corporation. The deposit is described as sedimentary exhalative, Monashee or Broken Hill-type, in marble, gneiss and calc-silicate rocks. A mineral resource estimate, released in March 2012, reported 4.65 million tonnes grading 6.77% Zn and 1.38% Pb (Indicated) and 5.38 million tonnes grading 6.69% Zn and 1.31% Pb (Inferred), using a 4.0% combined Pb+Zn cut-off.

The **Harper Creek** copper-gold-silver project, 90 km north of Kamloops, is described as a stratiform, disseminated volcanogenic deposit in metamorphosed volcanic and sedimentary rocks of the Eagle Bay Formation. In November, Yellowhead Mining Inc. submitted an application for an environmental assessment certificate to provincial and federal authorities, concluding a 10-month process of updating and revising an earlier application. If accepted, this will mark

the start of formal review for the **Harper Creek** project. Earlier in the year, the company released an updated, and positive, feasibility study (Merit Consultants, 2014). Proven and Probable mineral reserves now stand at 716 million tonnes grading 0.26% copper; 0.029 grams per tonne gold and 1.2 grams per tonne silver. The study proposes a 70,000 t/d operation with a mine life of 28 years. Initial capital costs would exceed \$1 billion.

Spanish Mountain Gold Ltd. continued to drill reverse-circulation holes in the proposed open pit area (Main zone) of its **Spanish Mountain** sediment-hosted gold deposit (Fig. 7), 70 kilometres northeast of Williams Lake, in order to refine resource estimates. This method of drilling results in better recovery of friable material than diamond drilling and allows more accurate sampling of mineralized layers. In April the company released an updated resource estimate. Measured and Indicated resources (using a cut-off grade of 2 grams per tonne)



Fig. 7. Upper Triassic metamorphosed siliciclastic rocks host disseminated and vein-controlled gold at Spanish Mountain.

are 237.8 million tonnes grading 0.46 grams per tonne gold and 0.69 grams per tonne silver. Baseline environmental studies continue as the company prepares for formal environmental review.

5. Exploration highlights

Exploration in 2014 focused on defining or expanding porphyry and porphyry-related deposits (copper-gold; copper-molybdenum), gold deposits of various types, and stratiform base-metal deposits. Herein, projects are grouped by deposit type and location (Fig. 1; Table 5).

5.1. Porphyry and porphyry-related deposits

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

In November, Fjordland Exploration Inc. and Sumac Mines Ltd. released preliminary results from drilling at their **Dillard** porphyry copper-gold project, 35 kilometres north of Princeton. Dillard West (7 holes; 3160 metres) tested coincident soil geochemistry and IP targets in a target area that measures 1400 by 1200 metres. The company trenched and sampled the Dillard East target, which now measures 2000 by 1500 metres, and drilled 3160 metres in 7 holes. Assays ranged from

0.1 to 0.25% copper over drill lengths of 6 to 153 metres. The company will release a detailed analysis in 2015.

In November, Colorado Resources Ltd. announced they had consolidated ownership of a large block of claims covering their **Hit-Aspen Grove** property (over 21,000 hectares). Earlier they announced plans to continue surface geochemical and geophysical surveys and compile historical data. Results are pending.

In December, Kaizen Discovery Inc. released preliminary results from drilling at the **Par** prospect on their Aspen Grove property, 45 kilometres north of Princeton. One hole intersected 9 metres grading 0.24% copper, 0.8% zinc and 6.4 grams per tonne silver. Another hole intersected 16 metres grading 0.3% copper. Mineralization occurs in variably altered Nicola Group volcanic and volcanoclastic rocks. To account for diverse mineralogy, alteration, and chemistry, the company suggests there may have been two superimposed mineralizing events: an early stage, massive to semi-massive volcanogenic event followed by a hybrid high-level porphyry-high sulphidation epithermal system. The company plans further work in 2015 to test the extent of mineralization and their exploration model.

In August, Sunrise Resources Ltd. announced plans to drill the **Man-Prime** property to follow up on their 2013 drill intersection on 124 metres of 0.25% copper and 0.08 grams per tonne gold.

In 2013, Copper Mountain Mining Corporation optioned the **Axe** property from Weststar Resources Corporation. Late in 2014 Copper Mountain commenced a 1500 metre drill program to test geophysical anomalies at the Main, West and Adit zones. The exploration target at Axe is a copper (molybdenum, gold, silver) porphyry in volcanic and sedimentary rocks of the Nicola Group (Triassic) that have been intruded by diorite-monzonite stocks of similar age. Resources at Axe (based on pre-2006 drilling, but compatible with NI43-101 standards) include 39 million tonnes grading 0.38% copper (Indicated) and 32 million tonnes grading 0.38% copper (Inferred).

Teck Resources Limited continued to explore targets near its **Highland Valley** copper-molybdenum mine hosted by the Guichon batholith (Fig. 2) with a focus on the Valley and Bethlehem pits. To date drilling has confirmed 100 million tonnes of new ore at Bethlehem. Ongoing engineering studies will determine how to mine and process it.

Tower Resources Ltd. announced results from their **Rabbit North** project, 25 kilometres southwest of Kamloops. Rabbit North comprises porphyry-style mineralization and alteration in Nicola Group volcanosedimentary rocks and coeval Durand stock. Tower reported extensions of known zones and the discovery of two new copper-gold targets: Kwil and KV.

In March, Constantia Resources Ltd. completed the first phase of drilling at the **Maggie** project, a porphyry copper-molybdenum prospect north of Cache Creek. Results are being evaluated. As part of their ongoing community engagement, Constantia opened a community office in Cache Creek, announced \$30,000 in scholarships to help ten students become drill core technicians, and reached a cooperation and benefits

Table 5. Selected exploration projects, Thompson-Okanagan-Cariboo Region, 2014 (listed alphabetically).

Property	Operator	MINFILE	Commodity	Deposit type	Work program	Significant results	Website
Axe	Copper Mountain Mining Corporation	092HSE040, 142, 143	Cu, Au	Porphyry	Drilling	Not available	www.cumtn.com; www.weststarresources.com
Brett	Ximen Mining Corp.	082LSW110	Au	Vein/ disseminated	Geology , geochemistry; geophysics; drilling	New targets; improved geological model	ximenminingcorp.com
Ben	Westhaven Ventures Inc.	n/a	Au, Co, Ni	Uncertain	Geophysics; drilling	New targets; improved geological model	www.westhavenventures.com
Bethlehem	Teck Highland Valley Copper Partnership	092ISE001	Cu, Mo	Porphyry	Drilling; engineering studies	Resource definition	www.teck.com
Cariboo Gold Quartz (Cow Mountain)	Barkerville Gold Mines Ltd.	093H019	Au	Vein/Breccia	Drill core re-assay program; resource evaluation	Improved resource definition	www.barkervillegold.com
Dillard	Fjordland Exploration Inc./Sumac Mines Ltd.	092HNE042	Cu	Porphyry	Geochemistry, trenching; drilling	Mineralized zones extended	www.fjordlandex.com
Donna	Interconnect Ventures Corporation	082LSE016	Au, Ag	Vein/ stockwork	Drilling	Not available	www.alpha-aex.com
Elk (Siwash North)	Gold Mountain Mining Corporation	092HNE096	Au, Ag	Vein/Breccia	Bulk sampling; metallurgy	Improved recovery	www.aumtn.com
Fox / Ridley Creek	Happy Creek Minerals Ltd.	093A 259	W, Mo, Ag	Skarn	Geology	New prospects	www.happycreekminerals.com
Ike	Amarc Resources Ltd.	092O 025	Cu, Mo, Ag	Porphyry	Geology, geochemistry; geophysics; drilling	New Cu-Mo-Ag discovery	www.amarcresources.com
Lavington	Asher Resources Corporation	082LSW120	Au	Vein/shear zone	Drilling	Mineralized zone extended; improved geological model	www.asher-resources.com
Maggie	Constantia Resources Ltd.	092INW015	Cu, Mo, Ag	Porphyry	Drilling; community engagement	Drill results not available	www.constantiaresources.com
Man-Prime	Sunrise Resources Ltd.	092HNE243	Cu, Au	Porphyry	Drilling	Not available	www.sunriseresourcesltd.ca
Par (Aspen Grove)	Kaizen Discovery Inc.	092HNE169	Cu, Zn, Mo, Ag, Au	Mixed (porphyry/ VMS)	Drilling	Mineralized zone extended; improved geological model	www.kaizendiscovery.com
Rabbit North	Tower Resources Ltd.	n/a	Cu, Au	Porphyry	Prospecting; geophysics; geochemistry	New mineral zones	www.towerresources.ca
Shovelnose	Westhaven Ventures Inc.	092HNE309	Au	Vein/Breccia	Drilling	Mineralized zone extended	www.westhavenventures

agreement with High Bar First Nation. Maggie is described as a typical, calc-alkaline porphyry deposit in which copper and molybdenum occur in stockwork veins and as disseminations. The intrusive is a multi-phase, Tertiary(?) quartz monzonite porphyry. Host rocks are part of the Carboniferous to Permian Cache Creek assemblage, consisting of deformed sedimentary and volcanic sequences of low metamorphic grade that are intruded by pyroxenite dikes and sills.

In October, NMC Resource Corporation completed a drilling program at **Boss Mountain**, a past-producing molybdenum mine in the Takomkane batholith, 90 kilometres east of 100 Mile House. Drilling in the existing open pit confirmed the tenor of mineralization and demonstrated extensions to depth. The company plans more drilling in 2015.

Amarc Resources Ltd. drilled the **Ike** property in the South Chilcotin Mountains, 110 kilometres northwest of Lillooet. The target is copper-molybdenum-silver porphyry mineralization in an extensive alteration zone in the Coast Plutonic complex. The project includes the Tasco (or Chilcotin Belle) mineral occurrence. In November, the company announced discovering copper and molybdenum mineralization in an area measuring 1200 x 600 metres. Drill intersections range from 90 to 310 metres grading ~0.3% copper, ~0.03% molybdenum and ~2 grams per tonne silver. Mineralization occurs as replacements and veins in granitic rocks that show evidence of repeated pulses of magmatism (Fig. 8). The mineralized zone has been tested to depths of 500 metres and remains open in all directions.

5.2. Skarn

Happy Creek Minerals Ltd. continued surface exploration at its **Fox** tungsten skarn property, 115 kilometres east of Williams

Lake. Prospecting and sampling expanded known zones and discovered new areas of favourable host rock with indications of tungsten mineralization. The company plans more work next year. Skarn mineralization is in flat lying Neoproterozoic to Lower Paleozoic Snowshoe Group sedimentary rocks that have been intruded by the Deception stock, a mid-Cretaceous (106 Ma) pluton that ranges in composition from quartz monzonite to muscovite-biotite granite.

GWR Resources Inc. was again unable to mount an exploration program this year at their **Lac La Hache** Project. The project embraces a large area (400 km²) with multiple deposit types and exploration targets, ranging from high-grade, massive to semi-massive, skarns, veins, replacements and breccias to lower grade porphyries and disseminations.

5.3. Gold deposits (including vein, breccia, disseminated, sediment-hosted)

In December 2013, Ximen Mining Corp. acquired **Brett**, an epithermal gold property in Kamloops Group volcanic rocks, 30 kilometres west of Vernon, on the west side of Okanagan Lake. Brett has seen intermittent exploration since its discovery in 1985 and, in 1995, briefly produced ore from pits and underground workings. Ximen conducted new mapping and geophysical surveys. Alteration on the property destroyed magnetite so magnetic lows can be suitable targets. Drilling at one large magnetic low, northeast of the main vein, intersected zones of silicified breccias similar to those found at Blackwater and Newton gold prospects. Further results will be released in 2015.

At the **Elk** project, between Merritt and Peachland, Gold Mountain Mining Corporation continued work on their open pit bulk sample test. One goal of the project is to compare assay

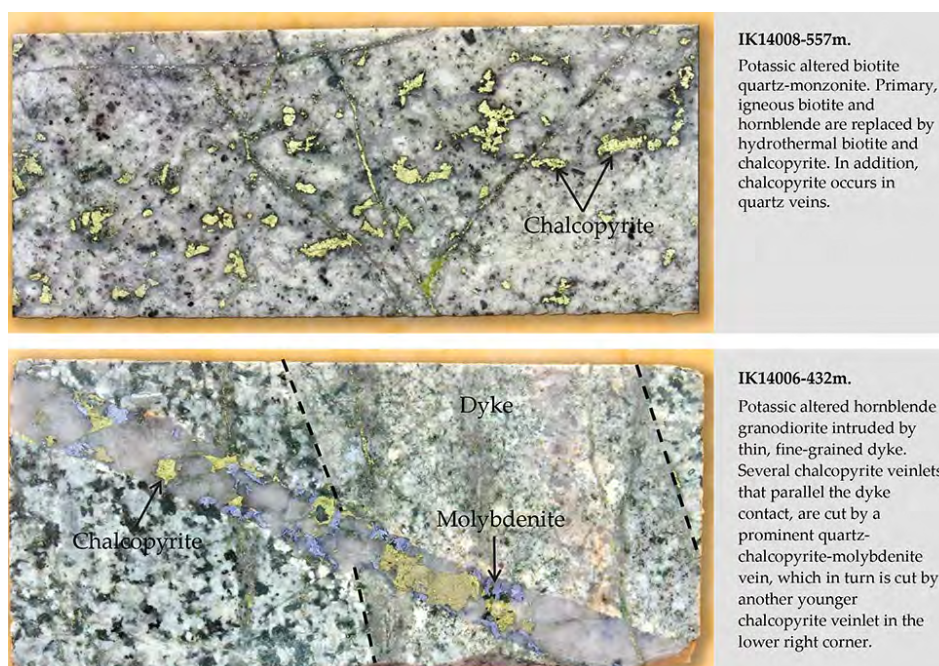


Fig. 8. Copper-molybdenum mineralization from the Ike discovery, South Chilcotin Mountains. Image courtesy of Amarc Resources Ltd.

results from mined material and exploration holes drilled the same area.

In 2013, Interconnect Ventures Corporation optioned the **Donna** property from Alpha Exploration Inc. Late in 2014, Interconnect commenced a 500 metre drill program to test a bulk-tonnage gold-silver target in sedimentary, volcanoclastic, and carbonate rocks of the Thompson assemblage (Carboniferous to Permian) intruded by a quartz diorite stock. Mineralization occurs in veins and stockworks related to a north-trending fault system near the intrusive contact. Results are expected in 2015.

Asher Resources Corp. drilled the Lavington prospect, 10 kilometres east of Vernon. Their target is shear-hosted gold in altered Nicola Group rocks. Drilling intersected long intervals of low-grade gold mineralization and extended mineralization to depth.

Barkerville Gold Mines Ltd. reported progress on their **Cariboo Gold Project**, 85 km east of Quesnel. The project is exploring a block of claims that covers more than 117,000 hectares and includes three historic groups of Crown grants (Cariboo Group, Island Mountain Group, and Mosquito Creek Group). In 2014, the company focused on systematic resampling of drill core to improve the quality of data for future resource estimates. Independent consultants Snowden Mining Industry Consultants Inc. and APEX Geoscience Ltd. are directing the work.

Berkwood Resources Ltd. conducted ground geophysics on their **Prospect Valley** property, 30 km west of Merritt, and extended a prospective trend 1200 metres south from the South Discovery zone. Quartz-chalcedony veins and silicified rocks have helped define a new prospective area (the QCA zone) which the company plans to follow up in 2015. Mineralization discovered to date is described as a low-grade, epithermal gold system with potential for higher grade zones. Drilling has outlined an NI 43-101 compliant mineral resource. Taken together, the North and South Discovery zones have approximately 10 million tonnes grading 0.5 g/t Au (Inferred; using 0.3 g/t Au cut off). A number of geophysical and geochemical targets remain to be tested.

Westhaven Ventures Inc. is working to acquire a 70% interest in the **Shovelnose** property, 30 kilometres south of Merritt, under an option agreement with Strongbow Exploration Inc. In 2014 Westhaven explored the Tower Creek zone, a recently recognized epithermal gold system. Au-Ag mineralization occurs in quartz stockworks and silicified zones in felsic tuffs. Six holes encountered anomalous gold and extended the area of known mineralization. Mineralization extends over an area at least 2 km east-west and 100 metres north-south, hosted in felsic volcanic rocks of the Spences Bridge Group (Cretaceous).

5.4. Stratiform base metal deposits

In the Adams Plateau area, 35 kilometres northeast of Barriere, SolidusGold Inc. (formerly Mantra Capital Inc.) commenced preliminary exploration on the **Honeymoon** project optioned from prospector David Piggitt. Grab samples with 0.6 to 0.8% copper and 6 to 35 grams per tonne silver

occur in metasedimentary rocks of the Eagle Bay assemblage.

In the Mabel Lake area, 60 kilometres northeast of Vernon, prospectors Robert Thompson, Renee Hetherington, and Colin Dunn used biogeochemical (Fig. 9) and geophysical methods to find new showings of Monashee-type massive sulphide mineralization in dense forests on the **TL** and **CD** properties. Grab samples returned up to 19% zinc.



Fig. 9. At the TL project, Mabel Lake area, biogeochemistry helps find massive Pb-Zn sulphides in dense forest with no outcrop.

5.5. Nickel

Westhaven Ventures Inc. reported positive results for nickel from drilling at the **Ben** project, 50 kilometres north of Williams Lake. Best intersections returned almost 20 metres of 0.3% nickel. The property is underlain by Cache Creek terrane. Nickel-cobalt mineralization appears to be related to ultramafic rocks; other parts of the Ben property have gold mineralization. The unusual geochemical association may represent superimposed mineralizing systems, or faults juxtaposing disparate assemblages.

6. Outlook for 2015

Foreseeable economic conditions seem to offer few incentives for exploration. Financing grassroots or early stage projects may be especially challenging. Some mines may reduce production or be placed on care and maintenance as a result of weak commodity prices.

Uncertainties also stem from the Supreme Court of Canada's landmark decision on Aboriginal title. Creation of this new form of title has raised questions about the applicability or validity of federal and provincial statutes, regulations, tenure and permits. Future years may see new claims for Aboriginal title areas in the region.

It is likely that the Tsilhqot'in National Government will develop management plans for the Dasiqox Tribal Park and release further drafts of their mining policy. Future work in the Chilcotin Range or Taseko Lakes area (e.g., New Prosperity; Ike; Ridgestake; Chita) may be affected because they lie within

the proposed boundaries of the tribal park. Technical analysis of the Mount Polley tailings dam failure may shape mining practices in the years ahead.

Two projects (Harper Creek and Ajax) should enter formal environmental review. Legal decisions on New Prosperity appeals may take more than one year to resolve. Most of the exploration projects that were active in 2014 generated positive results and are likely to continue. If economic conditions improve, grassroots exploration should pick up in the Eagle Bay assemblage near Barriere, and the Quesnel terrane, in particular between Merritt and Princeton and between 100 Mile House and Quesnel.

Acknowledgments

Grateful thanks go to Sharon Cadieux, Ministry of Forests, Lands and Natural Resource Operations, Kamloops for drafting early versions of Figure 1. I also thank Paul Schiarizza and Bruce Northcote (British Columbia Geological Survey) for providing substantial last-minute help.

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Exploration and mining in the Coast Area, British Columbia

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Recommended citation: Northcote, B., 2015. Exploration and mining in the Coast Area, British Columbia. In: Exploration and Mining in British Columbia, 2014. British Columbia Ministry of Energy and Mines, British Columbia Geological Survey, Information Circular 2015-2, pp. 83-95.

1. Introduction

This report considers the Coast Area natural resource sector, comprising the South Coast and West Coast regions, including Haida Gwaii (Fig. 1). The area has one major metal mine (Myra Falls) one coal mine (Quinsam Mine), and numerous industrial minerals and aggregate operations. An informal survey of industrial minerals producers and the largest aggregate operations indicates most are producing at or above volumes reported in 2013. Quinsam Coal, a thermal coal producer, has reduced its workforce and output. Polymetallic producer Myra Falls appears less affected by lower commodity prices and continues to mine at a rate similar to 2013, although they report higher zinc grades. Exploration activities requiring significant capital were reduced in 2014 (Figs. 2-4); companies reported only one significant off-lease drill program and two smaller ones. The largest exploration program was the ongoing effort to replace reserves at Myra Falls.

2. Geological overview

Metallogeny in British Columbia is intimately linked to the tectonic evolution of the Canadian Cordillera, an accretionary orogen consisting of exotic and parautochthonous terranes that were welded to ancestral North America during the last 180 million years (e.g. Nelson et al., 2013). The South and West Coast regions include parts of the Insular, Coast, and Intermontane morphogeological belts; most of the area is underlain by rocks of the Wrangell terrane and the Coast Plutonic complex (Fig. 1). Wrangellia is part of the Insular superterrane, a Paleozoic-Mesozoic allochthonous assemblage that docked with Intermontane terranes in the Early-Middle Jurassic as Panthalassic oceanic crust subducted beneath them (e.g. Nelson et al., 2013). A Middle-Late Jurassic magmatic arc resulted from this subduction, the roots of which are represented in the Coast Plutonic complex. Southeast-directed oblique convergence brought the Insular composite terrane southward with respect to the Intermontane terranes, trapping segments of oceanic crust and arc rocks that became the terranes of the southeastern Coast Mountains, and transecting and duplicating part of the Middle-Late Jurassic arc (Bustin et al 2013, Monger and Brown in press). From the Cretaceous onward, accretion continued outboard of Wrangellia. Today, oceanic crust of the Juan de Fuca plate slides eastward beneath previously accreted terranes on Vancouver Island (Pacific Rim, Crescent, and

Wrangell, Fig. 1) along the Cascadia subduction zone (e.g., Hyndman, 1995). The principal deposit types in the South and West Coast regions are tied to Cordilleran terranes (Fig. 5).

2.1. Insular Superterrane

Wrangellia is the most prominent terrane of the Insular belt. The oldest rocks on Vancouver Island are Devonian volcanic arc andesites, basalts, breccias, tuffs and tuffaceous sediments of the Sicker Group and allied intrusive rocks. The Sicker Group is overlain by Mississippian-Permian limestones, argillites, and minor conglomerate of the Buttle Lake Group. This Paleozoic basement is exposed in two major uplifts on southern and central Vancouver Island. The Cowichan Anticlinorium and the Buttle Lake Anticlinorium have particular economic significance as they host past and present volcanogenic massive sulphide polymetallic producers at Mount Sicker and Myra Falls, probably emplaced in back-arc settings.

Unconformably overlying the Paleozoic rocks are Middle to Upper Triassic oceanic flood basalts and related sedimentary rocks of the Vancouver Group. The Vancouver Group consists of a thick (up to 6 km) sequence of flood basalts (Karmutsen Formation), and limestones (Quatsino Formation; on Haida Gwaii, Kunga Formation). The upper part of the Vancouver Group contains numerous skarn occurrences adjacent to Jurassic intrusions (Island Plutonic suite). Iron and iron-copper skarns are particularly abundant. The Tasu past producer (MINFILE 103C 003) on Haida Gwaii is one of the larger examples. Between 1914 and 1983, it produced 12 million tonnes of iron concentrate and copper, gold and silver.

The Vancouver Group is overlain by arc rocks of the Bonanza Group (Upper Triassic-Middle Jurassic), which includes a volcanosedimentary succession (Parson Bay Formation) and a unit of subaerial basaltic to rhyolitic flows and tuffs ('LeMare Lake volcanics'; Nixon and Orr, 2007). The LeMare rocks are of economic significance on northern Vancouver Island. North of Holberg Inlet, where intruded by Island Plutonic suite granodiorite and quartz diorite, the LeMare rocks host the past-producing Island Copper Cu-Mo-Au porphyry deposit (MINFILE 092L 158) and other undeveloped porphyry and epithermal prospects.

On the east coast of Vancouver Island, in the Strait of Georgia, and on the western mainland, Wrangellia is buried by rocks of the Nanaimo Group, an Upper Cretaceous continental

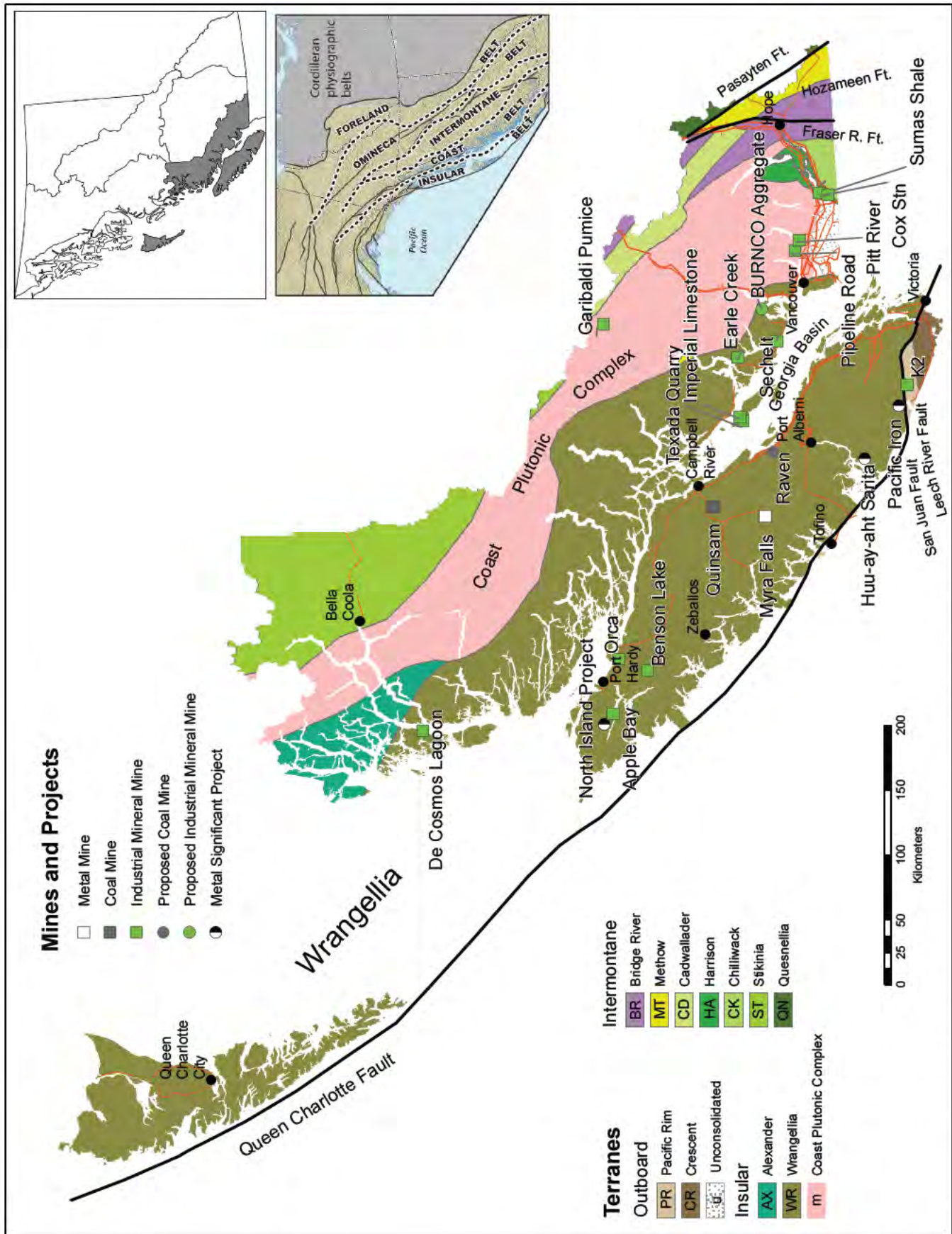


Fig. 1. Operating mines and selected major exploration projects, the Coast Area, 2014. Terranes from Nelson et al. (2013).

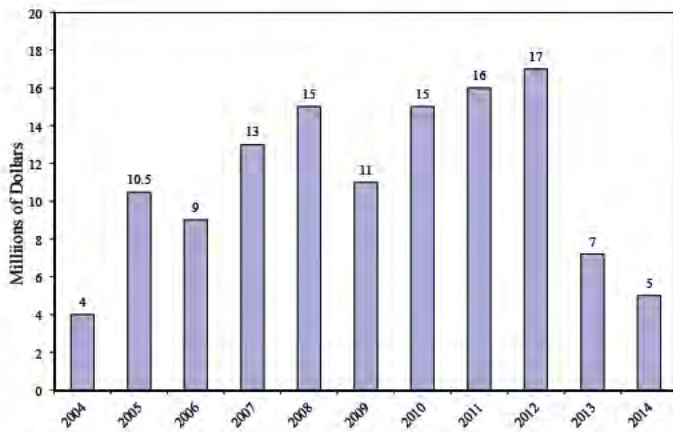


Fig. 2. Exploration spending estimates, Coast Area 2004-2014.

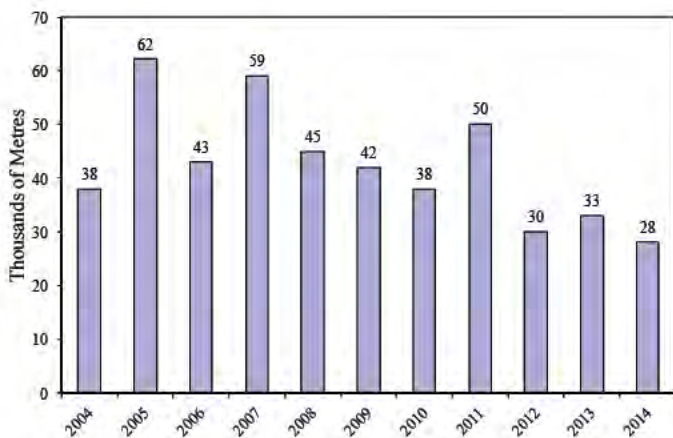


Fig. 3. Exploration drilling in the Coast Area, 2004-2014.

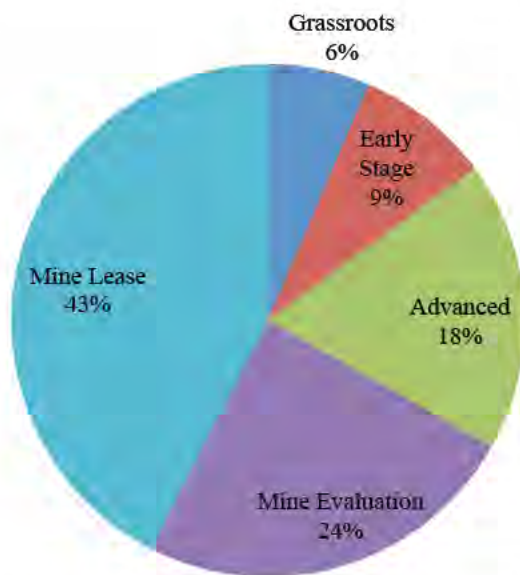


Fig. 4. Coast Area exploration spending by exploration stage, 2014.

to marine molassoid succession containing debris derived from unroofing of the Coast Belt and northern Cascades (Mustard, 1994). The Comox Formation, the basal unit of the Nanaimo Group, hosts economically important coal deposits that were mined historically in the Nanaimo area and are currently mined near Campbell River.

On Vancouver Island, the western flank of Wrangellia is bound by the Pacific Rim terrane, which consists of possible mélangé deposits (Pandora Peak unit, Rusmore and Cowan, 1985; Pacific Rim complex, Brandon, 1989) and the Leech River complex, an assemblage of greenschist- to amphibolite-grade mudstones, sandstones, and mafic volcanic rocks cut by granitic bodies (Groome et al., 2003). Slate and siltstone is quarried for building stone in the Leech River complex. The Leech River complex has been an active placer gold camp since 1864. Gold quartz veins have been the subject of recent exploration near the Leech River Fault, along the southern margin of the terrane (Fig. 1).

The Crescent terrane represents Eocene accretion of Late Cretaceous or Paleocene to Early Eocene seamounts. The Leech River Fault marks the boundary of Pacific Rim and Crescent terranes. The Metchosin Igneous complex, a partial ophiolite and the northernmost extent of the Coast Range Basalt Province (Massey, 1986), contains three tholeiitic intrusion-hosted past producers of copper and precious metals, the most significant of which was the Sunro mine (MINFILE 092C 073).

2.2. Coast Plutonic complex

The Coast Mountain range is underlain by the Coast Plutonic complex, a large northwest-trending batholith consisting largely of diorite, quartz diorite, tonalite and granodiorite calc-alkaline rocks with less abundant high-grade metamorphic rocks. For the most part, uplift and erosion appear to have removed the levels at which epithermal and porphyry style mineralization form, however there are exceptions.

At the southern end of the Coast Plutonic Complex, economically important deposits occur in pendants of Gambier Group, overlapping Late Jurassic to Mid-Cretaceous arc-related volcanic and sedimentary rocks. The most productive of these deposits was the Britannia mine (MINFILE 092GNW003), a Kuroko-type polymetallic volcanogenic massive sulphide deposit that produced 517,000 tonnes of copper with zinc, silver, gold, lead and cadmium between 1905 and 1974.

2.3. Terranes of the Southeastern Coast Belt

The Coast Area boundary transects small parts of the Quesnel Terrane and a larger area of Stikinia, however much is covered by parkland and is unavailable for mineral development or otherwise inaccessible. Exceptions include the Redbird, a molybdenum prospect west of Tweedsmuir Provincial park and east of Kitlope Heritage Conservancy (Fig. 1; MINFILE 093E 026).

The southeastern Coast Belt north of the international border is underlain by the Harrison, Chilliwack, Bridge River, Cadwallader and Methow terranes (Fig.1). These represent

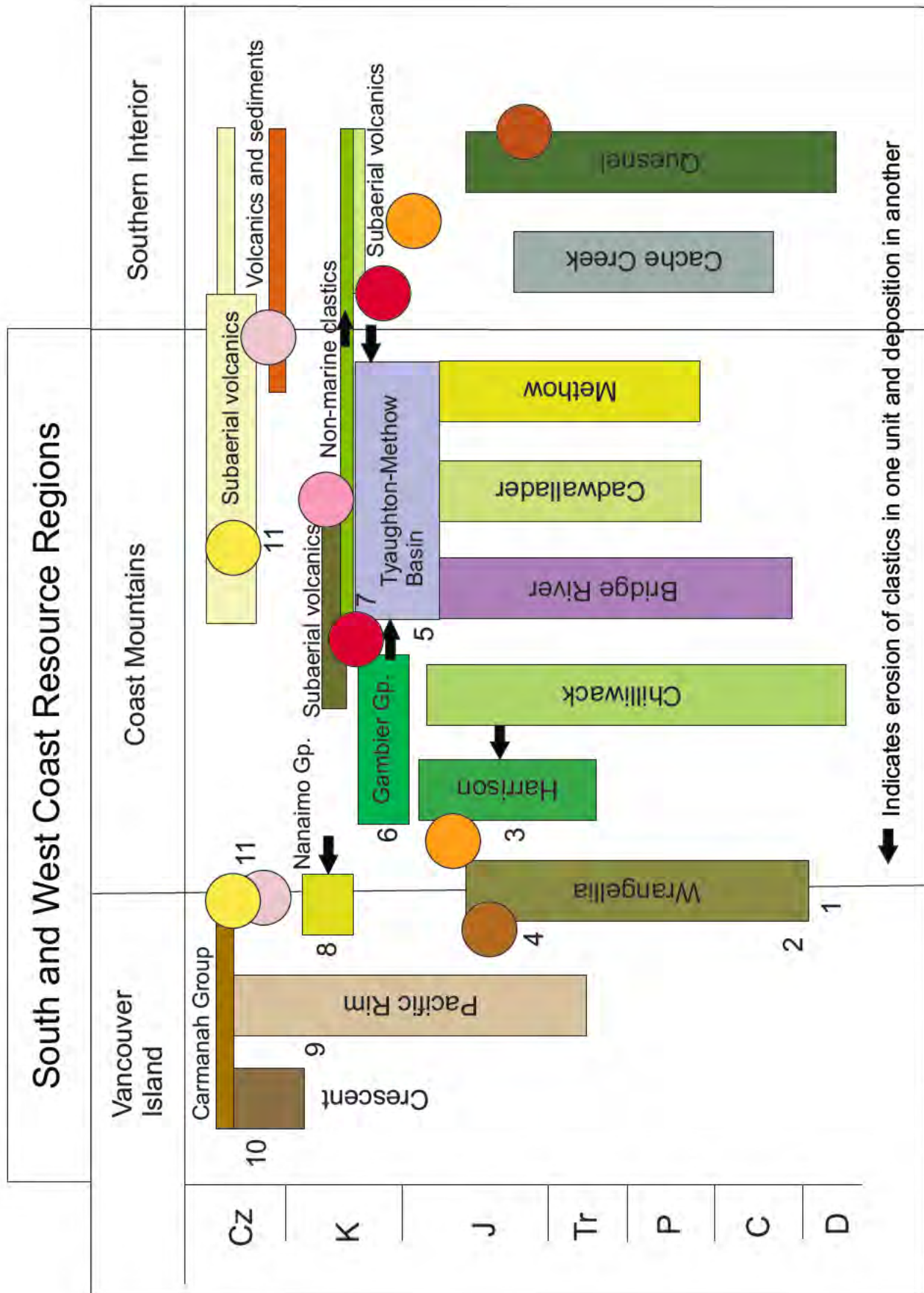


Fig. 5. Time-space diagram showing relations between terranes, basins, plutonic rocks (circles), and significant mineralizing events in southwestern British Columbia. 1) Sicker Group volcanicogenic massive sulphide; 2) orogenic gold veins in Sicker Group; 3) Harrison Formation volcanic massive sulphide; 4) Island plutonic suite porphyry Cu-Mo, Fe, Cu skarn; 5) orogenic Au vein (Coquihalla serpentine belt); 6) Gambier Group volcanic massive sulphide; 7) tholeiitic intrusion hosted Cu-Ni (Cretaceous); 8) Nanaimo Group coal; 9) orogenic Au veins; 10) tholeiitic intrusion hosted Cu-Ni (Eocene?); 11) porphyry Cu, Mo, Epithermal Au (Eocene to Miocene). Modified from Bustin et al. (2013).

slices of oceanic and arc-related rocks enclosed between intermontane and insular terranes during Middle Jurassic to Middle Cretaceous regional sinistral faulting (Bustin et al., 2013). Historically, these terranes have not been shown to host large deposits, which may explain why the area has not been intensively explored despite its accessibility and proximity to infrastructure. Gambier Group equivalent overlap deposits and parts of the Harrison terrane are prospective for VMS mineralization. The Coquihalla Serpentine belt, along the Hozameen fault between the Bridge River terrane to the west and the Methow terrane to the east, hosts several gold prospects and five past producers including the Carolin Mine, which operated between 1981 and 1984. The Late Cretaceous Giant Mascot ultramafic-mafic intrusive suite (Manor et al., 2014) hosts the province's only past producing nickel mine, Giant Mascot Nickel, which operated between 1958 and 1974.

2.4. Cenozoic Magmatism and Volcanism

Eocene to Miocene ancestral Cascades arc magmatism extended as far northward as southwestern British Columbia, as does present day Cascades magmatism. Evidence of forearc Paleocene to Miocene magmatism can be traced from southern Oregon through Alaska. Southwestern British Columbia was an active part of this semi-continuous belt (Madsen et al., 2006). Mineral deposits related to Cenozoic magmatism have not been particularly productive, but neither are they well explored. Between 1964 and 1967, Mount Washington Copper (Eocene; MINFILE 092F 117) produced 3548 tonnes of copper, 131 kg gold and 7235 kg silver. Catface Copper (MINFILE 092F 120) has a significant undeveloped resource. Other targets of presumed Cenozoic age include Giant Copper (MINFILE 092HSW001) and Okeover (MINFILE 092K 008). Harmony (MINFILE 103F 034) is a Miocene epithermal deposit with a significant undeveloped gold resource on Graham Island, Haida Gwaii (Figs. 1, 6). More recent Cascades magmatism has produced pumice and other volcanic rocks quarried for construction, landscaping and other applications. The Mount Meager area has also been investigated as a possible source of geothermal energy.

3. Mines

3.1. Metals

Myra Falls Operations (Fig. 7) is an underground polymetallic mine, owned and operated by Nyrstar N.V. The mine has operated for almost 50 years, despite being inside provincial park boundaries (Strathcona-Westmin), and its location on Buttle Lake, which is part of Campbell River's water supply. The deposits are hosted by the Sicker Group, a Middle Devonian volcano-sedimentary island-arc assemblage that forms basement to Wrangellia beneath much of Vancouver Island (Fig. 1). Ore bodies are in two horizons of the Myra Formation and are generally considered have formed as Kuroko type, bimodal (mafic-felsic) volcanogenic massive sulphides.

In the first three quarters of 2014, Myra Falls milled 377,000 tonnes of ore, with higher zinc and gold grades and better



Fig. 6. Mineralized Miocene conglomerate (Skonun Formation) at the Harmony project, Graham Island. Harmony is an undeveloped low-sulphidation epithermal gold deposit.

recoveries than in 2013. Typical annual throughput in recent years has been approximately 500,000 tonnes (Table 1). The operation has a history of success in replacing reserves. In 2014, underground development, exploration and definition drilling continued to add new areas to the mine plan. Myra Falls increased their ongoing exploration program in 2014 with more drilling, including development of underground access and drill platforms. This work extended lenses in the west, which were discovered in 2013. A surface ramp was extended to regain access to the historic Lynx mine, providing additional western drill platforms. At the eastern end of operations, production began at the Price deposit after several years in exploration and development. The Price development provides additional exploration drill platforms in the east.

Limited tailings storage capacity is perhaps more likely to limit mine life than is exhaustion of reserves. The mine employs 345 people.

3.2. Coal

Underground coal mining on Vancouver Island dates back to 1849. The **Quinsam** Thermal Coal Mine near Campbell River (Figs. 1, 8) has operated since 1986, and is currently the only active coal mine in the South and West Coast regions. The mine is operated by Quinsam Coal Corporation, a subsidiary of Hillsborough Resources Ltd., which is part of the Vitol Group. It is the only underground coal mine in the province, although others are proposed, including the Raven metallurgical coal

Table 1. Operating metal mines, South and West Coast regions.

Mine	Operator	Commodity; deposit type	Production Forecast 2014 (based on first 9 months)	Reserves (Proven + Probable, Dec 31, 2013)	Measured and Indicated Resources (inclusive of reserves)	Near-mine exploration	Website
Myra Falls	Nyrstar N.V.	Zn-Cu-Pb- Ag-Au; VMS	Approx. 0.5 Mt at head grades of 6.8% Zn, 0.77% Pb, 0.71% Cu, 2.12 g/t Au, 100.42 g/t Ag	5.49 Mt 5.69% Zn, 0.59% Pb, 0.88% Cu, 58.32 g/t Ag, 1.51 g/t Au	6.81 Mt 6.34% Zn, 0.67% Pb, 0.97% Cu, 66.53 g/t Ag, 1.74 g/t Au	Approx. 25,000 m diamond drilling + underground development	www.nyrstar. com

Table 2. Operating coal mines, South and West Coast regions.

Mine	Operator	Commodity	Production Forecast 2014	Reserves	Near-mine exploration	Website
Quinsam	Hillsborough Resources Limited	Thermal Coal	225,000 t clean coal	n/a	Drilling 14 holes (Percussion + core) 514.38 m; Trenching, 4 total length 100 m	hillsboroughresources. com

project near Comox. The Quinsam mine produces from coal seams in the upper part of the Comox Formation, the basal unit of the Nanaimo Group (Late Cretaceous). The mine is capable of producing over half a million tonnes a year. As a private company, Hillsborough does not release reserve and resource figures.

Similar to other coal mines in the province, Quinsam has been affected by recent low prices; 61 workers were laid off during the year, leaving a workforce of 69. Production was accordingly lower (225,000 tonnes clean coal, Table 2). Mine site exploration has continued, but a proposed exploration project south of the mine site is not yet permitted. Hillsborough has been testing and researching underground waste and tailings disposal. The mine now disposes of coarse rock rejects underground in disused flooded workings. Potentially acid generating tailings are currently disposed of subaqueously in an open pit. Underground tailings injection infrastructure is in place.

3.3. Industrial minerals

Large quarries on the coast serve the lower mainland, Vancouver Island, and US Pacific Northwest markets by barge. Those with access to freighter loadout facilities can also supply eastern Pacific international markets, and Hawaii. The largest industrial minerals producers in the region are listed in Table 3 (exclusive of aggregate-only quarries).

The largest limestone quarry on the coast is **Texada Quarrying** operation near Gillies Bay. Texada Quarrying Ltd. is a subsidiary of Lafarge North America. Most of its projected

production for 2014 (3.8 million tonnes) will supply local cement plants. The quarry also produces aggregate, mainly from quartz monzonite to gabbro dikes and sills, which would otherwise be waste rock. The site also hosts a white carbonate quarry, one of only a few sources on the coast. The quarry has been in operation for 62 years and employs 65 people directly. The quarry has extensive reserves and, at current rates, is capable of producing for more than 100 years.

The Imperial Limestone Co. Ltd. quarry near **Van Anda** on Texada Island (Fig. 1) produces approximately 250,000 tonnes annually. They report approximately 272,000 tonnes produced and shipped in 2014. Quarrying at the Imperial site dates back to the 1930s, and the current owners have operated it since the early 1950s. They anticipate reserves will last more than 50 years.

Ashgrove Cement Company's **Blubber Bay** limestone quarry on Texada Island has remained on care and maintenance since 2010, after more than 100 years of operation. It reopens for sufficiently large contracts. It can still supply limestone aggregate and continues to supply dolomite to lower Mainland and northwest US markets. It shipped 56,000 tonnes of dolomite early in 2014.

On northern Vancouver Island, Electra Gold Ltd. continued to mine silica and alumina products from silicified and clay-altered rhyolitic flows and volcanoclastic rocks at the **PEM 100** or **Apple Bay Quarry**. Similar to 2013, the company expects to ship approximately 70,000 tonnes in 2014. The quarry ships raw product by barge to Ash Grove Cement Company in Seattle.



Fig. 7. The HW headframe at Myra Falls, an underground Zn-Cu-Pb-Ag-Au producer on Vancouver Island. Exploration is ongoing at this Kuroko-type VMS camp.



Fig. 8. Operator's view from the back of a continuous miner at Quinsam Coal.

At the **Benson Lake** white carbonate deposit, also on northern Vancouver Island, Imasco Minerals Inc. reports 2014 shipments and sales similar to those of 2013, at over 45,000 tonnes.

The **Sumas Shale** quarry on Sumas Mountain is owned by Clayburn Industrial Group Ltd. and operated by contractor

Fraser Pacific Enterprises Inc. It delivers sandstone and shale product to the Lafarge and Lehigh cement plants in Richmond and Ashgrove in Seattle, a joint venture with Lafarge North America (Sumas Shale Ltd.). Production and shipments will be approximately 500,000 tonnes in 2014. Because Clayburn's brick and refractory products plant in Abbotsford closed, fireclay is no longer produced separately.

Ironwood Clay Company Inc. mines glacial marine clay deposits on the central coast. Recent production has been from **DeCosmos Lagoon** south of Bella Bella (Fig. 1). They have a new proposed quarry at the head of Bute Inlet and a site at Hvidsten Point 15 km east of DeCosmos Lagoon. Ironwood reported continuing strong sales in 2014, and continued to process approximately 600 tonnes of material collected in 2013. They will quarry again in 2015. Ironwood produces cosmetic products at its Richmond plant. Other individuals and companies supply the growing cosmetic clay market at smaller scales from locations on the central coast and Vancouver Island. Generally, Mines Act permits are not required where material is collected by hand, and therefore some of these operations are unreported.

In the Mount Meager area, Garibaldi Pumice Ltd. shipped 14,000 cubic metres of pumice from the **Garibaldi Pumice** quarry in 2014, up considerably from 2013 as recent testing supported the product's suitability as a lightweight fill and road base. Neighbouring Great Pacific Pumice Inc. did not produce at their **Mount Meager** quarry in 2014, but continued to ship material from stockpiles. These stockpiles are now depleted and mining is planned for 2015.

K2 Stone is a natural stone product supplier with quarries near Port Renfrew on Vancouver Island, (**K2**). In 2014, K2 Stone mined and shipped over 17,000 t from Port Renfrew with a 5 person crew. The rock is trucked to Nanaimo for processing into masonry and landscaping products. Other smaller producers of slate quarry rocks of the Leech River complex. **Van Isle Slate** has been offering a line of hand-cut products. Island Stone Landscape Supply is another established producer and supplier of flagstone from the area. Matrix Marble and Stone Inc. continues to quarry marble on Vancouver Island and fabricate a line of products including countertops, sinks, tiles, and building products. They quarry their Carmanah Black near Port Renfrew (**Gordon River**) and Tlupana Blue Grey and Vancouver Island White near **Hisnit Inlet**.

Landscaping stone and dimension stone is quarried in the Squamish-Whistler corridor. The largest operator is Northwest Landscape and Stone Supply, with the **Spumoni Quarry**. In 2014 they upgraded their Cabin Group property to mining leases and obtained a Mines Act quarry permit. Others active in the area include Bedrock Granite Sales Ltd., Citadel Stone Ltd., Alpine Natural Stone Ltd.

Haddington Island and **Hardy Island** (MINFILE 092F 425) are two regular producers of dimension stone on the coast. The Haddington Island product (typically referred to as Haddington Island andesite) is a durable, resistant dacitic volcanic rock (70.5% silica), part of the Alert Bay volcanic belt (Neogene).

Table 3. Selected operating industrial mineral mines (excluding aggregate), South and West Coast regions.

Mine	Operator	Commodity; deposit type	Production Forecast 2014	Reserves (approx.)	Website
Apple Bay	Electra Gold Ltd.	Silica + alumina; hydrothermal clay-silica	70,000 t	Unreported	www.electragoldltd.com
Benson Lake	Imasco Minerals Inc.	High brightness carbonate; white marble	45,000 t	100+ years	www.imascominerals.com
Blubber Bay	Ashgrove Cement Company	Aggregate, dolomite; Limestone and dolostone	56,000 t (dolomite)	100+ years	www.ashgrove.com
Garibaldi Pumice	Garibaldi Pumice Ltd.	Pumice	14,000 cubic metres	Unreported	garibaldipumice.com
Imperial Limestone	Imperial Limestone Co. Ltd. (J.A. Jack & Sons Inc.)	Limestone	272,000 t	50+ years	www.jajack.com
K2	K2 Stone Quarries Inc.	Building stone	17,000 t	Unreported	www.k2stone.com
Sumas Mountain	Sumas Shale Ltd. (Clayburn Industries Ltd., Lafarge North America)	Silica -alumina; Shale and sandstone	500,000 t	60-70 years	www.clayburnrefractories.com
Texada Quarry	Texada Quarrying Ltd. (Lafarge North America)	Limestone, aggregate, high brightness carbonate	3,800,000 t	100+ years	www.lafarge-na.com

Haddington Island Stoneworks Ltd. shipped approximately 300 tonnes in 2014. They now use a diamond wire saw that causes less fracturing than traditional drilling and blasting. Most of the product is used in restoration work on historic buildings.

Hardy Island produces from a uniform grey Coast Plutonic complex granodiorite unit. Like Haddington Island, it is an historic quarry that has resumed regular annual production, mainly serving the local market. It shipped approximately 3,000 tonnes in 2014. Hardy Island Granite Quarries Ltd. is opening another quarry on Valdes Island which is to supply sandstone (Nanaimo Group), another rock type that can be found on many older buildings in Vancouver and Victoria.

Aggregates are an important part of the mining industry on the south coast, generating more jobs in the region than metal and coal mining. The area hosts some of the largest aggregate pits and quarries in Canada. Most quarries serve local markets, although a few of the largest also export. General sales and production trends follow those of the construction industry. Lafarge North America, Lehigh Hanson and, a local company Mainland Sand and Gravel Ltd., are the three largest participants in the Coast Area, although hundreds of pits and quarries produce in the region.

One of the largest aggregate-only mines is the **Sechelt Mine**, operated by Lehigh Hanson. The company no longer makes production figures public, but volumes have been in the 3-5

million tonne range in recent years. It is permitted for up to 7.5 million tonnes per year. A loading facility capable of accommodating Panamax class freighters handles most of the shipments.

In addition to the Texada Quarry, Lafarge North America operates two of the largest aggregate quarries in the region, **Earle Creek** and **Pitt River Quarries**, each of which typically produces more than 1 million tonnes per year. In 2014, Lafarge continued to make capital improvements to the Pitt River Quarry. Production and employment estimates for 2014 reported by Lafarge include: 3.8 million tonnes and 65 people (Texada Quarry); 1.3 million tonnes and 24 people (Earle Creek), 1.6 million tonnes and 30 people (Pitt River); 1.0 million tonnes and 25 people (Central Agg); and 0.9 million tonnes and 19 people (Ward Road). The Pipeline Road site employed 6 people for remediation work.

Also on Pipeline Road are large operations by Jack Cewe Ltd. and Allard Contractors Ltd. Together they produce in excess of one million tonnes per year most years. Cewe also operates a large quarry on Jervis Inlet. They do not release yearly production figures.

Polaris Minerals Corporation operates the **Orca Quarry** (Fig. 9) near Port McNeill, which produces sand and gravel mainly for export. Polaris Minerals Corporation reported production and sales of approximately 2.4 million tonnes is the first three



Fig. 9. Sign at the entrance of the Orca Sand and gravel mine, northern Vancouver Island. Photo taken September 18, 2014 indicates nearly 15 million tonnes produced since 2007, most of which was exported to California.

quarters of 2014. This represents an increase over the same period in 2013 and continues a multi-year trend. If production and sales hold steady in the last quarter, 2014 production and sales will be in the 3-3.5 million tonne range.

One of the largest operations in the area is the **Cox Station Quarry**. It is on the north side of Sumas Mountain, and is operated by Mainland Sand and Gravels Ltd. Over 95% of the crushed quartz diorite product goes to the lower mainland market via barge on the Fraser River. The quarry also has two CN Rail spur lines, which allow shipment by rail. Production and shipments are typically 2-3 million tonnes per year. The quarry employs 45-50 people.

4. Mine development and mine evaluation

Major new mining projects are not being developed in the South or West Coast regions, but significant exploration and development work continues at existing mines and quarries (see above). A proposed coal mine and a large aggregate operation are in the pre-application phase of Environmental Assessment (Table 4).

The **Raven Underground Coal Project** is a proposed mine south of Comox on Vancouver Island (Fig. 1). As projected in the feasibility study, the main product is to be a semi soft coking coal with a thermal byproduct. Forecast production is approximately 830,000 tonnes of clean coal per year, over 16 years. Compliance Energy Corporation is the majority partner in the Comox Joint Venture with LG International Corp. The company submitted its application for an Environmental Assessment Certificate in 2013, but the Environmental Assessment Office determined that the application did not contain all required information. Compliance has been working on a revised application in 2014.

The **BURNCO Aggregate Project** in the McNab Creek Valley (Fig. 1) is also in the pre-application stage of Environmental Assessment with both provincial and federal agencies. They submitted Draft Application Information Requirements in September 2013. The proposed mine would ramp up to a 1.5 million tonne-per-year operation, initially barging product to BURNCO Rock Products Ltd.'s ready-mix concrete plants in South Burnaby and Port Kells. BURNCO submitted revisions to the project in 2014 changing production rate, relocating some facilities and specifying a mine life of 16 years. The project now has approved Application Information Requirements and may proceed to an application for environmental certification.

5. Exploration projects

The largest off-lease exploration projects active in 2014 are listed in Table 5.

5.1. Haida Gwaii

Haida Gwaii saw little in the way of reported exploration activity in 2014, although several properties remain in good standing, notably grass roots to advanced stage gold properties such as Tasu Global (MINFILE 103B 076), More (MINFILE 103G 009), Sandspit Gold (MINFILE 103G 005) and Taseko Mines Limited's Harmony (MINFILE 103F 034), an epithermal gold property with a substantial undeveloped resource.

5.2. Central coast

Like Haida Gwaii, the central coast saw little exploration activity in 2014. A few mineral properties are in good standing, including glacial marine clay targets and a rhodonite prospect at Rivers Inlet (MINFILE 092M 015). Kisameet Glacial Clay Inc. worked their property, collecting material by hand. Along the interior coast, east of Vancouver Island, properties in good standing are more numerous, including skarn and gold vein targets but large exploration projects were not reported in 2014.

5.3. Northern Vancouver Island

Between 1971 and 1994, the Island Copper Mine produced 345 million tonnes with average head grades of 0.41% Cu, 0.017% Mo, and 0.19 g/t Au. NorthIsle Copper and Gold Inc.'s North Island Project includes several porphyry copper and epithermal gold targets extending along a 40 km west-north-west trend from Island Copper. **Hushamu** (MINFILE 092L 240), a copper-molybdenum-gold porphyry prospect, is the most advanced with Indicated 304,000 tonnes 0.21% Cu, 0.29 g/t Au, 0.010% Mo, and 0.56 ppm Re and Inferred 205,600 tonnes 0.18% Cu, 0.26 g/t Au, 0.008 % Mo and 0.38 ppm Re.

NorthIsle Copper and Gold Inc. returned to the Hushamu deposit in 2014 with a four-hole drill program designed to test an IP target northwest of the resource area (Fig. 10). The new drilling confirmed the presence of copper-molybdenum (+rhenium) mineralization, however it is unclear if it will augment the existing resource. A fifth drill hole was for metallurgical testing in the existing resource area. Other porphyry and epithermal targets in the area include the

Table 4. Proposed mines, South and West Coast regions.

Mine	Operator	Commodity; deposit type	Reserves	Work program	Website
BURNCO Aggregate	BURNCO Rock Products Ltd.	Aggregate	>24 million t	Engineering, environmental assessment application	www.burnco.com
Raven Underground Coal	Comox Joint Venture (Compliance Energy 75%, LG International Investments (Canada) Ltd.	Metallurgical coal	29.9 million t (Run of mine, Proven and Probable)	Environmental assessment application	www.complianceenergy.com

Table 5. Off lease exploration, South and West Coast regions.

Project	Operator	MINFILE	Commodity	Deposit type	Work program	Website
North Island Project (Hushamu)	NorthIsle Copper and Gold Inc.	092L 240	Copper, molybdenum, gold, rhenium	Porphyry	Diamond drilling, 1800 m, 5 holes, geochemistry, metallurgy	www.northisle.ca
Huu-ay-aht Sarita	Huu-ay-aht First Nation	092C 032	Gold	Skarn	Diamond drilling 300 m, 9 holes	huuayaht.org
Pacific Iron	Canadian Dehua International Mines Group Inc.	092C 022, 23, 25, 27 and others	Iron (magnetite)	Skarn	Ground magnetic survey (100 line km), rock geochemistry, geological mapping	www.dehua.ca

**Fig. 10.** Drill rig testing a target to the northwest of the Hushamu resource area, northern Vancouver Island.

Pemberton Hills, South MacIntosh, Hep, and NW Expo.

Guohua Furen Mining Inc. proposes to bulk sample and re-process crushed surface material at the **Nimpkish Iron** project near the former Iron Crown iron mine (MINFILE 092L 034), a skarn deposit. The project is in the permitting stage.

In addition to recent rock geochemistry, Canadian Dehua International Mines Group Inc. reported results of a ground magnetic survey conducted at **Iron Ross** (MINFILE 092K 043) in December 2013. Iron Ross is one of four magnetite skarn properties Canadian Dehua is exploring on Vancouver Island.

5.4. Central Vancouver Island

Near Campbell River, Canadian Dehua International Mines Group Inc. was active at the Argonaut (MINFILE 092F 075), a past producing magnetite skarn. The 2014 program consisted of a ground magnetic survey, geological mapping, and rock sampling. The property is underlain by Vancouver Group basalt and limestone and Bonanza Group volcanic rocks. All are intruded by Island Plutonic Suite granodiorite to quartz diorite.

Red Hut Metals Inc. reported a soil sampling program at its Conuma property in April. Targets include polymetallic VMS mineralization, as was discovered in the 1980s at nearby Dragon (MINFILE 092E 072) where Sicker Group rocks are exposed.

In 2012, Lu'an Canada Capital and Energy Investment Inc. purchased the **Mineral Creek** property near Port Alberni

(MINFILE 092F 079, 331) and, in 2103, optioned it to Sona Resources Corporation. The property was explored in the 1980s and test mined in the mid 1990s. Between 2005 and 2010, programs included drilling, geophysics and initiation of a bulk sample. Sona Resources Corporation carried out verification sampling at Ember and Linda Veins at Mineral Creek late in 2013 with results published in 2014. Surface grab samples returned up to 397 g/t Au, consistent with 2006 and 2009 drill results.

Prospectors reported grass roots discoveries in 2014. For example, Herb McMaster and Dan Bruner found a previously undocumented massive sulphide showing on the north side of Great Central Lake near Port Alberni and Joe Paquet identified wollastonite in skarns near Campbell River (Fig. 11).

5.5. Western Vancouver Island

Canadian Dehua International Mines Group Inc. had a field program at **Head Bay** (MINFILE 092E 001, 5, 6, 15 and others), which included a ground magnetometer survey, geological mapping, and stream, moss, soil, and rock sampling. The property is underlain by Vancouver Group and Bonanza Group rocks and intruded by Island Plutonic suite granodiorites and Eocene to Oligocene quartz diorites. The property includes a past producer of magnetite (Glengarry). Iron and gold skarn and vein mineralization are exploration targets.

The Ministry of Energy and Mines issued a permit for drilling at the **Fandora** gold prospect in 2013 (MINFILE 092F 040, 41, 205). Imperial Metals Corporation has not announced plans for the property although they reported geochemical sampling for assessment in 2013 and again in 2014. Geochemical soil and stream sediment surveys in 2009-2013 identified previously unknown gold anomalies. Results for 2014 are not yet published.

The **Catface Copper** (MINFILE 092F 120) porphyry copper project north of Tofino (Fig. 1) is at an advanced stage of exploration, but was inactive in 2014. Imperial Metals Corporation published resource figures in 2009 and further

defined the main resource area with drilling in 2010. Porphyry mineralization at Catface is related to the Tofino Intrusive suite (Eocene; Fig. 5).

The Huu-ay-aht First Nation conducted a 7-hole core drilling program at the **Huu-ay-aht Sarita** project, largely on treaty land. Skarn showings in the area have been explored for iron, copper, lead, zinc, silver and gold since 1895 (MINFILE 092C 032). Percussion drilling of shear zones north of the skarns on the Numukamis Indian Reserve returned gold and silver values in 1979 (Hunter and Roberts 1989). Results came under official scrutiny; although work commissioned by the Vancouver Stock Exchange and the RCMP was unable to verify the results, neither did it confirm errors or sample salting. Subsequent workers documented traces of visible gold in siliceous skarn (Pollmer, 2013). In what may be a first, the Huu-ay-aht First Nation is investigating on its own treaty lands and on adjacent mineral tenures it owns. The objective goes beyond a typical exploration venture to address uncertainty about previous work by using modern best practices. The property is underlain by granodiorite, probably part of the Island Plutonic suite, in intrusive contact with Quatsino Formation limestone and Bonanza Group rocks. To the north is a fault contact with the Karmutsen Formation.

5.6. Southern Vancouver Island

The **Pacific Iron** project (formerly the Pearson project) was the largest of Canadian Dehua's iron skarn projects in 2014, in terms of area under tenure and amount of fieldwork completed. Work consisted of ground magnetic surveys, geological mapping and geochemical sampling. The previous operator of the property outlined an inferred resource at the Bugaboo (MINFILE 092C 022, 23, 25, 27) area. The new work identified additional targets on this large property (Figs. 12, 13).

The Sunro Copper Group has been conducting preliminary engineering studies on the past-producing **Sunro** mine (MINFILE 092C 073) for several years. Work in 2014 included re-entry and inspection of the existing workings. Sunro was an underground copper mine with byproduct gold and silver. Full-scale production ceased in 1974. In June of 1973 ore reserves were estimated at 1,030,465 tonnes grading 1.47% Cu in proven category and 423,782 tonnes 1.33% Cu in probable category (historical estimates). Mineralization is mainly hosted by basalts of the Metchosin Igneous complex, concentrated near contacts with intruding the Sooke gabbro.

5.7. Texada Island

Texada Quarrying Ltd. filed part of its 2013 work for assessment in 2014, but did not report new work in 2014.

South of the quarries, a large holding by Coast Minerals Corporation and Northstar Mining Ltd., the **Texada** property remains in good standing, with work filed for assessment including a spectral analysis study in 2013 followed by prospecting and geochemical sampling in 2014. Vein and porphyry style copper, gold, and molybdenum occurrences were reported.



Fig. 11. One of several previously undocumented occurrences of wollastonite on prospector Joe Paquet's properties near Campbell River.



Fig. 12. Massive magnetite at the Pacific Iron Project, southern Vancouver Island.



Fig. 13. A forge blower at abandoned workings on the Pacific Iron property, probably dating to 1916.

5.8. Squamish-Pemberton (Sea to Sky area)

In 2014, Ashlu Mines Inc., a private company that has assembled a land position around the former Ashlu Mine near Squamish, reported continuing geophysics and geochemistry at its **Ashlu** property (Fig. 1; MINFILE 092GNW045, 47, 55, 62; MINFILE 092GNW013). A five-year rock, soil, and silt sampling program has relocated showings around the former mine. The Ashlu Mine is a past producer that exploited a narrow (<1 to 4.6 metre) gold-bearing quartz vein over a strike length of 90 metres and extending 85 metres down dip. In 1981, reserves were just under 90,000 tonnes of 8.57 g/t Au and 12.31 g/t Ag. The property is largely underlain by the Clodburst pluton (Jurassic).

5.9. Sunshine Coast

Eastfield Resources reports further geochemical sampling on the **Okeover** (MINFILE 092K 008, 57, 168) or **OK** property in

2014, following small programs in 2011-2013 which identified chargeability and soil geochemical anomalies, representing Cu-Mo targets beyond the existing North Lake Zone resource area. The property is under option to Prophecy Coal Corp. (60%).

5.10. Lower Mainland-Coquihalla-Northern Cascades

NSS Resources Inc. acquired tenures surrounding the **Seneca** (MINFILE 092HSW013) and **Vent** (MINFILE 092HSW139) VMS occurrences, last active in 2007. The new land package includes the Fleetwood zone (MINFILE 092HSW165). NSS filed a technical report recommending further work. The Vent and Seneca prospects themselves are held by Goldsource Mines Inc. To the east, Pacific Bay Minerals Ltd. proposes a small drill program near the **LD** showing (MINFILE 092HSW070). To the south, Abram Reimer prospected a property with VMS and polymetallic vein showings (e.g. MINFILE 092HSW072). All of these occurrences are within the Harrison terrane (Fig.1).

At the **Krof** property, a soil geochemical survey by Mystic Capital Corporation identified a zinc-copper-barium anomaly approximately 1.5 km south-southeast of the Krof massive sulphide occurrence (MINFILE 092HNW070). Together with results of a 2008 electromagnetic survey, it suggests a new exploration target. To the southeast, prospecting at the **Lekcin** (MINFILE 092HSW168, 82) property in 2014 resulted in discovery of a sulphide showing in bedrock near the edge of a magnetic high identified by a previous airborne magnetic survey (Fig.14).

New Carolin Gold Corp did not report fieldwork at the **Ladner Gold Project** (MINFILE 092HNW007, 18, 3 and others) however they did report reaching an agreement with the receiver for the property vendor to acquire the remaining interest in the Carolin Mine. The average recovery from 1982-1984 production was slightly better than 50%. Consequently, tailings reprocessing is being considered. The Carolin Mine (Idaho Zone) is in the Coquihalla gold belt (McMaster Zone, Montana), which has not been well explored by modern



Fig. 14. Nickel bloom field test for nickel sulphide at a discovery on the Lekcin property north of Hope. Photo by Chris Paul.

methods.

To the northwest, Alexandra Resources Inc. reported a small geological program on its **Alexandra** property (MINFILE 092HNW031). To the southeast along the same trend, Savoy Ventures Inc. followed up an airborne survey with a program of prospecting, geology, and rock, soil, and silt geochemistry at the **Big Range** property. Targets include both porphyry Cu-Mo and gold quartz veins (MINFILE 092HSW144, 145). The Hozameen fault, which runs through the property, hosts serpentine similar to the Carolin Mine. Spatially associated with the fault, a felsic stock with arsenic, molybdenum, and copper in quartz veins has been reported. Other mineralization occurs as orogenic gold, and porphyry Cu-Mo or Mo.

Homegold Resources Ltd. conducted a limited (90 metre) drill program at **Silver Peak**, which includes the Eureka-Victoria past producer (MINFILE 092HSW011).

6. Outlook

Several years of difficult venture markets are having a clear impact on exploration and other pre-development activities in southwestern British Columbia. Exploration continued at the Myra Falls and Quinsam mines, but lower thermal coal prices had a direct impact on Quinsam's operations. Regardless, Quinsam is looking to the future as it continues to expand reserves. Industrial minerals and aggregate producers are generally holding steady.

Acknowledgments

I thank those in industry who generously provided information and access to their properties.

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Exploration and mining in the Skeena Region, British Columbia

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Recommended citation: Kyba, J., 2015. Exploration and mining in the Skeena Region, British Columbia. In: Exploration and Mining in British Columbia, 2014. British Columbia Ministry of Energy and Mines, British Columbia Geological Survey, Information Circular 2015-2, pp. 97-114.

1. Introduction

Mineral exploration continued in the Skeena Region (Fig. 1) despite challenging market conditions, and about 80 projects were active (Fig. 2). Some major programs continued to drill, expand, and define deposits, but most projects focused on relatively inexpensive work such as soil sampling, prospecting, and geological mapping. Total exploration expenditures decreased 20% from 2013 levels to \$161 million (Fig. 3). Similarly, exploration drilling decreased by 39% to 151,204 metres (Fig. 4). Mine development expenditures totalled about \$208 million. At least \$300 million was spent on infrastructure projects directly related to the mining and exploration industry including hydro transmission lines and port expansions in Stewart and Prince Rupert. In 2014,

- Red Chris Development Company Ltd. (Imperial Metals Corporation) crushed and stockpiled ore taken from the Main and East zones of the **Red Chris** copper-gold project (Fig. 5) and continued final stages of construction
- Banks Island Gold Ltd. began producing at the **Yellow Giant** gold project
- Avanti Mining Inc. began construction activities at their **Kitsault** molybdenum-silver project
- Seabridge Gold Inc. received their Environmental approval and initial construction permits for their **KSM** gold-copper project
- the Northwest Transmission line to Bob Quinn Lake and extension to Red Chris was commissioned
- Pretium Resources Inc. delivered a feasibility study for their high-grade gold **Brucejack** project
- Gold Reach Resources Ltd. expanded resources at **Ootsa** by 87%
- Colorado Resources Ltd. released a maiden resource at the **North ROK** copper-gold project and completed an exploration program at the **KSP** gold project
- Kaizen Discovery Inc. confirmed porphyry-style copper mineralization at **Tanzilla**
- A new copper-gold system, **Pyramid**, was discovered 50 km north of Dease Lake by Gold Jubilee Capital Corp.
- Doubleview Capital Corp. drilled 404 m grading 0.25% Cu and 0.25 g/t Au at the **Hat** project

Industry activities are summarized herein by geographic area (Fig. 1, inset) and deposit stage.

2. Regional geology

The Skeena Region is underlain by autochthonous rocks of ancestral North America, parautochthonous terranes with North American affinities (Slide Mountain, Yukon-Tanana) and exotic terranes (Quesnel, Cache Creek, Stikine, Alexander) that were accreted to the western North American margin (Fig. 1, Nelson et al., 2013). Metal prospects span a spectrum of deposit types including porphyry and intrusion-related, volcanogenic massive sulphides, precious metal veins, skarns, sedimentary exhalite, Carlin-type gold, and manto replacement. The most economically significant deposits are porphyry and precious metal veins in Stikinia and Quesnellia. In the Skeena Region, most occurrences are in Stikinia; an island arc terrane analogous to the Philippines (Marsden and Thokelson, 1992). Successions in Stikinia record three arc-building episodes: Paleozoic (Stikine assemblage); Triassic (Stuhini Group); and Late Triassic-Jurassic (Hazelton Group). Most porphyry copper-gold mineralization in Stikinia formed between 220 Ma to 195 Ma (Logan and Mihalynuk, 2014).

3. Operating mines

The **Huckleberry** copper-gold-silver-molybdenum mine (Fig. 6; Table 1) is a porphyry deposit spatially related to the Bulkley intrusions (late Cretaceous). In the Main zone, mineralization is in hornfelsed and fractured Hazelton Group volcanic rocks adjacent to a 500 m-diameter granodiorite stock. The mined-out East zone is centred on a 40 m-wide granodiorite dike. Ore in both zones is in a stockwork of quartz, pyrite and chalcopyrite, crosscut by gypsum-filled fractures. The mine is operated by Huckleberry Mines Ltd. Ownership is divided between Imperial Metals Corporation (50%) and the Japan Group (50%) comprising of Mitsubishi Materials Corporation, Dowa Mining Co. Ltd., and Furakawa. Co. Higher grades and better recovery during 2013 resulted in a metal production increase of 17%. Total output was 18,693 tonnes copper, 92.8 kilograms gold, and 7403.5 kilograms silver from 5,895,193 tonnes of ore mined from the Main Zone Extension pit. Grades averaged 0.346% Cu with copper recoveries averaging 91.6%. Concentrate is trucked to the Port of Stewart and loaded onto marine vessels destined for Asia.

Milling operations were temporarily shut down in late February after the mill was damaged. Short-term repairs allowed milling to resume in early April and permanent repairs were completed

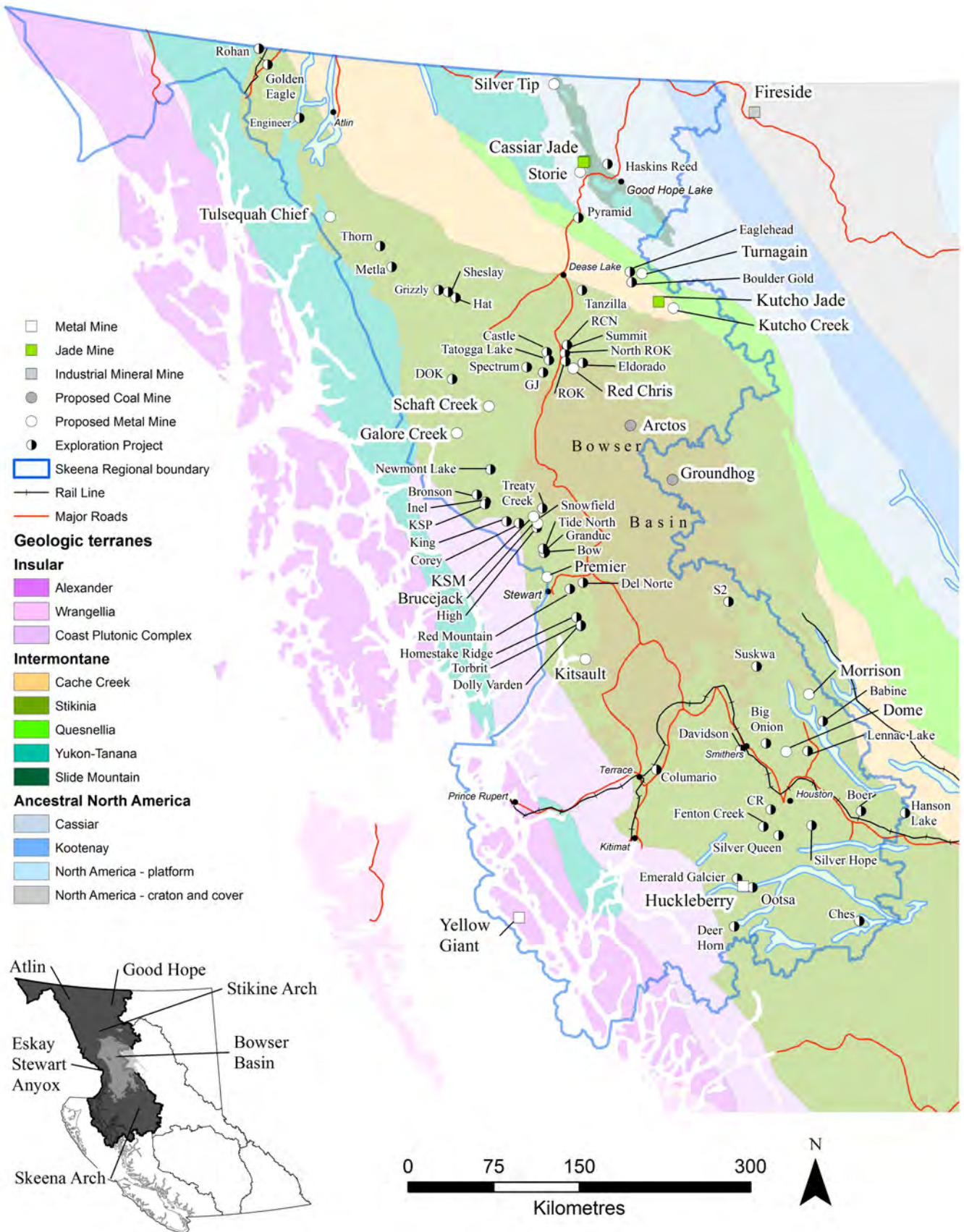
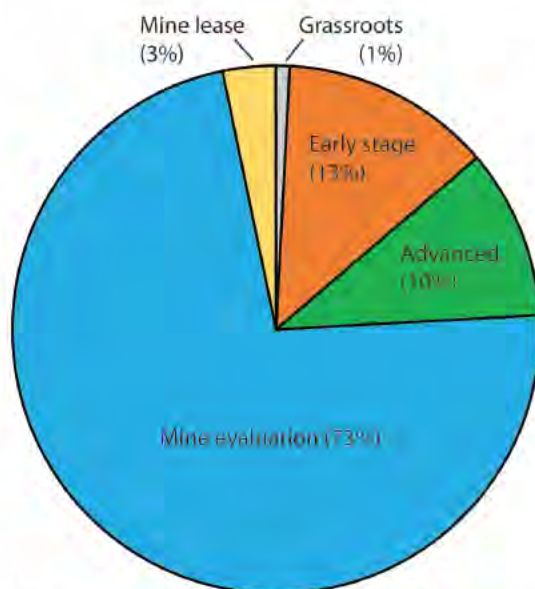
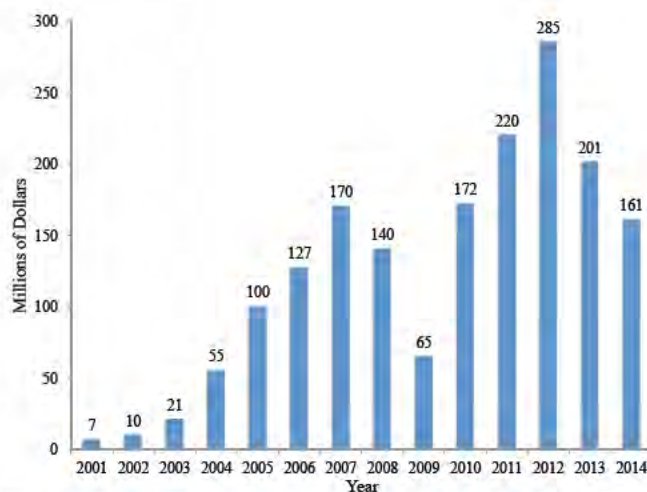
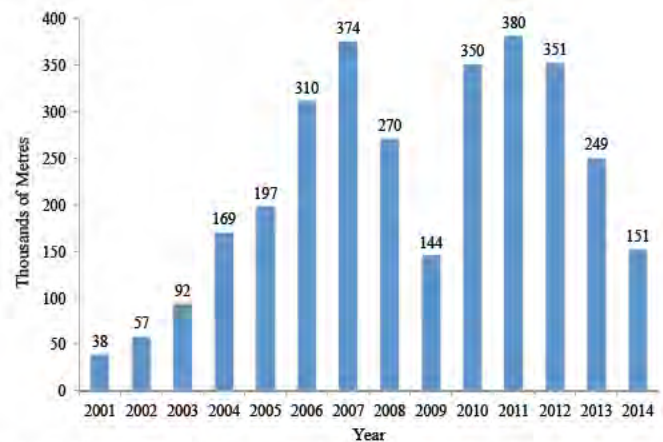


Fig. 1. Active mining and exploration projects Skeena Region, 2014. Cordilleran terranes after Nelson et al. (2013). Inset shows geographic areas discussed herein. Although the Fireside and Groundhog projects are not in the Skeena Region, they are reported on in this paper.

Table 1. Operating mines in the Skeena Region, 2014.

Mine	Operator	Commodity; deposit type; MINFILE	Forecast 2014 Production (based on Q1-Q3)	Reserves	Near-mine exploration	Website
Huckleberry	Huckleberry Mines Ltd.	copper, gold, silver, molybdenum 093E 037	16,329.3 tonnes (36 M lbs) copper, 90 kg (2900 oz) gold, 5443 kg (175,000 oz) silver	42.7 Mt at 0.330% copper and 0.009% molybdenum (December 31, 2013)	soil sampling, claim expansion	http://www.imperialmetals.com/s/HuckleberryMine.asp
Fireside	Fireside Minerals Ltd.	barite 094M 003	35,000 tonnes	550,000 tonnes (non 43-101 compliant)	drilling	http://www.firesideminerals.com/
Yellow Giant	Banks Island Gold Ltd.	gold, silver 103G 024, 26	373 kg (12,002 oz) gold, 1005 kg (32,321 oz) silver	35,718 t at 19 g/t gold and 45 g/t silver (non 43-101 compliant)	drilling	http://www.banksislandgold.com/s/Home.asp

**Fig. 2.** Exploration expenditures in 2014 by exploration stage for the Skeena Region.**Fig. 3.** Annual exploration spending estimates for the Skeena Region from 2001-2014.**Fig. 4.** Annual exploration drilling estimates for the Skeena Region from 2001-2014.

in November. Onsite infrastructure developments included commissioning and ongoing construction of the tailings storage facility and production of cyclone sands for incremental lifts of dam material. The Main Zone Optimization project to remove legacy tailings and waste rock from the former Main Zone Pit (Fig. 6) continued for the third year. The project extends the mine life to 2021 with reserves totalling approximately 33.8 Mt grading 0.343% Cu and 0.009% Mo at a 0.20% Cu cut-off grade. Exploration was limited to reconnaissance-scale surveys at the nearby Whiting Creek prospect.

Fireside Minerals Ltd. continued to mine barite (Fig. 7) from the **Fireside** mine. Barite is in steeply dipping veins in Kechika Group sedimentary rocks near a Paleozoic (?) gabbro dike (Wojdak, 2008). In 2014, production increased 30% from 2013 levels to approximately 32,000 tonnes from 36,000 tonnes mined. Increased production was partly due to commissioning of a second Raymond roller mill and packing system. A non NI-43-101 compliant reserve estimate totals 550,000 tonnes. Exploration drilling at the Moose Pit identified sufficient barite resources to justify plans for its reactivation. Barite ore is crushed, milled, and bagged onsite. It is sold mainly as a heavy



Fig. 5. Overview of the Red Chris copper-gold deposit.



Fig. 6. Mining at Huckleberry Mines Main zone extension pit.



Fig. 7. Barite mining at Fireside Minerals Bear Pit. Photo by Andrew Allan.



Fig. 8. Overlooking Banks Island Gold processing plant at Yellow Giant.

drilling fluid additive.

Banks Island Gold Ltd. received Mines Act and Environmental Management Act permits for their **Yellow Giant** gold-silver mine on Banks Island, about 105 km south of Prince Rupert. By the end of 2014, underground mining was well underway from the Bob and Tel portals. The processing facility (Fig. 8) was fully operational in early August. As of early June, the company reported producing 222.2 kg of gold (7,145 ounces) and 577.3 kg silver (18,559 ounces) from the Bob zone (Fig. 9). Exploration defined a 600 m-long gold-in-soil anomaly. Follow-up drilling identified a new zone of

gold mineralization at Quartz Hill, where drill hole QH-14-01 returned 14.5 m grading 2.5 g/t Au including 2.25 m grading 14.0 g/t Au. Further drilling is planned.

Nephrite jade is found in deformed serpentinites of the Cache Creek terrane (east of Dease Lake) and of the Slide Mountain terrane (at Cassiar). It was mined from at least four quarries in the Dease Lake area: **Provencher Lake, Kutcho, Cassiar, and Dynasty**. Jade sales are by private arrangement, and range from small, highly polished pendants to multi-tonne rough boulders. Jade is generally mined from placer tenures, except at Dynasty, where it is mined from outcrops.

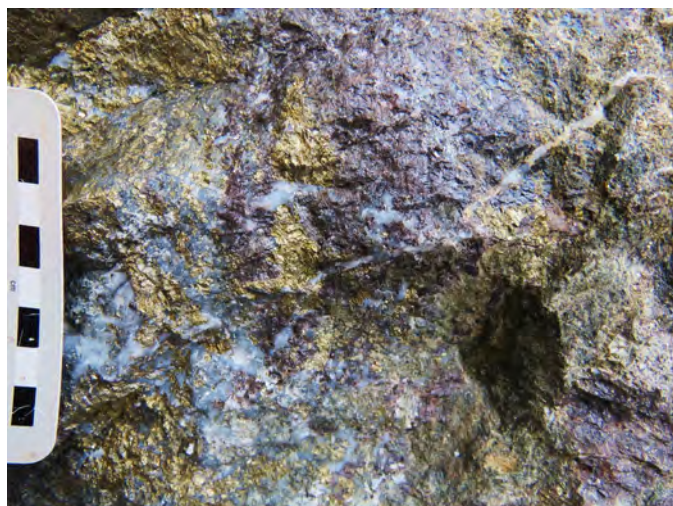


Fig. 9. Gold-bearing chalcopyrite and interstitial sphalerite from the Bob zone at Banks Island Gold's Yellow Giant gold project.

4. Eskay-Stewart-Anyox area

The Eskay-Stewart-Anyox area, in western Stikinia, is bounded by the Iskut River, Bowser Basin, Nass River and the Alaskan border. The area contains significant porphyry, volcanogenic massive sulphide, and precious metal vein deposits (Fig. 1; Table 2).

4.1. Proposed mines

The KSM gold-copper porphyry project (Seabridge Gold Inc.) received provincial approval of an Environmental Assessment application in late July and federal approval in mid-December. Significant pre-construction permits were also granted in September, allowing building of roads, construction camps, and rights-of-way to the Mitchell-Treaty tunnels, and site preparations at the mine site and tailing management facility. Ground-breaking activities are expected in 2015.

Exploration activities included mapping and drilling at Deep Kerr, MacQuillan and Iron Cap. Drilling followed up 2013 results and totalled 29,508 m in 29 holes (Table 3). Thirteen holes totalling 12,900 m targeted Deep Kerr and are expected to increase the Inferred Resource estimate of 514 Mt grading 0.53% Cu and 0.36 g/t Au (in addition to known reserves) generated from 2013 drilling. Results expanded the deposit by 400 m along strike and 300 m at depth. An updated resource estimate is expected in early 2015. The bottom of known mineralization is now understood to be at a similar elevation as the Sulphurets valley floor, allowing for potential underground access.

Approximately 10,429 m in 10 drill holes targeted the Lower Zone of the Iron Cap deposit, which is mostly below known Iron Cap deposit reserves. Iron Cap now measures approximately 750 m along strike. Limits at depth and to the north have not yet been defined. Drilling toward the proposed Mitchell-Treaty tunnel to the north returned strong gold-copper grades. A maiden resource estimate for the Lower Zone is expected in early 2015.

KSM consists of four deposits: Kerr, Sulphurets, Mitchell, and Iron Cap. Proven plus Probable reserves total over 2.1 billion tonnes averaging 0.55 g/t Au and 0.21% Cu, forming one of the largest undeveloped gold-copper porphyry resources in North America. Measured plus Indicated resources (inclusive of reserves) total 2,780 Mt grading 0.55 g/t Au, 0.21% Cu, 2.9 g/t Ag and 55 ppm Mo. Inferred resources total 1,127 Mt grading 0.41 g/t Au, 0.17% Cu, 3.0 g/t Ag and 50 ppm Mo. Recent exploration has found deeper zones and higher grades that remain to be added to the mineral reserves and mine plan; an updated resource estimate is expected in early 2015.

The KSM project is planned to operate over a 55 year mine life with an estimated capital cost of \$5.3 billion. The initial 25 years would be an open pit mining operation processing 130,000 t/d decreased to 90,000 t/d for the remaining 30 years. Ore would be fed to a floatation mill, produce a gold-copper-silver concentrate, and then trucked to the Stewart port facility. Metallurgical testing indicates that a clean 25% copper concentrate can be produced, as well as a separate molybdenum concentrate and gold-silver dore.

The KSM deposits are spatially and genetically related to high-level diorite to monzonite plugs and dikes (Mitchell intrusions) that intrude Stuhini Group and Hazelton Group rocks (Nelson and Kyba, 2014). The Mitchell zone (Febbo et al., 2015) is exposed in an erosional window below the Mitchell thrust fault and consists of schistose rocks with abundant sericite, disseminated pyrite and a deformed quartz-pyrite-chalcopyrite stockwork containing remarkably uniform copper and gold grades. Iron Cap is in the hanging wall of the Mitchell thrust fault, and below the Sulphurets thrust. Chalcopyrite occurs as fine disseminations and in quartz-pyrite veins. Epithermal-style mineralization in quartz stockwork and breccias containing higher gold and silver grades are also present at Iron Cap. Original lithologic textures are commonly obliterated by intense, pervasive silicification. However, in windows of weaker alteration, primary textures are preserved including porphyritic intrusions and screens of pebble conglomerate. Quartz-rich arkose, granulestone, pebble conglomerate, mudrocks, and andesitic volcanic rocks at Iron Cap are considered part of the Jack Formation, the basal unit of the Hazelton Group, and are interpreted to have been deposited adjacent to syndepositional faults that controlled late Triassic-Early Jurassic porphyry systems (Nelson and Kyba, 2014).

Pretium Resources Inc. continued exploration and development activities at the **Brucejack-Snowfield** high-grade gold (Fig. 10) project, 65 km north of Stewart and 6 km from the KSM project. Efforts during 2014 were largely focused on corporate initiatives to ensure that project financing and permitting remained on schedule. The company's Environmental Assessment application was formally accepted in mid-August. Surface drilling totalled 9,325 m in 7 drill holes and 14 wedges. Results confirmed high-grade gold mineralization at the Valley of the Kings below the present Mineral Resource estimate (Table 4).

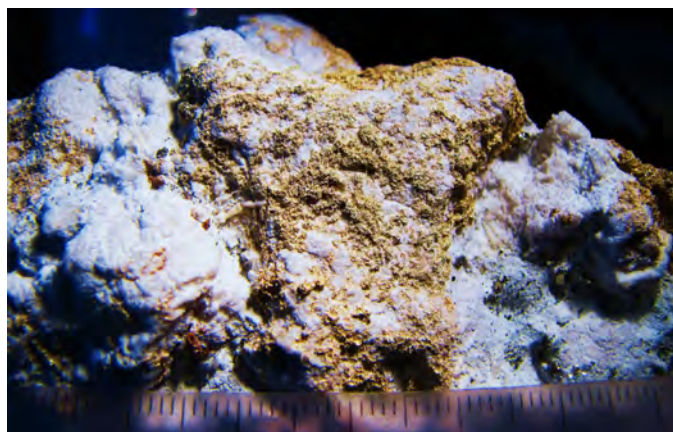
An updated feasibility study released in June adjusted project

Table 2. Proposed mines and exploration projects, Eskay-Stewart-Anyox area.

Property	Proponent	MINFILE	Deposit Type	Commodities	2014 Activities	Website
Bow	Decade Resources Ltd.	104B 132	Porphyry	Au	Diamond drilling (15 holes)	www.decadresources.ca
Bronson	Snip Gold Corp.	104B 077	Porphyry	Au, Cu, Ag	Geology, Corporate	www.snipgoldcorp.com
Brucejack	Pretium Resources Inc.	104B 193	Porphyry	Au, Ag	Diamond drilling (9,325 m, 7 holes, 14 wedges) Geology, Geochemistry, Corporate, Underground development, environmental	www.pretivm.com
Columario	Argonaut Exploration Inc.	103I 077	Vein/Breccia	Au	Geochemistry (rock chips)	www.argonautexploration.com
Corey	Kenrich-Eskay Mining Corp.	104B 240	porphyry	Au, Ag, Cu	Geology, Geochemistry	www.eskaymining.com
Del Norte	Teuton Resources Corp.	104A 176	Vein/Breccia	Au	Diamond drilling (2 holes) Geology Geochemistry, Corporate	www.teuton.com
Dolly Varden	Dolly Varden Silver Corporation Hecla Mining Company	103P 188	Vein/Breccia	Ag	Diamond drilling (5,280 m, 12 holes) Geology, Geochemistry (2,500 soils), Geophysics (IP + EM, 10.9 line km, 2 borehole IP + EM)	www.dollyvarensilver.com
Granduc	Castle Resources Inc.	104B 021	Massive Sulphide	Cu, Ag, Au	Corporate	www.castleresources.com
High	Teuton Resources Corporation		Vein/Breccia	Au	Diamond drilling	www.teuton.com
Homestake Ridge	Homestake Resource Corporation	103P 216	Vein/Breccia	Au, Ag, Zn	Diamond drilling (2,972 m, 6 holes), Geology, Geochemistry	www.agnicoeagle.com
Inel	Colorado Resources Ltd./ Snip Gold Corp.	104B 113	Vein/Breccia	Au, Ag, Zn, Cu	see KSP below	www.coloradresources.com www.skylinegold.com
King	Metallis Resources Inc.	104B 079	Porphyry	Cu, Au, Mo	Geology, Geochemistry	www.metallisresources.com
KSM	Seabridge Gold Inc.	104B 103	Porphyry	Au, Cu, Ag, Mo	Diamond drilling (29,508 m, 29 holes), Geology, Geochemistry, Geophysics, Corporate	www.seabridgegold.net
KSP	Colorado Resources Ltd.	104B 138	Porphyry	Au, Cu	Diamond drilling (791 m, 6 holes) Geophysics (mag, 600 line km), Geology, Geochemistry (soils, rock chips)	www.coloradresources.com
Premier	Ascot Resources Ltd.	104B 054	Vein/Breccia	Au	Diamond drilling (36,672 m, 169 holes), Geology, Geochemistry	www.ascotresources.ca
Red Mountain	IDM Mining Ltd.	103P 086	Vein/Breccia	Au	Diamond drilling (3,630 m, 12 holes), Geology, Geochemistry, Corporate	www.idmmining.com
Snowfield	Pretium Resources Inc.	104B 179	Porphyry	Au, Cu, Mo	Corporate	www.pretivm.com
Tide North	Auramex Resources Corp.	104B 252	Massive Sulphide	Au	Diamond drilling (501 m, 1 hole), Geology	www.auramex.com
Torbrit	Dolly Varden Silver Corporation	103P 191	Sedimentary Replacement	Ag, Pb, Zn, Cu, Au	see Dolly Varden	www.dollyvarensilver.com
Treaty Creek	American Creek Resources Ltd.	104B 078	Vein/Breccia	Au, Ag, Cu	Corporate	www.americancreek.com

Table 3. Highlight drilling results from KSM.

Zone	Hole ID	From (m)	To (m)	Width (m)	Au (g/t)	Cu (%)	Ag (g/t)
Iron cap Lower Zone	IC-14-053	488.4	1002.4	514	0.68	0.3	5.2
	IC-14-054A	322.4	832.5	510.1	0.41	0.28	10.5
	IC-14-054A	604.4	872	267.6	0.39	0.23	4.8
	IC-14-055	257.5	624.3	366.8	0.59	0.17	2.5
	IC-14-057	176	600.2	424.2	0.4	0.22	4
	IC-14-058	5.9	802	796.1	0.39	0.22	4
	IC-14-059	178.7	771.4	592.7	1.14	0.37	3.7
	IC-14-060	124	525.3	401.3	0.47	0.17	8
	IC-14-061	431.4	794.4	363	0.38	0.28	6.8
Deep Kerr	K-14-28C	900	1257.4	357.4	0.5	0.63	1.9
	K-14-34A	871.4	1608.4	737	0.36	0.59	1.1
	K-14-39	945.4	1197.4	252	0.55	0.69	1.4
	K-14-45	400.4	1123	722.6	0.36	0.59	2.6

**Fig. 10.** Fine-grained electrum and pyrite in quartz-carbonate matrix from the Brucejack Cleopatra vein.

specifics including gold price, increased reserves, and higher gold grades. Results remained positive for the proposed 2,700 tonne per day milling operation forecasted to operate for 18 years and produce 226 tonnes (7.27 million ounces) of gold.

Brucejack is on the eastern limb of the northerly trending McTagg anticlinorium, a regional scale, mid-Cretaceous structural culmination in the western Skeena fold belt (e.g., Nelson and Kyba, 2014). The Brucejack property is underlain by volcanosedimentary rocks of the Stuhini Group (Triassic) that are unconformably overlain by the Hazelton Group (Late Triassic-Jurassic, Fig. 11) and Bowser Lake Group cover rocks. These rocks are cut by the Brucejack fault, which is interpreted to have had a long history of reactivation (Nelson and Kyba, 2014). Alteration is mainly pervasive quartz-sericite-pyrite replacement in zones several hundred metres wide and several kilometres long. Most of the five mineral resources (West Zone, Valley of the Kings, Bridge Zone, Gossan Hill, and Shore Zone) are in the intensely altered zones and associated with vein-stockworks. High-grade zones are either on the margins

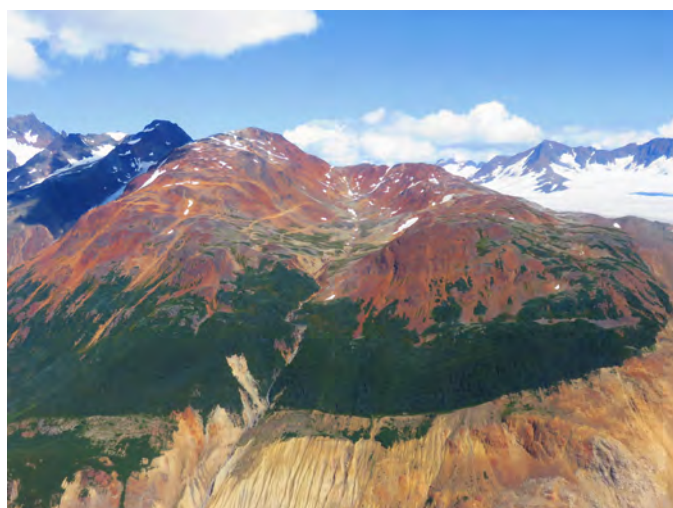
or contained in a zone of bulk low-grade mineralization up to several grams per tonne gold. Bulk low-grade mineralization tends to be associated with disseminated anhedral pyrite. High-grade gold-silver electrum mineralization is hosted in deformed transitional epithermal stockwork veins up stratigraphy from several large and slightly older porphyry deposits; the multi-phase Mitchell intrusions (Pretium Resources, 2015).

Ascot Resources Ltd. continued drilling at the **Premier** and **Big Missouri** gold projects 20 km north-northwest of Stewart. Drilling of a multiphase program completed in 2014 (36,672 m in 169 holes) identified a new area of mineralization at Big Missouri before focusing on zones around Premier. Broad zones of elevated (>1 g/t eAu) mineralization support the resource estimate released in March. Indicated Resources total 93.5 Mt grading 0.82 g/t Au and 6.9 g/t Ag. Additional Inferred Resources total 79.2 Mt grading 0.59 g/t Au and 7.2 g/t Ag. Both estimates used a 0.3 eAu cut-off and include the **Dilworth**, **Martha Ellen** and **Big Missouri** deposits. The Premier and surrounding deposits are hosted in Hazelton Group andesite tuffs, lapilli tuffs, and flows. Dikes of Premier porphyry are spatially associated with most mineralized zones and are interpreted to be ring dikes to a vent flanking a larger volcanic center in the Big Missouri area (Alldrick, 1993).

In April, the **Red Mountain** gold project (Fig. 12) was optioned from Seabridge Gold Inc. to Revolution Resources Corp. who changed their name to IDM Mining Ltd. An updated resource estimate and Preliminary Economic Assessment completed in July indicated favorable economics to pursue a 1,000 tonne per day seasonal underground mine. A Project Description was submitted to the British Columbia Environment Assessment office for review. IDM completed 12 drill holes (3,630 m) testing mineralization beyond known resources at the Marc, AV, and JW zones. Drilling and surface results confirm gold mineralization, most notably 138 m grading 1.41 g/t Au from 64 m depth in drill hole MC14-03. Retreat of the Bitter Creek

Table 4. Highlight drilling results from Brucejack.

Zone	Hole ID	From (m)	To (m)	Width (m)	Au (g/t)	Ag (g/t)
Valley of the Kings	SU-632-W4	78.76	80.86	2.1	2415.17	353.43
	SU-644-W1	113	135.1	22.1	26.14	10.59
	SU-644-W2	169.75	174.2	4.45	515.24	90.48

**Fig. 11.** Looking north, Hazelton Group conglomerate (left) unconformably overlying folded Stuhini Group argillite and sandstone. Unconformity is marked by white dashed line. Gossanous backdrop is Sulpurets ridge, foreground drops off to Brucejack Creek.**Fig. 12.** Looking northeast over IDM Mining's Red Mountain gold project. Photo courtesy of IDM Mining.

glacier and Cambria ice fields revealed new showings up to 500 m away from historic workings.

4.2. Exploration projects

Dolly Varden Silver Corporation partnered with Hecla Mining Company to complete multiple surveys and 5,280 m of drilling near the past producing **Dolly Varden**, **Torbrit** and **Wolf** high-grade silver mines 45 km southeast of Stewart. Exploration concepts focused on intersections of prospective stratigraphy with altered and mineralized structures. Twelve drill holes spaced over 2 km tested multi-element geochemical

and geophysical anomalies along the north-northwest regional structural trend hosting the Torbrit mine. Seven of the twelve drill holes returned intersections including 9.01 m grading 1,496 g/t Ag from hole DV14010 from the Kitsol vein. Drilling results also confirmed a direct correlation between silver mineralization and a 7.2 km-long potassium anomaly, which will be used to guide 2015 exploration.

Homestake Resource Corporation resumed 100% ownership of the **Homestake Ridge** silver-gold project. Agnico Eagle Mines Limited returned the project after their second year of exploration focussed on the Slide target. Drilling totalled 2,972 m in six holes which extended the Slide zone to a strike length of 800 m. Best results include 4.5 m grading 144 g/t Ag from drill hole HR14-264. Metal zonation patterns at the Slide zone appear analogous to the neighboring Main Homestake Silver deposit, which contains a deeper, gold enriched zone. Future drilling aims to test this deeper target at the Slide zone. The company also continued target generation work on their optioned Kinskuch Property. The cumulative 625 km² mineral claims host 58 MINFILE occurrences and have been divided into four target areas: Esperanza, FH, Illiance and Kitgold.

Teuton Resources Corp. completed five drill holes at their **Del Norte** property, 25 km east-northeast of Stewart. Results indicate porphyry copper-gold mineralization (Fig. 13) with a highlight intercept from drill hole D14-03 returning 12.19 m grading 0.92 g/t Au, 0.15% Cu and 3.07 g/t Ag. Teuton also completed sixteen drill holes at their **High** project, immediately south of Pretium Resources Brucejack project. Results confirmed gold-silver mineralization over widths up to 15 m.

Teuton and American Creek Resources Ltd. continued a legal dispute over ownership of the **Treaty Creek** project area



Fig. 13. Chalcopryite-bearing drill core from Teuton Resources Del Norte project. Photo courtesy of Teuton Resources.

northeast of Seabridge Gold's KSM project. Compilation of geotechnical drilling and geophysics completed by Seabridge for the Mitchell-Treaty twin tunnel access to KSM has highlighted areas for further testing.

Decade Resources Ltd. completed drill testing at the **Bow** property 35 km north-northwest of Stewart and adjacent to the past producing Scottie Gold mine. Early season grab sampling returned gold values up to 3,418 g/t Au and led to follow-up drilling. Best results were returned from drill-hole DDH-14-Bow-1; 49.6 m grading 15.25 g/t Au and DDH-14-Bow-2; 12.66 m grading 38.43 g/t Au. Fifteen drill holes were completed to test high-grade gold mineralization hosted in the Blueberry vein structure and the Sixties zone.

Auromex Resource Corp. and Pretium Resources Inc. completed a single 500 m hole at the **Tide North** prospect. The hole tested a deep conductivity target interpreted to be in the same stratigraphic units as Eskay Creek. Results found a thick succession of foliated carbonaceous sedimentary rocks with minor sulphides.

Metallis Resources Inc. completed a reconnaissance program at the **King** property, immediately west of the KSM project. Exploration aimed to ground truth the King VTEM geophysical

anomaly identified in 2013. Groundwork included geochemical sampling, prospecting, and geological mapping.

Eskay Mining Corp. conducted reconnaissance scale prospecting and mapping at their **Corey** property between Eskay Creek and KSM.

Colorado Resources Ltd. partnered with SnipGold Corporation to explore their **KSP** (Khyber, Sericite and Pins) property in the Bronson trend (Fig. 14; Metcalfe and Moors, 1992), which includes the past-producing Snip and Johnny Mountain gold mines. Extensive visible alteration (Fig. 14) led company geologists to compile legacy data and consolidate a ground position amenable to testing kilometre-scale deposit models. Analysis of 684 rock and 1,247 soil samples and 600 line km of airborne magnetic surveys led to further sampling and late-season drilling, including 791 m in six holes. Best results include 101.4 m grading 1.16 g/t Au (drill hole KSP14-003) and a 34 m interval grading 2.98 g/t Au. New geological mapping now covers over 50 square kilometres and indicates several untested zones. British Columbia Geological Survey mapping indicates that the structural and stratigraphic framework may be analogous to the KSM mineralized system (Kyba and Nelson, 2015).

5. Stikine Arch

The Stikine Arch includes parts of the Stikine, Cache Creek, and Quesnel terranes and is cut by regional east-west trending faults (Fig. 1). The most common metal prospects are high-potassium, calc-alkalic porphyry style deposits similar to Red Chris (Table 5). Late Triassic to Early Jurassic copper-gold bearing stocks intrude Stuhini and Hazelton Group rocks.

5.1. Mine development

Red Chris Development Company Ltd. (Imperial Metals Corporation) is in the final stages of construction at the **Red**

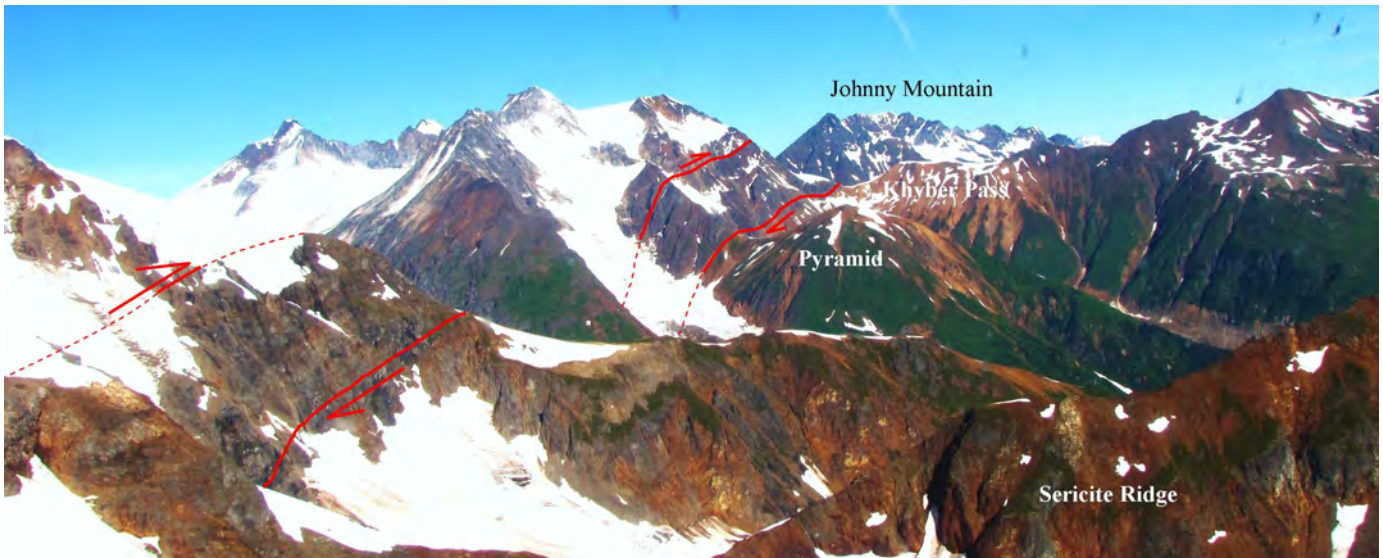


Fig. 14. Looking northwest along the Sky fault system (Kyba and Nelson, 2015) from Sericite ridge towards Pyramid, Khyber Pass and Johnny Mountain at Colorado Resources KSP project.

Table 5. Mine development, proposed mines, and exploration projects, Stikine Arch.

Property	Proponent	MINFILE	Deposit Type	Commodities	2014 Activities	Website
Boulder Gold	Pacific Bay Minerals Ltd.	104I 004	Vein/Breccia	Au	Diamond drilling (246 m, 1 hole), Geology, Geochemistry	www.pacificbayminerals.com
Castle	Kaizen Discovery Inc.	104G 076	Porphyry	Au, Cu, Mo, Ag	Geology, Corporate	www.kaizendiscovery.com
DOK	Boxxer Gold Corp.	104G 043	Porphyry	Cu, Au	Diamond drilling (834.9 m, 2 holes), Geology, Geochemistry	www.b maxxergold.com
Eaglehead	Carmax Explorations Ltd.	104I 008	Porphyry	Cu, Mo	Diamond drilling (2264.22 m, 4 holes), Geology, Geochemistry	www.carmaxex.com
Eldorado	Colorado Resources Ltd.	104H 026	Porphyry	Au, Cu	Diamond drilling (892 m, 4 holes), Geology, Geochemistry	coloradoresources.com
Galore Creek	Galore Creek Mining Corporation (Teck Resources Limited/NOVAGOLD Resources Inc.)	104G 090	Porphyry	Cu, Au	Corporate, Environmental	www.gcmc.ca
GJ	Teck Resources Limited	104G 034	Porphyry	Cu, Au	Corporate, Geology, Geochemistry	www.ngexresources.com
Grizzly	Garibaldi Resources Inc.	104G 079	Porphyry	Cu, Au	Geology, Geochemistry, Corporate	www.garibaldiresources.com
Hat	Doubleview Capital Corp.	104J 015	Porphyry	Cu, Au	Diamond drilling (2,831 m, 7 holes), Geology, Geophysics	www.doubleview.ca
Kutcho Creek	Capstone Mining Corp.	104I 060	Massive Sulphide	Cu, Zn, Ag, Au	Corporate	www.capstonemining.com
Kutcho Jade	Continental Jade Ltd.	104I 078	IM_Rock	Jade	Mining	www.jademine.com
Metla	Clive Aspinall	104K 113	Porphyry	Au	Corporate	
Newmont Lake	Romios Gold Resources Inc.	104B 281	Skarn	Au, Ag, Zn	Geophysics (ZTEM, 372 line km) Geology, Geochemistry (314 Rock chips)	www.romios.com
North ROK	Colorado Resources Ltd.	104H 035	Porphyry	Cu, Au	Diamond drilling (2,191 m, 5 holes), Geology,	www.coloradoresources.com
Pyramid	Gold Jubilee Capital Corp.		Porphyry	Cu, Au	Geophysics (IP), Geology, Geochemistry	
RCN	Serengeti Resources Inc.		Porphyry	Cu, Au	Geology, Geochemistry, Geophysics (IP)	www.serengetiresources.com
Red Chris	Red Chris Development Company Ltd. (Imperial Metals Corporation)	104H 005	Porphyry	Cu, Au	Mine Construction, Environmental	www.imperialmetals.com
ROK	Oz Minerals optioned from Firesteel Resources Inc.	104H 012	Porphyry	Mo, Cu	Diamond drilling (842.15 m, 2 holes), IP (44.85 line km), Geology	www.firesteelresources.com
Schaft Creek	Teck Resources Limited	104G 015	Porphyry	Cu, Mo, Au, Ag	Geology	www.teck.com
Sheslay	Prosper Gold Corp.	104J 035	Porphyry	Cu, Au	Diamond drilling (6,221.5 m, 19 holes), Geology, Geochemistry	www.prospergoldcorp.com
Spectrum	Skeena Resources Limited	104G 036	Vein/Breccia	Au	Diamond drilling (1,940 m, 9 holes), Geology, Geochemistry	www.skeenaresources.com
Summit	Pistol Bay Mining Inc./Vega Mining Inc.	104H 015	Porphyry	Cu, Au	Geology, Geochemistry,	www.vegamininginc.com
Tanzilla	Kaizen Discovery Inc.	104I 023	Porphyry	Cu, Mo	Diamond drilling (1,386 m, 5 holes), Geology, Geochemistry, Corporate	www.kaizendiscovery.com
Tatogga Lake	New Chris Minerals Ltd.	104G 166	Porphyry	Cu, Mo	Geology, Geochemistry, Geophysics (IP)	
Turnagain	Hard Creek Nickel Corp.	104I 119	Magmatic	Ni, Co, Pt, Pd	Corporate	www.hardcreeknickel.com/

Chris copper-gold project 80 km south of Dease Lake. The Northwest Transmission line (Fig. 15) now connects the project to a 287 KV grid-based power originating near Terrace. Imperial constructed the 93 km extension from Bob Quinn to the project and sold it to BC Hydro in late December for \$52 million. Ore taken from the Main and East zones (Fig. 16), is being crushed and stockpiled in preparation for mill equipment being commissioned. Before milling can proceed, Red Chris needs an Environmental Management Act permit to discharge tailings. Because of the tailings dam breach and resulting flood at the Mount Polley mine, also owned by Imperial, a third party review of the tailings impoundment area made recommendations to be integrated into the design. Capital costs have increased to total \$643M for the completion of the 30,000 tonne per day mine. The expected mine life is 28 years.

5.2. Proposed mines

Teck Resources Limited re-logged over 16,867 m of historic drill core at the **Schaft Creek** copper-gold-silver molybdenum deposit. Ongoing metallurgical, geotechnical, and environmental studies will enhance the 2013 feasibility



Fig. 15. Northwest Transmission Line near Bell 2.



Fig. 16. The first bench at the East Zone, Red Chris copper-gold mine.

report. Teck owns 75% of the project and Copper Fox Metals Inc. retains 25%. Teck and Novagold Resources Inc. completed little more than basic monitoring and maintenance at the **Galore Creek** gold-copper deposit. Capstone Mining Corp. continued to maintain an airstrip and camp at their **Kutcho Creek** massive sulphide project, 100 km east of Dease Lake.

5.3. Exploration projects

Oz Minerals Limited returned the **ROK-Coyote** copper-gold project to Firesteel Resources Inc. after the exploration program was interrupted by protests. Drill targets generated from overlapping IP and magnetic anomalies were tested with two holes totalling 842.15 m. Best results were returned from drill hole DD14RK006; 109.1 m grading 0.11 g/t Au and 0.05% Cu from 383 m depth. Colorado Resources Ltd. grew their **North ROK** copper gold project from a single rock chip sample collected during a British Columbia Geological Survey regional mapping project (Ash, 1997) to a 142.3 Mt Inferred Resource estimate grading 0.22% Cu and 0.26 g/t Au in nine months. The company returned in early 2014 and demonstrated continuity at depth and a new zone, West Mabon. Drilling totalled 2,191 m in five holes. Colorado also completed 892 m of drilling at the **Eldorado** prospect northeast along trend from the Red Chris deposit. Despite broad intersections of weak copper-gold mineralization, Colorado returned the property to Sunrise Resources Ltd.

New Chris Minerals Ltd. completed reconnaissance surveys at their **Tatogga Lake** project area. Over one thousand combined soil and rock samples were collected in conjunction with a ground IP survey and geological mapping. New showings were discovered along the 'Northern Lights' shear zone (Fig. 17). Skeena Resources Ltd. completed a late-season drill program at the **Spectrum** gold project 85 km south of Dease Lake, on the eastern flank of Mt Edziza. Nine drill holes totalling 1,950 m confirmed historical gold values and proved depth continuity well below historical drilling. The best intersection returned 27 m grading 10.63 g/t Au from 106 m depth in drill hole 14-SP-



Fig. 17. Chlorite shear hosted quartz-carbonate-chalcopyrite-malachite-azurite veining at the Northern Lights showing, New Chris Mineral's Tatogga Lake project.

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Serengeti Resources Inc. completed a program at their **RCN** property to follow up 2013 results. Groundwork included an IP survey and geochemical rock and soil sampling. Results of the 2014 program included outcrop samples up to 0.97% Cu and 1.38 g/t Au and open-ended chargeability highs.

Kaizen Discovery Inc. (formerly West Cirque Resources) proved porphyry and high-sulphidation style copper-gold-molybdenum mineralization at **Tanzilla**, 23 km southeast of Dease Lake (Fig. 18). The 2 x 1.5 km chargeability anomaly underlying Silica ridge was tested this year with three diamond drill holes, which returned copper-gold grades of up to 0.13% Mo and 0.148 g/t Au. Drill hole TZ 14-05 targeted the central chargeability high and intersected strong pervasive, silica and advanced argillic altered hydrothermal breccias containing disseminated and vein hosted covellite, chalcopyrite, enargite, and molybdenite.

Carmax Mining Corp. resumed exploration at the **Eaglehead** copper-molybdenum-gold-silver porphyry. Ground work



Fig. 18. Traversing across the strongly QSP altered Silica Ridge. Detailed studies of the clay alteration mineralogy helped define drill targets, which led to the discovery of a copper-gold-molybdenite bearing porphyry and high sulphidation system.

included four drill holes totalling 2,264 m and a TITAN 24 geophysical survey. Results of the 18-line km geophysical survey identified two areas of high chargeability over a 5.6 km strike length. Drilling targeted both the East zone and Bornite zone and intersected copper-molybdenum-gold-mineralization (Fig. 19) reflecting similar grades to those in a 2012 resource estimate. Drilling proved the mineralized system extends deeper than previously known.

Pacific Bay Minerals Ltd. completed a single 246 m drill hole at **Boulder Gold** 60 km east of Dease Lake. Boulder City has a rich placer gold history but a bedrock source has never been fully investigated. Drilling results have returned visual sulphide mineralization with assays pending.

Gold Jubilee Capital Corp. discovered a new copper-gold-

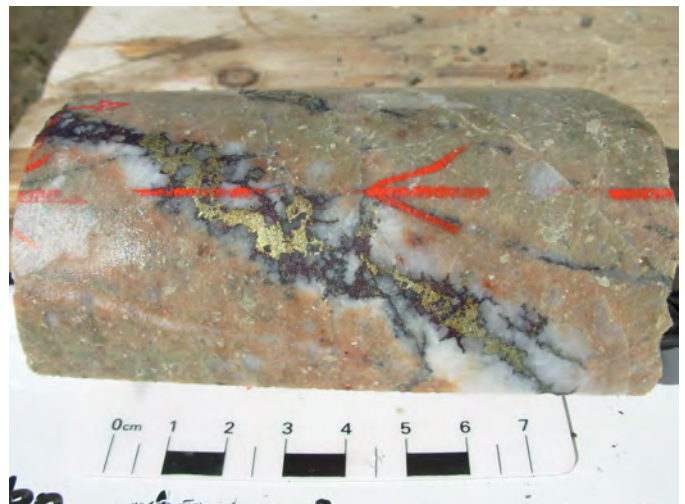


Fig. 19. Chalcopyrite- and bornite-bearing quartz vein in phyllic altered granodiorite at Carmax Mining's Eaglehead project. Photo by Bev Quist.

silver showing at **Pyramid** (Fig. 20) 50 km north of Dease Lake. The 2014 work program included a 32.3 line km Volterra 3D IP survey and 722 combined geochemical soil, silt, and rock samples. Widespread anomalous gold and copper values in soils coincident with IP chargeability and resistivity anomalies are guiding follow up work. The best hand sample returned 11.5 g/t Au, 7.0 g/t Ag and 0.08% Cu.

About 105 km west of Dease Lake, Prosper Gold Corp. completed a drilling program at the **Sheslay** copper-gold project, which was optioned from Firesteel Resources Inc. Drilling totalled 6,221 m in twenty holes and aimed to expand known mineralization. Results were consistent with historical copper gold values (Fig. 21). The best results were from drill hole S045: 106.98 m grading 0.77% Cu, 0.407 g/t Au and 1.02 g/t Ag.

Doubleview Capital Corp. continues exploration work through the winter at the nearby **Hat** gold-copper porphyry project 95 km west of Dease Lake. Over 7,000 m of drilling in 22 holes was completed in 2013-2014. The Lisle zone has received most of the drilling and returned the best intersections (drill hole HAT-022; 404.2 m grading 0.25% Cu and 0.255 g/t Au from 43.4 m depth including 118.4 m grading 0.55% Cu and 0.41 g/t Au). The deposit now extends along a strike length of 962 m, and to a depth of 400 m.

About 40 km northwest of Schaft Creek and 50 km southwest of Telegraph Creek, Boxxer Gold Corp. completed two drill holes totalling 834.9 m, on the **DOK** copper-gold-molybdenum-



Fig. 20. Fracture-controlled mineralization in quartz-sericite-pyrite altered diorite at Pyramid. Photo by Dustin Perry.

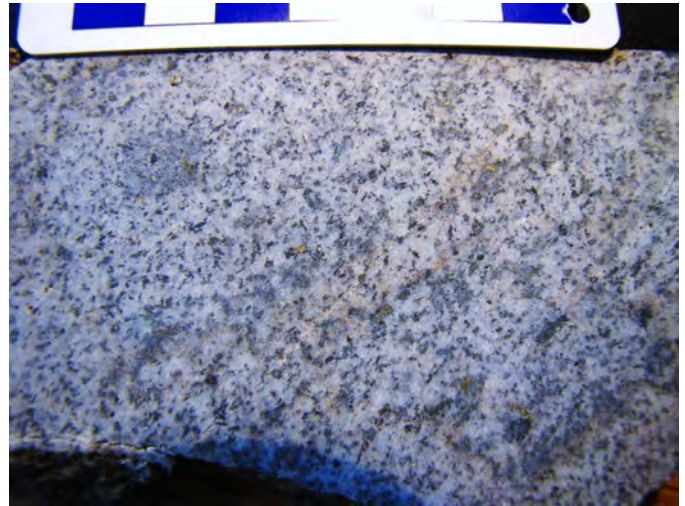


Fig. 21. Outcrop sample of the chalcopyrite-bearing Sheslay diorite.

silver project. Visible chalcopyrite has been reported but not validated by analytical results.

Romios Gold Resources Inc. followed up on their 2013 copper-gold-silver porphyry related skarn discovery at **Burgundy Ridge** with sampling and prospecting in the larger **Newmont Lake** project area. Rock chip samples (Fig. 22) were collected of which 173 targeted Burgundy Ridge. The average from Burgundy Ridge returned 0.40% Cu, 0.48 g/t Au and 4.78 g/t Ag; the highest grades were in excess of 9% Cu, 52 g/t Au and 171 g/t Ag. Prospecting nearly 2 km beyond Burgundy ridge identified several zones of porphyry-related copper-gold bearing skarns. Mineralization appears to be related to megacrystic potassium feldspar syenite porphyry and diorite porphyry dikes intruded into dolomitic limestones.

6. Skeena Arch

The Skeena Arch forms a topographic high separating the Bowser and Netchako basins. The district contains numerous Cretaceous and younger faults whose enveloping trend is northeast, at a high angle to the general northwest Cordilleran



Fig. 22. Systematic sampling at Burgundy Ridge. Photo courtesy of Romios Gold.

trend. Mineral deposits in the area include calc-alkalic porphyries, precious metal veins, and minor coal (Fig.1; Table 6).

6.1. Mine development

Avanti Mining Inc. (Alloy Corp Mining Inc. as of December 1st) is working to reopen the past-producing **Kitsault** molybdenum-silver mine, 115 km north of Terrace. In June, the project received an amendment to an existing Mines Act permit and federal approval of their Environmental Assessment application. These approvals allowed the company to begin road and camp construction and infrastructure upgrades. Also in June, the Nisga'a First Nation and the company successfully negotiated a Mine Benefits Agreement. Details of the agreement include a net smelter royalty of up to 2% (based on prevailing molybdenum prices) and a resolution to all outstanding litigation. A memorandum of understanding with the Wilp Luuxhon First Nation was also signed. Construction activities are scheduled to continue throughout the winter, focusing on upgrading the Nass River Bridge and a 150 bed construction camp. The mine plan outlines a 45,000 tonne per day mill to be active for at least 14 years. Current Proven plus Probable reserves total 226.3 Mt grading 0.083% Mo + 5.3 g/t Ag. The company plans to truck concentrate to Prince Rupert or Vancouver. Kitsault operated from 1967 to 1972 and again from 1981 to 1982, milling 13.4 Mt grading 0.101% Mo. Molybdenite mineralization (Fig. 23) is primarily hosted in aplite dikes and banded quartz-molybdenite veins related to diorite-quartz diorites of the Lime Creek intrusive complex (Eocene) that cut Jurassic greywackes and argillites of Bowser Basin (Carter, 1974).

6.2. Proposed mines

In February, Metal Mountain Resources Inc. submitted an application for an amendment to their existing Mines Act Permit to build a 250 tonne per day onsite mill at their **Dome Mountain** gold mine, 35 km east of Smithers. An Environmental Assessment application of the **Morrison** copper-gold project was referred to the Minister of Environment in mid-July but



Fig. 23. Sheeted quartz-molybdenite veins cutting Lime Creek intrusive complex quartz monzodiorite at Kitsault.

was suspended in mid-August pending the outcome of the Independent Expert Engineering Investigation and Review Panel, which is investigating the tailings dam breach at Mt. Polley.

6.3. Exploration projects

Goldreach Resources Ltd. continued drilling at their **Ootsa** copper-gold-silver molybdenum porphyry project about 6 km south of the producing Huckleberry copper mine. Measured and Indicated Resources increased from 2013 results and now total 153.9 Mt grading 0.21% Cu using a 0.20 eCu cut-off. Drilling in 2014 totalled 9,795 m in 20 drill holes (11 targeted known resource areas and 9 tested step out exploration targets). Goldreach also expanded their mineral claim holdings totalling over 71 km² and added several known prospects to their exploration inventory, including the Troitsa Peak gold-silver prospect and the past-producing Captain silver mine.

About 32 km southwest of Houston, Similco Mines Ltd. tested the **Fenton Creek** prospect with about 3,000 m of diamond drilling in nine holes. Targets were generated from 1,600 m of percussion drilling in 53 holes and deep penetrating IP geophysics. Finlay Minerals Ltd. completed about 1,000 m of drilling in 3 holes at their **Silver Hope** project, 35 km southeast of Houston and surrounding the past producing Equity Silver Mine. Northern Abitibi Mining Corporation completed seven trenches and 274 geochemical rock chip samples at the **Ches** porphyry project 80 km south of Burns Lake. Results indicate a variably mineralized zinc-copper-tungsten skarn system over an area 1.5 x 0.5 km. A 1.5 m rockchip sample returned 1.25% Zn, 0.16% Cu and 0.12% WO₃ (tungsten trioxide). KGE Management Ltd. completed biogeochemical bark sampling at the **Boer** property, a company completed an IP geophysical survey at the **CR** prospect and Astorior Resources Ltd. reported results of an IP survey at **Babine**.

7. Atlin area

The Atlin Area area, in the northwestern part of the Skeena Region, is underlain by the Cache Creek, Stikine, and Yukon-Tanana terranes (Fig. 1). The Stikine terrane hosts almost all of the active projects (Table 7), although the Cache Creek terrane hosts some economic mineral deposits, most significantly placer gold mined east of the community of Atlin. Deposit types include Kuroko-type massive sulphides (e.g., Tulsequah Chief), precious metal breccia pipes and porphyry (e.g., Thorn) and epithermal veins (e.g., Engineer).

7.1. Proposed mines

In early December, Chieftain Metals Corp. filed an updated feasibility study for their **Tulsequah Chief** high-grade copper-lead-zinc-gold-silver VMS deposit about 100 km south of Atlin. Rather than building a road between Atlin and the deposit, the plan calls for conventional barging during five months of the year, eliminating \$125 million of pre-production capital costs. The 1,100 tonne per day underground mine would operate for at least 11 years on 4.4 Mt of reserves.

Table 6. Mine development, proposed mines, and exploration projects, Skeena Arch.

Property	Proponent	MINFILE	Deposit Type	Commodities	2014 Activities	Website
Babine	Astorius Resources Ltd.	093L 209	Porphyry	Cu, Au	Geophysics (IP)	www.astoriusresources.com
Big Onion	Eagle Peak Resources Inc.	093L 124	Porphyry	Cu, Mo, Au, Ag	Geology, Geochemistry	www.eaglepeakresources.com
Boer	KGE Management Ltd.		Porphyry	Cu	Geochemistry (biogeochem, till), Geology	
Ches	Northern Abitibi Mining Corp.	093F 042	Porphyry	Mo, Cu, Zn, W	7 trenches, Geochemistry (274 rock chips)	www.naminco.ca
CR	Wes Moll	093L 007	Porphyry	Cu	Geophysics (IP), Geology	
Davidson	Don Davidson	093L 110	Porphyry	Mo	Corporate	
Deer Horn	Deer Horn Metals Inc.	093E 019	Vein/Breccia	Au, Ag, Te	Corporate	www.deerhornmetals.com
Dome	Metal Mountain Resources Inc./Gavin Mines Ltd.	093L 022	Vein/Breccia	Au, Ag	Corporate	www.metalmountainresources.com
Emerald Glacier	Lowprofile Ventures Ltd.	093E 001	Vein/Breccia	Zn, Ag, Pb, Cu, Au	Geology, Geochemistry	
Fenton	Similco Mines Ltd.	093L 248	Vein/Breccia	Cu, Ag, Zn	Diamond drilling (3,000 m, 9 holes), Percussion Drilling (1,600 m, 53 holes) Geology, Geochemistry, Geophysics (IP, 9 line km)	
Fireweed	Shamrock Resources Inc.	093M 151	Sedimentary Replacement	Ag	Corporate	www.shamrockresources.com
Hanson Lake	John Chapman/Gerry Carlson	093K 078	Porphyry	Mo, Cu	Geology, Geochemistry	
Huckleberry	Huckleberry Mines Ltd.	093E 037	Porphyry	Cu, Mo	Geology, Geochemistry (soils)	www.imperialmetals.com
Kitsault	Avanti Mining Inc./Alloy Corp. Mining Inc.	103P 120	Porphyry	Mo, Ag	Corporate	www.avantimining.com
Lennac Lake	Don MacIntyre	093L 190	Porphyry	Cu, Mo	Corporate	
Morrison	Pacific Booker Minerals Inc.	093M 007	Porphyry	Cu	Corporate	www.pacificbooker.com
Ootsa	Goldreach Resources Ltd.	093E 105	Porphyry	Cu, Au	Diamond drilling, (9,795 m, 20 holes), Geology, Geochemistry (soils)	www.goldreachresources.com
S2	Vale		Porphyry	Cu, Mo, Ag	Geophysics, Geology, Geochemistry	www.vale.com
Silver Hope	Finlay Minerals Ltd.	093L 256	Vein/Breccia	Ag, Cu	Diamond drilling	www.finlayminerals.com
Silver Queen	New Nadina Explorations Limited	093L 002	Porphyry	Cu, Mo	Corporate	www.nadina.com
Suskwa	Xander Resources Inc.	093M 027	Porphyry	Cu, Au	Geophysics (EM + Mag, 937 line km)	
Yellow Giant	Banks Island Gold Ltd.	103G 021	Vein/Breccia	Au, Ag	Diamond drilling	www.banksislandgold.com

Table 7. Proposed mines and exploration projects, Atlin area.

Property	Proponent	MINFILE	Deposit Type	Commodities	2014 Activities	Website
Engineer	BC Gold Corp.	104M 014	Vein/Breccia	Au	Geology, Corporate	www.bcgoldcorp.com
Golden Eagle	Troymet Exploration Corp.	104M 044	Vein/Breccia	Au	Geology, Corporate, Feasibility	www.troymet.com
Tulsequah Chief	Chieftain Metals Inc.	104K 002	Massive Sulphide	Cu, Zn, Ag, Au	Corporate	www.chieftainmetals.com
Rohan	Eagle Plains Resources Ltd./ Rosedale Resources Ltd.	104M 032	Vein/Breccia	Au	Geology	www.eagleplains.ca
Thorn	Brixton Metals Corp.	104K 031	Vein/Breccia	Au, Cu	Diamond drilling (1,287 m, 8 holes), Geology, Geochemistry, Corporate	www.brixtonmetals.com

7.2. Exploration projects

Brixton Metals Corporation continued exploration at the **Thorn** project 125 km south-southeast of Atlin. The project contains multiple targets including high-grade silver-gold-lead-zinc diatreme breccias, high-grade veins, porphyry copper-gold, and intrusion-related sediment-hosted gold. In 2014 the company completed eight drill holes totalling 1,287 m divided between the Glenfiddich zone (464 m in 4 holes) and the Outlaw zone (823 m in 4 holes). Results from the Outlaw zone discovered 59.65 m grading 1.15 g/t Au and 5.64 g/t Ag from 76 m depth in drill hole THN14-128. Mineralization is hosted in siltstone but is thought to be intrusion related. Brixton filed a maiden Inferred Resource estimate for the combined Oban, Talisker and Glenfiddich zones. Total estimated in-pit and underground inferred resources total 7.4 Mt grading 35.54 g/t Ag, 0.51 g/t Au, 0.13 % Cu, 0.32 % Pb and 0.59% Zn. Grades and cut offs vary between deposits. Grassroots prospecting, mapping, and geochemical sampling programs were completed by Eagle Plains Resources Ltd. at the **Rohan** property and by Troymet Exploration Corp. at the **Golden Eagle**. BCGold Corp. completed limited corporate activities to source financing for their **Engineer** gold mine 31 km west-southwest of Atlin. Discussions were unsuccessful to source financing for a 4,000 tonne bulk sample.

8. Good Hope area

The Good Hope area, in the northeastern part of the Skeena Region, is underlain by the Qusenell, Yukon-Tanana, and Slide Mountain terranes and the Cassiar platform of ancestral North America (Fig. 1). Economic mineral deposits include manto replacement at Silvertip, porphyry molybdenum at Storie, and nephrite jade at Cassiar (Table 8).

8.1. Proposed mines

JDS Silver Inc. has repaired the 26 km access road to the **Silvertip** high-grade silver manto deposit about 95 km west of Watson Lake. A concentrator has been purchased and is currently being stored in Watson Lake. The mine is proposed to be a 74,000 tonne per year underground operation. Limited mine site preparation work was completed in 2014 and the Mines Act Permit review began in November.

8.2. Exploration projects

BC Moly Ltd., formerly Columbia Yukon Exploration Inc., filed an updated resource estimate for their **Storie** molybdenum project 85 km north of Dease Lake. Measured plus Indicated estimates total 117 Mt grading 0.068 % Mo using a 0.03 % Mo cut off. Pacific Bay Minerals Ltd. completed a 409 m diamond drilling program at the **Haskins-Reed** polymetallic skarn

Table 8. Proposed mines and exploration projects, Good Hope area.

Property	Proponent	MINFILE	Deposit Type	Commodities	2014 Activities	Website
Cassiar Jade	Cassiar Mountain Jade		IM_Rock	Jade	Mining	www.jadecity.com
Cassiar Jade	Cassiar Jade Contracting	104P 005	IM_Rock	Jade	Mining	www.cassiarjadecontracting.com
Haskins Reed	Pacific Bay Minerals Ltd.	104P 021	Skarn	Zn, Pb, Ag, Mo	Diamond drilling (409 m, 6 holes), Geology, Geochemistry	www.pacificbayminerals.com
Silvertip	JDS Silver Inc.	104O 038	Sedimentary Replacement	Ag, Pb, Zn, Au	Access road repair, corporate	www.jdsmining.ca
Storie	BC Moly Ltd.	104P 069	Porphyry	Mo	Corporate	www.columbiayukon.com
Fireside	Fireside Minerals Ltd.	094M 003	IM_Rock	Barite	Diamond drilling (2242 m), mining	www.firesideminerals.com

Table 9. Proposed mines, Bowser Basin.

Property	Proponent	MINFILE	Deposit Type	Commodities	2014 Activities	Website
Arctos	Fortune Minerals Limited	104H 022	Metallurgical coal	Anthracite	Environmental	www.fortuneminerals.com
Groundhog	Atrum Coal	104A 078	Metallurgical coal	Anthracite	Diamond drilling, (10,084 m, 51 holes), Geophysics (seismic)	www.atrumcoal.com

project 5 km north of Highway 37 and 105 km north of Dease Lake. Results returned up to 48.6 m grading 2.31 % Zn from drillhole 14-02 targeting the Brett zone.

9. Bowser Basin

Jurassic to Cretaceous deltaic deposits of Bowser Basin host the only significant anthracite deposits in Canada in the Groundhog-Klappan Coalfield which, including Arctos and Groundhog, extends across the boundary between the Skeena and Omineca regions (Fig. 1; Table 9; British Columbia Geological Survey, 2015). The Government of British Columbia has extended the deferral of issuing new coal licences in the Klappan area for an additional year, ending in December 2015. Existing coal licences are not affected.

9.1. Proposed mines

Atrum Coal continued advancing the **Groundhog** ultra-high rank anthracite coal project toward an underground bulk sample. The project area is 150 km northeast of Stewart. Drilling in 2014 included 41 exploration holes and 10 hydrological monitoring holes totalling 10,084 m. Trenching, environmental baseline monitoring, and site planning have positioned the project to excavate a bulk sample in early 2015. A supplementary Pre-Feasibility Study details a 5.4 Mt/ year run-of-mine underground operation for 38 years for the Groundhog North deposit, which contains an estimated 609 Mt. The feasibility also proposes a multi-mine plan once the initial Groundhog North mine is operational. A project-wide JORC compliant Measured + Indicated + Inferred resource estimate totals 1,567 Mt. Fortune Minerals Limited completed minimal groundwork on the **Arctos** anthracite project jointly owned with POSCAN. Plans to conduct baseline work were put on hold as no new permits were issued in the Klappan Strategic Initiative Area.

Acknowledgments

This report was made possible by the cooperation of companies operating in northwestern British Columbia, and I thank mine staff, exploration geologists, and prospectors for their generous hospitality, time and resources. Special gratitude to those who provided photographs and specifics about their projects. The information in this report was summarized from news releases, quarterly reports, MD&A reports, company websites, technical reports, Geological Survey of British Columbia publications, site visits and discussions with industry professionals and personnel. Valuable assistance was provided by the Smithers Mines Office staff, JoAnne Nelson, and Adrian

Hicken (British Columbia Geological Survey). I benefitted from discussions with Regional Geologists Paul Jago, Bruce Northcote, Fiona Katay, and Jim Britton.

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