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

C. Paul Jago[1, a]

[1] Regional Geologist, British Columbia Ministry of Energy and Mines, Suite 350, 1011 Fourth Avenue, Prince George, BC, V2L 3H9
[a] corresponding author: Paul.Jago@gov.bc.ca

Recommended citation: Jago, C.P., 2016. Exploration and mining in the Omineca and Northeast regions, British Columbia. In: Provincial Overview of Exploration and Mining in British Columbia, 2015. British Columbia Ministry of Energy and Mines, British Columbia Geological Survey, Information Circular 2016-1, pp. 27-56.

1. Introduction

The Omineca (Northcentral) Region has subdued-to-mountainous physiography and varied geology reflecting a tectonic history of volcanic-arc and oceanic terrane accretion onto the western margin of ancestral North America followed by episodes of mountain-building, regional transcurrent faulting, and glaciation. The region is named after the Omineca Mountains which cover much of northcentral British Columbia, west and northwest of the town of Mackenzie (Figs. 1, 2). Rocks of the region are known to be prospective for copper, molybdenum, gold, silver, zinc, lead, nickel, niobium, rare-earth elements (REE), and anthracitic coal. Ore deposit types typically explored for in 2015 (Figs. 1, 3) included epithermal gold-silver (Stikine terrane), porphyry copper-gold ±molybdenum (Stikine and Quesnel terrane), stratiform zinc-lead-silver (ancestral North America), and anthracitic coal (post-accretionary).

Total exploration expenditure in 2015 is estimated at $39.6 million (Fig. 4), largely from mine evaluation-stage projects (Fig. 5), and is about 7% less than in 2014. Drilling, at 55,200 m, was 32% more than in 2014 (Fig. 6). In 2015,

- ramp-up activities continued at the **Mt. Milligan** mine (Thompson Creek Metals Company Inc.)
- engineering and environmental studies in support of Environmental Assessments continued at **Kemess Underground** (AuRico Metals Inc.), **Aley** (Taseko Mines Limited), **Blackwater** (New Gold Inc.), and **Giscome** (Graymont Western Canada Inc.);
- initial and updated resource estimates were provided for **Kemess East** (AuRico Metals Inc.) and **Groundhog** (Atrum Coal Groundhog Inc.);
- drilling programs were undertaken for porphyry copper-gold at **Kemess East** (AuRico Metals Inc.), **Kliyul** (Teck Resources Limited), **Col-Later** (Pacific Empire Minerals Corp.), **North Grid-Mt. Milligan** (Thompson Creek Metals Company Inc.); epithermal gold-silver at **Lawyers** (PPM Phoenix Precious Metals Corp.), **2 X Fred** (Kootenay Silver Inc., Theia Resources Ltd.), **Blackwater South** (New Gold Inc.); and sediment-hosted zinc-lead-silver at **Akie** (Canada Zinc Metals Corp.), and **Cirque** (Teck Resources Limited).

The Northeast Region comprises continental platform and slope, and foreland basin-style sedimentary geology, with a belt of thin-skinned style deformation associated with the Northern Rocky Mountains. Bituminous coal, phosphate rock and barite are the main exploration focus. Metallurgical coal has been proportionately the largest of British Columbia's mined export commodities in recent years, representing about 60% of mineral production in 2013 and 40% in 2014. Roughly 15% of the province's coal production has come from the Peace River Coalfield (Figs. 1, 7). The low-ash, low-sulphur bituminous coal mined in the northeast is internationally recognized for producing high-quality coke, a key ingredient in steel making. Nevertheless, due to pressures from international oversupply and price decreases, producers in the coalfield were idle in 2015 and exploration activity continued to decrease. Apart from coal mining operations, the region has one industrial mineral mine that produces barite. Total exploration expenditure was $31.3 million (Fig. 4), nearly all from mine evaluation-stage projects (Fig. 5), and is about 37% less than in 2014. Drilling, at 2,150 m, was 92% less than in 2014 (Fig. 6). In 2015,

- the decline at **Murray River** (HD Mining International Ltd.) was driven to 1,351 m, near the designed length for collecting a bulk coal sample;
- engineering and environmental studies in support of Environmental Assessments continued at **Murray River** (HD Mining International Ltd.) and **Sukunka** (Glencore plc);
- updated resource estimates were provided for **Sukunka** (Glencore plc) and **Wapiti East** (Fertoz International Inc.);
- exploration drilling for bituminous coal was undertaken at **Murray River** (HD Mining International Ltd.).

Ridley Terminals Inc., the main port servicing the Peace River Coalfield, reported reduced throughput for the first half of 2015. Rail unloading volumes and ship-loading volumes decreased 50% and 45% respectively.

2. Geological overview

Metallogeny in British Columbia is intimately linked to the tectonic evolution of the Canadian Cordillera, first as an accretionary orogen consisting of allochthonous terranes that

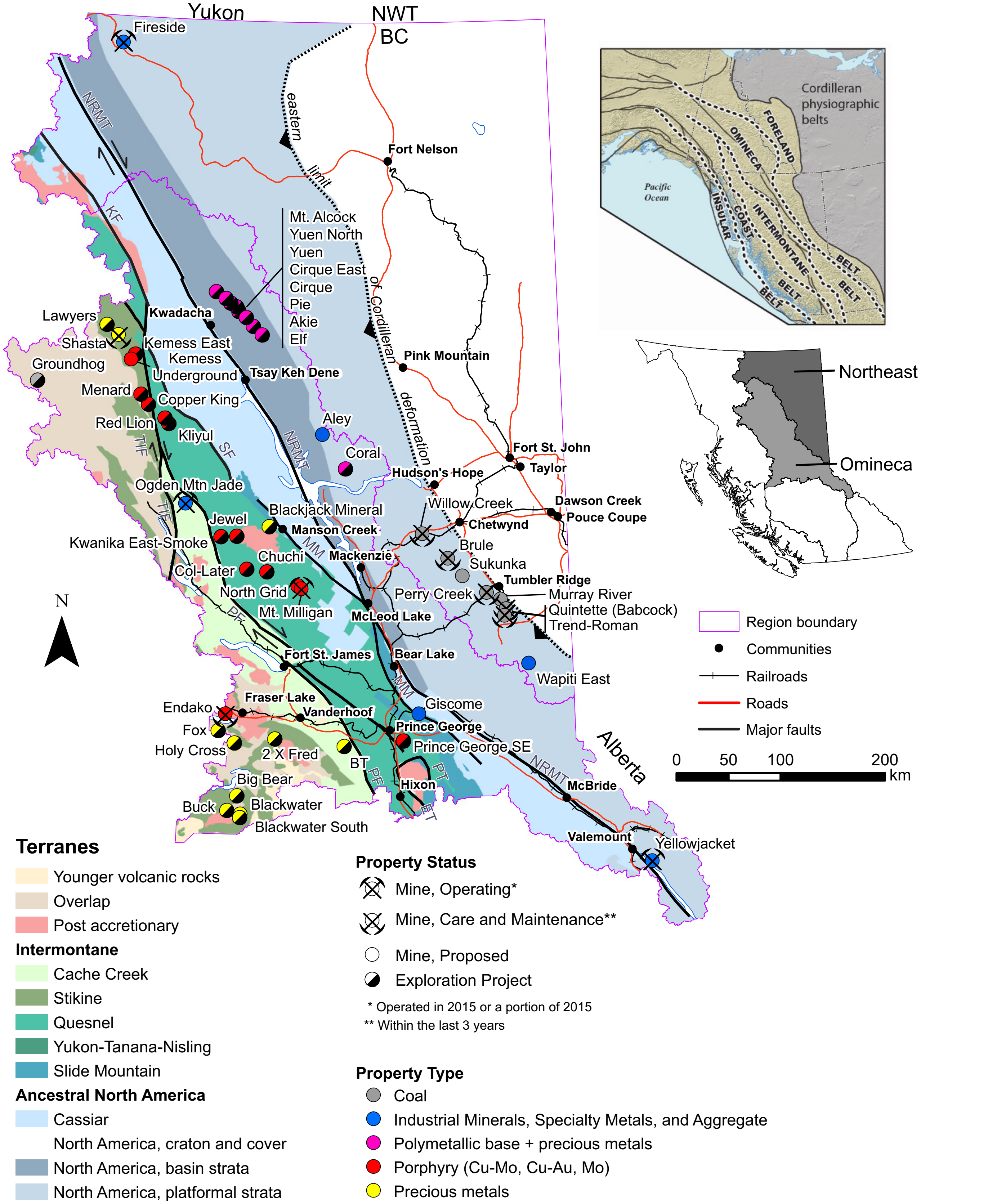

Fig. 1. Mines and selected exploration projects, Omineca and Northeast regions, 2015. Terranes from the BC digital geology map (Cui et al., 2015). Fault abbreviations: ET = Eureka thrust fault, KF = Kechika fault, MM = Manson-McLeod fault system, NRMT = Northern Rocky Mountain trench, PF = Pinchi fault, PT = Pundata thrust, SF = Swannell thrust fault, TIF = Takla-Ingenika-Finlay fault system.

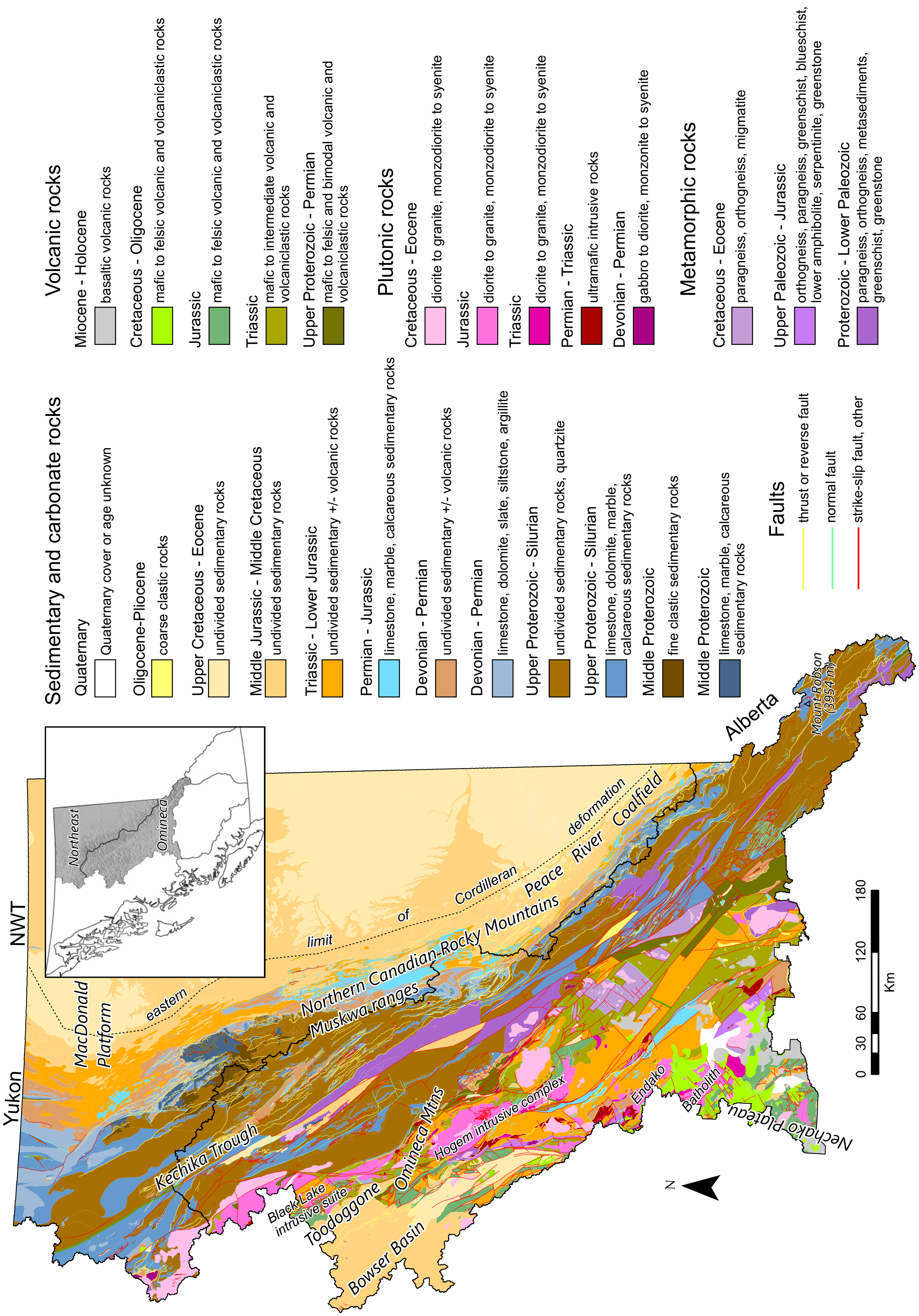

Fig. 2. Bedrock geology of the Omineca and Northeast regions. Map data was sourced in March 2015 from the BC digital geology map.

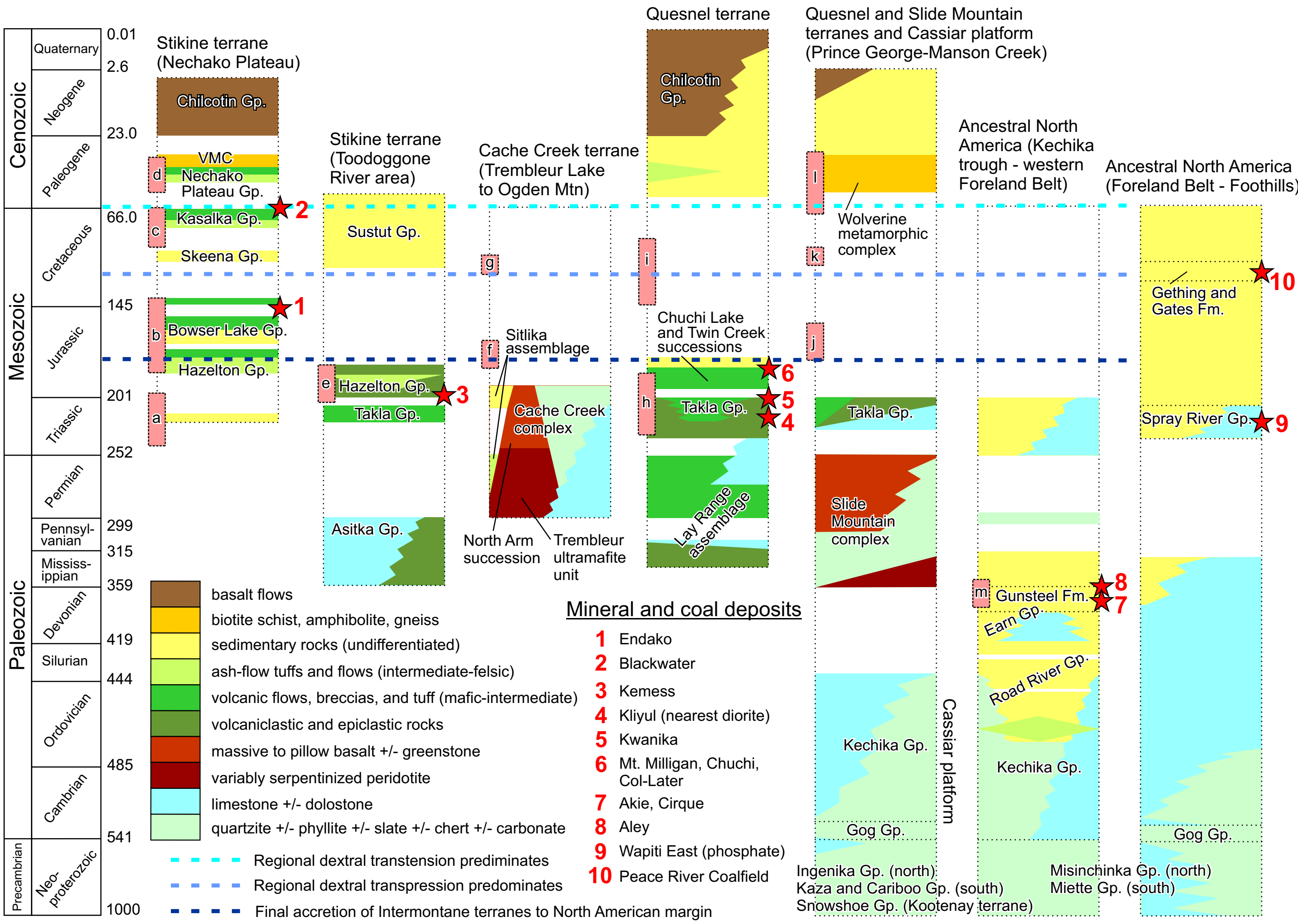

Fig. 3. Generalized stratigraphy, Omineca and Northeast regions. Selected intrusive rocks: a) Brooks diorite complex, b) Endako batholith and Laidman batholith; c) Capoose batholith and Blackwater pluton; d) Chu pluton; e) Black Lake plutonic suite; f) Spike Peak intrusive suite; g) granodioritic plutons (unnamed suite); h) Hogem plutonic suite (Triassic-Jurassic); i) Hogem plutonic suite (Cretaceous) and Germansen Batholith; j) Ste. Marie plutonic suite; k) Bayonne plutonic suite; l) Wolverine Range plutonic suite; m) Aley carbonatite complex. Unit ages from Diakow et al. (1993, 1997), Ferri (1997), Garnett (1978), Nelson and Bellefontaine (1996), MacIntyre (1998), Schiarizza and MacIntyre (1998), Stott (1984), Wetherup and Struik (1996) and the BC digital geology map. VMC is Vanderhoof metamorphic complex. Mineralization ages from Logan and Mihalynuk, (2014), McLeish (2013), Nelson and Bellefontaine (1996), New Gold Inc. (2015), Pell (1994), Schiarizza (2014). Geologic timescale from International Commission on Stratigraphy (2014).

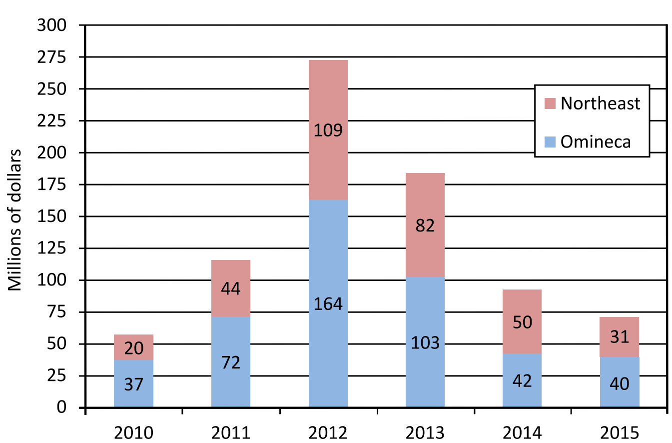

Fig. 4. Annual exploration spending estimates in millions of dollars for the Omineca and Northeast regions from 2010 to 2015. A total of $70.8 million for the combined regions in 2015 was down 23.3% from 2014.

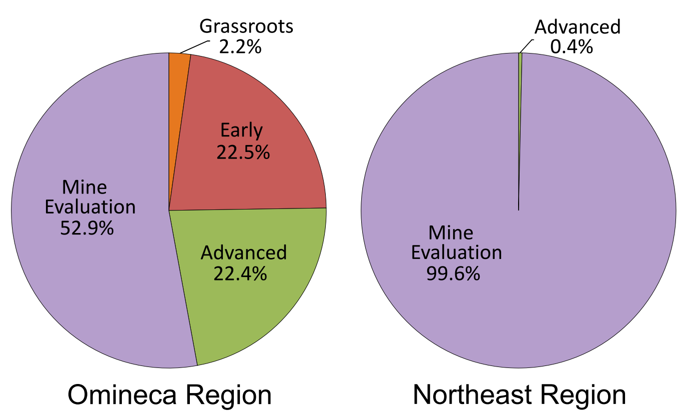

Fig. 5. Exploration expenditures in 2015 by exploration stage for the Omineca and Northeast regions.

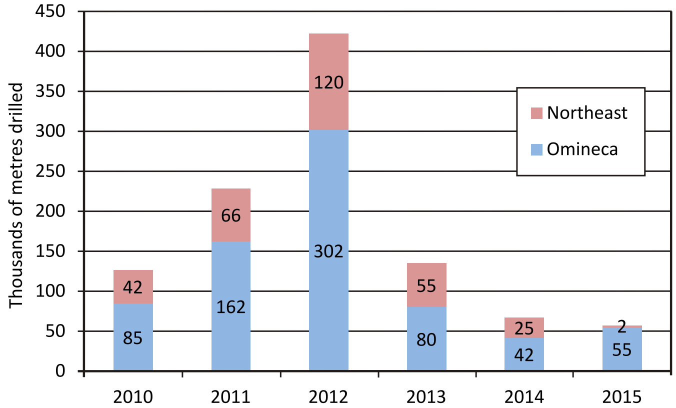

Fig. 6. Annual exploration drilling estimates in thousands of metres for the Omineca and Northeast regions from 2010 to 2015. A total of 57,350 m for the combined regions in 2015 was down 14.6% from 2014.

were welded to and deformed with the western margin of ancestral North America primarily during the Jurassic and then as the site of post-accretionary tectonism and magmatism (e.g., Nelson et al., 2013). The Omineca-Northeast combined region is underlain by:

1. Ancestral North America (Laurentia), including cratonic basement rocks and Proterozoic and Paleozoic siliciclastic and carbonate successions deposited on its western flank;
2. terranes of the Intermontane tectonic province: the Slide Mountain terrane marginal (back-arc) basin; the Quesnel and Stikine volcanic arc terranes, which formed outboard of ancestral North America starting in the Late Paleozoic and were accreted in the Middle Jurassic; and the late Paleozoic-early Mesozoic accretionary complex of the Cache Creek oceanic terrane, which intervenes between Quesnellia and Stikinia and represents their fore-arcs;
3. post-accretionary rocks; and
4. younger cover rocks (Figs. 1-3).

Two main episodes of mountain building occurred (Monger, 2008), the Columbia-Omineca-Cassiar mountains (Middle Jurassic-Early Cretaceous) and the Northern Rocky Mountains (Late Cretaceous-Paleogene). The first produced a continuous belt of metamorphic rocks in the collision zone between the Intermontane terranes and the continent margin (Fig. 2), and the second is characterized by thin-skinned style deformation of Paleozoic cover rocks (Wright et al., 1994).

2.1. Ancestral North America

In the Omineca and Northeast regions, Laurentian basement is unconformably overlain by Middle Proterozoic to Middle Paleozoic continental shelf, and deep-water marine siliciclastic and carbonate successions of the Western Canada Sedimentary Basin. These were deposited on the western margin of ancestral North America during protracted rifting and breakup of the supercontinent Rodinia (Fig. 3, see Nelson et al., 2013 for review). The oldest Middle Proterozoic rocks include dolomitic sedimentary rocks of the Muskwa basin (Middle Proterozoic, Fig. 2) which host the oldest known copper mineralization in British Columbia (MINFILE 094K 003). In the Rocky Mountains north of Prince George, rocks of the Windermere Supergroup (Upper Proterozoic) are represented by siliciclastic sedimentary units of the Misinchinka Group and their metamorphic equivalents (Ferri et al., 1994); south of Prince George, the similar Miette Group is representative. The Gog Group (Lower Cambrian) unconformably overlies the Windermere Supergroup and consists predominantly of sandstone, pebble conglomerate, quartzite and limestone. Near Valemount, the highest peak in the Canadian Rockies, Mt. Robson, comprises a succession of Middle-Upper Cambrian calcareous sedimentary and carbonate rocks. In the Rocky Mountains north of Mackenzie, Early to Middle Paleozoic sedimentation is represented mainly by phyllitic siltstone, shale and carbonate units of the Kechika Group (Cambrian-Ordovician), Road River Group (Middle Ordovician-Middle Devonian) and Earn Group (Devonian-Mississippian). This belt of Paleozoic rocks is prospective for sediment-hosted zinc-lead, Carlin-type gold deposits, carbonatite-hosted specialty metals, barite, silica (including frac sand), and quarry limestone.

The Kechika trough is the southeastern extension of the continental margin Selwyn basin of the Yukon and Northwest Territories, which hosts prolific Cambrian to Devonian sedimentary exhalatite (SEDEX) deposits (Yukon Geological Survey, 2007). The trough is in the Northern Rocky Mountain fold and thrust belt (Muskwa ranges), bounded to the west by the Northern Rocky Mountain trench and to the east by the Macdonald Platform (Figs. 1, 2). Siliceous and carbonaceous shale of the Upper Devonian Gunsteel Formation (Earn Group) hosts stratiform baritic zinc-lead 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 Muskwa ranges; 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). Regionally, it lies within a belt of alkaline igneous rocks and carbonatites that follows the Rocky Mountain Trench in British Columbia (Pell, 1994; Millonig and Groat, 2013).

About 60 km east of the Kechika trough a north-south trending regionally extensive belt in the Muskwa ranges hosts Mississippi Valley-type deposit prospects and showings in thrust-faulted dolomitic carbonate rocks (Silurian-Devonian) adjacent to the continental shelf-slope front (Nelson et al., 2002). These are regarded as being coeval with the Late Devonian SEDEX deposits farther west in the Kechika trough and are similarly associated with subduction-related extensional tectonics, back-arc and intra-arc spreading, in Devonian-Mississippian time.

Most outboard are the Cassiar platform and Kootenay parautochthonous terrane. Both originated as basement highs

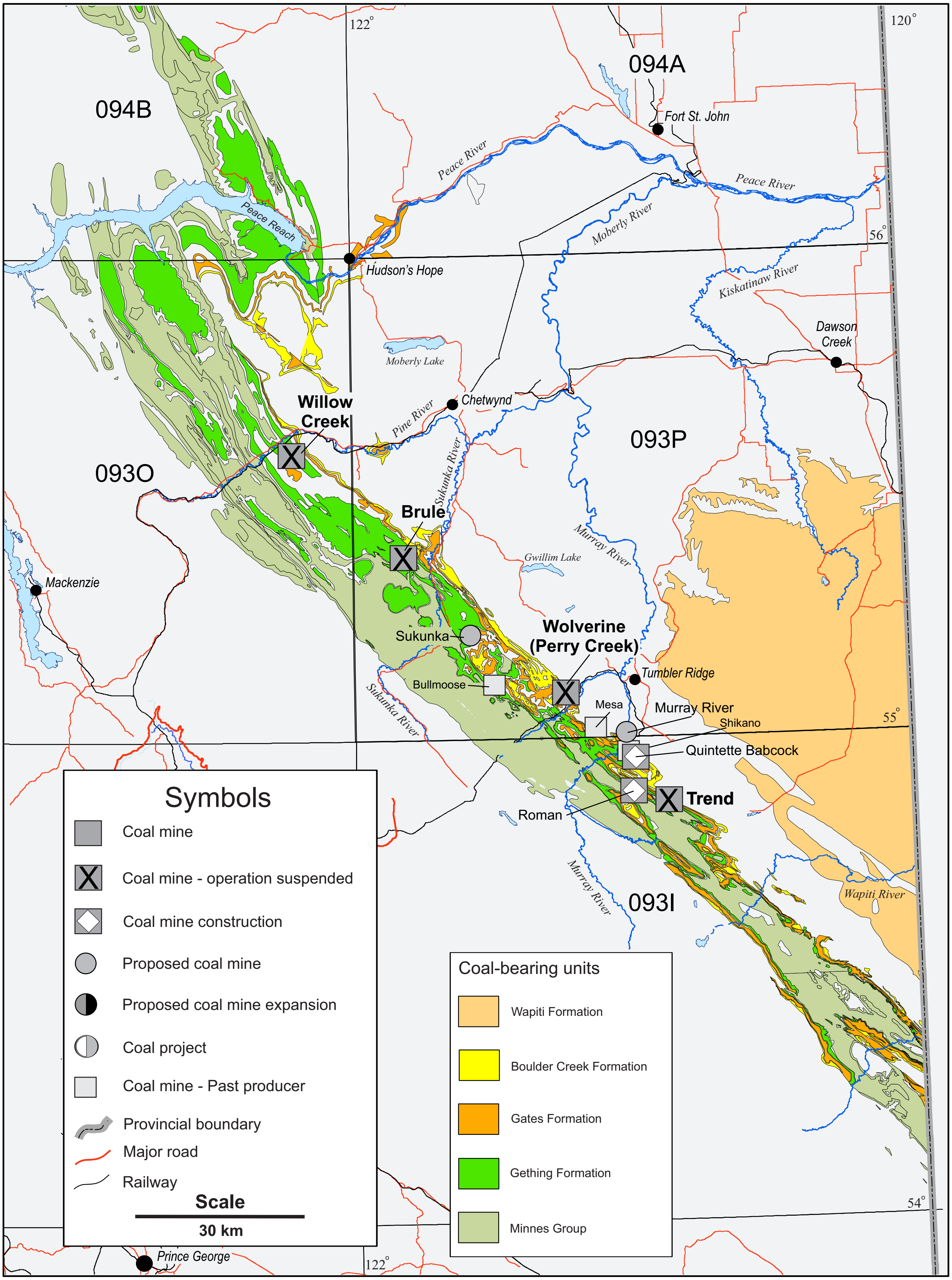

Fig. 7. Coal mines and exploration projects, northeastern British Columbia 2015. From British Columbia Geological Survey (2016).

during fragmentation of the margin as Laurentia rifted in Neoproterozoic to Cambrian time (Nelson et al., 2013). The Cassiar platform lies west of the Tintina-Northern Rocky Mountain Trench fault; restoration of approximately 490 km of Cretaceous-Eocene dextral motion (Gabrielse et al., 2006) places it outboard of the southern Kechika trough. Oldest rocks are Early-Middle Proterozoic and include orthogneiss and crystalline limestone along the Northern Rocky Mountain Trench near Kwadacha (Cassiar platform Fig. 1); and the Malton Gneiss Complex, the northernmost expression of the Monashee Mountains near Valemount (Kootenay terrane; Fig. 2; see Katay, this volume). The Cassiar platform is underlain by rocks similar to the Windermere Supergroup and Lower Paleozoic carbonate and siliciclastic units that correlate with those of the MacDonald platform of ancestral North America. North of Mackenzie, these include rocks of the Ingenika Group (Upper Proterozoic) and Kechika Group; whereas southeast of Prince George the Cariboo (Upper Proterozoic-Cambrian), Kaza (Upper Proterozoic), and Gog Group are representative (Ferri et al., 1994). Triassic limestone sequences near **Giscome** are assigned to the North American margin and are interpreted as tectonic windows through overthrust Slide Mountain Group basaltic volcanic units of Mississippian-Permian age (Struik et al., 1990). South of Prince George, metasedimentary rocks of the Snowshoe Group (Upper Proterozoic-Paleozoic) represent the northern extent of the Kootenay terrane. Cassiar platform rocks are locally prospective for quarry limestone and silica (including frac sand), whereas auriferous veins and placer gold are the main focus of Kootenay terrane. West of the Cassiar platform, Laurentian basement is inferred to underlie allochthonous rocks at depth as far west as beneath the Cache Creek terrane (Nelson et al., 2013).

2.2. Intermontane tectonic province

2.2.1. Slide Mountain terrane

In Devonian-Mississippian time, eastward subduction of oceanic crust beneath ancestral North America led to back-arc extension and opening of the Slide Mountain ocean (Ferri, 1997). Its crust is preserved as allochthons structurally overlying the deformed continental margin.

2.2.2. 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 over 600 km in the Omineca Region. The Mesozoic Quesnel arc developed in two phases above an Upper Paleozoic volcanic-sedimentary subterrane assemblage (Ferri et al., 1994; Nelson and Bellefontaine, 1996). The Takla Group (Upper Triassic) phase comprises basinal sedimentary rocks that are overlain by mafic and intermediate island-arc volcanic successions. These rocks are locally and paraconformably 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. Suites within both volcanic phases are considered to have mildly alkaline (or shoshonitic) geochemistry (Barrie, 1993). Coeval with the Takla Group and Early Jurassic successions, the regional (roughly 180 km long; Fig. 2) Hogem intrusive complex and its peripheral offshoots locally host porphyry copper-gold ±silver ±molybdenum deposits and prospects including **Kwanika**, **Mt. Milligan**, **Chuchi**, **Col-Later** and **Kliyul**. Petrogenesis of the Hogem intrusive suite was from more mafic peripheral to more felsic central phases generally, and from more weakly alkaline to sub-alkaline compositions from the Late Triassic to Early Cretaceous; with the exception of an Early Jurassic strongly alkaline phase that includes the Chuchi syenite and Duckling Creek syenite complex, known for being copper-gold prospective (Garnet, 1978; Bath et al., 2014; Devine et al., 2014). Terrane bounding faults include northwest-trending thrust and strike-slip faults -- Swannell fault, Manson-McLeod fault system, and Eureka and Pundata thrusts -- on its eastern side; and the regional Pinchi and Ingenika strike-slip faults on the western side (Fig. 1).

2.2.3. Stikine terrane

The Stikine terrane shares ancestry with the Quesnel terrane (Logan and Mihalynuk, 2014). Both are thought to have been part of a larger arc complex lying offshore of ancestral North America in Late Permian to Early Jurassic 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, including the Toodoggone River (northwest) and Nechako Plateau (southwest) areas (Fig. 2).

In the Toodoggone River 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; also referred to as Stuhini Group). Hazelton Group subaerial intermediate to felsic volcanic rocks (Toodoggone Formation; Lower Jurassic) unconformably overlie the Takla Group. Coeval with Hazelton Group, quartz monzonitic to granodioritic rocks of the Black Lake intrusive suite (Fig. 2) form a roughly 60-km long, north-northwest trending pluton that locally hosts porphyry-style mineralization. Intrusive rocks follow the margins of an elongate structural depression that was filled by 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 monoclinal blocks. Porphyry copper-gold-silver-molybdenum deposits such as **Kemess Underground** and **Kemess East** are located in the southern portion of the area; whereas epithermal gold-silver deposits of mainly low-sulfidation type, such as **Lawyers**, and lesser high-sulphidation type occur in the central and northern parts. The Finlay-Ingenika fault system bounds the Toodoggone River area on the east (Fig. 1).

2.2.4. Cache Creek terrane

The Cache Creek terrane is an oceanic fore-arc assemblage that formed outboard of the combined Stikine-Quesnel arc terranes. It contains blueschist belts, remnants of oceanic primitive arcs, and structural blocks of ocean island crust with exotic fossils of Tethyan (Asian) affinity (Schiarizza and MacIntyre, 1998; Nelson et al., 2013). From the Trembleur Lake area north to Ogden Mountain, the terrane consists of the Sitlika assemblage (Permian-Early Jurassic) and the Cache Creek complex (Late Pennsylvanian-Late Jurassic). In the Sitlika assemblage, a lower unit of bimodal metavolcanic rock is overlain to the east by a siliciclastic unit. These rocks are considered to be part of a primitive oceanic arc complex, the Sitlika-Kutcho-Venables arc (Logan and Mikalynuk, 2014). The Cache Creek complex includes an ophiolite sequence of variably serpentinized peridotite (Trembleur ultramafic unit), host rock of the Decar nickel-iron alloy deposit (see Jago, 2015), 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 Takla Fault bounds the Cache Creek terrane on the west.

2.3. Post-accretionary rocks (Middle Jurassic to Paleogene)

2.3.1. Bowser Basin and Sustut Group

The Omineca Region captures the eastern part of the Bowser Basin, which is more extensive in the Skeena Region. West of the Toodoggone River area, sedimentary rocks of the Bowser Lake Group (Middle Jurassic to Lower Cretaceous) formed in a foreland basin west of the uplifted Cache Creek terrane and Omineca mountains (Evenchick et al., 2007). Basin stratigraphy transitions upward from marine shale through increasingly non-marine conglomeritic clastic formations. The Groundhog Coalfield and **Groundhog** anthracite deposit is hosted in a deltaic sequence of alternating marine and non-marine sedimentary rocks. Non-marine sedimentary rocks of the Sustut Group (Lower to Upper Cretaceous), also derived from the Omineca highland (Diakow et al., 1993), extend for over 100 km along the western margin of the Toodoggone River area and southward, overlapping Upper Paleozoic-Lower Jurassic volcanic and sedimentary units.

2.3.2. Francois Lake plutonic suite

In the Nechako Plateau area, felsic and mafic Hazelton Group island-arc volcanic and volcanogenic sedimentary rocks predominate (Diakow et al., 1997; Angen et al., 2015) and are intruded by syn-accretionary Late Jurassic monzogranitic rocks of the Endako and Laidman batholiths. The Endako Batholith (Figs. 2, 3) is a composite intrusive complex (gabbro to monzongranite) that extends along a northwest trend at the northern end of the Nechako Plateau for roughly 90 km within both the Omineca and Skeena regions; and west of Fort St James, a 60 km long northwest trending body of quartz diorite (Middle Jurassic) is also assigned to it (Fig. 2). The batholith has a protracted history of emplacement (Late Triassic-Early Cretaceous) evolving from more mafic to felsic intrusions from margin to core (Villeneuve et al., 2001). The Endako subsuite (Late Jurassic) of the Francois Lake plutonic suite hosts the **Endako** low-fluorine porphyry molybdenum deposit (Pond, 2013; Devine et al., 2015).

2.3.3. Late Cretaceous and Eocene intrusions

In the Nechako Plateau area, Hazelton Group rocks are locally overlain by sedimentary and bimodal volcanic rocks of the Bowser Lake Group. Similar to the Sustut Group, coarse clastic sedimentary units of the Skeena Group (Lower-Middle Cretaceous) are exposed locally, but are more widespread in Skeena Region (Alldrick and Lin, 2008). By Late Cretaceous time, regional transpression 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 Blackwater Pluton, the latter being spatially related to the **Blackwater** deposit (Christie et al., 2014; Looby, 2015). Episodic volcanism continued with eruption of the intermediate calc-alkaline Kasalka Group rocks (Late Cretaceous), which host the Blackwater deposit; and Eocene rocks of the Nechako Plateau Group, including: the Ootsa Lake Formation (felsic volcanic, also known as the Ootsa Lake Group) and Endako Formation (mafic-intermediate volcanic, also known as the Endako Group). Eocene volcanism was concurrent with regional extension and horst-and-graben faulting, and exhumation of the Vanderhoof metamorphic complex (Wetherup and Struik, 1996). 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.

2.3.4. Regional post-accretionary faults

Regional dextral strike-slip faults offset older terrane boundaries as a component of overall transpression from the Middle Cretaceous to Paleogene, and then as a component of transtension in the Paleogene (Nelson et al., 2013; Fig. 3). In the Quesnel terrane, anastomosing fault strands, 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 Neogene sedimentary and minor volcanic rocks, and local coal beds (Nelson and Bellefontaine, 1996). The moderate tilt and faulting of the **Mt. Milligan** deposit may be in part 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, comprises schistose to gneissic amphibolite-grade Laurentian Neoproterozoic basement rocks that were rapidly exhumed in the Paleogene (Ferri et al., 1994; Staples, 2007).

2.3.5. Peace River Coalfield

In northeastern British Columbia, the Peace River Coalfield extends roughly 400 km along the Northern Rocky Mountain inner foothills, from the Alberta border to the Pink Mountain area (Figs. 1, 7). Coal seams of economic thickness and continuity are predominantly medium-volatile bituminous rank and hosted in the Gething and Gates formations (Lower Cretaceous) of the Bullhead and Fort St. John groups of the Western Canada Sedimentary Basin (Fig. 3; Cunningham and Sprecher, 1992, Smith et al., 1994). Coal-bearing cyclothems were deposited in deltaic and lagoonal settings along the western edge of the basin during marine transgressions and regressions (Stott, 1984; Grieve, 1995). These rocks were shortened during the Laramide Orogeny (Late Cretaceous-Paleogene), lying east of an eastwardly-prograding clastic wedge. 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. Product coals from both the Gething and Gates formations are generally low in ash and sulphur (Grieve, 1995). In 2012, the Government of British Columbia estimated 4,900 Mt of potentially mineable resources in the Peace River Coalfield.

East and north of the coalfield, marine and non-marine fine clastic sedimentary rocks (Cretaceous) of the Western Canada Sedimentary Basin comprise much of the shallow bedrock geology.

2.4. 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 within paleotopographic lows (Mihalynuk, 2007) and remnant olivine basalt volcanic centres and necks form local topographic highs (Resnick et al., 1999). Quaternary glacial till, glaciofluvial and glaciolacustrine deposits are extensive in the southern part of the Omineca Region where outcrop is sparse (Quesnel Trough and Nechako Plateau), and more topographically confined to the north within the Omineca mountains. More recent colluvial and alluvial deposits have formed along rivers and streams, and organic deposits occur in poorly drained depressions (Blais-Stevens and Clague, 2007).

3. Mines and quarries

The combined Omineca-Northeast region has three metal mines, five coal mines, and three industrial mineral mines including nephrite jade and dimension stone quarries. Due to challenges associated with falling commodities prices, two metal mines and all five coal mines have been placed on care and maintenance since 2013.

3.1. Metal mines

In 2015 there was one operating open pit mine (**Mt. Milligan**), one open pit mine that went from temporary suspension to care and maintenance (**Endako**), and one seasonal underground mine (**Shasta**) that remained on care and maintenance since 2013. All three are in the Omineca Region.

3.1.1. Endako

The Endako molybdenum mine (Fig. 1, Table 1; Thompson Creek Metals Company Inc., operator and 75% owner; Sojitz Moly Resources, Inc., 25% owner) is one of many porphyry deposits distributed along the length of Stikinia (Logan,

Table 1. Metal mines, Omineca and Northeast regions.

Mine	Operator	Commodity; deposit type; MINFILE	Forecast 2015 Production (based on Q1-Q3)	Reserves (Proven + Probable)	Resource (Measured and Indicated)	Comments
Endako	Thompson Creek Metals Company Inc.	Mo; Porphyry Mo (Low F-type); 093K 006	n/a	33.4 Mt at 0.049% Mo; containing 16,239 tonnes (35.8 Mlbs) Mo	109.2 Mt at 0.047% Mo (additional to reserves)	Placed on care and maintenance in July
Mt. Milligan	Thompson Creek Metals Company Inc.	Cu, Au, Ag; Alkalic porphyry Cu-Au; 093N 194	32,124 t (70.8 Mlbs) copper; 6771 kg (217,700 oz) gold	542.1 Mt at 0.201% Cu and 0.355 g/t Au; containing 1.092 Mt (2407.4 Mlbs) Cu and 192.8 t (6.20 Moz) Au	122.3 Mt at 0.15% Cu and 0.321 g/t Au (additional to reserves)	Ramp-up continued, engineering studies for permanent secondary crushing circuit, second SAG mill discharge screen deck installed, Q1-Q3 reported capex was $43.7 million
Shasta	Sable Resources Ltd.	Au, Ag; Epithermal Au-Ag-Cu (low sulphidation); 094E 050	n/a	n/a	n/a	Remained on care and maintenance in 2015, operations ceased in September 2012

2013; Logan and Mihalynuk, 2014). The orebody is hosted by the Endako quartz monzonite (Figs. 2, 3; Late Jurassic) and consists of early thin vein stockworks associated with K-feldspar alteration and later subparallel or en-echelon ribbon-textured quartz-molybdenite-pyrite veins associated with sericite alteration (Pond, 2013; Devine et al., 2015). Open-pits extend across four structural blocks separated by southwest-trending faults that appear to be offset as a series of Tertiary listric normal faults (Lowe, 2001). Due to adverse conditions in the molybdenum market, operations at the Endako mine were temporarily suspended at the end of 2014, and a decision followed to put the mine on care and maintenance at the start of July.

3.1.2. Mt. Milligan

The Mt. Milligan mine (Fig. 1, Table 1; Thompson Creek Metals Company Inc.) is a near-surface, silica-saturated alkalic copper-gold porphyry deposit in central Quesnellia (Lang et al., 1994; Logan, 2013; Logan and Mihalynuk, 2014). It is hosted by mafic-intermediate volcanic and volcaniclastic rocks of the Takla Group (Witch Lake succession) and by Early Jurassic monzonite stocks that are coeval with volcanic rocks of the Chuchi Lake succession (Fig. 3; Mortensen et al., 1995; Nelson and Bellefontaine, 1996). The deposit is a moderately dipping, tabular, approximately 2.5 x 1.5 km body that extends to a depth of 400 m (Clifford and Berthelesen, 2015). Copper-gold mineralization with accessory silver occurs as sulphide disseminations, fracture fills, and lesser veinlets in the monzonitic stocks, their brecciated margins, and hornfelsed and altered volcanic rocks. A core zone of magnetite-rich potassic alteration and copper-gold bearing sulphide mineralization (MBX sub-zone; Fig. 8) transitions southeastwardly to gold-predominant mineralization and carbonate-rich phyllic alteration in a peripheral zone (66 sub-zone) suggestive of an alkalic lithocap structural root (Holliday and Cooke, 2007). An oxidized zone with weak supergene enrichment contains native copper and extends to depths of about 70 m along faults, mainly on the northern margin of the MBX stock.

Commissioned in October 2013, the mine saw its second full-year of operations in 2015 (Fig. 9). Continuing ramp-up activities involved several scheduled and unscheduled mechanical issues and mill shutdowns, working towards a target processing rate of 60,000 t per day by year end. A second SAG mill discharge screen deck was installed to improve throughput, and a temporary secondary crusher is in use while detailed engineering work continues for a permanent circuit. By mid-October, nine shipments of approximately 12,500 dry tonnes of copper-gold concentrate had been made; with 150,000 dry tonnes expected to be shipped by year end. By the end of November, average daily mill throughput reached 59,066 tonnes. An updated NI 43-101 technical report was released in January, updating the resource block model and final pit definition, and extending the mine life to 23.9 years as of the start of 2015 (Clifford and Berthelesen, 2015). Further refinements to the resource and ore recovery models continued throughout the year. Over 300 people are employed by the mine.

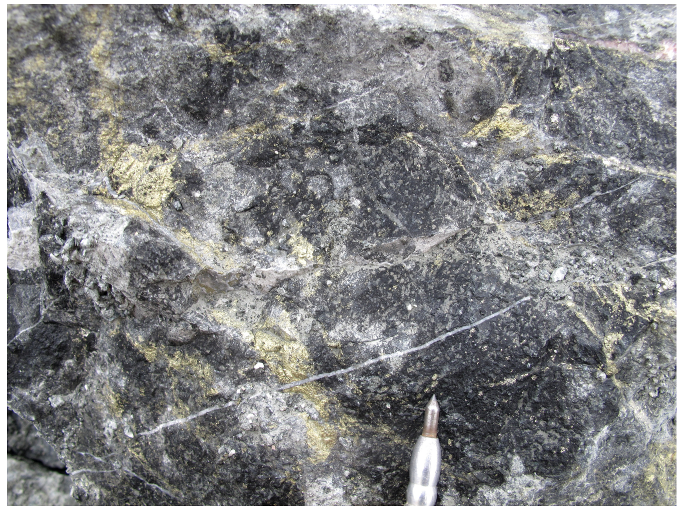

Fig. 8. Biotite hornfelsed, chalcopyrite-pyrite mineralized andesite-monzonite hybrid unit mined from the 995 bench at Mt. Milligan mine.

Fig. 9. Blast-hole drilling on the 1010 bench and shoveling on the 1085 bench at Mt. Milligan mine.

3.1.3. Shasta

The seasonal Shasta gold-silver mine (Fig. 1, Table 1) of Sable Resources Ltd. is underlain by Toodoggone Formation volcaniclastic rocks and is spatially associated with a dacitic dome. Structurally-controlled low sulphidation-type epithermal gold-silver mineralization is hosted in quartz-carbonate stockwork veins and breccia zones. The mine and mill remained on care and maintenance in 2015; operations ceased in September 2012.

3.2. Coal mines

Coal mining operations in the Peace River Coalfield of Northeast British Columbia were suspended and placed on care and maintenance in 2014 due to adverse market conditions. For the Western Coal Corp. operations, wholly owned by Walter Energy, Inc., the **Perry Creek (Wolverine)** mine remained idle while mined inventory from **Brule** was transported to **Willow Creek** for processing and rail load-out. Processing was completed in May and the plant at Willow Creek was idled in June. At **Trend** and the fully-permitted **Roman Mountain** expansion of Peace River Coal Inc., wholly owned by Anglo American plc, the transport and rail load-out of coal stockpile ceased in late January. The fully-permitted **Quintette (Babcock)** mine of Teck Coal Limited remained idle. The Trend and Perry Creek mines produced mainly hard coking coal (HCC), whereas the Brule mine produced only pulverized coal injection (PCI) coal, a high-rank thermal coal used to sustain blast furnace temperatures in steelmaking.

3.2.1. Brule and Willow Creek

When in operation, Walter Energy's **Brule** mine (Figs. 1, 7, Table 2) mine produces PCI coal from three seams in the lower part of the Gething Formation with average cumulative thickness of about 12 m. The mine lies within a northwest-trending anticline-syncline fold couplet within a larger structural block bound by northeast-verging thrust faults. Run-of-mine coal is trucked 60 km on a connector road to the processing plant and rail load-out facility at the **Willow Creek** mine (Figs. 1, 7, Table 2) where only one of the mined seams requires beneficiation and the others are crushed and direct-shipped. In recent years, targeted annual production was about 2 Mt of saleable coal. Both mines form part of Walter Energy's Brazion Group of properties. The **Willow Creek** mine was placed on care and maintenance in 2013.

3.2.2. Perry Creek (Wolverine)

At Walter Energy's **Perry Creek** mine (Wolverine Project; Figs. 1, 7, Table 2) medium-volatile bituminous HCC has been mined from seams in the Gates Formation within the Perry Creek syncline. The median cumulative thickness of the mineable seams is about 15 m. Before idling production in 2014, mining was forecast to continue another four years approximately and then switch over to the EB expansion project with no overlap in operations. Targeted annual production had been about 1.9 Mt of saleable coal.

3.2.3. Trend

At Anglo American-Peace River Coal's **Trend** mine (Table 2) HCC of medium-volatile bituminous rank has been mined from seams in the Gates Formation along the steeply dipping northeast limb of the Waterfall anticline. Cumulative thickness of Gates Formation seams is about 18 m, whereas seams in the Gething Formation, which can be blended with Gates Formation coals, have a cumulative thickness of 7.5 m. The **Roman Mountain** expansion (Fig. 7, Table 2) lies 1.5 km to the southwest in the Murray syncline and would comprise 5 km of linear open-cuts in 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). The combined Trend-Roman operation (Fig. 1) was planned to have a production rate of 2.5 Mt saleable coal per year and extend the Trend mine life by 16 years.

3.2.4. Quintette (Babcock)

The proposed **Quintette (Babcock)** mine (Figs, 1, 7, Table 2) of Teck Coal Limited would reopen the Windy (Big and Little Windy) and Window pits on the northern side of Mt. Babcock. Mt. Babcock is a box fold anticline with a coal sequence similar to that at the Trend mine. The historic Quintette mine operated from 1982-2000 with development in 1998 of the open-cuts on Mt. Babcock. For the next phase of mining, fully permitted in 2014, production averaging 3.5 Mt of saleable coal per year over a 12 year mine life was planned but the project is currently on hold due to low metallurgical coal prices.

3.3. Industrial mineral mines and quarries

In 2015 there was one operating industrial mineral mine in the Northeast Region, the **Fireside** barite mine. In the Omineca Region, nephrite jade was mined at **Ogden Mountain** and riprap material was quarried at **Yellowjacket**.

3.3.1. Barite

At **Fireside** (Fig. 1, Table 3), Fireside Minerals Ltd. mines coarse white barite veins hosted in Kechika Group sedimentary rocks. The north and east-northeast trending, steeply dipping veins are spatially related to Paleozoic(?) gabbro dikes (Wojdak, 2008). Production in 2015 was 32,000 tonnes milled and bagged from 65,000 mined tonnes of barite. The Bear Pit has been mined out and pre-stripping of overburden at the Moose Pit was underway in preparation for the 2016 mining season (Fig. 10). Barite is crushed, milled and bagged on site, and then trucked to a drilling mud supplier in Fort St. John where it is sold as a heavy drilling fluid additive.

3.3.2. Nephrite jade

Jade is a commercial term for jadeite and nephrite. In British Columbia jade occurs as nephrite. Nephrite is a metamorphic rock derived from an ultramafic protolith that has undergone dynamothermal metamorphism and metasomatism near a subduction zone. The **Ogden Mountain** property (Fig. 1, Table 3) of Green Mountain Gemstones Inc. is underlain by metamorphosed, thrust-faulted, and well-foliated ultramafic rocks, including serpentinite mélange and schist, of the Cache

Table 2. Coal mines, Omineca and Northeast regions.

Mine	Operator	Commodity; deposit type; MINFILE	Forecast 2015 Production (based on Q1-Q3)	Reserves (Proven + Probable)	Resource (Measured and Indicated)	Comments
Willow Creek	Walter Energy, Inc. (Western Coal Corp.)	HCC, PCI; Bituminous coal; 093O 008	n/a	16.6 Mt saleable	n/a	Placed on care and maintenance in 2013
Brule	Walter Energy, Inc. (Western Coal Corp.)	PCI; Bituminous coal; 093P 007	n/a	16.6 Mt saleable; Proven	n/a	Placed on care and maintenance in 2014, mined inventory processed to May 2015
Perry Creek (Wolverine)	Walter Energy, Inc. (Western Coal Corp.)	HCC; Bituminous coal; 093P 025	n/a	8.8 Mt saleable; Proven	n/a	Placed on care and maintenance in 2014
Trend	Anglo American plc (Peace River Coal Inc.)	HCC; Bituminous coal; 093I 030	n/a	8.3 Mt saleable	26.5 Mt mineable in situ (additional to reserves)	Placed on care and maintenance in 2014, 50,000 t mined inventory shipped in January 2015
Roman Mountain	Anglo American plc (Peace River Coal Inc.)	HCC; Bituminous coal; 093I 030	n/a	25.8 Mt saleable	4.3 Mt mineable in situ (additional to reserves)	Placed on care and maintenance in 2014
Quintette (Babcock)	Teck Coal Limited	HCC, TC; Bituminous coal; 093I 011	n/a	39.1 Mt saleable	124.4 Mt mineable in situ (additional to reserves)	Placed on care and maintenance in 2014

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

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

Mine	Operator	Commodity; deposit type; MINFILE	Forecast 2015 Production (based on Q1-Q3)	Reserves (Proven + Probable)	Resource (Measured and Indicated)	Comments
Fireside	Fireside Minerals Ltd.	Barite; Vein barite; 094M 003	32,000 t	485,000 tonnes (non NI 43-101 compliant)	n/a	Bear Pit has been mined out, pre-stripping overburden at Moose Pit
Ogden Mountain	Green Mountain Gemstones Inc.	Nephrite jade; Jade; 093N 156, 093N 165	n/a	n/a	n/a	Exploration and placer mining of alluvial jade boulders, excavation of in situ jade
Yellowjacket	Private individual	Construction stone	3,000 t	n/a	n/a	Mined rock for riprap material

Creek complex. These rocks are locally intercalated with massive white calc-silicate rock, historically called rodingite, considered to be a metasomatic replacement of mafic intrusive rocks (Simandl et al., 2000; Zharikov, 2007). Near the rodingite, altered ultramafic rock appears to grade from serpentinite to nephrite to soapstone (talc schist), with some variations. The nephrite forms lenses that pinch and swell along the regional fabric. In 2015 the company resumed exploration and placer mining of alluvial nephrite boulders, and excavation of in situ nephrite.

3.3.3. Dimension stone

Near Valemount, mining of Windermere Supergroup metamorphic and sedimentary rocks for construction stone

Fig. 10. Barite ore at Fireside mine.

continued at the **Yellowjacket** project (Fig. 1, Table 3). Production was 3,000 tonnes of riprap material.

4. Mine development

Mine Development starts when the project proponent has all key government approvals for constructing and operating a mine and has begun onsite construction activities. There was no mine development in the Omineca and Northeast regions in 2015.

5. Proposed mines

The proposed mine (or mine evaluation) stage, is concerned with the environmental, social, engineering and financial evaluation of a proposed mine. It includes application for an Environmental Assessment certificate and/or a Section 10 permit which states that a project is reviewable by the Environmental Assessment Office; or the direct submission of a Mines Act permit application for smaller scale projects not meeting the threshold criteria for review by the EAO.

The combined Omineca-Northeast region has seven projects at various stages and activity in the pre-application phase of Environmental Assessment, including **Aley**, **Blackwater**, and **KUG**. Two projects, **Giscome** and **Sukunka**, have submitted applications that are currently under review; one project, **Murray River**, was issued an Environmental Assessment certificate in 2015 following review that began in December 2014; and one project below the EAO threshold criteria, **Wapiti East**, has submitted a Mines Act permit application.

5.1. Proposed metal mines

Work was carried out on three proposed metal mines in 2015; the **Blackwater**, **Kemess Underground (KUG)** and **Aley** projects. All three projects are within the Omineca Region.

5.1.1. Blackwater

The **Blackwater** deposit (Figs. 1, 3; Table 4; New Gold Inc.) is interpreted as an intermediate sulphidation epithermal gold-silver system hosted by Kasalka Group volcanic rocks (Late Cretaceous; Christie et al., 2014; Looby, 2015). The volcanic section includes andesite flows, latitic lapilli tuffs and volcanic breccias, flow-banded and tuffaceous rhyodacites, heterolithic breccia containing altered fragments of other units, and silicified hydrothermal breccias. Bowser Lake Group sedimentary rocks underlie the volcanic sequence at depth. Alteration and mineralization associated with the deposit define a 1,300 x 950 m west-striking, shallowly north-northwest plunging feature that is bounded by east-northeast trending normal faults. A fragmental zone with an average vertical extent of 350 m tapers downward to 600 m vertical extent in a low-grade core. It contains pervasive muscovite-illite ±silica, smectite, biotite, and chlorite alteration accompanied by disseminated, replacement and veinlet-hosted pyrite-sphalerite-marcasite-pyrrhotite ±chalcopyrite, galena, and arsenopyrite. Native gold and electrum as micron-scale grains (ranging from about 30 µm up to 200 µm) are spatially associated with sulphide and silicification; and timing of main stage gold mineralization is interpreted to be earliest Paleogene (Looby, 2015). Steep, north-plunging higher-grade ore shoots are thought to be influenced by subvertical fault intersections. Highest grades returned in drilling (up to 47.49 g/t Au over 15 m) are along the margins of silicified breccia bodies. Local Mn-rich spessartine garnet, an important indicator mineral, occurs with pyrrhotite-bearing potassic alteration in the western part of the deposit, and may be related to a separate Late Cretaceous barren hydrothermal system. Illite and rare buddingtonite alteration suggests a late volatile phase common to shallow hydrothermal systems (Krohn et al., 1993).

New Gold Inc. continued engineering and environmental studies, including a tailings alternatives assessment, in support of their Environmental Assessment which remained in the screening stage at the end of the pre-application phase throughout the year. A 2014 feasibility study describes an open-pit mining operation with 60,000 t per day processing plant and a mine life of 17 years. Life-of-mine average annual production would be 12,846 kg (413,000 ounces) of gold and 54,182 kg (1.74 million ounces) of silver. Total metal production would be 217,724 kg (7.0 million ounces) of gold and 920,663 kg (29.6 million ounces) of silver. The proposed mine would create 1,200-1,500 jobs during construction, and a permanent workforce of over 500 employees.

5.1.2. Kemess Underground (KUG)

The **Kemess Underground** deposit (Figs. 1, 3; Table 4; AuRico Metals Inc.) is centered on the Kemess North pluton (earliest Jurassic), a quartz monzodiorite of the Black Lake intrusive suite that follows a south-dipping reverse 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 (Witte et al., 2013). An 80 m thick sulphate leach zone of clay-rich broken rock overlies the deposit. Subjacent phyllic alteration with pyrite-anhydrite/

Table 4. Selected proposed mines, Omineca and Northeast regions.

Project	Operator	Commodity; deposit type; MINFILE	Reserves (Proven + Probable)	Resource (Measured and Indicated)	Work Program	Comments
Blackwater	New Gold Inc.	Au, Ag; Epithermal Au-Ag-Cu (intermediate sulphidation); 093F 037	344.4 Mt at 0.74 g/t Au, 5.5 g/t Ag; containing 254,115 kg (8.17 Moz) Au, 1,891 tonnes (60.8 Moz) Ag	396.9 Mt at 0.74 g/t Au, 5.5 g/t Ag; containing 295,483 kg (9.50 Moz) Au, 2,181 tonnes (70.13 Moz) Ag (including reserves)	Environmental Assessment (pre-ap.), engineering studies, environmental studies	Proposed open-pit mine with 60,000 t/d processing. Life-of-mine average annual production would be 12,846 kg (413 Koz) Au and 54,182 kg (1.74 Moz) Ag. Mine life of 17 years
Kemess Underground (KUG)	AuRico Metals Inc.	Cu, Au, Ag, Mo; Porphyry Cu±Mo±Au; 094E 094	100.4 Mt at 0.28% Cu, 0.56 g/t Au, 2.0 g/t Ag; containing 280,842 tonnes (619.2 Mlbs) Cu, 56,142 kg (1.8 Moz) Au, 205,532 kg (6.6 Moz) Ag	65.4 Mt at 0.24% Cu, 0.41 g/t Au, 1.8 g/t Ag; containing 157,191 tonnes (346.5 Mlbs) Cu, 26,562 kg (854 Koz) Au, 118,535 kg (3.8 Moz) Ag (additional to reserves)	Environmental Assessment (pre-ap.), updated feasibility study, geotechnical drilling, test pitting	Proposed underground block cave mine with 24,600 t/d processing. Average annual production would be 3,266 kg (105 Koz) Au and 19,958 tonnes (44 Mlbs) Cu. Mine life of 12 years
Aley	Taseko Mines Limited	Nb; Carbonatite-hosted deposit; 094B 027	83.8 Mt at 0.50% Nb_2O_5; containing 292.9 Mkg* Nb *calculated by author	258.8 Mt at 0.37% Nb_2O_5; containing 669.4 Mkg* Nb (including reserves) *calculated by author	Environmental Assessment (pre-ap.), engineering studies, metallurgical testing, environmental data	Proposed open-pit mine with 10,000 t/d processing. Average annual production would be 9,000 tonnes niobium. Mine Life of 24 years
Murray River	HD Mining Int'l Ltd.	HCC; Bituminous coal; 093I 010	261.6 Mt mineable; proven	314.2 Mt in situ	Environmental Assessment (issued in October), driving decline, drilling (exploration, hydrogeological), bulk sample	Proposed underground longwall mining operation. Average annual production would be 4.8 Mt saleable coal. Mine life of 25 years.
Sukunka	Glencore plc	HCC; Bituminous coal; 093P 014	n/a	145 Mt in situ	Environmental Assessment (under review), updated resource and geologic model, engineering and environmental studies	Proposed open-pit mine. Initial annual production would be 1.5-2.5 Mt saleable coal. Mine life of >20 years
Giscome	Graymont Western Canada Inc.	$CaCO_3$; Limestone; 093J 041, 093J 025	n/a	>100 Mt of limestone (>95% calcium carbonate, <5% magnesium carbonate) in situ; Indicated	Environmental Assessment (under review), engineering and environmental studies, bulk sampling, test pitting	Proposed 600,000 t/y limestone quarry to feed a vertical lime kiln producing 198,000 t/y of lime. Mine life of > 50 years
Wapiti East	Fertoz Int'l Inc.	P_2O_5; Sedimentary phosphate deposits; 093I 008, 093I 022	n/a	0.81 Mt at 22.3% P_2O_5; Indicated	Upgraded resource, scoping study, small mine application submitted (late 2014)	Proposed seasonal shallow open-pit mine. Average annual production would be <75,000 tonnes phosphate rock. Mine life of >20 years

gypsum veining is predominant in the Takla Group volcanic rocks; at depth, quartz-magnetite ±biotite alteration becomes prevalent. Auriferous chalcopyrite-pyrite ±molybdenite mineralization occurs as disseminations, fracture fills and with quartz ±magnetite veins in the pluton, and less so in hanging wall volcanic rocks. Vein density approaches 100% in a high-grade northeast corner of the deposit.

AuRico continued to advance the proposed KUG block cave mine through a Substituted (federally and provincially harmonized) Environmental Assessment and towards an updated feasibility study. Geotechnical diamond and auger drilling was undertaken on key infrastructure areas, including the proposed triple decline portal, short tunnel portal and conveyor areas; and test pitting was completed to determine geotechnical and substrate characteristics. The underground block cave operation would use processing facilities and infrastructure at the Kemess South mine (now on care and maintenance; ERM Rescan, 2014). An average milling rate of 24,650 t per day would annually produce 3,266 kg (105,000 ounces) of gold and 19,958 t (44 million pounds) of copper. Total metal production would be 40,435 kg (1.3 million ounces) gold and 255,373 t (563 million pounds) copper. The operation would run for 12 years, with mining from a single extraction level. Construction is expected to take five years, employing approximately 400 people over the first four years.

5.1.3. Aley

The **Aley** niobium project (Figs. 1, 3; Table 4, Taseko Mines Limited and subsidiary Aley Corporation) is hosted by the Aley Carbonatite complex (Devonian-Mississippian). The complex is an alkaline ultrabasic 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 ±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. A fenitized aureole with abundant sodic-amphibole is cut by carbonatite dikes or sills and extends up to 500 m into the host rock beyond the brecciated carbonatite margin.

After completing a six-month engineering study and updated mine plan for their Gibraltar mine in May, the in-house construction and commissioning team of Taseko switched focus to the Aley project. Further engineering and metallurgical test work aimed to verify and improve results of the 2014 feasibility study, and environmental baseline data gathering continued. An open-pit mine with a 10,000 t per day processing plant and ferroniobium convertor is proposed. Average annual production over the 24 year mine life would be about 9,000 tonnes 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 (Aley Corporation, 2014), and is moving through the pre-application stage of a Substituted Environmental Assessment.

5.2. Proposed coal mines

Work was carried out on two proposed coal mines in 2015, the **Murray River** and **Sukunka** projects. Both projects are within the Northeast Region.

5.2.1. Murray River

The 35 km-long, 160 km^2 northwest-trending licensed area for the **Murray River** project (Figs. 1, 7, Table 4) of HD Mining International Ltd. is underlain by Lower to Upper Cretaceous successions of the Fort St. John Group above the Gates Formation. The main geologic structure is modelled as a gently northeast-dipping homocline with asymmetric subsidiary folds, and reverse faults that bring coal beds in the middle part of the Gates Formation to shallower depths (Norwest Corporation, 2010; ERM Rescan, 2014). The Project Description identifies 5-6 underground workable Gates Formation seams with average thickness of 1.6-6.2 m.

In 2015, HD Mining continued engineering and environmental studies in support of their Environmental Assessment, and an underground bulk coal sample project continued (Fig. 11) with the driving of a decline to 1,351 m (close to 400 m vertical depth) where the bulk sample will be extracted. Exploration drilling from the face of the decline was undertaken for further coal seam delineation and characteristics assessment. An 11-hole surface drilling program was also completed for additional coal resource data and deep groundwater system characterization. Contingent on coal quality results of the bulk sample, the proposed underground longwall mining operation would have

Fig. 11. Approaching the decline portal at the Murray River project.

a production rate of 4.8 Mt of saleable coal per year over a 25 year mine life. The construction phase of the project would take an estimated three years and create approximately 1,139 person-years (approximately 380 jobs) of direct employment for Canadian workers. The operations phase would require 764 direct jobs. The company is working with Northern Lights College on curriculum development and a training program for underground longwall mining. In October, an Environmental Assessment certificate for the project was issued.

5.2.2. Sukunka

The **Sukunka** project (Figs. 1, 7, Table 4) of Glencore plc (75% interest) and JX Nippon Oil & Energy Corporation (25% interest) lies in a broad monocline with sub-horizontal limbs that generally dip to the southwest. Southwest-dipping thrust faults cut across the property and have brought coal seams in the hanging wall closer to surface. Three coal seams ranging from 1 - 6 m thickness 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 have been described historically (BP Coal Limited, 1977) and are also being targeted.

Glencore continued engineering and environmental studies to support their Substituted Environmental Assessment application, which was accepted for review in August. An open-pit mining operation with initial production of 1.5-2.5 Mt of saleable metallurgical coal per year is proposed (Stantec, 2015). Addition of a room-and-pillar underground mining component in a future mine plan would increase production to 6 Mt per year. Mine life is expected to exceed 20 years. Workforce requirements are estimated at up to 250 jobs during construction, and 543 employees during operations. The reported coal resource increased in January by 5 Mt (Measured) to 145 Mt (Measured and Indicated, Table 4). The increase was due to an updated geological model that incorporates both upper and lower members of the Gething Formation and increases confidence in the northern part of the deposit.

5.3. Proposed industrial mineral mines

Work was carried out on two proposed industrial mineral mines in 2015, the **Giscome** and **Wapiti East** projects. Giscome is located within the Omineca Region and Wapiti East in the Northeast Region.

5.3.1. Giscome

The **Giscome** property (Fig. 1, Table 4) of Graymont Western Canada Inc., a subsidiary of Graymont Limited, is underlain by fossiliferous limestone (Triassic) attributed to the Cassiar platform and basaltic volcanic rocks of the Slide Mountain Group (Struik et al., 1990). Paragneiss of the southern portion of the Wolverine metamorphic complex lies about 1.5 km northeast of the project area (Fig. 3). High quality limestone grades of about 98% $CaCO_3$ have been described in the area (Dahrouge and Kluczny, 2006). In 2015, Graymont continued engineering and environmental studies in support of an Environmental Assessment draft application and final lime plant and quarry designs. A 1,000 tonne bulk limestone sample was collected from two outcrops for crushing and kilning tests (Fig. 12). A 600,000 tonnes per year limestone quarry and conveyor system is proposed that would feed a vertical lime kiln producing 600 tonnes of lime daily and 198,000 tonnes annually (Pottinger Gaherty Environmental Consultants Ltd., 2013). The mine life is estimated at 50 years minimum and would create 40-60 jobs during construction and about 15 permanent jobs during operations. Lime products have environmental and industrial applications.

5.3.2. Wapiti East

At the **Wapiti East** project (Figs. 1, 3, Table 4) of Fertoz International Inc., pelletal and nodular phosphate-bearing units are interbedded with siltstones in folded and thrusted 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 2015, Fertoz upgraded their JORC resource estimate and completed a scoping study for an at-surface resource averaging one metre width and 30 m depth over a strike length of 12.5 km in four zones. A seasonal (May-October) shallow open-pit mine is proposed with slot trenching along strike of a moderate-steeply dipping phosphorite unit and

Fig. 12. Loading blast-holes at Giscome.

production of up to 75,000 tonnes per year of phosphate rock. A Mines Act permit application was submitted in late 2014; mine life is expected to be greater than 20 years. Phosphate rock has agricultural applications as fertilizer.

6. Exploration activities and highlights

Exploration projects can be categorized by exploration stages. The grassroots stage represents initial reconnaissance of a property and involves such activities as airborne geophysical surveys, geochemical sampling, mapping and prospecting. Early stage exploration consists of focused work on a target and typically includes ground geophysical surveys, trenching, drilling, and continued grassroots stage work. As well, First Nation consultation should begin at least by early stage exploration and continue throughout the remaining stages. Advanced stage exploration includes resource delineation, preliminary economic assessments and prefeasibility studies. Activity at the advanced stage typically includes infill drilling, bulk sampling and baseline environmental data collection. These activities continue into the mine evaluation stage. At the mine evaluation stage; detailed environmental, social, engineering and financial evaluation activities are carried out. As well, permit applications are submitted and it is proposed that the project become a mine.

Of the 38 selected active exploration projects in the combined Omineca-Northeast region in 2015, seven (18%) were at the mine evaluation stage, four (11%) were at the advanced stage, 16 (42%) were at the early stage, and 11 (29%) were at the grassroots stage. Project types included precious metal (10 properties, 26%); porphyry (Cu-Au, Cu-Mo, Mo) projects (12 properties, 31%); polymetallic base and precious metals (nine properties, 24%); specialty metals (one property, 3%); industrial minerals including jade (three properties, 8%); and coal (three properties, 8%).

6.1. Precious metal projects

6.1.1. Stikine terrane

In June, New Gold Inc. resumed exploration near the Blackwater deposit, focusing on epithermal gold-silver targets up to five km south and west of the deposit in the **Blackwater South** project area (including the Dave and Kaolinite Ridge target areas), and about 13 km west of the deposit in the **Buck** project area.

At **Blackwater South** (Fig. 1, Table 5) exploration consisted of infill induced polarization and magnetic geophysical surveys, and drilling. Work followed up on the 2014 discovery of porphyry-style copper-molybdenum-silver mineralization at the northwest margin of the inferred Blackwater granodiorite pluton (Late Cretaceous), where a resistivity high and chargeability low geophysical anomaly had been targeted. Stockwork quartz veining and quartz-cemented breccia with coarse molybdenite and clots of chalcopyrite-pyrite was intercepted over lengths of 414 m and 272 m, and vertical depth of about 460-880 m (Fig. 13). Drilling in 2015 tested a geochemical anomaly coincident with a magnetite destructive linear feature in hornfelsed Bowser Lake Group sedimentary units at the margin of the pluton (Fig. 14).

About two km north at the Dave target, grassroots work was followed by drilling that targeted a coincident geochemical and geophysical (magnetic low, chargeability high) anomaly following a northeast-trending structure in Kasalka Group

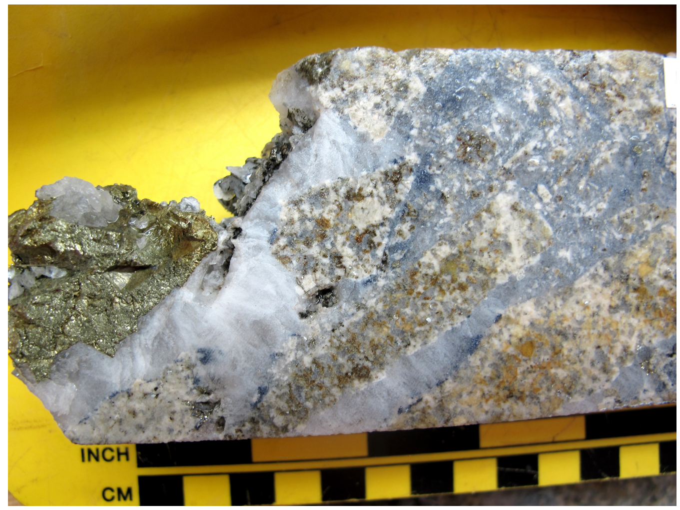

Fig. 13. Quartz-cemented chaotic breccia with disseminated and clotted chalcopyrite-pyrite-molybdenite mineralization in granodiorite at Blackwater South (New Gold Inc., 2015).

Fig. 14. Drilling at Blackwater South.

Table 5. Selected exploration projects, Omineca and Northeast regions.

Project	Operator	MINFILE	Commodity; Deposit type	Resource (NI 43-101 compliant unless indicated otherwise)	Work Program	Comments
Blackwater South	New Gold Inc.	093F 037	Au, Ag; Epithermal Au-Ag-Cu (intermediate sulphidation)	n/a	Drilling (5,150 m), heliborne magnetics survey, ground-based geophysics (IP, magnetics), geochemistry (soil, rock), mapping, prospecting	Exploration focused on epithermal Au-Ag targets within 5 km south and west of the Blackwater deposit
Buck	New Gold Inc.	093F 043	Au, Ag; Epithermal Au-Ag-Cu (low sulphidation)	n/a	Airborne geophysics (magnetics), geochemical sampling (rock), mapping, prospecting	Granite pluton is considered prospective for mineralized rhyolite dikes or sills
Big Bear	Parlane Resource Corp.	093F 075	Au, Ag; Epithermal Au-Ag-Cu (low sulphidation)	n/a	Geochemical sampling (soil), prospecting	Soil sampling outlined a 400 x 170 m geochemical anomaly south of the 2012 drilling area
Fox	Kootenay Silver Inc., Theia Resources Ltd.	093F 078	Au, Ag; Epithermal Au-Ag-Cu (low sulphidation)	n/a	Trenching and channel sampling (2014)	Six mineralized zones in a 400 x 100 m area; samples grade up to 45 g/t Au and 7,300 g/t Ag
2 X Fred	Kootenay Silver Inc., Theia Resources Ltd.	n/a	Au, Ag; Epithermal Au-Ag-Cu (low sulphidation)	n/a	2014: trenching, geochemical sampling (rock); 2015: drilling (720 m), prospecting	244 channel and composite rock samples from 16 trenches averaged 0.49 g/t Au, 8.7 g/t Ag
Holy Cross	C.J. Greig & Associates Ltd.	093F 029	Au, Ag; Epithermal Au-Ag-Cu (low sulphidation)	n/a	IP survey (7 line-km)	Two rock samples: 5.62 g/t Ag, 0.349 g/t Au (14EW105A), 4.86 g/t Ag, 0.0342 g/t Au, 1,075 ppm As (14EW108A)
Lawyers	PPM Phoenix Precious Metals Corp.	094E 066	Au, Ag; Epithermal Au-Ag-Cu (low sulphidation)	Historic non NI 43-101 compliant: 68.4 Kt at 7.3 g/t Au, 226 g/t Ag (Duke's Ridge; Cheni Mines Ltd., 1990)	Drilling (4,002 m; 3,282 m on Cliff Creek North, 720 m on Duke's Ridge zone), prospecting	Drilling to verify and infill historic results, and step-out deeper into the Cliff Creek north sub-zone and Duke’s Ridge zone, first drilling program in 9 years
BT	Porpoise Bay Minerals Ltd.	093G 002	Au, Mg, Ni: Intrusion-related Au pyrrhotite veins	n/a	Trenching, prospecting	Trenching through glacial till overburden to sample mineralized granite and serpentinite bedrock
Blackjack Mineral	Angel Jade Mines Ltd.	093N 061	Au-Ag; Au-quartz veins	n/a	Trenching, test pitting, geochemical sampling (rock)	Exploring for in situ veins in the Manson Creek placer gold mining area

Table 5. Continued.

Kemess East	AuRico Metals Inc.	094E 094 (Kemess East), 094E 012 (Duncan)	Cu, Au, Ag, Mo; Porphyry Cu±Mo±Au	55.86 Mt at 0.41% Cu, 0.52 g/t Au, 2.0 g/t Ag; containing 228.5 Kt (503.7 Mlbs) Cu, 29,206 kg (939 Koz) Au, 112,004 kg (3.6 Moz) Ag; Indicated	Drilling (27,719 m), geochemical sampling (rock), mapping, prospecting	Drilling highlights: 305 m of 0.625 g/t Au, 0.433% Cu (KH-15-01); 301 m of 0.466 g/t Au, 0.394% Cu (KH-15-02); 458 m of 0.640 g/t Au, 0.437% Cu (KH-15-23); 590 m of 0.516 g/t Au, 0.366% Cu (KH-15-27); 772 m of 0.465 g/t Au, 0.365% Cu (KH-15-30)
Menard	HPX Quesnellia Holdings 1 Inc.	094D 049, 094D 090, 094D 154, 094D 174	Cu, Mo; Porphyry Cu±Mo±Au	n/a	Geochemical sampling (rock, soil, silt), mapping, prospecting	Reconnaissance geochemical sampling generated three targets of interest
Copper King	Pacific Empire Minerals Corp.	094D 004, 094D 149, 094D 150, 094D 151	Cu, Mo; Porphyry Cu±Mo±Au	n/a	IP survey (5 line-km), mapping, prospecting	
Kliyul	Teck Resources Limited, Kiska Metals Corporation	094D 014, 094D 023, 094D 028, 094D 182	Cu, Au, Ag; Porphyry Cu±Mo±Au	Historic non NI-43-101 compliant 2.3 Mt grading 0.3% Cu and 1.03 g/t Au (Gill, 1994a)	Drilling (1908 m), geochemical sampling (rock), mapping, prospecting	Drilling highlights: 245.0 m of 0.18% Cu, 0.53 g/t Au (KLI-15-034), 162.4 m of 0.20% Cu, 0.26 g/t Au (KLI-15-033)
Red Lion	Garibaldi Resources Corp.	094D165, 094D167, 094D168, 094D169	Cu, Au, Mo; Porphyry Cu±Mo±Au	n/a	Aeromagnetic and radiometric survey, IP survey (47 line-km), geochemical sampling, mapping, prospecting	
Kwanika East-Smoke	Serengeti Resources Inc.	093N 152, 093N 168	Cu, Mo; Alkalic porphyry Cu-Au	n/a	Heliborne magnetics survey (328 line-km)	
Jewel	Serengeti Resources Inc.	093N 240	Cu, Au, Ag; Alkalic porphyry Cu-Au	n/a	Heliborne magnetics survey (55 line-km)	Survey identified a 2 km-long ring-shaped cluster of magnetic highs
Col-Later	Pacific Empire Minerals Corp.	093N 101, 093N 169, 093N 216, 093N 032	Cu, Au, Ag, Mo; Alkalic porphyry Cu-Au	Historic non NI 43-101 compliant: of 1.81 Mt at 0.6% Cu; indicated (Kookaburra Gold Inc., 1989)	IP survey (68 line-km, 2014-15), drilling (2,493 m)	Drilling tested two geophysical anomalies on the till-blanketed western side of the property
Chuchi	Kiska Metals Corporation	093N 159, 093N 162	Cu, Au; Alkalic porphyry Cu-Au	Historic non NI 43-101 compliant: 50 Mt at 0.21-0.40% Cu, 0.21-0.44 g/t Au (Digger Resources Inc., 1991)	IP survey (10 line-km), prospecting	IP survey results show chargeability anomalies within and flanking the intrusive centre in the BP zone, new drill targets
North Grid	Thompson Creek Metals Company Inc.	093N 123, 093N 204	Cu, Mo; Alkalic porphyry Cu-Au	n/a	Drilling (2,000 m)	Drilling targets (Snell and Mitzi) with similar geophysical-geochemical signatures as Mt. Milligan deposit mineralized stocks

Table 5. Continued.

Prince George SE	Tech-X Resources Inc.	093G 064	Cu, Mo; Cu+/-Ag quartz veins	n/a	IP survey (6 line-km)	
Akie	Canada Zinc Metals Corp.	094F 031	Zn, Pb, Ag; Sedimentary exhalative Zn-Pb-Ag	12.7 Mt at 8.4% Zn, 1.7% Pb, 13.7 g/t Ag; containing 1.07 Mt (2,352.3 Mlbs) Zn, 214,000 tonnes (471.8 Mlbs) Pb, 174,024 kg (5.6 Moz) Ag; Indicated	Diamond drilling (5,350 m), 2014-15 airborne gravity gradiometry data received, environmental baseline studies	Drilling highlights: 28.51 m of 10.22% Zn, 2.34% Pb, 20.45 g/t Ag (A-15-121); 23.36 m of 8.63% Zn, 1.68% Pb, 14.64 g/t Ag (A-15-122); 21.41 m of 9.47% Zn, 2.11% Pb, 18.22 g/t Ag (A-15-124); 15.76 m of 9.71% Zn, 1.74% Pb, 15.75 g/t Ag (A-15-125)
Kechika Regional (Yuen North, Mt. Alcock)	Canada Zinc Metals Corp.	094F 013, 094F 015	Zn, Pb, Ag; Sedimentary exhalative Zn-Pb-Ag	n/a	2014-15 airborne gravity gradiometry data received	
Cirque	Teck Resources Limited	094F 008	Zn, Pb, Ag; Sedimentary exhalative Zn-Pb-Ag	Historic non-NI 43-101 compliant: 38.5 Mt at 8% Zn, 2.2% Pb, 47.2 g/t Ag (North Cirque); indicated (MacIntyre, 1992)	Drilling (5,370 m), geochemical sampling (rock, soil), mapping, prospecting, 2014-15 airborne gravity gradiometry data received	Drilling to verify and step-out from historic drilling results at depth beneath a thrust sheet of Ordovician and Silurian sedimentary rocks
Kechika Regional (Yuen, Cirque East, Pie, Elf)	Teck Resources Limited	094F 013, 094F 023, 094F 011	Zn, Pb, Ag; Sedimentary exhalative Zn-Pb-Ag	n/a	Geochemical sampling (rock, soil), mapping, prospecting, gravity geophysical survey (12.5 line-km), 2014-15 airborne gravity gradiometry data received	2.2 x 0.5 km Zn-Pb-Ag soil anomaly defined at Yuen with two coincident airborne gravity anomalies
Coral	Minfocus Exploration Corp.	094B 007, 094B 008, 094B 021	Zn, Pb, Ag; Mississippi Valley-type Pb-Zn	n/a	Geochemical sampling (rock), mapping, prospecting	3.21% Zn, 0.70% Pb average grade in 12.9 m long trench sampled at 1 m intervals
Groundhog	Atrum Coal Groundhog Inc.	104A 083, 104A 086	HCC, UL coal, Industrial mineral: Anthracite	349.4 Mt in situ (Groundhog North), 259.7 Mt in situ (East of Skeena)	Engineering and environmental baseline studies, coal quality tests, upgraded resource and geological model	Planned underground bulk sample. Environmental Assessment yet to be initiated

volcanic rocks. About 3.5 km to the west, at the Kaolinite Ridge target, grassroots work and a ground magnetic geophysical survey was followed by drilling that tested a northeast-trending soil geochemical anomaly with a gold-in-till anomaly in the down-ice direction. The target area is underlain by crystal lithic tuff that is superjacent to the rhyolite flow sequence at Blackwater, and may belong to either the Kasalka Group or Ootsa Lake Formation. Further to the west at the **Buck** prospect (Fig. 1, Table 5), a heliborne magnetic survey was completed and grassroots work. The area is underlain by gossanous, hornfelsed tuffaceous sedimentary units and volcanic rocks of the Bowser Lake Group and/or Hazelton Group. A granite pluton was dated as Late Cretaceous, and is considered prospective for gold-mineralized rhyolite dikes or sills.

The **Big Bear** property (Fig. 1, Table 5) of Parlane Resource Corp. is underlain by volcanic units of the Hazelton Group, Bowser Lake Group, and Ootsa Formation; as well as sedimentary units of the Bowser Lake Group and dioritic intrusive plugs (probable Late Cretaceous; Diakow, 1997). North-northeast and northeast-striking assumed high-angle faults (Diakow and Levson, 1997) intersect in the southwest part of the property where drilling in 2012 returned mineralized intervals in two holes, including BB12-4 that averaged 0.26 g/t Au, 2.67 g/t Ag and 0.21% Zn over its entire length of 330.7 m (Webster, 2013). In 2015, soil sampling outlined a 400 x 170 m geochemical anomaly south of the 2012 drilling area.

In January, Kootenay Silver Inc. and Theia Resources Ltd. announced the results of a trenching and channel sampling program completed at the **Fox** property in 2014 (Fig. 1, Table 5 for assay highlights). The property is underlain by Ootsa Lake Formation felsic volcanic rocks and hypabyssal feldspar porphyry and features two mineralized zones, 400 m apart, near a 3 km long northeast-trending aeromagnetic low anomaly. Subvertical, open-space quartz veins, stockworks and breccias with fine grained pyrite are associated with moderate to strong argillic, sericitic, and silicic alteration.

At the **2 X Fred** property (Fig. 1, Table 5) of Kootenay Silver Inc. and Theia Resources Ltd., twelve subvertical north-south to northeast trending low-sulphidation epithermal chalcedonic quartz veins containing gold and silver have been identified. They occur over a 2.5 x 1.75 km area, with strike lengths up to 500 m or more, and widths up to 40 m. In 2014, a trenching program was carried out and an average grade of 0.49 g/t Au and 8.7 g/t Ag was returned from 244 channel and composite rock samples from 16 trenches. The property is underlain by Endako Formation volcanic rocks on the north side of the fault-bound Brooks diorite complex (Triassic-Jurassic; Fig. 3). The quartz veins (Fig. 15) are centred on a coincident airborne electromagnetic and magnetic high anomaly and feature multiple cross-cutting vein stages, crustiform banding, comb textures, lattice bladed quartz (Fig. 16), internal deformation textures, mosaic and chaotic breccia, and fine grained pyrite mineralization. Wall rock fragments are clay-chlorite-hematite altered. Following up on the 2014 trenching and channel sampling program, a 2015 drill program tested the veins down-dip below trenches in two target areas. Results are pending.

The **Holy Cross** property of C.J. Greig & Associates Ltd. (Fig. 1, Table 5) is underlain by Hazelton Group volcanic rocks, Skeena Group chert-pebble conglomerates, a quartz monzonite plug (Middle Jurassic) assigned to Endako batholith, Kasalka Group andesite to rhyolite flows, and Ootsa Lake Formation rhyolite (Lane and Shroeter, 1997). These units are in fault contact across northeast-trending horst-and-graben style bounding faults and a preceding northwest set. A northwest-trending series of resistant topographic knobs, historically interpreted as a rhyolite flow dome complex of Ootsa Lake Formation, hosts epithermal-style mineralization as pyritic quartz-chalcedony veins and silicified breccia. Recent mapping (Angen et al., 2015) interprets the flow dome complex as a kilometre-wide northwest-trending panel of Kasalka Group rhyolite based on alteration relationships and latest Cretaceous age date of andesite (Friedman et al., 2000). Two mineralized samples were collected from quartz-cemented rhyolite breccia (J.J. Angen, personal communication, November 2015; see Table 5 for assay results).

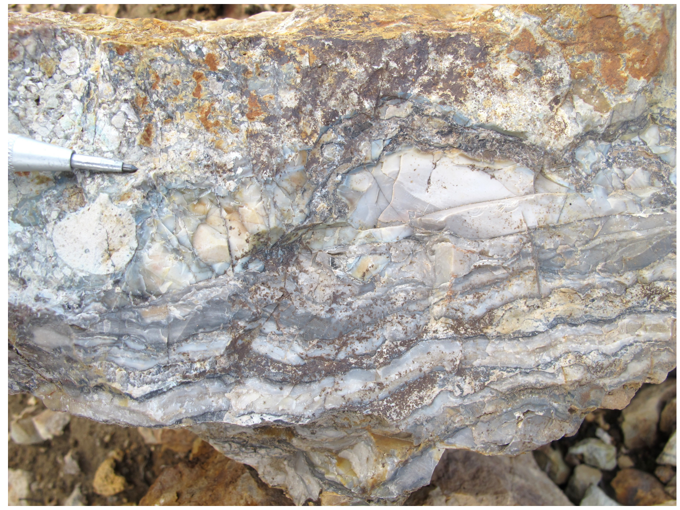

Fig. 15. Trench sample of crustiform banded and brecciated chalcedonic quartz vein at 2 X Fred.

Fig. 16. Trench sample with lattice bladed quartz texture at 2 X Fred.

The **Lawyers** property (Fig. 1, Table 5) of private company PPM Phoenix Precious Metals Corp. is underlain by andesitic volcanic units of the Toodoggone Formation (Hazelton Group). Northwest trending graben-bounding faults cut the property across a three km wide area and are the primary controlling structures for four sub-parallel steeply dipping zones of low-sulfidation epithermal mineralization. A high-sulfidation prospect lies 800 m farther west. The property contains the former Amethyst Gold Breccia (AGB), Cliff Creek and Phoenix mines which were operated by Cheni Mines Ltd. from 1989 to 1992, producing over 171,000 ounces of gold and 3.5 million ounces of silver, mainly from the AGB deposit, now reclaimed (Lane, 2011). The north sub-zone of the Cliff Creek deposit, two km to the west of AGB was only partially mined (Fig. 17). Underground development to >200 m vertical depth remains intact but is flooded; the remaining mineral resource is unknown. The Cliff Creek deposit has a strike length of about 1,600 m and variable width <58 m. It is

Fig. 17. Slabbed float sample of gold-silver bearing sulphide mineralized multi-stage quartz vein and breccia at Lawyers.

divided into three sub-zones (north, mid, and south) with best mineralization considered to be in the north and south sub-zones. The adjacent Duke's Ridge deposit has a 1,480 m strike length and its northern end intersects the Cliff Creek structural trend at a shallow angle. Veins are characterized by multiple stages of crackle-to-chaotic breccia, quartz-chalcedony veining and stockwork zones, and late quartz-amethyst-calcite fill. Sulphide mineralization comprises finely disseminated pyrite with accessory sphalerite, chalcopyrite, galena, bornite, covellite and acanthite. Alteration consists of silicification, intergrown sericite-clay, and selective-pervasive hematization. In 2015, a 24-hole drilling program began in late August that aimed to verify and infill historic drilling results, and step-out deeper into the north sub-zone at Cliff Creek (Fig. 18) and the Duke's Ridge zone. Assay results have not been made public.

Fig. 18. Drilling the Cliff Creek north zone at Lawyers.

6.1.2. Cache Creek terrane

The **BT** (Bobtail) property of private company Porpoise Bay Minerals Ltd. (Fig. 1, Table 5) is underlain by serpentinized ultramafic rocks and basaltic volcanic rocks of the Cache Creek complex. These are intruded by granite (Eocene) that lies about 6 km west of the Pinchi Fault. A trenching and test pitting program explored a target area where ten anomalous gold samples up to 0.318 g/t Au were previously collected. Trenching penetrated glacial till cover to sample granite bedrock with disseminated and vein-hosted pyrite mineralization, and serpentinite with shear-hosted ribboned quartz veins and foliation-hosted pyrite ±pyrrhotite. A bleaching calcite-chlorite-clay alteration envelopes quartz veins in granite. Assay results have not been made public.

6.1.3. Quesnel terrane

The **Blackjack Mineral** project (Fig. 1, Table 5) of private company Angel Jade Mines Ltd. is underlain by Takla Group sedimentary rocks and metamorphosed equivalents about two km southwest of the Manson fault zone. Bedrock in the area is covered by glacial and post-glacial gravels that have been mined for placer gold since 1871. Gold and silver occurs in quartz vein showings which lie within a kilometre of the property. In 2015, bedrock was exposed and sampled in a trenching and test-pitting program. Assay results have not been made public.

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

6.2.1. Stikine terrane

At the end of 2014, AuRico Metals Inc. announced the discovery of the **Kemess East** copper-gold porphyry (Fig. 1, Table 5) deposit. It is located one kilometre east of AuRico's **KUG** deposit (see section 5.1.2.). In January an initial resource estimate was released (Table 5). The Kemess East deposit appears to be similar in size and style to KUG, with gold-to-copper ratios ranging from 1:1 to 2:1 and good continuity of grade throughout. Mineralization, between about 850-1600 m depth, is hosted primarily in quartz monzonite (earliest Jurassic) and, to a lesser degree, in Takla Group basaltic-andesite. Auriferous chalcopyrite is mostly disseminated but also occurs in quartz veins within the intrusion. The highest copper-gold grades are associated with biotite and silica in a potassic alteration zone. Phyllic alteration is less intense than at KUG, and late calcite-zeolite alteration spatially associated with a granodiorite pluton south of the deposit appears to be grade destructive (Fig. 19). Two structurally offset zones comprise the Kemess East deposit. The Kemess Offset Zone (KOZ) is downthrown east of KUG, and the Kemess East zone is downthrown again east of KOZ before stepping up to shallower levels in a continuing series of horst-and-graben style fault blocks. The Kemess East deposit may represent the deeper portion of a single dissected mineralized system that includes KUG.

A 15-hole drill program in 2015 further delineated and expanded known mineralization at Kemess East (Fig. 20) and KOZ. Mineralization remains open in three directions in

Fig. 19. Quartz-chalcopyrite-pyrite vein in quartz monzonite at Kemess East. Potassic alteration is overprinted by sericite (phyllic) and pink zeolite alteration.

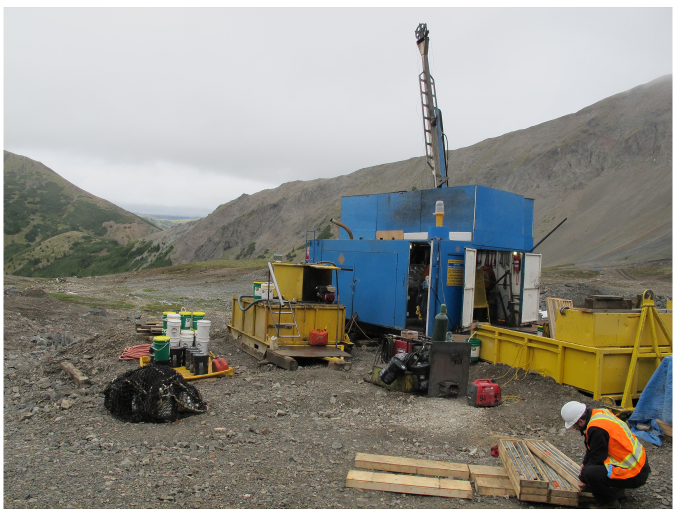

Fig. 20. Drilling at Kemess East.

both zones. Other geophysical and geochemical anomalies across the broader Kemess property (Orion and South Dam) were tested in a nine-hole fly drill program, but no significant values were returned. Grassroots work included rock sampling, mapping and prospecting over these target areas.

About 30 km south of the Kemess property in the McConnell range, the **Menard** property (Fig. 1, Table 5) of HPX Quesnellia Holdings 1 Inc. is cut by two main north- to north-northwest trending splays of the terrane-bounding Ingenika fault. The property is underlain by Takla Group volcanics which are intruded by a ~2.5 km diameter Alaskan-type ultramafic complex (Late Triassic; Nixon et al., 1997) and monzodiorite stocks and dikes (Early Jurassic) that trend predominantly northwest. Sustut Group sedimentary rocks are fault-bound at the property's southwestern margin. Mineralization consists of shear-hosted chalcopyrite ±pyrite disseminations and veinlets near lithological contacts and local gossans. A reconnaissance mapping and geochemical sampling program in 2015 generated three targets of interest.

Contiguous to the south, the **Copper King** property (Fig. 1, Table 5) of private company Pacific Empire Minerals Corp., is underlain by Takla Group basaltic units and Hazelton Group volcaniclastic rocks. These are intruded by quartz diorite plugs and northeast-trending porphyry dikes (Early Jurassic; Bradley, 1991). East-northeast trending epidote-altered fracture zones and epidote veins host bornite-chalcocite ±magnetite mineralization; and quartz-sericite altered porphyry dikes are chalcopyrite-pyrite mineralized. Two circular aeromagnetic high anomalies trend northwesterly across the property. In August, a single-line induced polarization survey was completed.

6.2.2. Quesnel terrane

Kiska Metal Corporation's **Kliyul** property (Fig. 1, Table 5), under option to Teck Resources Limited, lies about five km north of the northern extent of the Hogem plutonic complex. The property is underlain by a basin-to-arc sequence of the Takla Group. Volcanic sandstone on the west side of the property transitions into a sub-unit of intercalated andesite-sandstone-carbonate in the central part, and basaltic volcanic breccia lies farther east (Schiarizza, 2003; Voordouw, 2012). Intrusive rocks include a north to north-northwest trending elongate ultramafic-mafic suite (Late Triassic), a monzonite-diorite suite (early Middle Jurassic), and a northwest-trending granitic suite (Early Cretaceous). A 6.8 km-long, <1 km-wide phyllic alteration zone trends northwest along a fault bounding a mafic intrusion in the southeast part of the property and east-west across an interpreted linkage structure towards a north-south trending dextral strike-slip fault on the western side. The east-west central portion hosts a northwest-trending sheared monzonite-diorite dike swarm and the Kliyul magnetite replacement and breccia body (Fig. 21). An induced polarization survey over this area indicated a moderate chargeability and low-moderate resistivity anomaly. South-southeast trending auriferous polymetallic quartz veins of up to 300 m strike length are spatially associated with inflection points of the alteration zone. Disseminated and quartz-magnetite vein-hosted auriferous chalcopyrite ±bornite mineralization is associated with magnetite ±biotite alteration, and also with dikes. Mineralization in zones of phyllic (sericite-chlorite ±albite, anhydrite) alteration includes chalcopyrite-pyrite veinlets, fracture fill and disseminations. In 2015, a four-hole drilling program extended known mineralization down-dip of the magnetite breccia, to the southeast in a step-out hole, and to the northeast in a geophysical anomaly near an east-west trending fault structure (see Table 5 for assay highlights). Grassroots work was also completed.

Contiguous with the Kliyul property on the north, the **Red Lion** property of Garibaldi Resources Corp. (Fig. 1, Table 5) is underlain by the same geological units, and a portion of the strike-slip fault that borders the west side of the Kliyul zone. Both properties lie within a northwest-trending area of strongly anomalous copper-gold geochemistry in the British Columbia

Fig. 21. Gossanous magnetite breccia outcrop with copper oxide minerals at Kliyul.

Regional Geochemical Survey (RGS) dataset, comparable to anomalies associated with the Mt. Milligan and past-producing Kemess South mine areas. Historic showings on the Red Lion property include quartz vein hosted and disseminated chalcopyrite-pyrite associated with shear zones and diorite contact zones. In 2015, aeromagnetic and radiometric surveys were flown; and a ground-based induced polarization survey covering the eastern half of the property and mapping program were completed in September.

The **Kwanika East-Smoke** property of Serengeti Resources Inc. (Fig. 1, Table 5) is underlain by several phases of the Hogem intrusive complex including gabbro to diorite (Late Triassic-Early Jurassic), quartz monzonite (Early Jurassic), and granite (Early Cretaceaous); and by intermediate volcanic rocks of the Takla Group and Twin Creek succession on its eastern side. The property follows an east-northeast trending structure and has a strong VTEM geophysical anomaly. About eight km farther east, the **Jewel** property is underlain by fine clastic sedimentary rocks of the Takla Group at the western margin of the Germansen batholith (Early Cretaceous; Fig. 3), and has a single-line coincident VTEM and aeromagnetic anomaly. In 2015, a low-level high-sensitivity aeromagnetic survey was flown over the properties. The survey identified strong magnetic anomalies on both properties, including a 2 km-long ringed cluster of magnetic highs enclosing a magnetic low at Jewel.

The **Col-Later** property (Fig. 1, Table 5) of private company Pacific Empire Minerals Corp. covers the northern margin of the southeastern tail of the Hogem intrusive complex where it is in fault contact with gently south-dipping intermediate volcanic units of the Chuchi Lake succession. Copper ±gold mineralization has been identified on either side of the hornfelsed contact zone in both northwest and northeast trending structures. A 200 x 200 m mineralized zone in the main target area (Col target) is underlain by an interpreted northwest-trending potassically-altered monzodiorite-syenite dike complex (Early Jurassic) hosted in monzonite (Peters and Ritchie, 2014). Disseminated and vein-hosted chalcopyrite ±bornite and malachite is concentrated in steeply-dipping parallel fracture zones (Fig. 22). A potassic alteration zone forms the core of an interpreted 4.5 km wide zoned alteration footprint coincident with 4 km long copper-in-soil anomaly. An induced polarization geophysical survey completed in 2014-15 covered several target areas across the property and selected anomalies on the till-blanketed western side were drilled. At the Elbow target, eight km northwest of the Col target, drilling tested a coincident resistivity and magnetic high anomaly in an area where a structural bend or break in the regional fabric intersects an apparent northeast-trending transverse linear with a magnetic low geophysical signature. Less than five km farther northwest, at the Sooner target, drilling tested a similar anomaly near the faulted contact between intrusive and volcanic rocks. Drilling was completed by early July. Assay results have not been made public.

Contiguous to the east, the **Chuchi** property (Fig. 1, Table 5) of Kiska Metals Corporation is centered immediately northeast of the southeastern end of the Hogem intrusive complex. It is underlain by a cluster of porphyritic monzonite stocks, dikes, and sills (Early Jurassic) emplaced in Chuchi Lake succession volcanic and sedimentary units. A central target (BP zone) of

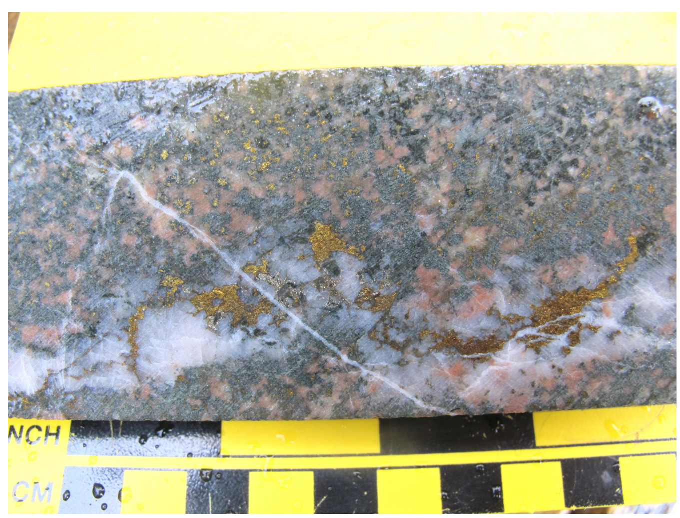

Fig. 22. Quartz-chalcopyrite-pyrite vein with potassic alteration and weak sericite overprint in monzodiorite at Col-Later.

copper-gold mineralization over a >1.5 x 1.5 km area remains open in three directions and at depth (Chadwick, 2014). A 4 x 3 km zoned alteration footprint transitions inwards from propylitic to calc-potassic alteration and biotite hornfels (Nelson and Bellefontaine, 1996), and is coincident with an inwardly zoned high to moderate ground-based IP chargeability signature. A north-south trending fault bisects the property. Historic drilling west of this fault, in the northeast part of the BP Zone, intersected mineralization from top to bottom consisting of disseminations, clots, and veins of chalcopyrite-pyrite ±bornite. An aeromagnetic high anomaly and copper and gold soil geochemical anomalies continue eastward across a fault-bound valley. In 2015, two east-west oriented lines of induced polarization geophysical survey were run 500 m apart across the BP zone. Results confirmed chargeability anomalies coincident with a magnetic high feature and zones of known mineralization, and extending beyond these both laterally and at depth, and also to the east across the fault valley. The southern line crossed an east-northeast striking structure interpreted as a normal fault with down-dropped block on the south.

Thompson Creek Metals Company Ltd. began a multi-year drilling program at the **North Grid** target area (Fig. 1, Table 5) about five km northwest of the Mt. Milligan mine lease. The area is underlain by Takla Group (Witch Lake Formation) volcaniclastic units less than two km south of the predominantly monzonitic Mount Milligan pluton (Early Jurassic), which lies on trend with the southern tail of the Hogem intrusive complex (Nelson and Bellefontaine, 1996); and less than two km west of an interpreted southeast-trending deep extension of the pluton towards the Mt. Milligan deposit area (Clifford and Berthelsen, 2015). Geophysical and geochemical surveys on the North Grid target area produced the Snell and Mitzi targets which have similar coincident IP chargeability, magnetic, and geochemical anomalies as those associated with mineralized stocks at the Mt. Milligan deposit. These targets were tested with five drill holes in 2015. Results are pending.

The **Prince George SE** property (Fig. 1, Table 5) of private company Tech-X Resources Inc. is underlain by Takla Group sedimentary and basaltic-andesite volcaniclastic rocks that are partially blanketed by glacial till. Showings include shale-hosted quartz veins and shear zones with chalcopyrite, pyrite and malachite mineralization. In 2015, a ground-based induced polarization survey was completed.

6.3. Polymetallic base and precious metal projects

6.3.1. Ancestral North America (Kechika trough and Muskwa ranges)

At the **Akie** property (Figs. 1, 3, Table 5) of Canada Zinc Metals Corp., the Cardiac Creek baritic zinc-lead-silver SEDEX deposit is hosted in Gunsteel Formation shale (Earn Group; Upper Devonian). The steeply southwest-dipping tabular mineralized body averages about 20 m thick (<35 m thickness) and extends for an approximate strike length of 1,950 m, 1,300 m of which is considered potentially economic (Sim, 2012). From bottom to top, mineralization generally defines a stratiform sequence of: 1) bedded to massive barite and minor quartz-carbonate veining at the base; 2) mottled sphalerite-galena-pyrite banding with deformed beds and upwardly-decreasing barite-calcite; 3) grey sphalerite bands with thickly banded pyrite and minor galena and barite; 4) thickly banded fine-grained laminar pyrite with few bands of grey sphalerite; 5) distal fine-grained laminar pyrite and 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) that include interbedded black shale and limestone debris flows (MacIntyre, 1998). In 2015, an eight-hole drilling program focused mainly on down-dip and lateral resource expansion of Cardiac Creek deposit high-grade core, and infilling of gaps in the resource model. All eight holes intercepted mineralization (Fig. 23, see Table 5 for assay highlights). In the footwall of the Cardiac Creek zone, drilling intercepted a weakly mineralized pyritic massive sulfide lens that graded into an underlying debris flow. Pyrobitumen-calcite veining was also intercepted in one hole; in similar deposits (Broadbent et al., 1998; Leach et al., 2010), thermochemical sulfate reduction in organic-rich sediments is considered a mechanism for sulphide deposition associated with pyrobitumen.

In September, preliminary results of a heliborne gravity gradiometry survey flown between November 2014 and March 2015 over the Akie, **Yuen North**, and **Mt. Alcock** properties were received. The survey was designed to identify significant structural features and gravity high anomalies within the Gunsteel Formation shale. The data in conjunction with previously acquired airborne VTEM, soil geochemistry, and geologic mapping data is being used to further delineate target areas on the properties.

The **Cirque** project (Figs. 1, 3, Table 5) is a joint venture between Teck Resources Limited and Korea Zinc Company Limited that includes the Cirque, Fluke and **Elf** properties. These properties, along with the adjacent **Pie**, **Yuen** and

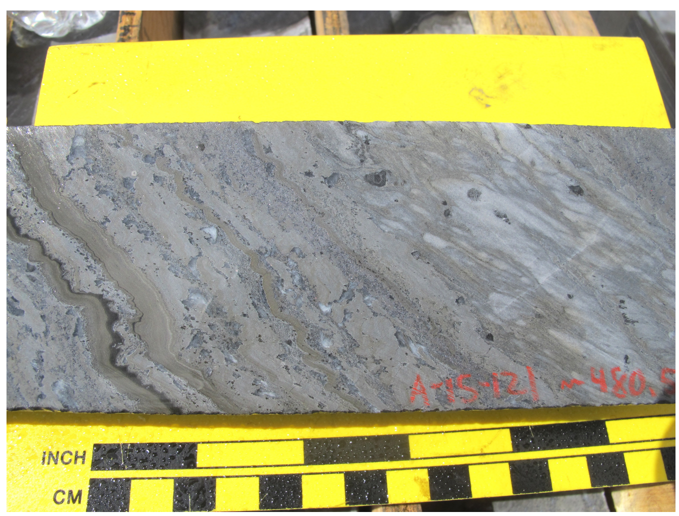

Fig. 23. Mottled sphalerite-galena-pyrite banding with barite near the base of the Cardiac Creek zone at Akie.

Cirque East properties presently under option by Teck and Korea Zinc from Canada Zinc Metals (the "Pie Option"), are located within the prospective Gunsteel Formation trend of the Kechika trough. In 2015, a five-hole drilling program focused on the South Cirque target on the Cirque property (Fig. 24). The program was designed to verify and step-out from historic drilling results at depth beneath a thrust sheet of Ordovician and Silurian sedimentary rocks. The South Cirque occurrence, hosted in Gunsteel Formation shale, is a partially-delineated apparent tabular mineralized body that does not crop out at surface, as does the better defined North Cirque deposit. Zinc-lead-silver mineralization at Cirque may have a replacement-style component instead of being strictly exhalative, similar to the Red Dog deposit in Alaska where mineralization formed by subsea-floor replacement of a sea-floor barite deposit (Leach, 2010).

In addition to drilling at Cirque, a ground-based gravity geophysical survey was completed on select targets on the Yuen, Pie, Cirque and Elf properties; and results of an airborne gravity gradiometry survey were received. Soil sample grids were expanded on Pie and Yuen, and mapping and prospecting continued on these as well as at Cirque. In addition, three historic drill holes from the Yuen property were re-logged.

About 16 km north of the Peace Arm of Williston Lake, the **Coral** property of Minfocus Exploration Corp. is a Mississippi Valley-type deposit prospect underlain by dolomitic carbonate rocks (Upper Silurian-Lower Devonian) in an east-dipping limb of a folded hanging wall sequence above a thrust fault (Thompson, 1986). Zinc-lead mineralization is disseminated within a northwest-trending irregular zone of dolomite breccia with sparry dolomite matrix (Haynes and Hardy, 1987). In 2015, a historic trench and geochemical survey grid was re-established. The trench is less than 100 m from an open-ended 800 x 600 m zinc soil anomaly. Mineralized rock chip samples were collected and diamond drilling is planned for 2016.

Fig. 24. Drilling the South Cirque deposit on the Cirque property.

6.4. Coal projects

6.4.1. Stikine terrane (Bowser Basin)

The Groundhog-Klappan Coalfield, in the northcentral part of the Bowser Basin, extends across the Skeena-Omineca regional boundary. The **Groundhog** (Fig. 1, Table 5) anthracite coal property of Atrum Coal Groundhog Inc. lies within a broad, northwest-southeast trending open-folded synclinorium (Atrum Coal, 2014). The main coal bearing sequence is the Groundhog Unit (Middle-Upper Jurassic; Bowser Lake Group); a 600 m thick alternating marine and non-marine deltaic sequence with 46 modelled coal seams. Primary and secondary targeted seams are gently-folded with average thicknesses of about 2 m and 3 m, and average depths of about 72 m and 265 m. Following a 2014 prefeasibility study update, Atrum completed engineering studies, coal quality tests and upgraded the resource and geological model for the Groundhog North component of the project. The permitting process for a 100,000 tonne underground bulk sample continued. An underground mine producing 3.2 million tonnes per year of saleable high and ultra-high rank anthracite product is planned, with a mine life of 38 years. The project has yet to enter the Environmental Assessment process; environmental baseline work is continuing. Anthracite coal has both steelmaking and industrial applications.

7. Geological research

7.1. Stikine terrane

In 2015, 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). Geologic mapping studies focused on the relationship of rock petrophysics to airborne magnetic data (Angen et al., 2015), the characterization of Late Cretaceous volcanic suites (Kim et al., 2015), and a preliminary surface-of-bedrock geology map for the TREK project area supported by geophysical data (Angen et al., 2015). Surficial geochemical and mineralogical surveys focused on basal till (Sacco and Jackaman, 2015; Jackaman et al., 2015), and re-analysis of archived till samples using modern laboratory techniques (Jackaman et al., 2015).

For the Endako mine area, Geoscience BC also released the results of a geochemical study on the use of tree sap for detecting buried mineralization (Heberlein et al., 2015), and published a comprehensive geo-exploration atlas for of the Endako porphyry molybdenum district (Devine et al., 2015).

Additionally, an M.Sc. thesis on the ore-forming processes and geochronology of the Blackwater deposit was completed through the Mineral Deposit Research Unit at the University of British Columbia and published (Looby, 2015).

7.2. Quesnel terrane

To generate a new structural interpretation of the QUEST survey area, Geoscience BC released data from a geologic mapping study that used a multi-dataset stacking methodology with public domain airborne geophysical and geological datasets (Sánchez et al., 2015).

7.3. Ancestral North America

The British Columbia Geological Survey (BCGS) and Geoscience BC released the results of studies exploring the use of Wilfley shaking table and Mozley C800 laboratory mineral separator for concentrating specialty metal indicator minerals from stream sediment samples near the Aley niobium deposit (Mackay et al., 2015). In November, a symposium on critical and strategic minerals was held in Victoria, and the proceedings were released with papers relevant to the Rocky Mountain rare metal belt (Simandl and Neetz, 2015).

BCGS also released the study results of a statistically robust treatment of public domain multi-element geochemical data from streams and lake sediments to reveal anomalies in the northern Kechika trough. The results are similar to those associated with Carlin-type gold deposits in Yukon and Nevada, where there is comparable geology (Rukhlov, 2015).

8. Summary

Due to the challenges associated with falling commodities prices, five operational or fully permitted coal mines, and two operational metal mines have gone into care and maintenance in the combined Omineca-Northeast region since 2013. For junior exploration companies the difficulties raising capital through equity financing has significantly slowed exploration since 2012-13. In the past two years, drilling programs have been primarily undertaken by intermediate-level companies or by private exploration companies.

Main highlights for 2015 include the continued ramp-up of the **Mt. Milligan** mine of Thompson Creek Metals Company Ltd. towards its design capacity mill throughput rate as it progresses into Phase 3 of mining; the issuing of an Environmental Assessment certificate for the **Murray River** project of HD Mining International Ltd.; the acceptance of the **Sukunka** (Glencore plc) and **Giscome** (Graymont Western Canada Inc.) Environmental Assessment applications for formal review; increased and upgraded resources at **Groundhog** (Atrum Coal Groundhog Inc.), **Sukunka**, and **Wapiti East** (Fertoz International Inc.); the continued delineation of an orebody through drilling at the **Kemess East** property of AuRico Metals Inc.; and drilling results indicating a more extensive mineralized zone at the **Kliyul** property of Teck Resources Limited and Kiska Metals Corporation. Projects continuing to advance through Environmental Assessment towards final application submission include: **Blackwater** (New Gold Inc.) and **Aley** (Taseko Mines Limited).

New discoveries continue to be made such as the epithermal vein system at the **2 X Fred** property of Kootenay Silver Inc. and Theia Resources Ltd., and underexplored parts of the Omineca Region are generating interest and seeing more grassroots to early-stage exploration. These include, for porphyry-style mineralization, the southern tail of the Hogem intrusive complex and the Ingenika fault corridor (McConnell range) north of the Hogem intrusive complex; and for epithermal-style mineralization, the central part of the Toodoggone River area, north of the Kemess property.

Acknowledgments

The information in this report was derived from news releases, quarterly reports, MD&A reports, company websites, technical reports, assessment reports, COALFILE reports, MINFILE reports, Geological Survey of British Columbia publications, Geological Survey of Canada publications, the British Columbia digital geology map, 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.

References cited

Aley Corporation, 2014. Aley Mine Project: Project Description summary: Prepared for Canadian Environmental Assessment Agency, 65p.

Alldrick, D.J. and Lin, C.M., 2007. Geology of the Skeena Group, central British Columbia (NTS 093E,F,K,L,M; 103I,P). BC Ministry of Energy, Mines and Petroleum Resources, Open File 2007-8.

Angen, J.J., Westberg, E., Hart, C.J.R., Kim, R., and Raley, C., 2015. TREK geology project: recognizing Endako Group and Chilcotin Group basalts from airborne magnetic data in the Interior Plateau region, south-central British Columbia (NTS 093B, C, F, G). In: Geoscience BC Summary of Activities 2014, Geoscience BC, Report 2015-1, pp. 21-32.

Angen, J.J., Westberg, E., Hart, C.J.R, Kim, R., and Rahimi, M., 2015. Preliminary geological map of the TREK project area, Central British Columbia. Geoscience BC Map 2015-10-01, also as Geoscience BC Report 2015-10.

Atrum Coal NL, 2015. Atrum Coal - 100% increase in JORC resources at Groundhog North [Press release]. http://atrumcoal.com/wp/wp-content/uploads/2014/10/015618991.pdf (Last accessed December, 2015).

Barrie, C.T., 1993. Petrochemistry of shoshonitic rocks associated with porphyry copper-gold deposits of central Quesnellia, British Columbia, Canada. Journal of Geochemical Exploration 48, no. 2, pp. 225-258.

Bath, A.B., Cooke, D.R., Davies, A.G.S, Friedman, R.M., Faure, K., Kamenetsky, V.S., Tosdal, R.M, and Berry, R.F., 2014. Mineralization, U-Pb geochronology, and stable isotope geochemistry of the Lower Main Zone of the Lorraine Deposit, north-central British Columbia: a replacement-style alkalic Cu-Au porphyry. Economic Geology, 109, pp. 979-1004.

Blais-Stevens, A., and Clague, J.J., 2007. Surficial geology, south-eastern portion of the Prince George map area British Columbia. Geological Survey of Canada, Open File 5274.

BP Coal Limited, 1977. Sukunka/Bullmoose coal mine project. British Columbia Ministry of Energy and Mines, British Columbia Geological Survey COALFILE 669, 73p.

Bradley, M.D., 1991. An assessment report on the 1990 reconnaissance program of geological mapping and geochemical survey on the Copper King #1 and Copper King #2 mineral claims, Omineca Mining Division: Prepared for Arbor Resources Inc., British Columbia Ministry of Energy and Mines, British Columbia Geological Survey Assessment Report 21064, 54p.

British Columbia Geological Survey, 2015. British Columbia coal industry overview 2015. British Columbia Geological Survey Information Circular 2016-2.

Broadbent, G.C., Myers, R.E., and Wright, J.V., 1998. Geology and origin of shale-hosted Zn-Pb-Ag mineralization at the Century deposit, northwest Queensland, Australia. Economic Geology, 93, pp. 1264-1294.

Butrenchuk, S., 1996. Phosphate deposits in British Columbia. British Columbia Ministry of Energy, Mines and Petroleum Resources Bulletin 98, 126p.

Chadwick, P., 2014. Chuchi project executive summary: Prepared for Kiska Metals Corporation, 23p.

Christie, G., Lipiec, I., Simpson, R.G., Horton, and J., Borntraeger, B., 2014. Blackwater gold project, British Columbia, NI 43-101 technical report on feasibility study. AMEC, GeoSim Services Inc., Norwest Corporation, Knight Piésold Consulting: Prepared for New Gold Inc., 336p.

Clifford, A., and Hart, C.J.R., 2014. Targeting Resources through Exploration and Knowledge (TREK): Geoscience BC's newest minerals project, Interior Plateau region, central British Columbia (NTS 093B, C, F, G). In: Geoscience BC Summary of Activities 2013, Geoscience BC, Report 2014-1, pp. 13-18.

Clifford, R., and Berthelsen, D., 2015. NI 43-101 Technical Report: Mount Milligan mine, north central British Columbia: Prepared by Thompson Creek Metals Company Inc. 223 p.

Cohen, K.M., Finney, S.C., Gibbard, P.L., and Fan J.-X., 2013; updated. The ICS International Chronostratigraphic Chart. Episodes 36: pp. 199-204.

Cui, Y., Miller, D., Nixon, G., and Nelson, J., 2015. British Columbia digital geology. British Columbia Geological Survey Open File 2015-2.

Cunningham, J.M., and Sprecher, B., 1992. Peace River Coalfield digital mapping program (930/8, 15). In: Geological Fieldwork 1992, British Columbia Geological Survey Paper 1993-1, pp. 537-546.

Dahrouge, J.,and Kluczny, P., 2007. 2006 Diamond drilling of the Pat claims: Giscome, British Columbia: Prepared for Ecowaste Industries Ltd. British Columbia Ministry of Energy and Mines, British Columbia Geological Survey Assessment Report 29089, 108p.

Devine, F. A. M, Chamberlain, C.M., Davies, A.G.S, and Friedman, R., 2014. Geology and district-scale setting of tilted alkalic porphyry Cu-Au mineralization at the Lorraine deposit, British Columbia. Economic Geology, 109, pp. 939-977.

Devine, F.A.M., Pond, M., Heberlein, D.R., Kowalczyk, P., and Kilby, W., 2015. A geo-exploration atlas of the Endako porphyry molybdenum district. Geoscience BC Report 2015-08 (Final Version), 44p.

Diakow, L.J. and Levson, V.M., 1997. Bedrock and surficial geology of the southern Nechako Plateau, central British Columbia (NTS 93F/2,3,6,7). British Columbia Ministry of Energy and Mines, Geoscience Map 1997-2, 1:100,000 scale.

Diakow, L.J., Panteleyev, A., and Shroeter, T.G., 1993. Geology of the Early Jurassic Toodoggone Formation and gold-silver deposits in the Toodoggone River map area, northern British Columbia. British Columbia Ministry of Energy, Mines and Petroleum Resources Bulletin 86, 80p.

Diakow, L.J., Webster, I.C.L., Richards, T.A., and Tipper, H.W., 1997. Geology of the Fawnie and Nechako ranges, southern Nechako Plateau, central British Columbia (93F/2, 3, 6, 7). British Columbia Ministry of Employment and Investment, Geological Survey Paper 1997-2, 30p.

ERM Rescan. 2014. Murray River Coal Project: Application for an Environmental Assessment Certificate / Environmental Impact Statement: Prepared for HD Mining International Ltd. by ERM Consultants Canada Ltd.: Vancouver, British Columbia, 174p.

ERM Rescan, 2014. Kemess Underground project: Project Description: Prepared for AuRico Gold by ERM Rescan, 231 p.

Evenchick, C.A., McMechan, M.E., McNicoll, V.J., and Carr, S.D. 2007. A synthesis of the Jurassic-Cretaceous tectonic evolution of the central and southeastern Canadian Cordillera: exploring links across the orogeny. In: Sears, J.W., Harms, T.A., and Evenchick, C.A. (Eds.), Whence the mountains? Inquiries into the evolution of orogenic systems: a volume in honour of Ramond A. Price, Geological Society of America, Special Paper 433, pp. 117-145.

Ferri, F. Melville, D.M., and Orchard, M.J., 1994. Bedrock geology of the Germansen Landing - Manson Creek area, British Columbia (94N/9, 10, 15; 94C/2). British Columbia Ministry of Mines and Petroleum Resources Bulletin 91, 148p.

Friedman, R.M., Diakow, L.J., Lane, R.A., Mortensen, J.K., 2001. New U-Pb age constraints on latest Cretaceous magmatism and associated mineralization in the Fawnie Range, Nechako Plateau, central British Columbia. Canadian Journal of Earth Sciences, 38, pp. 619-637.

Gabrielse, H., Murphy, D.C. and Mortensen, J.K., 2006. Cretaceous and Cenozoic dextral orogen-parallel displacements, magmatism and paleogeography, north-central Canadian Cordillera. In: Paleogeography of the North American Cordillera: Evidence For and Against Large-Scale Displacements, Haggart, J.W., Monger, J.W.H., and Enkin, R.J., (Eds.), Geological Association of Canada Special Paper 46, pp. 255-276.

Garnett, J.A., 1978. Geology and mineral occurrences of the southern Hogem Batholith. British Columbia Ministry of Mines and Petroleum Resources Bulletin 70, 75p.

Gill, D. G., 1994a, Drilling assessment report on the Kliyul Group of claims, British Columbia Ministry of Energy, Mines and Petroleum Resources Assessment Report 23797, 160p.

Grieve, D.A., Holuszko, M.E. and Goodarzi, F., 1995. British Columbia coal quality survey. British Columbia Ministry of Employment and Investment, Geological Survey Branch Bulletin 96, 114p.

Haynes, L.R., and Hardy, J.L., 1987. Diamond drilling on the Coral Group - Liard Mining Division, NTS 943B/W: Prepared for Northgate Exploration Ltd. British Columbia Ministry of Energy and Mines, British Columbia Geological Survey Assessment Report 16254, 70p.

Heberlein, D.R., Dunn, C.E. and Hoffman, E., 2015. Investigation of tree sap as a sample medium for regional geochemical exploration in glacial sediment covered terrains: A case history from the Endako area, north-central BC (NTS map sheets 093F14, 093F15, 093K03 and 093K02). Geoscience BC, Report 2015-02, 49p.

Holliday, J.R., and Cooke, D.R., 2007. Advances in geological models and exploration methods for copper ±gold porphyry deposits. In: Proceedings of Exploration, 7, pp. 791-809.

Jackaman, W., Sacco, D. and Lett, R.E., 2014. Geochemical reanalysis of archived till samples, TREK project, Interior Plateau, central BC (parts of NTS 093C, 093B, 093F & 093K). Geoscience BC, Report 2015-09, 5p.

Jackaman, W., Sacco, D.A. and Lett, R.E., 2015. Regional geochemical and mineralogical data, TREK project - Year 2, Interior Plateau, British Columbia. Geoscience BC, Report 2015-12.

Kim, R., Hart, C.J.R., Angen, J.J. and Westberg, E., 2015. Characterization of Late Cretaceous volcanic suites in the TREK project area, central British Columbia (NTS 093F, K). In: Geoscience BC Summary of Activities 2014, Geoscience BC, Report 2015-1, 33-40.

Krohn, M.D., Kendall, C., Evans, J.R., and Fries, T.L., 1993. Relations of ammonium minerals at several hydrothermal systems in the western US. Journal of volcanology and geothermal research, 56, pp. 401-413.

Lane, R.A., and Schroeter, T.G., 1997. A review of metallic mineralization in the Interior Plateau, central British Columbia (parts of 93B, C and F). In: Interior Plateau geoscience project: Summary of geological, geochemical and geophysical studies,

Diakow, L.J. and Newell, J.M. (Eds.), B.C. Ministry of Energy, Mines and Petroleum Resources, Paper 1997-2, pp. 237-256.
Lane, B., 2011. Geochemical and geological report on the Lawyers property, Omineca Mining Division, British Columbia. Guardsmen Resources Inc. British Columbia Ministry of Energy and Mines, British Columbia Geological Survey Assessment Report 32055, 67p.
Lang, J.R., Stanley, C.R., and Thompson, J.F.H., 1995. Porphyry copper-gold deposits related to alkalic igneous rocks in the Triassic-Jurassic arc terranes of British Columbia. Arizona Geological Society Digest, 20, pp. 219-236.
Leach, D.L., Bradley, D.C., Huston, D., Pisarevsky, S.A., Taylor, R. D., and Gardoll, S.J., 2010. Sediment-hosted lead-zinc deposits in Earth history. Economic Geology, 105, pp. 593-625.
Levson, V.M., and Giles, T., 1993. Geology of Tertiary and Quaternary gold-bearing placers in the Cariboo region, British Columbia (93A, B, G, H). British Columbia Ministry of Energy, Mines and Petroleum Resources Bulletin 89, 202p.
Logan, J.M., 2013. Porphyry systems of central and southern BC: Overview and field trip road log. Society of Economic Geologists, Inc., Guidebook Series, 44, pp. 1-45.
Logan, J.M., and Mihalynuk, M.G., 2014. Tectonic controls on Early Mesozoic paired alkaline porphyry deposit belts (Cu-Au ±Ag-Pt-Pd-Mo) within the Canadian Cordillera. Economic Geology, 109, pp. 827-858.
Looby, E.L., 2015. The timing and genesis of the Blackwater gold-silver deposit, central British Columbia: constraints from geology, geochronology and stable isotopes. Master of Science thesis, University of British Columbia, 172p.
Lowe, C., Enkin, R.J., and Struik, L.C., 2001. Tertiary extension in the central British Columbia Intermontane Belt: magnetic and paleomagnetic evidence from the Endako region. Canadian Journal of Earth Sciences, 38, pp. 657-678.
Mackay, D.A.R., Simandl, G.J., Grcic, B., Li, C., Luck, P., Redfearn, M. and Gravel, J., 2015. Evaluation of Mozley C800 laboratory mineral separator for heavy mineral concentration of stream sediments in exploration for carbonatite-hosted specialty metal deposits: case study at the Aley carbonatite, northeastern British Columbia (NTS 094B). In: Geoscience BC Summary of Activities 2014, Geoscience BC, Report 2015-1, pp. 111-122.
Mackay, D.A.R., Simandl, G.J., Luck, P., Grcic, B., Li, C., Redfearn, M., and Gravel, J., 2015. Concentration of carbonatite indicator minerals using a Wilfley gravity shaking table: A case history from the Aley carbonatite, British Columbia, Canada. In: Geological Fieldwork 2014, British Columbia Ministry of Energy and Mines, British Columbia Geological Survey Paper 2015-1, pp. 189-195.
MacIntyre, D.G., 1998. Geology, geochemistry and mineral deposits of the Akie River area, northeast British Columbia. British Columbia Ministry of Energy and Mines Bulletin 103, 91p.
Mäder, U.K., 1986. The Aley carbonatite complex, Northern Rocky Mountains, British Columbia (94B/5). In: Geological fieldwork 1986, British Columbia Geological Survey Branch Paper 1987-1, pp. 283-288.
McLeish, D., 2011. Technical report on structural geology, Aley carbonatite niobium project, British Columbia, Canada. Private report to Taseko Mines Ltd., 18p.
McLeish, D.F., 2013. Structure, stratigraphy, and U-Pb zircon-titanite geochronology of the Aley carbonatite complex, northeast British Columbia: evidence for Antler-aged orogenesis in the Foreland Belt of the Canadian Cordillera. Master of Science thesis, University of Victoria, 142p.
Mihalynuk, M.G., Nelson, J., and Diakow, L.J., 1994. Cache Creek terrane entrapment: oroclinal paradox within the Canadian Cordillera. Tectonics, 13-3, pp. 575-595.
Mihalynuk, M.G., 2007. Neogene and Quaternary Chilcotin Group cover rocks in the Interior Plateau, south-central British Columbia: a preliminary 3-D thickness model. In: Geological Fieldwork 2006, BC Ministry of Energy, Mines and Petroleum Resources, Paper 2007-1 and Geoscience BC, Report 2007-1, pp. 143-147.
Millonig, L.J., and Groat, L.A., 2013. Carbonatites in western North America - occurrences and metallogeny. Society of Economic Geologists, Special Publication 17, pp. 145-164.
Monger, J.W.H., 2008. Evolution of Canada's western mountains; Geological Survey of Canada, Open File 5804, 1 poster.
Mortensen, J.K., Ghosh, D.K., and Ferri, F., 1995. U-Pb geochronology of intrusive rocks associated with copper-gold porphyry deposits in the Canadian Cordillera. In: Canadian Institute of Mining and Metallurgy, special volume 46, pp. 142-158.
Nelson, J.L., and Bellefontaine, K.A., 1996. The geology and mineral deposits at north-central Quesnellia: Tezzeron Lake to Discovery Creek, central British Columbia. British Columbia Ministry of Employment and Investment, Geological Survey Bulletin 99, 100p.
Nelson, J.L., Colpron, M., and Israel, S.K., 2013. The Cordillera of British Columbia, Yukon, and Alaska: tectonics and metallogeny. In: Colpron, M., Bissig, T., Rusk, B., and Thompson, J.F.H., (Eds.), Tectonics, Metallogeny, and Discovery - the North American Cordillera and similar accretionary settings. Society of Economic Geologists, Special Publication 17, pp. 53-109.
New Gold Inc., 2015. Blackwater project exploration update: Nechako Plateau, British Columbia, Canada. 2015 annual KEG conference, Kamloops, BC. http://s1.q4cdn.com/240714812/files/doc_presentations/2015/BW_2015-BLACKWATER_KEG_Prestn_v-FINAL2.pdf (Last accessed December, 2015).
Nixon, G.T., Hammack, J.L., Ash, C.H., Cabri, L.J., Case, G., Connelly, J.N., Heaman, L.M., Laflamme, J.H.G., Nuttall, C., Paterson, W.P.E., and Wong, R.H., 1997. Geology and platinum-group-element mineralization of Alaskan-type ultramafic–mafix complexes in British Columbia. In: British Columbia Ministry of Employment and Investment, Energy and Mines Division, Bulletin, p. 93.
Norwest Corporation, 2010. Geology and coal resources of the Murray River coal property, Peace River Coalfield, British Columbia: Submitted to Canadian Dehua International Mines Group Inc., British Columbia Ministry of Energy and Mines, British Columbia Geological Survey COALFILE 910, 122p.
Peace River Coal Inc., 2007. Project Description - Roman Mountain coal project: Submitted to BC Environmental Assessment Office, 25p.
Pell, J., 1994. Carbonatites, nepheline syenites, kimberlites and related rocks in British Columbia. British Columbia Ministry of Energy, Mines and Petroleum Resources Bulletin 88, 136p.
Peters, B. and Ritchie, R., 2014. Assessment report on the Col-Later property. British Columbia Geological Survey Assessment Report 34717, 179p.
Pond, M., 2013. The Endako Mine porphyry molybdenum deposit: update 2013. In: Logan, J., and Schroeter, T.G., (Eds.), Porphyry systems of central and southern BC: Prince George to Princeton. Society of Economic Geologists Field Trip Guidebook Series 44, pp. 46-54.
Pottinger Gaherty Environmental Consultants Ltd., 2013. Project Description - Giscome Quarry and Lime Plant: Prepared for Graymont Western Canada Inc., Submitted to BC Environmental Assessment Office, 40p.
Resnick, J., Anderson, R.G., Russell, J.K., Edwards, B.R. and Grainger, N.C., 1999. Neogene basaltic flow rocks, xenoliths, and related diabase, northern Nechako River map area, central British Columbia. In: Current Research 1999-A, Geological Survey of Canada, pp. 157-167.
Riddell, J., 2012. Potential for freshwater bedrock aquifers in northeast British Columbia: regional distribution and lithology of surface and shallow subsurface bedrock units (NTS 093I, O, P; 094A, B, G, H, I, J, N, O, P). In: Geoscience Reports 2012, British

Columbia Ministry of Energy and Mines, pp. 65-78.
Rukhlov, A.S., Han, T., Nelson, J., Hickin, A.S., and Ferri, F., 2015. Carlin-type geochemical signal in lake and stream sediments from the Kechika trough, north-central British Columbia. In: Geological Fieldwork 2014, British Columbia Ministry of Energy and Mines, British Columbia Geological Survey Paper 2015-1, pp. 165-188.
Sacco, D.A. and Jackaman, W., 2015. Targeted geochemical and mineralogical surveys in the TREK project area, central British Columbia (parts of NTS 093B, C, F, G): year two. In: Geoscience BC Summary of Activities 2014, Geoscience BC, Report 2015-1, pp. 1-12.
Sánchez, M.G., Bissig, T. and Kowalcyzk, P., 2015. Toward an improved basis for beneath-cover mineral exploration in the QUEST area, central British Columbia: new structural interpretation of geophysical and geological datasets (NTS 093A, B, G, H, J, K, N). In Geoscience BC Summary of Activities 2014, Geoscience BC, Report 2015-1, pp. 53-62.
Schiarizza, P., and MacIntyre, D., 1998. Geology of the Babine Lake - Takla Lake area, central British Columbia (93 K/11, 12, 13, 14; 93 N/3, 4, 5, 6). In: Geological fieldwork 1998, British Columbia Geological Survey Branch Paper 1999-1, pp. 33-68.
Schiarizza, P., 2003. Geology and mineral occurrences of Quesnel Terrane, Kliyul Creek to Johanson Lake (94D/8,9). In: Geological Fieldwork 2003, BC Ministry of Energy and Mines, Paper 2004-1, pp. 83-100.
Schiarizza, P., 2004a. Geology of the Kliyul Creek-Johanson Lake area, Parts of NTS 94D/8 and 9. British Columbia Ministry of Energy and Mines, Open File Map 2004-5, scale 1:50,000.
Sim, R.C., 2012. NI 43-101 technical report - Akie zinc-lead-silver project, British Columbia, Canada: Prepared for Canada Zinc Metals Corp., 130p.
Simandl, G.J., Riveros, C.P., and Schiarriza, P., 2000. Nephrite (jade) deposits, Mount Ogden area, central British Columbia (NTS 093N 13W). In: Geological fieldwork 1999, British Columbia Geological Survey Paper 2000-1, pp. 339-348.
Simandl, G.J. and Neetz, M., (Eds.), 2015. Symposium on Strategic and Critical Materials Proceedings, November 13-14, 2015, Victoria, British Columbia, British Columbia Ministry of Energy and Mines, British Columbia Geological Survey Paper 2015-3.
Smith, G.G., Cameron, A.R., and Bustin, R.M., 1994. Chapter 33 - Coal resources of the Western Canada Sedimentary Basin. In: Geological Atlas of the Western Canada Sedimentary Basin, G. Mossop and I. Shetsen (compilers), Canadian Society of Petroleum Geologists and Alberta Research Council, pp. 471-481.
Stantec Consulting Ltd., 2013. Project Description - Proposed Sukunka coal mine project: Prepared for Xstrata Coal Canada, Submitted to Canadian Environmental Assessment Agency and BC Environmental Assessment Office, 122p.
Staples, R.D., 2009. Thermotectonic evolution of the Wolverine metamorphic complex, British Columbia: limitations on the use of combined ion exchange and net-transfer reaction geothermobarometry at upper amphibolite-facies metamorphism. Master of Science thesis, Simon Fraser University, 125p.
Stott, D.F., 1984. Cretaceous sequences of the foothills of the Canadian Rocky Mountains. In: The Mesozoic of Middle North America, D.F. Stott and D.J. Glass, (Eds.), Canadian Society of Petroleum Geologists Memoir 9, pp. 85-107.
Struik, L.C., Fuller, E.A. and Lynch, T.E., 1990. Geology of Prince George (East Half) Map Area (93 G/E) descriptive notes and fossil list, Geological Survey of Canada Open File 2172, scale 1:250,000.
Thompson, R.I. 1986. Geology of Halfway River (94B), Geological Survey of Canada Map 1634A, 1:250,000 scale.
Turner, R.J.W., Nowlan, G.S., Franklin, R., and Focht, N. 2010. GeoTour guide for Prince George, British Columbia. Geological Survey of Canada Open File 5559, 22p.
Voordouw, R., 2012. 2012 Geological and geophysical report on the Kliyul project: Prepared for Kiska Metals Corporation, British Columbia Ministry of Energy and Mines, British Columbia Geological Survey Assessment Report 33031, 109p.
Webster, I., 2013. The Big Bear property: NTS sheet 093E/02, 03, 06, 07: Prepared for Little Bear Gold Corp., British Columbia Ministry of Energy and Mines, British Columbia Geological Survey Assessment Report 34134, 678p.
Wetherup, S. and Struik, L.C., 1996. Vanderhoof Metamorphic Complex and surrounding rocks, central British Columbia. In: Current Research 1996-A. Geological Survey of Canada, pp. 63-70.
Witte, A., Bostwick, C., Skrecky, G., Bent, H., Jakubec, J., Volk, J., Major, K., and Corpuz, P., 2013. NI 43-101 technical report for the Kemess Underground project, British Columbia, Canada: Prepared by SRK Consulting (Canada) Inc. for AuRico Gold Inc., 249p.
Wright, G.N., McMechan, M.E., and Potter, D.E.G. 1994. Chapter 3 - Structure and architecture of the Western Canada Sedimentary Basin. In: Geological Atlas of the Western Canada Sedimentary Basin, G. Mossop and I. Shetsen (compilers), Canadian Society of Petroleum Geologists and Alberta Research Council, pp. 25-40.
Villeneuve, M., Whalen, J. B., Anderson, R. G., and Struik, L. C., 2001. The Endako Batholith: episodic plutonism culminating in formation of the Endako porphyry molybdenite deposit, north-central British Columbia. Economic Geology, 96, pp. 171-196.
Wojdak, P., 2008. Fireside deposit: Diagenetic barite in strata of the Kechika trough, northwestern British Columbia (NTS 094M/14). In: Geological Fieldwork 2007, British Columbia Geological Survey Paper 2008-1, pp. 219-225.
Yukon Geological Survey, 2007. Selwyn Basin metallogeny. Government of Yukon. http://www.geology.gov.yk.ca/pdf/SelwynBasin.pdf (Last accessed December, 2015).
Zharikov, V. A., Pertsev, N. N., Rusinov, V. L., Callegari, E., and Fettes, D. J., 2007. Metasomatism and metasomatic rocks. Recommendations by the IUGS subcommission on the systematics of metamorphic rocks, paper 9. https://www.bgs.ac.uk/scmr/docs/papers/paper_9.pdf (Last accessed December, 2015).