Exploration and mining in the North Central 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

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1. Introduction

The North Central (Omineca) Region has subdued to mountainous physiography and varied geology reflecting a history of volcanic arc and oceanic terrane accretion onto the western margin of ancestral North America followed by episodes of mountain-building, post-accretionary volcanism and sedimentation, regional transcurrent faulting, and glaciation. The Omineca Mountains cover much of north-central British Columbia, west and northwest of the town of Mackenzie (Figs. 1, 2). Rocks of the region are prospective for metals including copper, molybdenum, gold, silver, zinc, lead, nickel, niobium, rare-earth elements, for anthracite coal, and for other industrial, construction and ornamental minerals including silica, limestone, aggregate, and nephrite jade. The main ore deposit types explored for in 2016 (Figs. 1, 3) included epithermal gold-silver, porphyry copper-gold, and stratiform zinc-lead-silver. The Mt. Milligan open-pit copper-gold mine is the only operating mine in the region. It is in its third year of production and completed its ramp-up phase at the start of the year. The open-pit Endako molybdenum mine remained on care and maintenance status into a second year. Small-scale mining continued for nephrite jade north-northwest of Fort St. James. Along the tributaries of several rivers in the region, placer gold and sand and gravel operations were carried out. As of December, the number of notice-of-work applications for 2016 was over 30 for mineral (down about 25% from more than 40 in 2015); over 30 for sand-and-gravel (down about 25% from over 40 in 2015); and 70 for placer (up about 40% from close to 50 in 2015). About 1.40 million hectares or 8.86% of the region were under mineral claim; about 259,750 hectares under coal licence (117,350 ha) and coal licence applications (142,400 ha), or 1.64% of the region; and about 61,880 hectares under placer claim (59,420 ha) or placer lease (2460 ha) or 0.40% of the region.

In 2016, exploration expenditures, drilling estimates, and other metrics for British Columbia were captured in the British Columbia Mineral and Coal Exploration Survey, which replaces the annual Ministry of Energy and Mines mineral exploration expenditures survey. The survey is a joint initiative between the Province of British Columbia Ministry of Energy and Mines, the Association for Mineral Exploration, and Ernst & Young LLP. For the North Central Region, exploration expenditures were estimated at 29.0 million dollars and exploration drilling was estimated at approximately 34,500 m (Clarke et al., this volume; Ernst & Young LLP (E&Y), 2017 in press).

In 2016, ramp-up activities were completed at the **Mt. Milligan** mine (Centerra Gold Inc.), environmental assessments continued for **Kemess Underground** (AuRico Metals Inc.), **Aley** (Taseko Mines Limited), **Blackwater** (New Gold Inc.), and **Giscome** (Graymont Western Canada Inc.), NI 43-101 compliant technical reports with updated resource estimates were provided for **Kemess Underground** and **Kemess East** (AuRico Metals Inc.), and **Lawyers** (PPM Phoenix Precious Metals Corp.), and Atrum Coal Groundhog Inc. was permitted to obtain an underground bulk coal sample and use an existing railbed subgrade for access.

Drilling was undertaken for porphyry copper-gold at **Kemess East** (AuRico Metals Inc.), **Kwanika** (Serengeti Resources Inc.), **Later** (ML Gold Corp., Pacific Empire Minerals Corp.), **North Grid-Mt. Milligan** (Centerra Gold Inc.), **Q7a** (Vale Exploration Canada Inc.), and **Thor** (Copper North Mining Corp); for sediment-hosted zinc-lead-silver at **Cirque** and **Pie** (Teck Resources Limited); for anthracitic coal at **Panorama North** (Atrum Coal Panorama Inc.); and for amber-bearing coal at **Bowron River**.

The Northeast Region is underlain by continental platform and slope and foreland basin strata exposed in the thin-skinned thrust and fold belt of the Northern Rocky Mountains. Bituminous coal, phosphate rock, and barite are the main exploration focus, although copper±silver quartz vein and stratiform zinc-lead deposit types are also prospective in areas. Aggregate is an important mineral product in the region, regularly used in the energy sector as roadwork and well-site construction material, and more recently as material for the $8.8 billion Site C Clean Energy Project (BC Hydro) project, which began construction in summer 2015 and is scheduled for completion in 2024. Metallurgical coal has been proportionately the largest of British Columbia's mined export commodities in recent years in terms of mineral production value, ranging from about 40-60%. Roughly 15% of the province's coal production was derived from the Peace River coalfield (Fig. 1) before challenging market conditions forced coal mines to

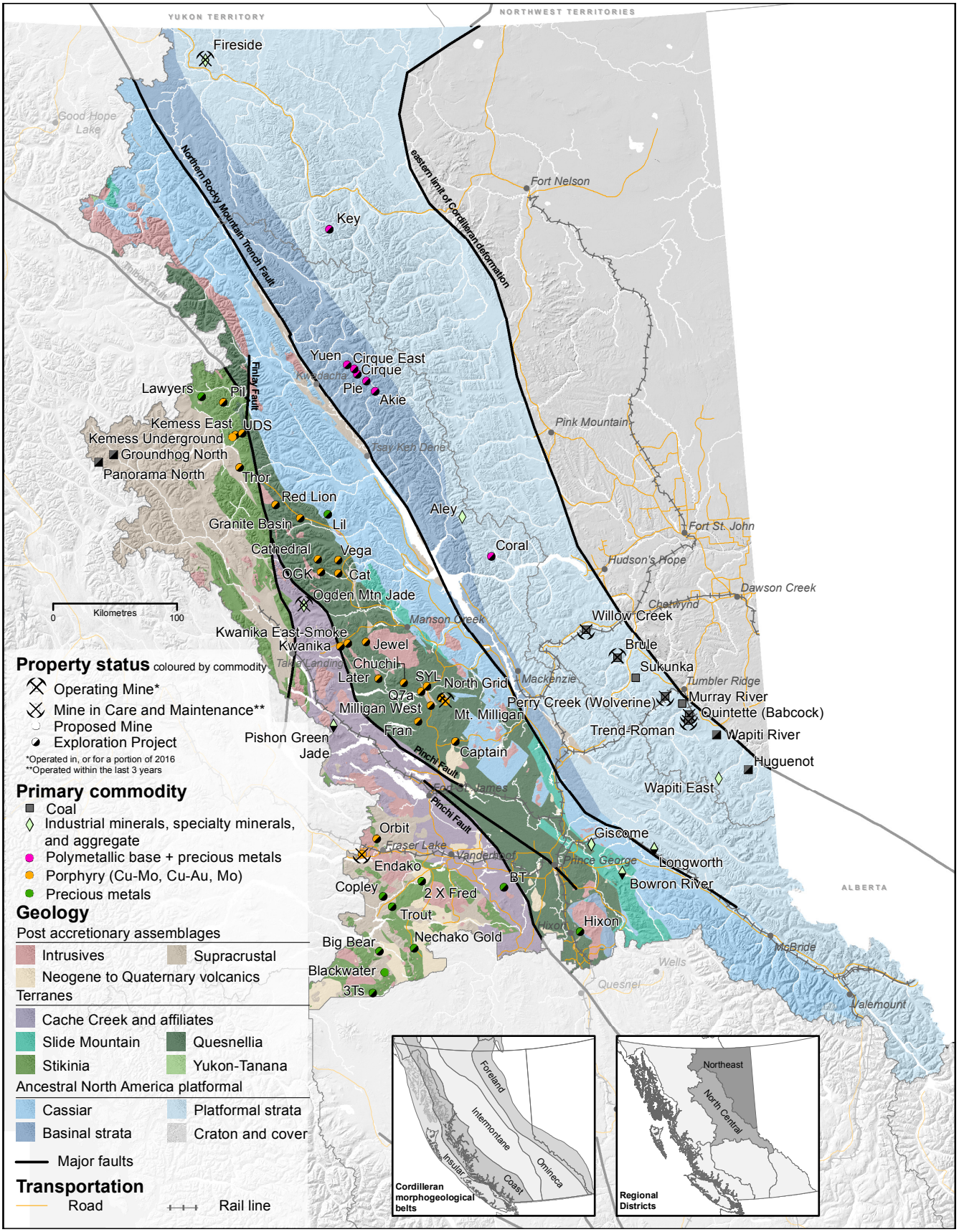

Fig. 1. Mines and selected exploration projects, North Central and Northeast regions, 2016. Terranes from the BC digital geology map (Cui et al., 2015).

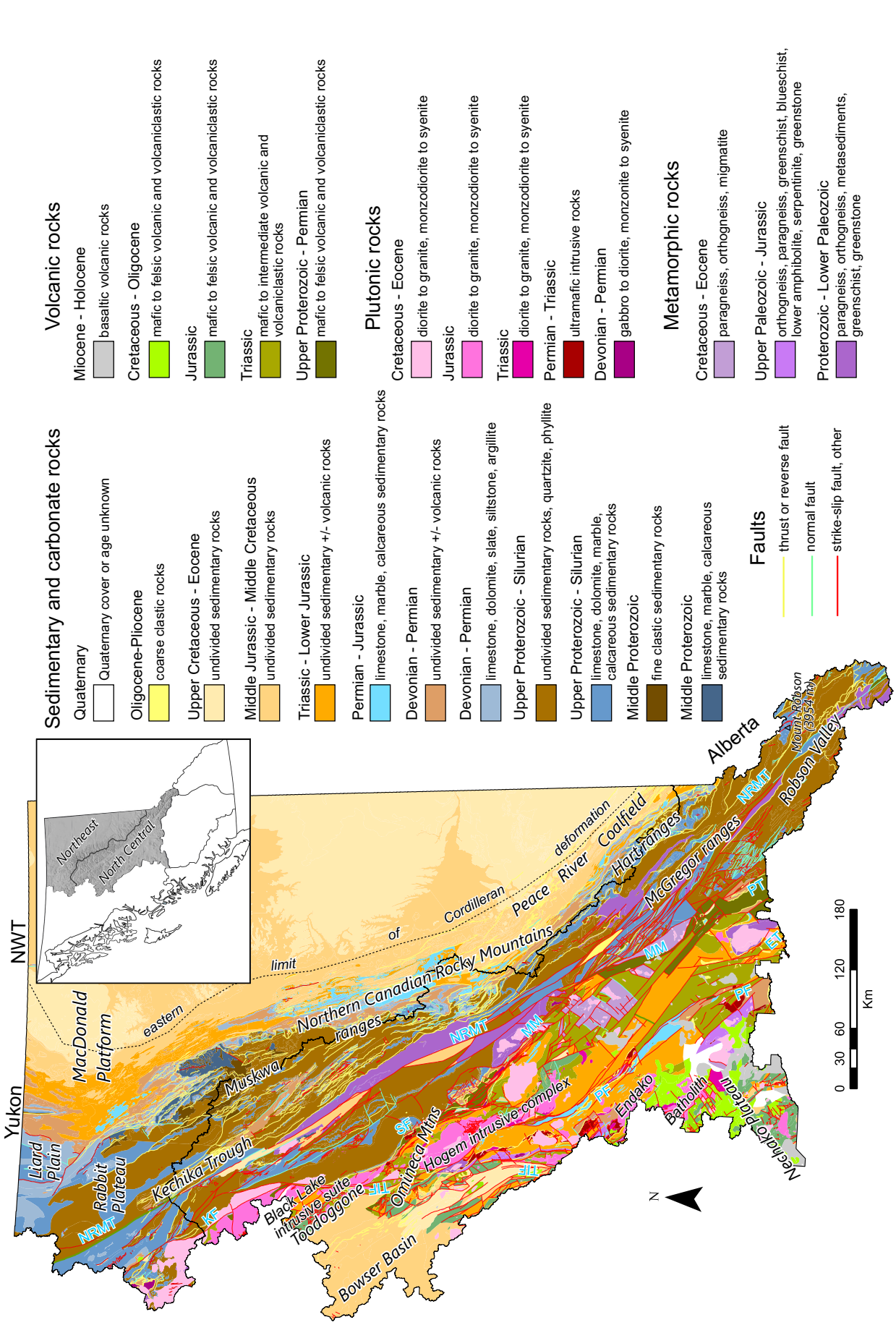

Fig. 2. Bedrock geology of the North Central and Northeast regions with selected geographic domains and features. Map data were sourced in March 2015 from Cui et al. (2015). Fault abbreviations: ET = Eureka thrust fault, KF = Kechika fault, MM = Manson-McLeod fault system, NRMT = Northern Rocky Mountain trench, PF = Pinchi fault, PT = Pundata thrust, SF = Swannell thrust fault, TIF = Takla-Ingenika-Finlay fault system.

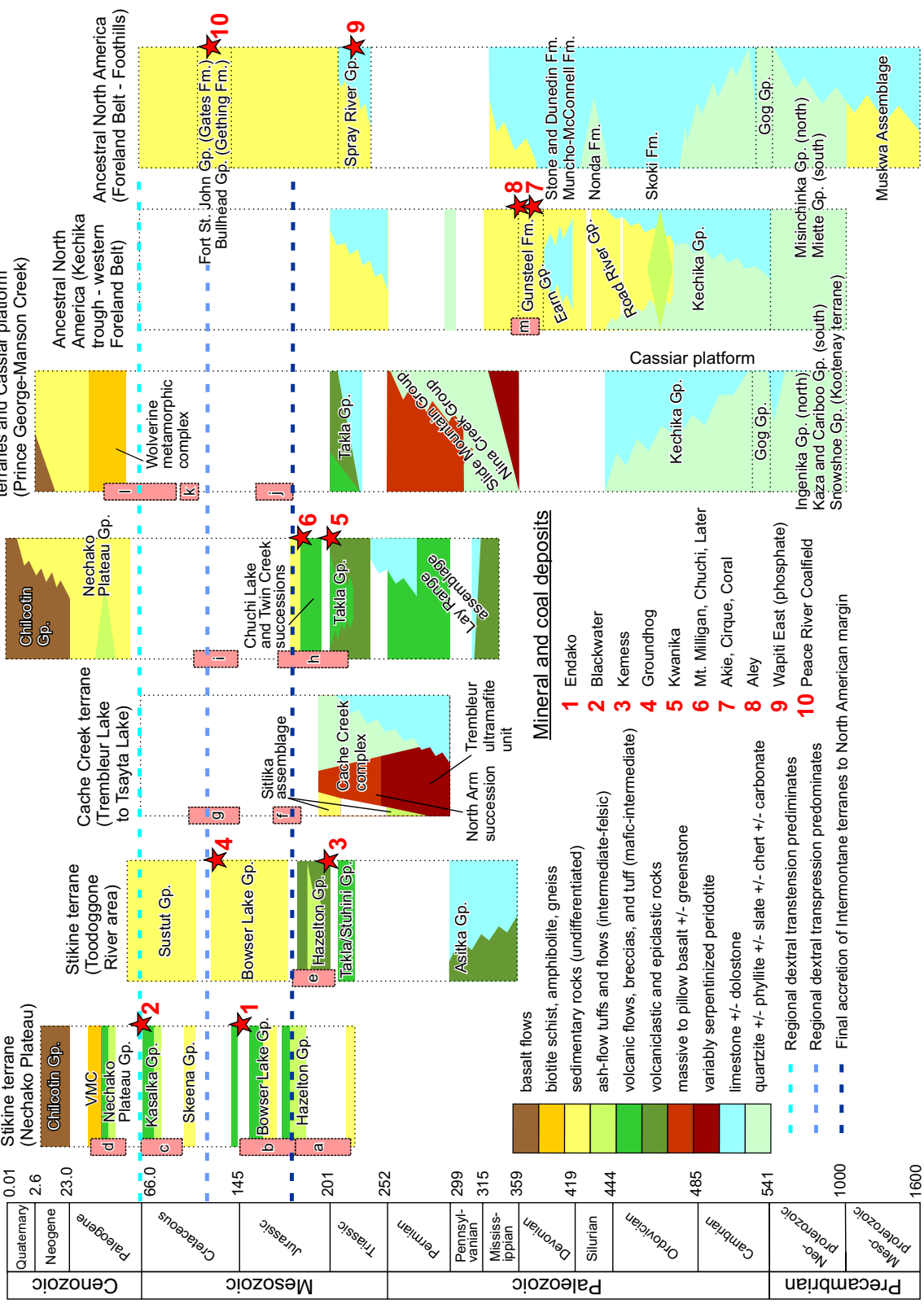

Fig. 3. Generalized stratigraphy, North Central and Northeast regions. Selected intrusive rocks: a) Brooks diorite complex and Stern Creek plutonic suite (Endako batholith), b) Endako batholith and Laidman batholith; c) Capoose batholith and Blackwater pluton; d) Chu pluton; e) Black Lake plutonic suite; 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 et al. (1994), Garnett (1978), Nelson and Bellefontaine (1996), MacIntyre (1998), Schiarizza and MacIntyre (1998), Staples (2009), Stott (1984), Wetherup and Struik (1996), Villeneuve et al. (2001), and the BC digital geology map (Cui et al., 2015). VMC is Vanderhoof metamorphic complex. Mineral and coal deposit ages are from Evenchick and Thorkelson (2005), Logan and Mihalynuk, (2014), McLeish (2013), Nelson and Bellefontaine (1996), New Gold Inc. (2015), and Pell (1994). Geologic timescale from International Commission on Stratigraphy (Cohen et al., 2013).

idle operations in 2013 and 2014. 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. In 2016, three of the idled coal mines entered a sale and investment solicitation process, attracting a number of potential bidders. In August, international spot prices for premium hard coking coal began making strong gains just as an asset purchase agreement was signed between Walter Energy Canada Holdings, Inc. and Conuma Coal Resources Limited. In September the sale was finalized and, by the end of the month, restart activities had begun at the Brule mine. There was negligible exploration activity for coal in the region in 2016.

The region has one active industrial mineral mine (Fireside) in the Liard Plain area (Fig. 2), which produces barite. Numerous aggregate quarries and sand-and-gravel pits are distributed along river valleys in the central and eastern part of the region.

As of December, the total number of notice-of-work applications for 2016 included six for coal (down 40% from 10 in 2015); and over 70 for sand-and-gravel (up about 40% from close to 50% in 2015). About 533,990 hectares, or 3.0% of the region, were under coal lease (28,730 ha), coal licence (397,030 ha), and coal licence applications (108,230 ha); and about 44,730 hectares, or 0.26% of the region, under mineral claim. For the Northeast Region, exploration expenditures were estimated at $9.0 million and exploration drilling was estimated at approximately 2,900 m (Clarke et al., this volume; Ernst & Young LLP (E&Y), 2017 in press).

In 2016, restart activities commenced at the **Brule** mine (Conuma Coal Resources Limited); the underground bulk coal sample program at **Murray River** (HD Mining International Ltd.) was completed; engineering and environmental studies continued at **Murray River** supporting a Mines Act permit application, and at **Sukunka** (Glencore plc), supporting an environmental assessment; and a NI 43-101 compliant technical report with updated resource estimate was reported for **Wapiti River** (Canadian Dehua International Mines Group Inc.)

Ridley Terminals Inc., the main port servicing the Peace River coalfield, reported continued reduction in throughput for the first half of 2016. Rail unloading volumes decreased year-on-year by 44.83% (Q1) and 13.91% (Q2), and ship-loading volumes by 45.83% (Q1) and 15.07% (Q2).

2. Geological overview

Metallogeny in British Columbia is linked to the tectonic evolution of the Canadian Cordillera, first as an accretionary orogen consisting of allochthonous terranes that 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 North Central-Northeast combined region is underlain by: 1) ancestral North America (Laurentia), including cratonic basement rocks and Mesoproterozoic to Early Mesozoic siliciclastic and carbonate successions deposited on its western flank; 2) the Intermontane belt, including the Slide Mountain terrane (back-arc basin) the Quesnel and Stikine volcanic arc terranes, which formed outboard of ancestral North America starting in the Late Paleozoic and then accreted by the Middle Jurassic, and Late Paleozoic-Early Mesozoic oceanic rocks of the Cache Creek terrane; 3) post-accretionary rocks; and 4) younger cover rocks (Figs. 1-3).

Two main episodes of mountain building occurred (Monger, 2008), forming the Columbia-Omineca-Cassiar mountains (Middle Jurassic-Early Cretaceous) and the Northern Rocky Mountains (Late Cretaceous-Paleogene). The first produced a continuous belt of polydeformed 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 (e.g., Wright et al., 1994).

2.1. Ancestral North America

In the North Central and Northeast regions, Laurentian basement is unconformably overlain by Mesoproterozoic to Early Mesozoic continental shelf and deep-water marine siliciclastic and carbonate successions of the Western Canada Sedimentary Basin. These were deposited as a westward-thickening prism on the western cratonic margin of ancestral North America during protracted rifting and breakup of the supercontinent Rodinia (Fig. 3, Thompson, 1989; Nelson et al., 2013). Passive margin sedimentation ended in the Jurassic with orogenic activity related to terrane accretion. The oldest Mesoproterozoic rocks include dolomitic sedimentary units of the Muskwa basin (Muskwa assemblage, Figs. 2, 3), which host northeast-striking Churchill-type Cu±Ag quartz-ankerite veins spatially related to diabase dikes (MINFILE 094K 003) including those at the **Key** prospect.

In the Rocky Mountains north of Prince George, rocks of the Windermere Supergroup (Neoproterozoic) are represented by siliciclastic sedimentary units of the Misinchinka Group and their metamorphic equivalents (Ferri et al., 1994); south of Prince George are similar rocks of the Miette Group. The Gog Group (Lower Cambrian) unconformably overlies the Windermere Supergroup and consists predominantly of shield-derived sandstone, pebble conglomerate, quartzite and limestone.

In the Rocky Mountains north of Mackenzie, Early to Middle Paleozoic marine 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). The highest peak in the Canadian Rockies, Mt. Robson (Fig. 2) exposes a succession of Middle-Upper Cambrian carbonate rocks correlative to the Kechika Group. East of Prince George, Nonda Formation (Silurian; Fig. 3) greenstone, limestone and quartzite, including that at the **Longworth** silica prospect, are found in a westernmost range of the Rocky Mountains (McGregor range). Farther east, in the Hart ranges and west of the Peace River coalfield (see section 2.3.5.), Middle Triassic phosphorite-bearing siltstones

of the Sulphur Mountain Formation (Spray River Group; Fig. 3), host of the **Wapiti East** phosphate prospect, represent off-self sedimentation in open marine conditions with upwelling currents (Butrenchuk, 1996). Portions of this belt of Proterozoic to Lower Mesozoic rocks are prospective for copper±silver quartz veins, sediment-hosted zinc-lead, Carlin-type gold deposits, carbonatite-hosted specialty metals, barite, silica (including frac sand), and phosphate.

The Kechika trough is the southeastern extension of the Selwyn basin of the Yukon and Northwest Territories, which hosts prolific sedimentary exhalatite (SEDEX) zinc-lead deposits of Cambrian, Silurian and Late Devonian age (Magnall et al., 2014). 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 (Fig. 2). Siliceous and carbonaceous shale of the Upper Devonian Gunsteel Formation (Earn Group) hosts stratiform baritic zinc-lead-silver deposits including those at **Akie** and **Cirque**. The host shales are preserved in a series of Cretaceous to Paleogene northwest-trending imbricate thrust sheets and asymmetric synclinal keels (MacIntyre, 1998). A series of northwest-trending elongate asymmetric graben systems, with more localized restricted sub-basins, would have formed during Paleozoic extension and marine transgression; basin bounding normal faults may have been reactivated during Cretaceous shortening (Henry and Theissen, 2014).

The **Aley** carbonatite complex (Late Devonian-Early Mississippian) also lies in the Muskwa ranges and it is hosted by Cambrian to Ordovician carbonate and siliciclastic rocks, including shelf carbonates of the Skoki Formation (Ordovician; Fig. 3). The complex is 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 BC (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 and folded platformal dolomitic carbonate rocks, including the Muncho-McConnell Formation (Silurian-Devonian), and Stone and Dunedin formations (Lower to Middle Devonian; Fig. 3). Prospects, including **Coral**, are regarded as being coeval with Late Devonian SEDEX deposits farther west in the Kechika trough and are similarly associated with Devonian-Mississippian subduction in back-arc and intra-arc settings (Nelson et al., 2002).

The most outboard continental components of ancestral North America are the Cassiar platform and Kootenay parautochthonous terrane. Both originated as basement highs during Neoproterozoic to Cambrian fragmentation of Laurentia (Nelson et al., 2013). The Cassiar platform lies west of the Tintina-Northern Rocky Mountain trench fault; restoration of ca. 490 km of Cretaceous-Eocene dextral motion (Gabrielse et al., 2006) places it outboard of the southern Kechika trough. The oldest rocks are Paleoproterozoic to Mesoproterozoic, and include amphibolite facies metamorphic rocks and crystalline limestone along the Northern Rocky Mountain trench near Kwadacha (Cassiar platform; Fig. 1); and orthogneiss of the Malton Gneiss complex, which is the northernmost expression of the Monashee Mountains near Valemount (Kootenay terrane; 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 (Neoproterozoic) and Kechika Group, whereas southeast of Prince George are the Kaza (Neoproterozoic), Cariboo (Neoproterozoic-Cambrian) and Gog Group (Ferri et al., 1994). 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).

Triassic limestone sequences near **Giscome** are assigned to the North American margin and are interpreted as tectonic windows through overthrust Slide Mountain Group Mississippian-Permian basaltic volcanic units (Struik et al., 1990). South of Prince George, metasedimentary rocks of the Snowshoe Group (Neoproterozoic-Paleozoic) represent the northern extent of the Kootenay terrane. Cassiar platform rocks are locally prospective for argentiferous polymetallic veins, carbonatite-hosted specialty metals, limestone, and silica (including frac sand), whereas placer gold is the main focus of fluvial deposits that overly Kootenay terrane rocks.

2.2. Intermontane belt

In the North Central Region, the Intermontane belt (Fig. 1 inset) comprises a group of allochthonous terranes of the peri-Laurentian realm (Nelson et al., 2013) including volcanic arc terranes (Quesnel and Stikine), and structurally intervening oceanic terranes (Slide Mountain and Cache Creek).

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 et al., 1994). Its crust is preserved as imbricated allochthons structurally overlying the deformed continental margin. East and southeast of Prince George, the Antler Formation of the Slide Mountain Group (Mississippian-Permian; Fig. 3) includes pillowed basalt, basalt breccia, gabbro, diorite, argillite and chert. Northwest of Mackenzie, the Nina Creek Group (Mississippian-Permian) has marine sedimentary units, including chert and argillite, as well as basalt and gabbro. The terrane is bounded by strands of the Manson-McLeod fault system and the west-dipping Pundata thrust (Fig. 2).

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 more than 600 km in the North Central Region. The Quesnel arc (Mesozoic) developed in two phases above an Upper Paleozoic volcanic-sedimentary subterrane assemblage (Ferri et al., 1994; Nelson and Bellefontaine, 1996). The Takla Group (Fig. 3) phase comprises a lower unit of deep-water basin sedimentary rocks, including the Slate Creek succession (Middle to Upper Triassic), which underlies placer mining activities in the Manson Creek area (Fig. 1) and is prospective for gold-bearing quartz veins. This is overlain by Upper Triassic mafic and intermediate island-arc volcanic successions that represent several discrete volcanic centres. Facies variability is reflected in local names. In the Nation Lakes area, fine-grained volcaniclastic rocks of the Inzana Lake succession, which host rock of the **Fran** prospect, interfinger with overlying volcanic rocks of the Witch Lake succession, partial host of the **Mt. Milligan** deposit.Farther north, equivalent successions are the Willy George and Plughat Mountain facies, the latter considered host of the **Cat**, **Vega** and **Granite Basin** prospects.

In some areas, these rocks are paraconformably overlain by partially subaerial intermediate volcanic rocks, including the Chuchi Lake and Twin Creek successions (Early Jurassic; Fig. 3), which were emplaced on a more mature arc. The Chuchi Lake succession hosts the **Later** and **Q7a** prospects. 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 180-km long north-northwest trending Hogem intrusive complex (Figs. 2, 3) and its peripheral offshoots locally host, or are spatially related to, porphyry copper-gold±silver±molybdenum deposits and prospects including **Mt. Milligan**, **Kwanika**, **Cathedral**, and **Cat**.

Petrogenesis of the Hogem intrusive suite was from more mafic peripheral to more felsic central phases, 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 (Garnett, 1978; Bath et al., 2014; Devine et al., 2014). At its southern end, the intrusive complex bends towards the east-southeast, suggesting influence of a deep basement structure (Nelson and Bellefontaine, 1996), and the exploration projects **Later**, **Chuchi**, **Q7a**, **SYL**, **Milligan West**, **North Grid**, and the **Mt. Milligan** mine lie along this prospective trend.

Structurally, open upright northwest-trending kilometre-scale folds of probable Late Triassic to Early Jurassic age predominate, but basal slaty units exhibit tight folding (Nelson et al., 1990; Ferri et al., 1994). The Quenel Terrane is bounded on its eastern side by northwest-trending thrust and strike-slip faults that include the Swannell fault, Manson-McLeod fault system, and Eureka thrust. It is bounded on its western side by the Pinchi and Ingenika strike-slip faults (Fig. 2).

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 the Late Permian to Early Jurassic. Accretion of the joint terranes and closure of the intervening ocean basin is thought to have resulted from westward subduction of oceanic crust beneath an anticlockwise rotating Stikinia and eastward subduction beneath Quesnellia (Diakow et al., 1993; Mihalynuk et al., 1994; Nelson et al., 2013). The Stikine terrane underlies much of the Northwest Region and the westernmost part of the North Central Region, including the Toodoggone River (northwest) and Nechako Plateau (southwest) areas (Fig. 2).

In the Toodoggone River area (Fig. 3), bimodal volcanic and sedimentary rocks of the Asitka Group (Lower 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 (Figs. 2, 3) 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 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, are in the central and northern parts. The terrane-bounding Finlay-Ingenika fault system defines the eastern extent of the Toodoggone River area (Fig. 1), juxtaposing Quesnel terrane, Cassiar platform and post-acccretionary rocks to the east.

In the Nechako Plateau area (Fig. 3), Hazelton Group island-arc rocks (Early to Middle Jurassic) include marine sedimentary and bimodal volcanic rocks of the Entiako Formation, and overlying mafic volcanic and volcanogenic sedimentary rocks of the Naglico Formation (Angen et al., 2015; Diakow et al., 1997), both of which underlie the **Nechako Gold** prospect area. Southwest-vergent recumbent folded and thrust-faulted Hazelton Group rocks (Entiako Formation) are exposed near the Blackwater project access road.

2.2.4. Cache Creek terrane

The Cache Creek terrane is a thrust-stacked 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 northward to the Takla Landing-Tsayta Lake area (Fig. 3), the terrane consists of the Sitlika assemblage (Permian-

Early Jurassic) and the Cache Creek complex (Pennsylvanian-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 known as 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 (MINFILE 093K 039); the gabbro-diorite-diabase Rubyrock intrusive complex; 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. Farther to the east a massive limestone unit lies underneath Fort St. James (Fig. 1).

Nephrite jade lenses are found in high-pressure, low-temperature metamorphic rocks of the Cache Creek complex and mining activity continues locally at the **Ogden Mountain** and **Pishon Green Jade** projects. Predominantly west-directed structural imbrication and obduction of oceanic rocks onto Stikinia occurred during Early-Middle Jurassic terrane accretion. The Cache Creek terrane is bounded to the west by the Takla fault and to the east by the Pinchi fault.

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

Post-accretionary successions formed following the final accretion of terranes of the Intermontane belt to the margin of ancestral North American in the Middle Jurassic. They include plutonic rocks, volcanic and sedimentary cover rocks, and unconsolidated sediments including glacigenic deposits, alluvium, and colluvium.

2.3.1. Bowser Basin, Sustut Group, and Skeena Group

The North Central Region includes the eastern part of the Bowser basin (Fig. 2), which is more extensive in the Northwest Region. West of the Toodoggone River area, sedimentary rocks of the Bowser Lake Group (Middle Jurassic-Lower Cretaceous; Fig. 3) formed in a foreland basin west of the uplifted Cache Creek terrane and Omineca mountains (Evenchick et al., 2007) and recorded the amalgamation of Stikine and Cache Creek terranes. Bowser Lake Group units transition upward from marine shale through increasingly non-marine conglomeritic siliciclastic rocks. In the Groundhog coalfield, which includes the **Groundhog North** and **Panorama North** projects, coal of semianthracite to meta-anthracite rank is hosted in a deltaic sequence of alternating marine and non-marine sedimentary rocks up to 1100 m thick (British Columbia Geological Survey, 2016). Structurally, the coalfield, a 30 x 80 km area, lies in the Skeena fold and thrust belt, and in a northwest-trending synclinorium with thrust-faulted subordinate folds. Non-marine sedimentary rocks of the Sustut Group (Lower-Upper Cretaceous; Fig. 3), also derived from the Omineca highland (Diakow et al., 1993), extend for more than 100 km along the western margin of the Toodoggone River area and southward, overlapping Upper Paleozoic-Lower Jurassic volcanic and sedimentary units.

In the Nechako Plateau area (Diakow et al., 1997; Angen et al., 2015), the Hazelton Group is unconformably overlain by deep-water sedimentary rocks (Ashman Formation), and mafic volcanic rocks with coarse- to fine-grained sedimentary units (Nechako Formation) of the Bowser Lake Group (Fig. 3). Coarse siliciclastic sedimentary units of the Skeena Group (Lower-Middle Cretaceous; Fig. 3) are exposed locally, but are more widespread in the Northwest Region (Alldrick and Lin, 2007). These Skeena Group rocks are similar to the Sustut Group rocks found in the Toodoggone River area.

2.3.2. Endako batholith, Laidman batholith, Brooks diorite complex

In the Nechako Plateau area, the Jurassic volcanic-sedimentary sequence is intruded by syn-accretionary Late Jurassic monzogranitic rocks of the Endako and Laidman batholiths, and by the Brooks diorite complex (undated, inferred Triassic-Jurassic). The Endako batholith (Figs. 2, 3) is a composite intrusive complex (gabbro to quartz monzonite) that extends along a northwest trend at the northern end of the Nechako Plateau for roughly 90 km, in both the North Central and Northwest regions. West of Fort St. James, a 60-km long northwest-trending body of quartz diorite (Middle Jurassic) is also assigned to it.

The batholith has a protracted history of emplacement (Late Triassic-latest Jurassic) evolving from more mafic to felsic phases from margin to core (Villeneuve et al., 2001). The oldest magmatic rocks include the Stern Creek suite (Late Triassic) consisting of north-northwest trending foliated dioritic rocks, which host the **Orbit** prospect and are near the contact between the Cache Creek and Stikine terranes. 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). The Brooks diorite complex (Fig. 3) is a composite pluton 25-km long that is partially high-grade metamorphosed and features northwest-striking steeply dipping foliation (Angen et al., 2016). The **Trout** and **2 X Fred** epithermal vein prospects lie at its southwest and northeast margins.

2.3.3. Cretaceous and Eocene magmatism

In the Quesnel terrane, Cretaceous granitic plutonic rocks are widespread (Figs. 2, 3). Intrusive rocks include: the Early Cretaceous phase of the Hogem intrusive complex; the Wolverine Range plutonic suite in the Wolverine metamorphic complex; and two-mica granodiorite-granite of the Germansen and Naver (Bayonne plutonic suite) batholiths near the Manson Creek and Hixon placer mining areas.

In the Nechako Plateau area (Fig. 3), regional transpression and the development of a continental arc to the west by the Late Cretaceous led to an episode of granodiorite intrusion (Diakow et al., 1997; Nelson et al., 2013; Angen et al., 2015), which included the Capoose batholith and Blackwater pluton, and the Quanchus plutonic suite (Eocene). The **Blackwater** intermediate sulphidation epithermal gold-silver deposit

(Christie et al., 2014; Looby, 2015) is spatially related to the Blackwater pluton and the Chu low fluorine-type porphyry molybdenum deposit (MINFILE 093F 001) to the Ch pluton of the Quanchus plutonic suite.

Episodic volcanism continued with eruption of the intermediate to felsic calc-alkaline Kasalka Group rocks (Late Cretaceous), which host the Blackwater deposit; and Eocene rocks of the Nechako Plateau Group. The Nechako Plateau Group includes 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 magmatism 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 epithermal vein-type showings developed during Late Cretaceous to Eocene uplift and extension, such as at the **Trout** and **2 X Fred** prospects. The Nechako uplift, an inferred northeast-trending horst with obscured bounding faults (Diakow et al., 1997), 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 faults in the **Mt. Milligan** deposit may in part be related to motion along a strand of the Manson-McLeod fault system, which truncates the deposit on the east, separating uplifted basement (Nelson et al., 1990) from an Early Tertiary sedimentary basin. The Wolverine metamorphic complex (Fig. 3), a core complex related to extensional and strike-slip tectonics, comprises schistose to gneissic amphibolite-grade Neoproterozoic basement rocks that were rapidly exhumed in the Paleogene (Ferri et al., 1994; Staples, 2009).

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, 4). Coal seams of economic thickness and continuity are predominantly medium-volatile bituminous rank and are 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 foreland basin during a major transgression of the inland sea (Stott, 1984; Thompson, 1989; Grieve et al., 1995). These synorogenic rocks, comprising siliciclastic units and coal seams, were shortened during the Laramide Orogeny (Late Cretaceous-Paleogene), lying east of a tectonically thickened eastwardly prograding 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 et al., 1995). The middle Gething Formation seams are those of interest at the **Brule** mine. 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, Cretaceous marine and non-marine fine siliciclastic rocks of the Western Canada Sedimentary Basin comprise much of the shallow bedrock.

2.4. Neogene to Quaternary cover rocks

Tertiary fluvial deposits formed in large braided and meandering river systems (Levson and Giles, 1993) such as the ancient Peace River, which flowed north (Turner et al., 2010). Flood basalts of the Chilcotin Group (Miocene and younger) outcrop locally in 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 North Central Region where outcrop is sparse (Quesnel Trough, Nechako Plateau) and in the northwestern part of the Northeast Region (Rabbit Plateau, Liard Plain; Fig. 2) and are more topographically confined in the Omineca and Northern Rocky mountains. More recent alluvial and colluvial deposits are along rivers and streams and organic deposits in poorly drained depressions (Blais-Stevens and Clague, 2007).

3. Mines and quarries

The combined North Central-Northeast region has two metal mines, five coal mines, and one industrial mineral mine for nephrite jade (Fig. 1). Of these, one metal mine and all five coal mines have gone on care and maintenance status in the last three years due to challenging market conditions. One coal mine began restart activities towards a planned return to full scale operation by year end. Small-scale, privately owned dimension stone quarries near Valemount were inactive in 2016.

3.1. Metal mines

In 2016, there was one operating open-pit mine (Table 1), the **Mt. Milligan** mine of Centerra Gold Inc., and one open-pit mine that was on care and maintenance status, the **Endako** mine of Centerra Gold Inc. (75% interest) and Sojitz Moly Resources, Inc. (25% interest). Both are in the North Central Region.

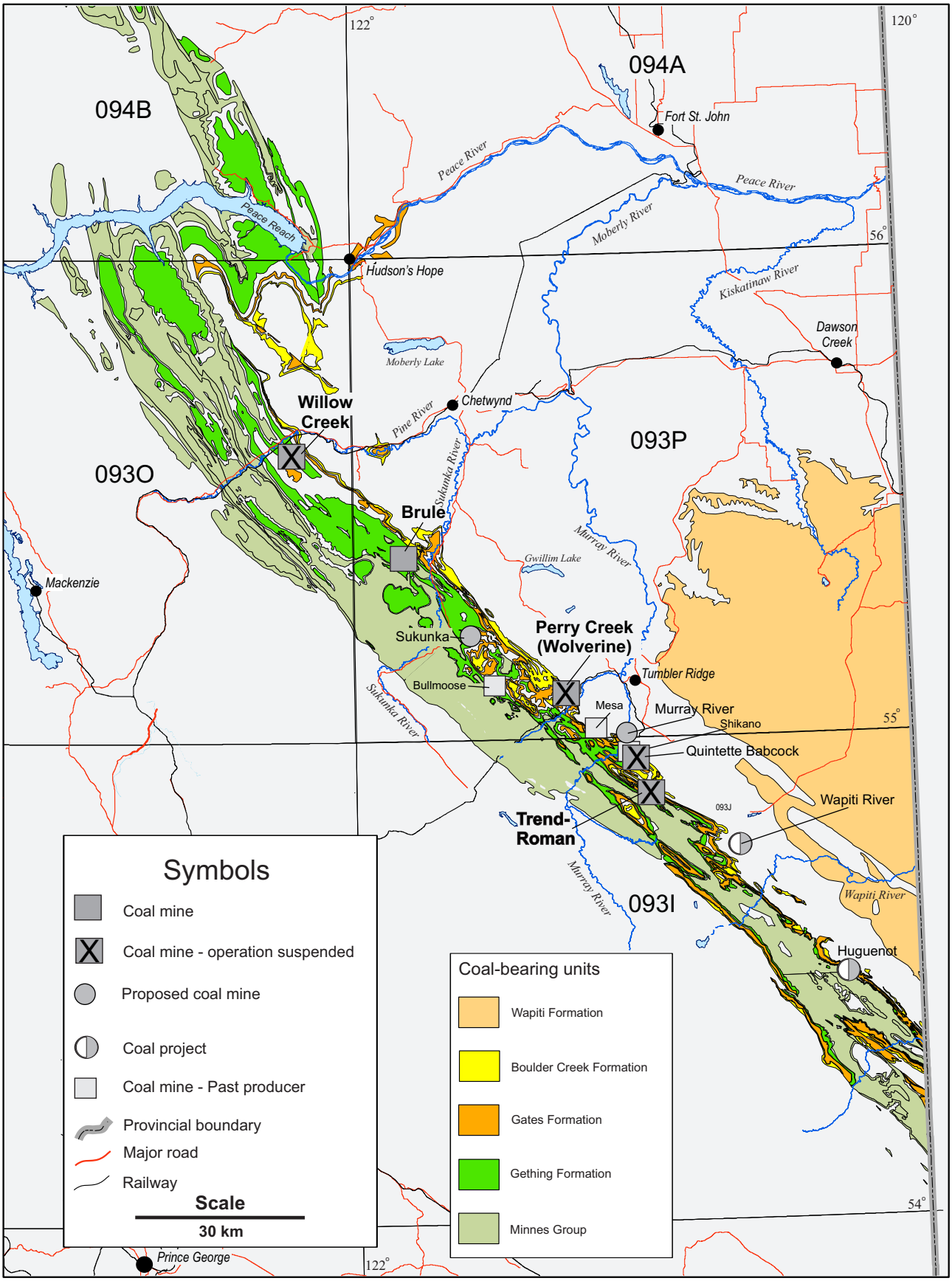

Fig. 4. Coal mines and exploration projects, northeastern British Columbia, 2016. From British Columbia Geological Survey (2017).

Table 1. Metal mines, North Central Region.

Mine	Operator	Commodity; deposit type; MINFILE	Forecast 2016 Production (based on Q1-Q3)	Reserves (Proven + Probable)	Resource (Measured and Indicated)	Comments
Mt. Milligan	Centerra Gold Inc. (Centerra B.C. Holdings Inc.), Thompson Creek Metals Company Inc.	Cu, Au, Ag; Alkalic porphyry Cu-Au; 093N 194, 093N 191	27 Kt (60 Mlbs) Cu; 6.22 t (200,000 oz) Au	506.4 Mt at 0.196% Cu and 0.349 g/t Au; containing 991.1 Kt (2,185 Mlbs) Cu and 177 t (5.69 Moz) Au	118.5 Mt at 0.16% Cu and 0.320 g/t Au (additional to reserves)	Ramp-up completed by January. Permanent secondary crusher was constructed and commissioned in October. Annual capex estimated at $72 million ±10%. Closing of an Arrangement Agreement with Centerra Gold Inc. for the US$1.03 billion acquisition of Thompson Creek Metals Company Inc. was finalized in late October. Mine life about 22 years. Over 350 employees.
Endako	As above	Mo; Porphyry Mo (Low F-type); 093K 006	N/A	N/A	33.4 Mt at 0.049% Mo	Placed on care and maintenance in July 2015. Mineral reserves were re-classified as mineral resources in the 2015 mineral resources statement (Dec. 31, 2015).

3.1.1. Mt. Milligan (Centerra Gold Inc.)

The Mt. Milligan deposit (Fig. 1; Table 1; Centerra Gold Inc.) is a silica-saturated alkalic copper-gold porphyry deposit in central Quesnellia (Lang et al., 1995; Logan, 2013; Logan and Mihalynuk, 2014). It is a moderately dipping, roughly tabular body (ca. 2.5 x 1.5 km) extending to a depth of 400 m (Clifford and Berthelesen, 2015). It is hosted in mafic-intermediate volcanic and pyroclastic rocks of the Takla Group (Witch Lake succession) and by Early Jurassic monzonite porphyry stocks that are coeval with volcanic rocks of the Chuchi Lake succession (Fig. 3; Mortensen et al., 1995; Nelson and Bellefontaine, 1996). The roughly 400 m diameter magnetite-breccia (MBX) stock in the current open-pit area features a sheet intrusion (Rainbow dike) up to 50 m wide that protrudes from its footwall. Copper-gold mineralization with accessory silver occurs as sulphide disseminations, fracture fills, and lesser veinlets in monzonite stocks, their brecciated margins, and in hornfelsed and altered volcanic rocks. A core zone of magnetite-rich potassic alteration and auriferous chalcopyrite-pyrite mineralization (MBX sub-zone) transitions southeastward to a sericite-carbonate (phyllic) altered, potentially down-dropped peripheral zone of gold-predominant mineralization (66 sub-zone) suggestive of an alkalic lithocap structural root (Holliday and Cooke, 2007, Jago et al., 2014). An oxidized zone with weak supergene enrichment affects the uppermost benches of the pit to about 20 m depth, extending to about 70 m depth along faults, mainly on the northern margin of the MBX stock.

Commissioned in October 2013, the Mt. Milligan mine saw its third full-year of operations in 2016 (Fig. 5). By January, the ramp-up process of the mine and mill facility to its design capacity of 60,000 tonnes-per-day was complete. Mill throughput then averaged about 52,800 tonnes-per-day over the first three quarters of the year. Phase 3 mining of the MBX pit continued with some modification such that mining in the gold-rich 66 zone began earlier than previously scheduled, and Phase 4 was to start by year end. Mining in the 66 zone on the hanging-wall side of the southeast dipping Rainbow Fault has confirmed a modelled repetition in zoned alteration and mineralization sequence (Jago et al., 2014). Construction of a permanent secondary crusher began in the first quarter and commissioning started in mid-October. This addition is expected to increase average mill throughput to 62,500 tonnes-per-day or higher (Fig. 6). Efforts to optimize mine and mill operations and increase recoveries continued, including blast fragmentation and movement monitoring and ongoing geometallurgical modelling. Copper-gold concentrate production in the first half of the year totaled 72,000 dry tonnes, and seven shipments were completed. Production guidance for

Fig. 5. Emulsion trucks on blast pattern in the 66 Zone at Mt. Milligan mine. View is looking north.

Fig. 6. Permanent secondary crusher under construction at Mt. Milligan mine. View is looking south.

the year was estimated at close to 65 million pounds of copper and over 240 thousand ounces of gold. Capital expenditure for the year was estimated at $72 million ±10% including $5 million for operations, $20 million for the tailings dam, and $47 million for the secondary crusher. Remaining mine life is about 22 years. More than 350 employees are working at the mine. The closing of an Arrangement Agreement for the US$1.03 billion acquisition of Thompson Creek Metals Company Inc. was finalized in late October and common shares were transferred to Centerra B.C. Holdings Inc., a wholly-owned subsidiary of Centerra Gold.

3.1.2. Endako (Centerra Gold Inc.)

In 2016, the Endako mine became an asset of Centerra Gold Inc. through the acquisition of Thompson Creek Metals Company Inc. The current ownership status is Centerra Gold Inc. (operator and 75% owner) and Sojitz Moly Resources, Inc. (25% owner). Mining of the 5200 x 900 m, and 320 m deep, northwest-trending low-fluorine porphyry molybdenum Endako deposit (Fig. 1; Table 1) ceased in July 2015 and the mine is currently on care and maintenance.

The former ore body is hosted in Endako phase quartz monzonite (Late Jurassic; Figs. 2, 3). Mineralization 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 et al., 2001).

3.2. Coal mines

Metallurgical coal mining operations (Table 2) in the Peace River coalfield of the Northeast Region were suspended and placed on care and maintenance in 2013 and 2014. At the end of 2015, Walter Energy Canada Holdings, Inc. obtained creditor protection under the Companies' Creditors Arrangement Act. In January of 2016 it began a sale and investment solicitation process for its idled **Perry Creek (Wolverine)**, **Brule**, and **Willow Creek** mines and exploration projects. In September, an asset purchase agreement was finalized with Conuma Coal Resources Limited, a stand-alone Canadian company that is a related by common ownership to ERP Compliant Fuels, LLC. Restart activities for the **Brule** mine began immediately and return to full operations was expected by December with a 170 person workforce. The **Perry Creek (Wolverine)** operation is being considered for restart in 2017, contingent on market conditions and meeting permit requirements. A restart would employ about 180 people. Of the three idled mines, **Willow Creek** was the highest cost producer. Further study is required before restart, but its processing plant and rail loadout are shared with the Brule mine, together forming the Brazion Group operations. Conuma Coal is operating under contract with Walter Energy until ownership transition is complete.

Elsewhere, the **Trend-Roman** mine of Peace River Coal Inc. (wholly owned by Anglo American plc), and **Quintette (Babcock)** mine of Teck Coal Limited remained on care and maintenance status. The Trend, Quintette and Perry Creek mines produced mainly hard coking coal (HCC), whereas the Brule mine produces pulverized coal injection (PCI) coal, a high-rank thermal coal used to sustain blast furnace temperatures in steelmaking. The Willow Creek mine produced both HCC (one third of production) and PCI coal (two thirds of production).

3.2.1. Brule and Willow Creek (Conuma Coal Resources Limited)

Conuma Coal's **Brule** mine (Figs. 1, 4; Table 2) produces PCI coal from three seams in the lower part of the Gething Formation, with an average cumulative thickness of about 12 m. The mine lies in a northwest-trending anticline-syncline pair in a larger structural block bound by northeast-verging thrust faults. Run-of-mine coal is crushed and then trucked 60 km on a connector road to the processing plant and rail load-out facility at the **Willow Creek** mine (Figs. 1, 4) where only one of the mined seams requires beneficiation; the others are 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 April 2013. Restart activities for the Brule mine began around mid-September. By October, 40,000 tonnes of run-of-mine coal had been hauled (Fig. 7), and by November the first trainload of coal had been shipped. Work on a bioreactor for selenium treatment had continued during the summer. The mine was last in full production in June 2014, before suspending operations, processing final inventory, and entering care and maintenance mode. Expansion plans initiated in 2014 were to culminate in a merging of the North and South Brule pits over a mine life of about eight years. Mining activity is now focused on the north wall of the South Brule pit and working northward. Conuma may introduce new mining techniques to operations including cast blasting and highwall mining.

Table 2. Coal mines, Northeast Region.

Mine	Operator	Commodity; deposit type; MINFILE	Forecast 2016 Production	Reserves (Proven + Probable)	Resource (Measured and Indicated)	Comments
Willow Creek	Conuma Coal Resources Limited	HCC, PCI; Bituminous coal; 093O 008	N/A	16.6 Mt saleable	N/A	Placed on care and maintenance in 2013. Property under contract with Walter Energy Holdings, Inc. until ownership transition is complete.
Brule	Conuma Coal Resources Limited	PCI; Bituminous coal; 093P 007	250,000 t	16.3 Mt saleable; Proven	N/A	Restart activities began in Sept. 2016. Operating under contract with Walter Energy Holdings, Inc. until ownership transition is complete.
Perry Creek (Wolverine)	Conuma Coal Resources Limited	HCC; Bituminous coal; 093P 025	N/A	8.8 Mt saleable; Proven	N/A	Placed on care and maintenance in 2014. Property under contract with Walter Energy Holdings, Inc. until ownership transition is complete. Potential 2017 restart.
Trend (Trend-Roman)	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 (Trend-Roman)	Anglo American plc (Peace River Coal Inc.)	HCC; Bituminous coal; 093I 043	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	120.3 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

Fig. 7. Coal of the Upper Seam on the 1105 bench near the north wall of the Brule South Pit.

3.2.2. Perry Creek (Wolverine) (Conuma Coal Resources Limited)

At Conuma Coal's **Perry Creek** mine (Wolverine Project; Figs. 1, 4; Table 2) medium-volatile bituminous HCC has been mined from seams in the Gates Formation in the Perry Creek syncline. The median cumulative thickness of the mineable seams is about 15 m. Before idling production in April 2014, mining was forecast to continue for approximately another four years and then switch over to the EB expansion project (MINFILE 093P 015) with no overlap in operations; EB has an estimated mine life of ten years. Targeted annual production had been about 1.9 Mt of saleable coal. Conuma Coal is considering restart of the mine in 2017 with a 180-person workforce, contingent on market conditions and meeting permit requirements.

3.2.3. Trend (Peace River Coal Inc.)

At Anglo American-Peace River Coal's **Trend** mine, HCC of medium-volatile bituminous rank had been mined until the mine was placed on care and maintenance in December 2014.

Coal seams occur in the Gates Formation along the steeply dipping northeast limb of the Waterfall anticline, which forms an anticline-syncline pair with the closely folded Murray syncline to the southwest on Roman Mountain. The 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 project, about 1.5 km from

the former Trend operations in the Murray syncline, was fully permitted by March 2014. Related construction activities had been underway before the project went on care and maintenance with the Trend mine. If the expansion goes into operation as planned, the combined operations would be known as **Trend-Roman** (Figs. 1, 4; Table 2). The expansion, reported to have a capital cost of about $200 million in 2013, would comprise 5 km of linear open-cuts in three phases to capture the middle Gates coal seams, and satellite pits for the upper Gething coal seams (Peace River Coal Inc., 2007). The combined operation (Figs. 1, 4; Table 2) would have a saleable coal production rate of 2.5 Mt per year and extend the mine life for 16 years. The mine remained on care and maintenance in 2016.

3.2.4. Quintette (Babcock) (Teck Coal Limited)

If brought back into operation, the **Quintette (Babcock)** mine (Figs. 1, 4) 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 anticline with a coal sequence similar to that at the Trend-Roman mine. The historic Quintette mine operated from 1982 to 2000 with development in 1998 of the open-cuts on Mt. Babcock. For the next phase of mining, fully permitted in 2014, production would average 3.5 Mt of saleable coal per year over a 12 year mine life. In mid-2014 the project was placed on care and maintenance and a restart deferred until market conditions improve. Capital expenditure for the mine re-opening was estimated at $858 million in late 2012, of which about $130 million was spent in 2013.

3.3. Industrial mineral mines and quarries

In 2016, one industrial mineral mine operated in the Northeast Region, the **Fireside** barite mine of Fireside Minerals Ltd., and one in the North Central Region, the **Ogden Mountain** nephrite jade mine of Green Mountain Jade Inc. (Table 3).

3.3.1. Fireside (Fireside Minerals Ltd.)

At **Fireside** (Fig. 1; Table 3) in the Liard Plain (Fig. 2), Fireside Minerals Ltd. mines veins of massive white barite hosted in Kechika Group sedimentary rocks. The north- and northeast-trending, steeply dipping veins are spatially related to probable Early-Middle Paleozoic gabbro dikes (S. Allan, personal communication, November 2016; Wojdak, 2008). In late summer of 2016, the first 10,000 tonnes of barite were mined from the Moose Pit (Fig. 8). Exploration drilling completed in 2014 indicates the vein system continues north of previous workings and remains open to the northeast. A recently stripped area revealed two, steeply dipping barite veins with a combined true thickness of 6.5 m. Vein composition ranges from 96.0 - 99.4% barite with variable silica, iron, zinc and lead impurities. Exploration efforts continue at the nearby Moose Southwest pit and the Beaver prospect. Mined barite is crushed and bagged on site and trucked to Fort St. John, BC and Alberta for use in the drilling industry as a weighting additive in drilling fluids.

Fig. 8. First trenching in preparation to bench down and blast the Moose pit at Fireside mine.

3.3.2. Ogden Mountain (Green Mountain Jade Inc.)

Jade is a commercial term for jadeite and nephrite. In British Columbia jade occurs as nephrite. Nephrite is composed of interlocking fibrous amphibole minerals derived from an ultramafic protolith that has undergone dynamothermal metamorphism and metasomatism in a subduction-related orogenic belt. The **Ogden Mountain** property (Fig. 1) of Green Mountain Jade Inc., a partner of the Jade West Group, is underlain by metamorphosed, thrust-faulted, and well-foliated ultramafic rocks, including serpentinite mélange and schist, of the Cache 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 2016, Green Mountain Jade resumed exploration and placer mining of alluvial nephrite boulders, and excavation of nephrite from bedrock.

4. Placer operations

Placer gold exploration and mining is a significant traditional and ongoing activity in the North Central Region, occurring along numerous creeks and several rivers but centred around the Manson Creek and Hixon communities. Approximately 70 notice-of-work applications for placer gold were submitted to the Ministry of Energy and Mines regional office in 2016. From north to south these were mainly in three general areas: 1) Manson Creek, in the Quesnel terrane between the Pinchi and Manson fault zones and generally following arc transverse structure on the north side of the Germansen batholith; 2) Fort St. James to Mackenzie, in the Quesnel terrane near the McLeod Lake fault zone or other structures; and 3) Hixon, near the faulted contact (Eureka thrust) of the Quesnel terrane with

Table 3. Industrial mineral mines and quarries, North Central and Northeast regions.

Mine	Operator	Commodity; deposit type; MINFILE	Forecast 2016 Production	Reserves (Proven + Probable)	Resource (Measured and Indicated)	Comments
Fireside (Northeast region)	Fireside Minerals Ltd.	Barite; Vein barite; 094M 003, 094M 019	10,000 t	475,000 t (non NI 43-101 compliant)	N/A	Mined from the Moose Pit. Overburden stripping revealed two 96% to 99.4% barite veins with a combined true thickness of 6.5 m.
Ogden Mountain (North Central region)	Green Mountain Jade Inc.	Nephrite jade; Jade; 093N 156, 093N 157, 093N 165	35 t	N/A	N/A	Exploration and placer mining of alluvial jade boulders, excavation of in situ jade.

the Kootenay terrane, and near the Naver pluton (Bayonne plutonic suite).

Placer mining is generally conducted on abandoned benches and abandoned channels above the current level of streams. Medium-scale operations use power machinery such as hydraulic excavators and backhoes to excavate pay gravel, which is then either trucked or directly dumped into a wash plant for processing. Wash plants generally comprise a grizzly, trommel or screening plant, sluice box and jigs to concentrate gold (Fig. 9).

Placer gold exploration in the region targets Tertiary, and pre-Late Wisconsinan paleochannel and paleofan deposits (Eyles and Kocsis, 1989; Levson and Giles, 1993).Older (Tertiary) gravels are pebble-cobble gravels that were deposited during non-glacial intervals and rest on older bedrock. These gravels incorporated lode gold from locally weathered bedrock and were then overlain by Wisconsin glacial drift. The glacial deposits were subsequently downcut by post-glacial watercourses. Paleochannel systems can have little relation to modern drainage patterns and can be controlled by major long-lived faults. Subglacial deposits are found on the leeside of bedrock highs, in the basal portion of lodgement tills, in boulder pavements, and narrow gravel-filled notches. Postglacial deposits that formed by reworking of subglacial and older gravels are typically lower grade.

Fig. 9. Gold with heavy minerals from a sluice box capture mat at a Manson Creek placer mine.

5. Mine development

A mine development project has financing in place and construction is underway with a targeted production start-up date. The project proponent must have all required government approvals and permits for constructing and operating a mine. There was no mine development in the North Central and Northeast regions in 2016. The last mine development project in the North Central Region was **Mt. Milligan** (see section 3.1.1.), which officially opened as a mine in October 2013.

The last planned mine development projects in the Northeast Region were the Roman Mountain expansion and the Quintette (Babcock) planned restart. Construction activities for the Roman Mountain expansion were halted when the **Trend** mine (see section 3.2.) was placed on care and maintenance at the end of 2014. The **Quintette (Babcock)** mine (see section 3.2.) was in a combined development and early production stage when it went into care and maintenance in mid-2014.

6. Proposed mines or quarries

The proposed mine, or mine evaluation, stage (Table 4) is concerned with the environmental, social, engineering, and financial evaluation of an exploration project that is moving beyond an advanced stage. It includes, at minimum, the submission of an application for an environmental assessment certificate and/or receipt of 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, commonly seasonally active, projects not meeting the threshold criteria for review by the EAO. It also includes projects that have received an environmental assessment certificate but are in the final Mines Act permit application review process before potentially going into development and commercial production.

In 2016, the combined North Central-Northeast region had five projects, including **Aley** (Taseko Mines Limited),

Table 4. Selected proposed mines, North Central and Northeast regions.

Project	Operator	Commodity; deposit type; MINFILE	Reserves (Proven + Probable)	Resource (Measured and Indicated)	Work Program	Comments
Blackwater (North Central region)	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 t (8.17 Moz) Au, 1,890 t (60.8 Moz) Ag	55.49 Mt at 0.72 g/t Au, 4.4 g/t Ag; containing 40.2 t (1.29 Moz) Au, 243 t (7.82 Moz) Ag; additional to reserves	*EA (under review), engineering and environmental studies	Proposed open-pit mine with 60,000 t/d ore processing rate and life-of-mine average annual production of 12.8 t (413 Koz) Au and 54.2 t (1.74 Moz) Ag over a 17 year mine life.
Kemess Underground (KUG) (North Central region)	AuRico Metals Inc.	Cu, Au, Ag; Porphyry Cu±Mo±Au; 094E 021	107.38 Mt at 0.27% Cu, 0.54 g/t Au, 1.99 g/t Ag; containing 285.6 Kt (629.6 Mlbs) Cu, 58.1 t (1.87 Moz) Au, 214 t (6.88 Moz) Ag; Probable	246.4 Mt at 0.22% Cu, 0.42 g/t Au, 1.75 g/t Ag; containing 542.2 Kt (1195 Mlbs) Cu, 103 t (3.33 Moz) Au, 431.3 t (13.87 Moz) Ag; inclusive of reserves; Indicated	Feasibility study update, EA (under review), engineering and environmental studies	Proposed underground panel cave mine with 24,600 t/d ore processing rate and life-of-mine average annual production of 3.30 t (106,000 oz) Au and 21 Kt (47 Mlbs) Cu over a 12 year mine life.
Aley (North Central region)	Taseko Mines Limited (Aley Corp-oration)	Nb; Carbonatite-hosted deposit; 094B 027	83.8 Mt at 0.50% Nb_2O_5; containing 293 Kt* Nb *calculated by author	285.8 Mt at 0.37% Nb_2O_5; containing 739.2 Kt* Nb (including reserves) *calculated by author	EA (pre-app), geochemical characterization studies, environmental baseline monitoring	Proposed open-pit mine with 10,000 t/d ore processing rate and average annual production of 9,000 t niobium over a 24 year mine life.
Murray River (Northeast region)	HD Mining Int'l Ltd.	HCC; Bituminous coal; 093I 010	261.6 Mt mineable; proven	314.2 Mt in situ	Mines Act permit and federal EA (under review), drilling (hydro-geological, geotechnical) hand trenching, 2D seismic survey, engineering and environmental studies	Proposed underground longwall mining operation with average annual production of 4.8 Mt of saleable coal over a 25 year mine life.
Sukunka (Northeast region)	Glencore plc	HCC; Bituminous coal; 093P 012, 093P 014	N/A	145 Mt in situ	EA (under review), engineering and environmental studies	Proposed open-pit mine with initial annual production of 1.5 - 2.5 Mt of saleable coal over a 20+ year mine life.
Giscome (North Central region)	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	EA (under review), hand auguring, baseline studies	Proposed 600,000 t/y limestone quarry to feed a vertical lime kiln producing 198,000 t of lime annually over a 50+ year mine life.
Wapiti East (Northeast region)	Fertoz Int'l Inc.	P_2O_5; Sedimentary phosphate deposits; 093I 039, 093I 022, 093I 008	N/A	0.81 Mt at 22.3% P_2O_5; Indicated	Mines Act permit application, bulk sample (17,500 t permitted), temporary road (2.2 km)	Proposed seasonal shallow open-pit mine with average annual production of less than 75,000 t phosphate rock over a 20+ year mine life; organic certification obtained.

*EA = Environmental Assessment

at various stages and activity in the pre-application phase of environmental assessment. One project below the EAO threshold criteria, **Wapiti East** (Fertoz International Inc.), continued work on information requirements for a Mines Act permit application before a final submission. Four projects, **Blackwater** (New Gold Inc.), **Giscome** (Graymont Western Canada Inc.), **Kemess Underground** (AuRico Metals Inc.) and **Sukunka** (Glencore plc), have submitted applications and were under review. One project, **Murray River** (HD Mining International Ltd.) received an environmental assessment certificate in October 2015 and was under review for a final Mines Act permit.

6.1. Proposed metal mines

Work continued on three proposed metal mines in 2016; the **Blackwater** (New Gold Inc.), **Kemess Underground** (AuRico Metals Inc.) and **Aley** (Taseko Mines Limited) projects. All three projects are in the North Central Region. Blackwater is in the Nechako Plateau area, Kemess Underground in the Toodoggone River area, and Aley in the Muskwa ranges of the Northern Rocky Mountains.

6.1.1. Blackwater (New Gold Inc.)

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. The volcanic sequence unconformably overlies Bowser Lake Group sedimentary rocks at depth. Alteration and mineralization associated with the deposit define a continuous 1300 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 that occur as micron-scale grains (ranging from about 30 µm up to 200 µm) are spatially associated with sulphide and silicification. The timing of main stage 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 gold 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 continued engineering and environmental studies to support provincial and federal environmental assessments that were under review, and to advance further permitting requirements; capital expenditure was US$7 million to the end of September.

A 2014 feasibility study describes an open-pit mining operation with a 60,000 tonnes-per-day processing plant and a 17-year mine life. Life-of-mine average annual production would be 12.8 t (413,000 ounces) of gold and 54.1 t (1.74 million ounces) of silver. Total metal production would be 217 t (7.0 million ounces) of gold and 920 t (29.6 million ounces) of silver. The mine, with total development capital costs estimated at $1.576 billion, would create an average 1,200 jobs during construction and a permanent workforce of over 500 employees. The 180 day provincial EA review process was suspended twice during the year for development and review of suggested project design changes. A certification decision is anticipated by mid-2017. Exploration of significant porphyry copper-molybdenum-silver and epithermal gold-silver targets within several kilometres to the south and west of the proposed mine area was temporarily suspended by New Gold due to challenging market conditions and allocation of financial resources to other projects.

6.1.2. Kemess Underground (KUG) (Aurico Metals Inc.)

The **Kemess Underground** proposed mine (Fig. 1; Table 4; AuRico Metals Inc.) would extract part of a porphyry copper-gold-silver deposit (Fig. 3) that is centered on the tabular Kemess North pluton (earliest Jurassic). The quartz diorite pluton, assigned to the Black Lake intrusive suite, follows a south-dipping reverse fault. The fault separates Takla Group basaltic-andesites from a barren wedge of Toodoggone Formation (Hazelton Group) fragmental dacite to the north, and cuts off the pluton and mineralization at depth probably due to reactivation (Chevrier et al., 2016). An 80 m thick sulphate leach zone (probable Jurassic) of clay-rich broken rock overlies the deposit. Subjacent phyllic alteration with pyrite-anhydrite/gypsum veining is predominant and widespread in the Takla Group volcanic rocks; at depth, quartz-magnetite±biotite potassic 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. Stockwork vein density intensifies in the potassically altered high-grade northeast corner of the deposit. The deposit is truncated on the east by a northwest-trending normal fault with east side down displacement; about 400 m to the west, grade weakens and pluton morphology changes from tabular to wide dikes hosted in Takla Group volcanic units.

In March, AuRico announced the results of an updated feasibility study (Chevrier et al., 2016) for the proposed underground panel cave mine with a single extraction level. An average production rate of nearly 25,000 tonnes-per-day would generate 4.01 t (129,000 ounces) gold and 23 Kt (52 million pounds) copper annually over the first five years. Total

production over a 12-year mine life would be 43 t (1.4 million ounces) gold and 260 Kt (573 million pounds) copper, and 140 t (4.5 million ounces) of silver. Mineralization is 200-500 m below surface, and includes a 107.4 Mt reserve within a larger 246.4 Mt indicated resource (Table 4). Existing processing facilities (one of two grinding circuits) and infrastructure from the Kemess South mine would be reused, estimated to be worth about $1 billion in replacement cost and currently under care and maintenance. A stirred regrinding mill circuit would be added to produce the finer grind needed for KUG ore. The Kemess South pit with dam enhancement would be reused as a tailings storage facility, and is the constraining factor on reserve tonnage. Pre-commercial capital expenditure is estimated at $524 million; construction is expected to take four years to reach first production. Workforce requirements would generally range from 100-475 jobs during construction and operations (Witte et al., 2013) with a peak workforce of 573 in year one of construction. The project entered the review stage of a Substituted (federally and provincially harmonized) environmental assessment in May and a certification decision is anticipated in early 2017. Detailed engineering work continued and project capital expenditures of US$3.0 - $3.8 million were estimated for 2016 and included the **Kemess East** resource update (see section 7.2.1.). Updated lithology, structure, and alteration models were used to define the grade estimation domains and parameters for the resource estimate.

6.1.3. Aley (Taseko Mines Limited)

The **Aley** niobium deposit (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 $(Fe,Mn)Nb_2O_6$ ±olivine, baddeleyite (ZrO_2), and pyrite that have been fragmented and disseminated within the intrusive. Within this zone, mineralization is continuous over a 900 m east-west by 350 m north-south area. A lower zone of silico-carbonatite contains sodic-amphibole and extends to roughly 300 m depth. Niobium occurs in the minerals pyrochlore $(Na,Ca)_2Nb_2O_6(OH,F)$, 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.

Taseko continued environmental baseline data collection and geochemical characterization of ore, waste rock, and tailings to support a substituted environmental assessment that remained in pre-application status throughout the year. Metallurgical test work continued with the aim of improving efficiency to help reduce projected costs.Capital expenditure, cumulative for the first three quarters, was $600,000.

A two-phase open-pit mine with a 10,000 tonnes-per-day processing plant and ferroniobium convertor is planned. The near surface nature of mineralization is reflected in a low waste-to-ore strip ratio of 0.5 to 1. Average annual production over the 24 year mine life would be about 9,000 tonnes of niobium in the form of ferroniobium (annual production of about 14,000 t FeNb). Pre-production capital cost is estimated at $870 million. A workforce of about 700 people would be employed during construction and up to 350 at full operation (Aley Corporation, 2014). Niobium is used in the production of high-strength low-alloy steel.

6.2. Proposed coal mines

Work continued on two proposed coal mines in 2016, the **Murray River** (HD Mining International Ltd.) and **Sukunka** (Glencore plc) projects. Both projects are in the Peace River coalfield of the Northeast Region.

6.2.1. Murray River (HD Mining International Ltd.)

The 35 km-long, 160 km^2 northwest trending licensed area for the **Murray River** project (Figs. 1, 4; Table 4) of HD Mining International Ltd. is underlain by Lower to Upper Cretaceous successions of the Fort St. John Group that lie 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 December 2015, HD Mining International Ltd. completed their underground bulk sample program. Following completion, equipment was pulled from the 1,357 m decline (to about 400 m depth) and the decline was sealed with a bulkhead and allowed to flood. Geotechnical drilling and hand trenching, hydrogeological drilling, a 2D seismic survey, and engineering and environmental studies continued in support of a Mines Act permit application. Both the application and federal environmental assessment were under review; a provincial environmental assessment certificate was received in October 2015. The bulk sample was being tested for processing, coal quality and marketability. Contingent on the results, the proposed underground longwall mining operation would produce 4.8 Mt of saleable coal per year over a 25-year mine life. The three year construction phase would require a workforce of about 270 people on average but peak at about 450. The operations phase would provide approximately 780 direct employment opportunities (ERM Rescan, 2014). The company is working with Northern Lights College on curriculum development and a training program for underground longwall mining.

6.2.2. Sukunka (Glencore plc and JX Nippon Oil & Energy Corporation)

The **Sukunka** project (Figs. 1, 4; Table 4) of Glencore plc (75% interest) and JX Nippon Oil & Energy Corporation (25% interest) lies in a broad monocline that generally dips gently 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 thick in the upper part of the Gething Formation are on the property and include the mineable Skeeter and Chamberlain seams. Additional seams in the lower part of the Gething Formation (BP Coal Limited, 1977) are also being targeted and are included in the current measured and indicated resource estimate (Table 4).

Glencore reported ongoing progress in open cut and underground mining studies, and engineering and environmental studies continued in support of a substituted environmental assessment application which was under review. An open-pit mining operation is proposed with initial production of 1.5-2.5 Mt of saleable metallurgical coal per year, and a mine life of at least 20 years (Stantec, 2013). Addition of a room-and-pillar underground mining component in a future mine plan would increase production to 6 Mt per year. Workforce requirements are estimated at about 250 jobs during construction, and 543 direct employees during operations.

6.3. Proposed industrial mineral mines

Work was carried out on two proposed industrial mineral mines in 2016, the **Giscome** lime plant and quarry project (Graymont Western Canada Inc.) and the **Wapiti East** phosphate rock project (Fertoz International Inc.). The Giscome project, in the North Central Region, was under review by the Environmental Assessment Office whereas the Wapiti East project, in the Northeast Region, is below the EAO threshold for review and its Mine's Act application is being assessed through the Ministry of Energy and Mines regional office.

6.3.1. Giscome (Graymont Western Canada Inc.)

The **Giscome** property (Fig. 1; Table 4) of Graymont Western Canada Inc., a subsidiary of Graymont Limited, is underlain by fossiliferous limestone (Triassic) of the Cassiar platform, and basaltic volcanic rocks of the Slide Mountain Group (Antler Formation; Struik et al., 1990). High-quality limestone grades of about 98% $CaCO_3$ have been described in the area (Dahrouge and Kluczny, 2007). The environmental assessment application review process for the proposed quarry and lime plant was suspended in March to allow for consideration of proposed changes to the project. In July the process recommenced with the original project design. Auger drill testing for borrow material was completed and environmental baseline monitoring continued. The initial phase of operations would include a 600 Kt per year limestone quarry and conveyor system that would feed a vertical lime kiln producing 600 tonnes of lime daily and 198 Kt 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.

6.3.2. Wapiti East (Fertoz International Inc.)

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 2016, construction of a linkage road for improved longer term access was followed by continued trenching of a permitted 17,500 tonne bulk sample. Refinement of the project design and a scoping study continued, as did compiling of information requirements for a Mines Act permit application. A seasonal (May-October) shallow open-pit mine is proposed with excavation along strike of a moderate- to steeply dipping phosphorite unit. Production would be up to 75,000 tonnes-per-year of phosphate rock and mine life is expected to exceed 20 years. The at surface resource averages one metre width and 30 m depth over a strike length of 12.5 km in four zones, but is thought to extend an additional 26.5 km in strike length beyond the indicated and inferred estimate. Organic certification for the low-leaching direct application fertilizer product was obtained in April through continued farm trials and laboratory testing.

7. Exploration activities and highlights (North Central Region)

Exploration projects can be categorized by exploration stages. The grassroots stage represents initial reconnaissance of a property and involves activities such 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 by at least 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 (proposed mine) stage. At this stage, detailed and professionally managed environmental, social, engineering and financial evaluation activities are undertaken. As well, permit applications are submitted to regulators proposing that the project become a producing mine.

Compared to 2015, which saw 35 active exploration projects in the North Central Region, 48 were tracked in 2016 (Tables 4, 5), reflecting an increase in grassroots to early-stage exploration. Of the 48 projects, four (8%) were at the mine evaluation stage, six (13%) were at the advanced stage, 25 (52%) were at the early stage, and 13 (27%) were at the

grassroots stage. Project types included precious metal (10 properties, 21%); porphyry (Cu-Au, Cu-Mo, Mo) projects (23 properties, 48%); polymetallic base and precious metals (seven properties, 15%); specialty metals (one property, 2%); industrial minerals including jade and amber (five properties, 10%); and coal (two properties, 4%).

7.1. Precious metal projects

In 2016, 10 precious metals projects were tracked in the North Central Region. With the exception of the mine evaluation stage Blackwater project (section 6.1.1.) all were at the early exploration stage (four projects) or grassroots stage (five projects). These included epithermal gold-silver deposit prospects (seven projects) and other vein-type deposit prospects (two projects). Seven of the properties are in the Nechako Plateau area of the Stikine terrane.

7.1.1. Lawyers (PPM Phoenix Precious Metals Corp.)

The **Lawyers** property (Fig. 1; Table 5) of private company PPM Phoenix Precious Metals Corp. (100% owned) is accessed by the Omineca Resource Access Road past the Kemess property, through the inactive Baker mine site, and about 7 km farther north by an exploration road. It is underlain by andesitic volcanic units of the Hazelton Group (Toodoggone Formation). North-northwest trending graben-bounding faults cross the property over a 3 km wide area and are the primary controlling structures for four sub-parallel moderate-steeply dipping zones of low-sulfidation epithermal mineralization. A high-sulfidation prospect lies less than 2 km farther west (Silver Pond North; MINFILE 094E 069). 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. They produced over 5.32 t (171,000 ounces) of gold and 109 t (3.5 million ounces) of silver, mainly from the AGB deposit, now reclaimed (Lane et al., 2016). The north sub-zone of the Cliff Creek deposit, 2 km to the west of AGB was only partially mined. Underground development to >200 m vertical depth remains intact but is flooded. The Cliff Creek deposit has a strike length of about 1,600 m and variable width <58 m (Lane, 2011). It is 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 with sulphide mineralized clasts, grey quartz-chalcedony veining and stockwork zones with fine grey sulphide; and late milky quartz-amethyst-calcite fill (Fig. 10). Mineralization comprises finely disseminated pyrite with accessory sphalerite, galena, chalcopyrite, bornite, native gold, native silver, electrum and acanthite. Alteration consists of silicification ±adularia, intergrown sericite-clay with chlorite, relict biotite, and selective-pervasive hematization.

In 2016, a NI 43-101 technical report (Lane et al., 2016) was completed, including an updated resource estimate (Table 5) consisting of a 550 Kt inferred resource at Cliff Creek North containing 2.5 t (80,000 ounces) of gold and 115 t (3.7 million ounces) of silver; and a 58 Kt inferred resource at Duke's Ridge containing 250 kg (8,000 ounces) of gold and 8.1 t (260,000 ounces) of silver. The estimate incorporates results of a 2015 drilling program and historic data. Drilling results indicate the two sub-zones have minimum strike lengths of 225 m (Cliff Creek North) and 380 m (central Duke's Ridge). The newly discovered P2 semi-massive sulphide vein in the Cliff Creek North hanging-wall returned a high-grade drill intersection of 2.40 m including 293.40 g/t Au and 7,622 g/t Ag over 0.70 m. A 51.00 m intersection in the deeper part of the sub-zone graded 1.71 g/t Au and 41.5 g/t Ag and represents a bulk-mineable target. Drilling in the central part of Duke's Ridge returned low to moderate gold-silver grades near surface. The property, including the neighboring Silver Pond group of high-sulphidation epithermal prospects, was included in a 2016 Geoscience BC project (see section 9.1.) that aims to develop an exploration framework for porphyry-to-epithermal transitions in the area.

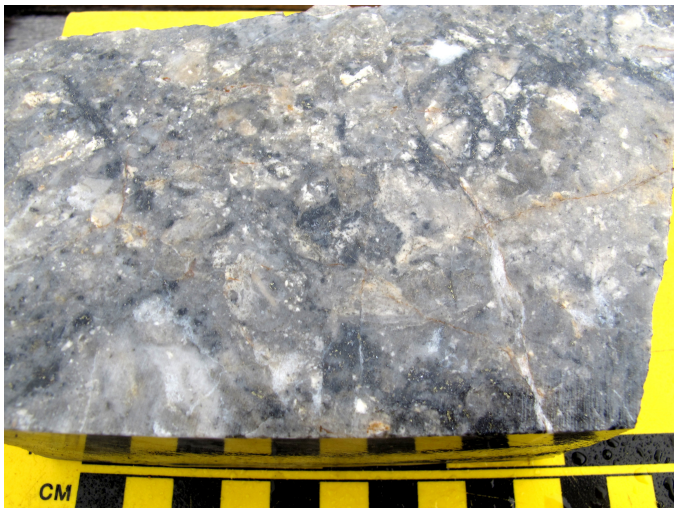

Fig. 10. Slabbed quartz vein grab sample from Lawyers with gold-silver bearing sulphide mineralization.

7.1.2. Two Times Fred (Kootenay Silver Inc., Theia Resources Ltd.) and Copley (Kootenay Silver Inc.)

The **Two Times Fred (2 X Fred)** property (Fig. 1; Table 5) of Kootenay Silver Inc., is under option to Theia Resources Ltd. It is 24 km southwest of Vanderhoof and accessed by logging roads. The property is underlain by Endako Formation basalt with local felsic volcanic and conglomeritic units on the north side of the fault-bound Brooks diorite complex (Fig. 3). At least six major subvertical north- to northeast-trending shallow-level low-sulphidation epithermal vein systems have been identified on the property. They occur over a 3.0 x 1.4 km area, with strike lengths of individual veins up to 500 m and true widths up to 30 m. The gold-silver bearing quartz veins are centred on a coincident airborne electromagnetic and magnetic high anomaly and feature multiple crosscutting

Table 5. Selected exploration projects, North Central Region.

Project	Operator	MINFILE	Commodity; Deposit type	Resource (NI 43-101 compliant unless indicated otherwise)	Work Program	Comments
3Ts	Independence Gold Corp.	093F 055, 093F 068	Au, Ag; Epithermal Au-Ag-Cu (low sulphidation)	5.452 Mt at 2.52 g/t Au, 71.5 g/t Ag; containing 13.7 t (441,000 oz) Au and 390.0 t (12.54 Moz) Ag; Inferred	geochemical sampling (MMI soil), prospecting	Following up of Au-As-Zn anomalies generated by a 2015 Geoscience BC spruce top biogeochemical survey.
Akie	Canada Zinc Metals Corp.	094F 031	Zn, Pb, Ag; Sedimentary exhalative Zn-Pb-Ag	19.6 Mt at 8.17% Zn, 1.58% Pb, 13.6 g/t Ag; containing 1.6 Mt (3,540 Mlbs) Zn, 311 Kt (685 Mlbs) Pb, 267 t (8.6 Moz) Ag; Indicated	NI 43-101 technical report, resource estimate update, environmental baseline monitoring	Reviewing plans for permitted underground exploration.
Big Bear	Parlane Resource Corp.	093F 075	Au, Ag; Epithermal Au-Ag-Cu (low sulphidation)	N/A	geochemical sampling (rock, soil), prospecting	Rock samples up to 1.7 g/t Au, 39 g/t Ag, 1.7% Zn, 2.1% Pb (Old Crow); 10.1 g/t Au, 13.8 g/t Ag, 0.5% Zn (the Cub).
Bowron River	First Amber Mines Inc.	093H 005, 093H 130	Amber; Bituminous coal	historic non NI 43-101 compliant 40 Mt coal reserves (Norco Resources Ltd., March 1981)	drilling (core, percussion RAB)	
BT	Porpoise Bay Minerals Ltd.	093G 002, 093G 032	Cu, Co; Cu±Ag quartz veins	N/A	geochemical sampling (channel sampling)	Sampling over 24 m returned over 1% Cu values.
Captain	Orestone Mining Corp.	093J 026, 093J 180	Cu, Au; Alkalic porphyry Cu-Au	N/A	ground geophysics (IP/resistivity, magnetics; 8 line-km)	
Cat	Cat Syndicate	094C 069	Cu, Au, Ag; Alkalic porphyry Cu-Au	N/A	geochemical sampling (rock), hand trenching, prospecting	
Cathedral	Thane Minerals Inc.	094C 018, 094C 048, 094C 072, 094C 109 094C 176	Cu, Au; Alkalic porphyry Cu-Au	N/A	aerial photography, airborne geophysics (magnetic, radiometric; 974 line-km, 2015), LiDAR survey, geochemical sampling (soil, silt, rock), ground geophysics (magnetics, 2016)	Pinnacle showing sampling highlights: 6.96% Cu, 0.26 g/t Au, 12.4 g/t Ag (2015, massive sulfide); 3.60 g/t Au (F1 fault, 2013); 7.78 g/t Au, 12.3 g/t Ag and 2.54% Cu (F2 fault, 2013); 4.37 g/t Au and 10,000+ ppm As (F6 fault, 2013).
Chuchi	Kiska Metals Corporation	093N 159	Cu, Au; Alkalic porphyry Cu-Au	historic non NI 43-101 compliant: 50 Mt at 0.21-4.0% Cu, 0.21-0.44 g/t Au; inferred (Digger Resources Inc., 1991)	core relogging (4,000 m), geochemical sampling (historic core, 350 samples)	

Table 5. Continued.

Cirque	Teck Resources Limited (Cirque Operating Corp.)	094F 008	Zn, Pb, Ag; Sedimentary exhalative Zn-Pb-Ag	historic non NI 43-101 compliant: 28.38 Mt at 7.85% Zn, 2.17% Pb, 46.8 g/t Ag (North Cirque); indicated and inferred (Teck Corporation, 1995)	core drilling (495 m), processing and interpretation of airborne and ground gravity datasets, mapping, prospecting	2013 drilling highlights (released in 2015): 10.5 m at 1.26% Zn, 0.22% Pb, 3.36 g/t Ag (gap area, CRQ-13-001); 63 m at 1.61% Zn, 0.30% Pb, 3.94g/t Ag, including 12 m at 3.22% Zn, 0.65% Pb, and 8.23 g/t Ag (South Cirque, CRQ-13-003).
Copley	Kootenay Silver Inc.	093F 070, 093F 071	Au, Ag; Epithermal Au-Ag-Cu (low sulphidation)	N/A	geochemical sampling (rock), geologic mapping, prospecting	
Coral	Minfocus Exploration Corp.	094B 008, 094B 021	Zn, Pb; Mississippi Valley-type Pb-Zn	N/A	core drilling, geochemical sampling (rock), prospecting	2016 drilling highlights: 1.1 m at 2.47% Zn and 4.0 m at 0.97% Zn (C16-09); 3.0 m at 0.38% Zn (C16-06); 1.0 m at 0.30% Zn (C16-03); chip sampling of new showing returned 5.0 m at 0.94% Zn, including 1.5 m at 2.33% Zn.
Fran	MGX Minerals Inc.	093K 108	Cu, Au; Alkalic porphyry Cu-Au	N/A	geochemical sampling (soil, rock), prospecting	Angular float sample in eastern part of property returned 34.1 g/t Au.
Granite Basin	Canasil Resources Inc.	094C 009	Cu, Au, Ag; Porphyry Cu±Mo±Au	N/A	geochmical sampling (rock), prospecting	
Groundhog North	Atrum Coal Groundhog Inc.	104A 086, 104A 078	Coal; Anthracite	349 Mt in situ (Western Domain; Measured and Indicated), 260 Mt in situ (Eastern Domain; Indicated)	Prefeasibility study update, preparatory work for underground bulk sample, washability tests, engineering and environmental studies	Permits received for underground and surface bulk coal sample (<100,000 t) and special use of existing railbed. Improved float sink yields for Duke E seam (averaging >80%, compared to previous average yields of 60%).
Hixon	Gitennes Exploration Inc.	093G 068, 093G 070	Au; Au-quartz veins	N/A	geochemical sampling (soil, till), ground geophysics (EM, Mag), mapping, prospecting	Claims acquired in June 2016.
Jewel	Serengeti Resources Inc.	093N 240	Cu, Au, Ag; Alkalic porphyry Cu-Au	N/A	ground geophysics (EM, IP)	
Kemess East	AuRico Metals Inc.	094E 315	Cu, Au, Ag; Porphyry Cu±Mo±Au;	39.27 Mt at 0.40% Cu, 0.50 g/t Au, 1.99 g/t Ag, 0.008% Mo containing 157,650 t (347.55 Mlbs) Cu, 19.6 t (630 Koz) Au, and 78.1 t (2.51 Moz) Ag, 3.20 Kt (7.05 Mlbs) Mo, Indicated	resource estimate update, core drilling (13 holes, 13,544 m; infill, expansion), metallurgical testwork	2016 drilling highlights: 628 m at 0.53 g/t Au, 0.41% Cu (KH-16-13); 549 m at 0.55 g/t Au, 0.41% Cu (KH-16-12); 504 m at 0.52 g/t Au, 0.36% Cu (KH-16-9); 372 m at 0.59 g/t Au, 0.40% Cu (KH-16-11); 344 m at 0.51 g/t Au, 0.43% Cu (KH-16-07).

Table 5. Continued.

Kwanika	Serengeti Resources Inc. (95%) Daewoo Minerals Canada Corp. (5%)	093N 073	Cu, Au, Ag; Porphyry Cu±Mo±Au	Central Zone pit: 101.5 Mt at 0.31% Cu, 0.32 g/t Au, 0.96 g/t Ag, containing 316.2 Kt (697.2 Mlbs) Cu, 32.3 t (1.04 Moz) Au, 97.0 t (3.12 Moz) Ag; Central Zone UG: 29.7 Mt at 0.34% Cu, 0.36 g/t Au, 1.05 g/t Ag, containing 100.8 Kt (222.3 Mlbs) Cu, 10.9 t (350 Koz) Au, 31.4 t (1.01 Moz) Ag; Indicated	core drilling (2,446 m), ground geophysics (IP), resource estimate update, preliminary economic assessment update	2016 Central Zone drilling highlights: 438 m at 0.71% Cu, 0.83 g/t Au, 2.0 g/t Ag including 233.6 m at 1.18% Cu, 1.30 g/t Au, 3.2 g/t Ag (K-16-177); 58 m at 0.26% Cu, 0.29 g/t Au, 1.2 g/t Ag (K-16-179).
Kwanika East-Smoke	Serengeti Resources Inc. (95%) Daewoo Minerals Canada Corp. (5%)	093N 152, 093N 168	Cu, Au, Ag; Porphyry Cu±Mo±Au	N/A	ground geophysics (IP, 14 line-km), geochemical sampling	
Later	ML Gold Corp., Pacific Empire Minerals Corp.	093N 169	Cu, Au; Alkalic porphyry Cu-Au	N/A	core drilling (1,107m)	2015-16 drilling highlights: 94 m at 0.34 g/t Au (DD15 ELB001); 28 m at 0.25 g/t Au (DD15 ELB004); 41.3 m at 0.42 g/t Au, including 3.0 m at 2.88 g/t Au (DD16 ELB007); 103.6 m at 0.14 g/t Au (DD16 ELB005).
Lawyers	PPM Phoenix Precious Metals Corp.	094E 066	Au, Ag; Epithermal Au-Ag-Cu (low sulphidation)	550 Kt at 4.51 g/t Au, 209.15 g/t Ag (Cliff Creek North zone); 58 Kt at 4.30 g/t Au, 139.13 g/t Ag (Duke's Ridge zone); both at 4.0 g/t AuEq cut-off, Inferred, see main text for contained metal	NI 43-101 technical report released, updated resource estimate	2015 drilling highlights (data released 2016): 8.63 m at 9.64 g/t Au and 307.0 g/t Ag (Cliff Creek North); 2.40 m at 87.04 g/t Au, 2,407 g/t Ag, including 0.70 m at 293.40 g/t Au, 7,622 g/t Ag (P2 vein); 51.99 m at 1.71 g/t Au, 41.5 g/t Ag (Cliff Creek North); 4.00 m at 8.54 g/t Au and 171.8 g/t Ag (Duke's Ridge).
Lil	Canasil Resources Inc.	094C 079	Polymetallic veins Ag-Pb-Zn±Au	N/A	geochmical sampling (rock), prospecting	
Longworth	MGX Minerals Inc.	093H 038	Silica; Silica-rich rocks	N/A	geochemical sampling (rock), metallurgical testing	99.34% SiO_2 average value of 10 rock chip samples (Snow zone).
Milligan West	Serengeti Resources Inc. (50%) Fjordland Exploration Inc. (50%)	093N 131	Cu, Au; Alkalic porphyry Cu-Au	N/A	ground geophysics (IP), mapping, prospecting	
Nechako Gold	Tower Resources Ltd.	093F 004, 093F 060	Au, Ag; Epithermal Au-Ag-Cu (low sulphidation)	N/A	sampling (rock, till), prospecting	

Table 5. Continued.

North Grid	Centerra Gold Inc. (Centerra B.C. Holdings Inc.)	093N 123	Cu, Au; Alkalic porphyry Cu-Au	N/A	core drilling (2,000 m; Mitzi and Snell targets)	Agreement with Centerra Gold Inc. for the US$1.03 billion acquisition of Thompson Creek Metals Company Inc. was finalized in late October.
OGK (Nova Block)	Cat Syndicate	O94C 177, O94C 138, O94C 174	Cu, Au, Ag; Alkalic porphyry Cu-Au	N/A	geochemical sampling (rock), prospecting	
Panorama North	Atrum Coal Panorama Inc.	104A 085, 104A 089	Coal; Anthracite	N/A	core drilling (1,180 m)	2016 drilling highlights: 6.85 m total coal (1.90 m thickest seam) to 326 m depth (DHPN-16-01); 9.87 m total coal (2.05 m thickest seam) to 260 m; (DHPN-16-02); 10.75 m total coal (2.30 m thickest seam) to 325 m; (DHPN-16-03); 11.80 m total coal (1.70 m thickest seam) to 269 m (DHPN-16-04).
Pie, **Cirque East**, **Yuen** (Pie Option properties)	Teck Resources Limited	094F 023; 094F 008; 094F 013	Zn, Pb, Ag; Sedimentary exhalative Zn-Pb-Ag	N/A	core drilling (Pie; 1080 m), ground geophysics (gravity), geochemical sampling (rock, soil), mapping, prospecting	
Pil (Pillar East)	Finlay Minerals Ltd.	094E 213 094E 215 094E 216 094E 217	Cu, Au, Ag; Porphyry Cu±Mo±Au; Au-Ag-Cu (low sulphidation)	N/A	geochemical sampling (soil, stream, rock), prospecting	Pillar East zone: 0.6 m at 2.80 g/t Au, 6.5 g/t Ag (P1 hand drill sample); up to 6.57 g/t Au and 69.7 g/t Ag (12 rock samples, 2016); Copper Cliff zone: 1.27% Cu, 33.8 g/t Ag (talus sample, 2015); 0.05-1.04% Cu, 2.8-23.9 g/t Ag (11 rock samples, 2016).
Pishon Green Jade	Private individual	093K 005	Nephrite jade; jade;	N/A	surface bulk sample (1000 t)	largest nephrite exposure is known as the jade cliff.
Q7a	Vale Exploration Canada Inc.	093N 206	Cu, Au; Alkalic porphyry Cu-Au	N/A	historic core relogging, prospecting (2015), core drilling (1101 m; 2016)	Historic core resampling returned anomalous copper and gold values.
Red Lion	Garibaldi Resources Corp.	094D 165 094D 167 094D 169	Cu, Au; Porphyry Cu±Mo±Au	N/A	geochemical sampling (soil, rock), prospecting	
SYL	Serengeti Resources Inc.	093N 163	Cu, Au; Alkalic porphyry Cu-Au	N/A	ground geophysics (IP)	
Thor	Copper North Mining Corp.	094D 126	Cu, Au, Ag; Porphyry Cu±Mo±Au	N/A	core drilling, prospecting	2016 drilling highlights: 107.60 m at 0.14% Cu, 0.045 g/t Au (Thor East).
Trout	Venerable Ventures Ltd.	093F 044	Au, Ag; Epithermal Au-Ag-Cu (low sulphidation)	N/A	geochemical sampling (soil; late 2015)	Soil sampling delineated a 900 x 100 m northeast trending Au-As-Sb geochemical anomaly.

Table 5. Continued.

Two Times Fred (2 X Fred)	Theia Resources Ltd., Kootenay Silver Inc.	093F 036	Au, Ag; Epithermal Au-Ag-Cu (low sulphidation)	N/A	geochemical sampling (rock), geologic mapping, prospecting	2015 drilling highlights: 7.6 m at 1.69 g/t Au, 29.36 g/t Ag, including 1.9 m at 3.20 g/t Au, 46.48 g/t Ag (Saki vein system); 67 m at 0.37 g/t Au and 7.22 g/t Ag (Saki vein); 24.4 m at 0.29 g/t Au, 7.70 g/t Ag (Gold Hill vein system).
UDS	Serengeti Resources Inc.	094E 070	Cu, Au, Ag; Porphyry Cu±Mo±Au	N/A	ground geophysics (IP), prospecting	900 x 1500 m southward plunging strong IP chargeability anomaly identified at the South Valley target.
Vega	Canasil Resources Inc.	094C 021	Cu, Au; Alkalic porphyry Cu-Au	N/A	geochmical sampling (rock), prospecting	

vein stages, crustiform banding, comb textures, lattice bladed quartz, internal deformation textures, mosaic and chaotic breccia, and fine grained pyrite mineralization (Fig. 11). Wall rock fragments are clay-chlorite-hematite altered. In 2016, results were released from a 2015 drilling program that tested two of the vein systems to 100 m depth (see Table 5 for assay highlights). Consistent grade and vein textures suggest a higher-grade boiling horizon could lie deeper or along-strike. Follow-up grassroots mapping and geochemical sampling focused on recently discovered gold-silver bearing flat-lying vein system and sinter targets in the northern part of the property. Grab samples taken 750 m north of the 2015 drilling area returned high values including 12.7 g/t Au, 4.4 g/t Au and 11.4 g/t Au from sub-cropping veins.

Grassroots mapping and geochemical sampling was also conducted on nearby **Copley** property of Kootenay Silver Inc.

Fig. 11. Crustiform-colloform banded chalcedonic quartz vein with comb texture and lattice bladed quartz in vugs at 2 X Fred.

(100% owned).The property is about 35 km south of Fraser Lake and is accessible by a logging road. Three northeast-trending topographic domes are underlain by silicified and clay-hematite altered Ootsa Lake Formation rhyolite (Thompson, 2010). Previous exploration suggested a large 6 x 2 km near-surface low-sulfidation epithermal gold system featuring banded chalcedonic quartz veins, stockwork veining and breccias, and disseminated and vein-hosted pyrite.

7.1.3. Trout (Venerable Ventures Ltd.)

The **Trout** property (Fig. 1; Table 5), of Venerable Ventures Ltd. (100% owned) is 70 km southwest of Vanderhoof and accessible by logging and spur roads. It is underlain by mafic-intermediate volcanic units of the Hazelton Group and Nechako Plateau Group (Endako Formation), and Chilcotin Group basalt. The property is at the southwest side of the Brooks diorite complex about 31 km southwest of the 2 X Fred project, which is on the northeast side of the complex. The low-sulphidation epithermal Discovery zone has estimated dimensions of 150 x 100 m, and 100 m depth, and is hosted in polymictic conglomerate and andesitic to trachytic volcanic breccia units mapped as Kasalka Group within an interpreted graben at its southeast margin (Cuttle, 2014; Ostensoe, 2011). Steeply dipping banded chalcedonic quartz veins and silicified breccia host fine-grained pyrite, argentite and native gold and appear to be controlled by southwest- and southeast- trending structures. Soil sampling into late 2015 delineated a 900 x 100 m northeast-trending Au-As-Sb geochemical anomaly 3.5 km southwest of the Discovery zone along the northwest-dipping interpreted graben boundary. The geochemical anomaly is coincident with an airborne resistivity high and magnetic low.

7.1.4. Big Bear (Parlane Resource Corp.)

The **Big Bear** property (Fig. 1; Table 5) of Parlane Resource Corp. (claims held in the name Little Bear Gold Corp.) is 95

km southwest of Vanderhoof and is accessible by logging roads. It is underlain by volcanic units of the Hazelton Group, Bowser Lake Group, and Nechako Plateau Group (Ootsa Lake Formation) 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 in the Black Bear target area where drilling in 2012 returned mineralized intervals in two holes, including 330.7 m of 0.26 g/t Au, 2.67 g/t Ag and 0.21% Zn (BB12-4; Webster, 2013) hosted in intermediate-felsic lapilli and crystal tuff units. In 2016, follow-up soil sampling was completed to determine additional drill locations. In addition, a 12,968 hectare claim block contiguous to the property on the north was acquired. Follow-up prospecting and sampling confirmed vein-hosted gold-silver-zinc mineralization at the Old Crow and Cub showings (Fig. 12; Table 5) in volcaniclastic units. An additional showing of mineralized boulders in a narrow forest road was discovered 2 km east of the Cub and named the Sugar Bear. The bedrock source of the boulders was located and sampled for similar style vein-hosted mineralization. The claim block also hosts the recently discovered Liesegang redbed copper type showing (Angen et al., 2016) underlain by Hazelton Group (Entiako Formation) basalt with hematitic Liesegang rings and epidote veins. Parlane completed mapping and prospecting in the area and the showing was resampled.

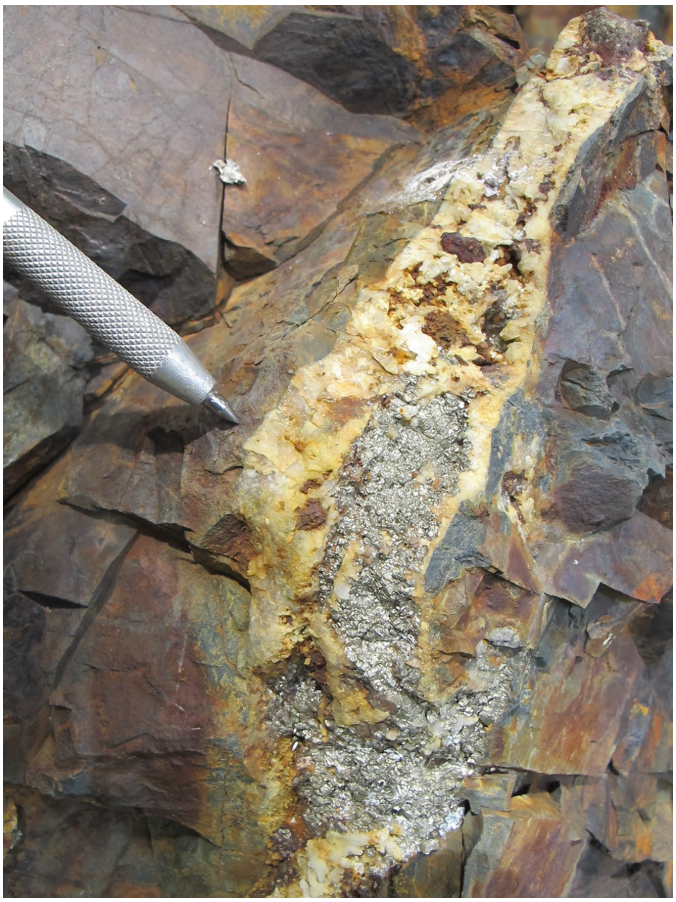

Fig. 12. Auriferous vuggy quartz-pyrite vein with comb texture in Hazelton Group volcaniclastic unit at the Cub showing.

7.1.5. Nechako Gold (Tower Resources Ltd.)

The **Nechako Gold** property (Fig. 1; Table 5), under option to Tower Resources Ltd. from a private vendor, is 78 km southwest of Vanderhoof and is accessible by logging roads. It is underlain by volcanic and volcaniclastic units of the Hazelton and Kasalka groups, sedimentary units of the Hazelton and Bowser Lake groups, a composite dioritic intrusive (Late Cretaceous), and granodiorite rocks of the Ch pluton (Eocene). The Ch pluton is spatially related to the Chu low fluorine-type porphyry molybdenum developed prospect (MINFILE 093F 001). The property and two other claim areas to the northwest were staked to cover the interpreted source of down-ice till geochemical anomalies and geophysical signatures suggestive of Blackwater-type mineralization. Grassroots prospecting and geochemical sampling was followed by a property-scale till sampling survey conducted by Overburden Drilling Management (ODM).

7.1.6. 3Ts (Independence Gold Corp.)

The **3Ts** property (Fig. 1; Table 5) of Independence Gold Corp. (100% owned) is about 126 km southwest of Vanderhoof and is accessible by logging and exploration roads. It is underlain by Hazelton Group rhyolite tuffs and flows (Entiako Formation) and mafic-intermediate volcanic units (Naglico Formation), Bowser Lake Group coarse siliciclastic units, and quartz monzonite intrusive units assigned to the Capoose batholith. Rhyolitic units host a low-sulfidation epithermal vein system that has more than a dozen subvertical, north-striking mineralized veins up to 900-m long and 20-m wide that appear to have formed by open space fillings along faults (Armitage, 2014). The veins have quartz-calcite±chalcedony, sericite, adularia, amethyst gangue, and feature crustiform banding and comb textures. Vein breccia fragments and silicified wall rock fragments indicate multiple pulses of vein formation during faulting. Mineralization includes pyrite and Cu-Ag sulphosalt(?) disseminations and sooty hairline veinlets, with accessory chalcopyrite, sphalerite, and galena. A generally 80 m thick Late Cretaceous (73.8 Ma, U-Pb zircon; Friedman et al., 2001) microdiorite sill crosscuts the veins. However, an Early Miocene (21.2 Ma Re-Os; D. Pawliuk, personal communication, November 2014) hydrothermal quartz breccia vein above the sill implies a protracted mineralizing history. The western side of the property is covered by glacial till. In 2016, an MMI and B-horizon soil geochemical sampling program was conducted following the release of the 2015 Geoscience BC spruce top biogeochemical survey results that show gold, arsenic, and zinc anomalies in the up-ice (west) direction from the known vein system. Soil sampling included an orientation survey and some regional sampling with the aim of developing targets in new areas. Prospecting continued in the area of known veins.

7.1.7. Lil (Canasil Resources Inc.)

The **Lil** property (Fig. 1; Table 5) of Canasil Resources Inc. (100% owned) is 200 km northwest of Mackenzie and is accessible by logging roads to within 3 km of the main showings. It is underlain by sedimentary rocks of the Ingenika Group (and metamorphosed equivalents) that host narrow argentiferous quartz veins and breccia with tetrahedrite, argentite and pyrargyrite (ruby silver) mineralization and Ordovician to Lower Devonian carbonate rocks that host disseminated and irregular replacement lead-zinc-silver mineralization (Lane, 2015b). A north-trending granitic dike cuts across the central part of the property. In 2016, grassroots prospecting and geochemical sampling continued.

7.1.8. Hixon (Gitennes Exploration Inc.)

The **Hixon** project (Fig. 1; Table 5) of Gitennes Exploration Inc. (100% owned) is 61 km south of Prince George near the Hixon placer mining community and is accessible by logging roads. It is underlain by a northwest-trending sequence of Snowshoe Group metasedimentary rocks, Takla Group basaltic volcanic and fine-grained volcaniclastic rocks, including the black phyllite unit correlative with the Slate Creek succession near the Manson Creek (Ferri et al., 1994), ultramafic intrusive rocks of the Polaris Ultramafic suite, and granite of the Naver pluton (Bayonne intrusive suite). The Eureka thrust zone (southwest dipping) crosses the area. In 2016, a grassroots program of ground magnetic and electromagnetic surveys, soil sampling, geological mapping, and prospecting for bedrock hosted vein-type gold mineralization was completed.

7.2. Porphyry projects

There were 23 porphyry projects tracked in 2016 in the North Central Region. One project, Kemess Underground (section 6.1.2.), was at the mine evaluation stage. Two projects were at the advanced exploration stage (Kemess East and Kwanika). The remainder were either at the early exploration stage (13 projects), or the grassroots stage (seven projects). Six of the properties are within the eastern margin of the Stikine terrane; five of these in the Toodoggone River area, and one in the Nechako Plateau area (Endako batholith). Most properties (17 projects) are in the Quesnel terrane.

7.2.1. Kemess East (AuRico Metals Inc.)

The **Kemess East** property (Fig. 1; Table 5) of AuRico Metals Inc. (100% owned) is one kilometre east of AuRico's **KUG** deposit (see section 6.1.2.) and is accessible by exploration roads, or by helicopter from the Kemess South property, 6.5 km to the south. 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, at 900-1600 m below surface, is hosted primarily in the dioritic Kemess East pluton (earliest Jurassic) and, to a lesser degree, in Takla Group basaltic-andesite.A high-grade core has been identified over a 300 x 300 m zone. A similar lower-grade diorite intrusive unit at greater depth suggests a series of flat-lying to gently south dipping sills (Chevrier et al., 2016). Auriferous chalcopyrite is mostly disseminated but also occurs in quartz veins in the pluton. The highest copper-gold grades are associated with secondary biotite and silica in a potassic alteration zone (Fig. 13). Phyllic alteration is less intense than at KUG, and late calcite-zeolite alteration is spatially associated with a granodiorite pluton south of the deposit. A structurally offset prospect between KUG and Kemess East, the Kemess Offset Zone (KOZ), is downthrown east of KUG. 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. A southwest-dipping strike-slip fault (Kemess East Offset) truncates the system on the east. The Kemess East deposit may represent the deeper portion of a single dissected mineralized system that includes KOZ and KUG; it remains open in three directions, as does the high-grade core zone.

An updated resource estimate for the project was released with the KUG feasibility study (Chevrier et al., 2016) and features a 19.2 Mt potassically altered high-grade core zone grading 0.47% Cu and 0.72 g/t Au within a 39.2 Mt indicated resource (Table 5). The estimate incorporates drilling from 2015 and, similar to the KUG resource estimate, used updated lithology, structure, and alteration models to define grade estimation domains and parameters. Exploration continued in 2016 in a US$4.9 million 13-hole (18,544 m) drilling program (Fig. 14). Drilling targeted the existing resource and high-grade core for infill and step-out expansion, and also refinement of the geological model through better delineation of key faults. Except for one abandoned hole, all drilling intersected mineralization, including a 628 m interval grading 0.53 g/t Au, 0.41 % Cu, 2.07 g/t Ag, and 0.005 % Mo (KH-16-13; Table 5). Metallurgical testwork on drill core was planned.

Fig. 13. Kemess East chalcopyrite-pyrite mineralization with magnetite-quartz-biotite-chlorite alteration in brecciated Black Lake monzodiorite unit (KH-15-23).

Fig. 14. Two drills on the upper flat of East Squared Cirque valley at Kemess East. A third drill rig is out of view down-slope. View is looking northwest.

7.2.2. Pil (Finlay Minerals Ltd.)

The **Pil** property (Fig. 1; Table 5) of Finlay Minerals Ltd. (100% owned) is about 35 km north of the Kemess South property and is accessible by the Omineca Resource Access Road and secondary resource roads. The property is underlain by Hazelton Group volcanic rocks including fragmental andesitic to dacitic units of the Toodoggone Formation. A monzonitic body of the Black Lake intrusive suite crosses the claim block alongside a north-northwest trending fault. In 2015 and 2016, grassroots exploration focused on two target areas in the Pillar East zone, an epithermal gold-silver target and a porphyry copper target. Geophysically, the Pillar East zone features a 2 km diameter aeromagnetic high ring anomaly with a central magnetic low. In 2015, a rusty outcrop was sampled using a portable drill. Drill results included 2.80 g/t Au over 0.6 m (drill sample P1) and 12.7 g/t Ag over 0.6 m (drill sample P4). Angular talus fragments collected at the epithermal gold-silver target returned up to 8.30 g/t Au and 39.7 g/t Ag.

In 2016, follow-up soil sampling was undertaken to confirm and refine previously identified gold-in-soil anomalies. Quartz veining and breccia were located in outcrop. Composite rock samples were collected, twelve of which returned assays ranging from anomalous up to 6.57 g/t Au and 69.7 g/t Ag. Some also returned significant zinc and lead values. A steeply dipping, north-northeast trending controlling structure has been identified and is about 800 m in length and open along strike.

In 2015, prospecting in the area targeted for porphyry copper mineralization discovered chalcopyrite mineralized phyllic altered lapilli tuff on a talus slope south of the epithermal gold-silver target area. Assays ranged between 0.99-1.67% Cu and up to 33.8 g/t Ag in four composite rock samples. In the 2016 follow-up program, a 40 x 30 m area of disseminated and veinlet-hosted chalcopyrite mineralization was discovered in potassically altered monzonite porphyry bedrock upslope of the talus.Eleven rock samples collected in this area assayed between 0.05-1.04% Cu and 2.8-23.9 g/t Ag.

7.2.3. UDS (Serengeti Resources Inc.)

The **UDS** property (Fig. 1; Table 5) of Serengeti Resources Inc. (100% owned) is about 8 km northeast of the Kemess South property and is accessible by helicopter. The property is underlain by Asitka Group limestone, Stuhini Group volcanic and sedimentary rocks, Hazelton Group (Toodoggone Formation) fragmental dacitic volcanics, and granodiorite of the Black Lake intrusive suite. Recent work outlined the August 30 and South Valley target areas. The August 30 target area (1500 x 800 m) features copper mineralized outcrops and phyllic alteration associated with felsic dikes that occupy a faulted lithological contact. The South Valley target area (1.5 x 3 km) features a strong copper-zinc-gold soil anomaly. The Kemess East deposit lies about 4 km to the west. In 2016, a follow-up deep-penetrating induced polarization survey in four widely spaced lines delineated a 900 x 1500 m southward plunging strong chargeability anomaly at the South Valley target area that is coincident with the soil geochemical anomaly and remains open to the north.

7.2.4. Thor (Copper North Mining Corp.)

The **Thor** property (Fig. 1; Table 5) of Copper North Mining Corp. (under option from Electrum Resources Corp.) is about 15 km south of the Kemess South property and is accessible by the Omineca Resource Access Road and spur roads to base camp, and then by helicopter. The property overlies a strand of the terrane-bounding Ingenika fault (Fig. 1) and the north-northwest trending Moose Valley Fault which separates Sustut Group sedimentary rocks on the west from Asitka Group limestone, Takla Group basaltic volcanic rocks, and granodiorite intrusive rocks (Early Jurassic) on the east. Copper sulphide mineralized veins and fractures are associated with silicified and oxidized shear zones. In 2016, drilling tested two target areas on the western flank of the north-south trending McConnell Range and adjacent valley. The Thor East target in the uplands is defined by potassic alteration and mineralization in outcrop coincident with local aeromagnetic high anomalies. Drilling results (Table 5) included more than 107 m of copper-gold mineralization in fractured granodiorite near a contact with Takla volcanics, and a transition to phyllic alteration at depth.

The Thor West target is along the till covered lower slopes in the valley. The target is defined by a large (4 x 2 km) ground IP chargeability anomaly and a coincident broad aeromagnetic high that suggests a large intrusive complex underlies the glacial overburden (McClintock, 2015).

7.2.5. Red Lion (Garibaldi Resources Corp.)

The **Red Lion** property (Fig. 1; Table 5) of Garibaldi Resources Corp. (under option from a private vendor) is about 235 km northwest of Mackenzie and is accessible by the Omineca Resource Access Road. Similar to the contiguous Kliyul developed prospect (MINFILE 094D 023) it is underlain by the Takla Group. A lower unit of volcanic sandstone on the west side of the property transitions to an upper unit of basaltic

volcanic breccia on the east side (Schiarizza, 2003; Voordouw, 2012). Intrusive rocks include a north- to northwest-trending ultramafic-mafic suite that includes diorite (Late Triassic), a quartz dioritic-monzonitic suite (early Middle Jurassic), and a northwest-trending granodioritic suite (Early Cretaceous). The northern end of the Hogem intrusive complex (Early Jurassic suite) is about 16 km to the south. A north-trending dextral strike-slip fault crosses the property. Historic showings include quartz vein hosted and disseminated chalcopyrite-pyrite mineralization associated with shear zones and diorite contact zones. In 2016, grassroots geochemical sampling was conducted near the access road, following up the 2015 geophysical surveys.

7.2.6. Granite Basin and Vega (Canasil Resources Inc.)

The **Granite Basin** property (Fig. 1; Table 5) of Canasil Resources Inc. (100% owned) is about 215 km northwest of Mackenzie and is accessible by resource roads and spur roads. The property is underlain by Takla Group volcanic and fine siliciclastic rocks, diorite sills, and late feldspar porphyry dikes and sills (Lane, 2015a). Gold-silver mineralization is hosted in west- to northwest-trending, carbonate-sericite-pyrite-jarosite altered shear zones that cut across all rock types. About 50 km southeast, the southeast corner of the **Vega** property (Fig. 1; Table 5) of Canasil Resources Inc. (100% owned) is accessible by logging roads. The property is underlain predominantly by Takla Group volcanic, volcaniclastic and sedimentary rocks, dioritic intrusive rocks (Late Triassic-Early Jurassic), and quartz monzonitic intrusive rocks (Early Jurassic) of the Hogem intrusive complex. Copper-gold mineralization is hosted in quartz-carbonate healed fracture/shear zones, in massive sulfide lenses with magnetite, or is disseminated (Lane, 2016c). In 2016, a grassroots geochemical sampling and prospecting was completed on both properties.

7.2.7. Cathedral (Thane Minerals Inc.)

The **Cathedral** property (Fig. 1; Table 5) of private company Thane Minerals Inc. (100% owned) is a large claim block (over 28,700 ha) located about 170 km northwest of Mackenzie. The southern and eastern edges of the property can be accessed by logging roads. The property is predominantly underlain by dioritic to quartz monzonitic rocks of the Hogem intrusive complex (Early Jurassic), but in the northeast is underlain by Takla Group volcanic rocks and fine-grained siliciclastic rocks. At least eight target areas are on the property, with the Cathedral area (Pinnacle showing; southern part of the property) and Lake area (northern part of the property) being the main focus in recent years (Naas, 2014; 2016). The Pinnacle showing is a 60 m wide outcrop of a north-northwest trending copper-gold mineralized fault zone (Table 5) with anomalous arsenic values associated with significant gold grades. The Cathedral area also hosts lenses of massive sulfide mineralization with magnetite and specularite. Alteration is mainly potassic. Chalcopyrite and pyrite is disseminated, in fractures, and in quartz±calcite veins. Mineralization in the Lake area is more disseminated and, visually, most abundant in diorite. Magnetite is pervasive to semi-massive. Aerial photography covering the entire property was flown in 2015 and an airborne magnetic and radiometric survey was completed. In 2016, a LiDAR survey was flown over the Cathedral area, geochemical sampling was conducted on several targets, and some ground magnetometer test surveying was completed. Reconnaissance work was conducted on newly acquired tenure that covers the CJL showing (MINFILE 094C 176), a magnetite breccia zone with copper grades up to 9% (C. Naas, personal communication, November 2016).

7.2.8. Cat and OGK (Cat Syndicate)

The **Cat** property (Fig. 1; Table 5) of the private Cat Syndicate group of prospectors, (100% owned) is about 164 km northwest of Mackenzie and is accessible by logging roads. The property is underlain by Takla Group mafic-intermediate volcanic, pyroclastic and fine-grained siliciclastic rocks up to about 4 km east of the north-northwest trending eastern margin of the Hogem intrusive complex (Early Jurassic suite; Fig. 2). Small monzonite and syenite intrusions in the volcanic rocks form an apparent ring-dike complex associated with a 700 x 400 m variably-altered and mineralized area (Macdonald, 2013). Structurally hosted, steeply dipping, north- and northwest-trending auriferous magnetite veins with accessory chalcopyrite, pyrite, quartz and calcite (Fig. 15) range up to 0.6 m wide. Chalcopyrite also forms disseminations and veinlets in magnetite-chlorite-epidote altered volcanic host rocks. Monzonitic intrusive rocks are sericite-carbonate altered. Three main target areas are on the property. The deposit-type may be transitional between shear-hosted vein and alkalic porphyry system. In 2016, a grassroots program included geochemical sampling, prospecting, and hand trenching across a north-south striking oxidized vein hosted in monzodiorite. The **OGK** property (100% owned) is about 14 km to the west of the Cat property. The east and central portions of the OGK property are accessible by logging roads; access to other parts of the

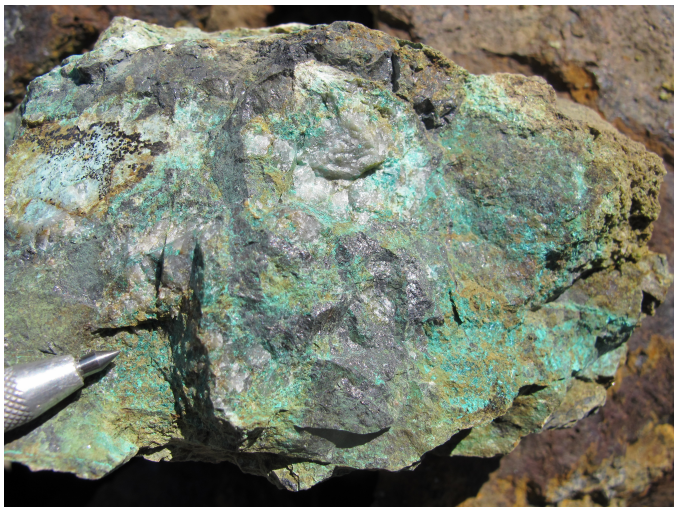

Fig. 15. Malachite-stained sample from the No. 1 magnetite vein on the Cat property.

property is by helicopter. The property consists of four separate claim blocks underlain by the Hogem intrusive complex (Early Jurassic suite), with the northern part underlain mainly by granodiorite and the southern part by the Duckling Creek syenite complex. In 2016, grassroots geochemical sampling continued in the Nova zone (northwest block) which features northwest-trending magnetic highs and sulphide mineralized quartz veins that have returned several high gold assays (Price and Mclaughlin, 2012).

7.2.9. Kwanika and Kwanika East-Smoke (Serengeti Resources Inc.)

The **Kwanika** property (Figs. 1, 3; Table 5) of Serengeti Resources Inc. (95% interest) and Daewoo Minerals Canada Corp. (5%) is about 140 km northwest of Fort St. James and is accessible by logging roads. It comprises two porphyry deposits, the Central Zone (Cu-Au-Ag) and the South Zone (Cu-Mo-Au-Ag), which are separated by about 1 km. Both deposits are associated with potassically altered dioritic to monzonitic rocks of the Hogem intrusive complex (Late Triassic to Early Jurassic). The 1250 x 600 m Central Zone features two moderate to steeply west-dipping intrusive bodies and several minor intrusive units hosted in Takla Group andesites. Both intrusive and volcanic rocks are mineralized, but copper-gold grades are higher in the intrusive units, particularly monzonite (Rennie, 2011). The Pinchi fault (north-northwest trending) and associated half-graben shaped conglomeritic basin (Cretaceous) truncates the Central Zone on the west. Mineralization occurs as chalcopyrite-pyrite-quartz±anhydrite, magnetite, bornite veins, vein stockwork and disseminations with potassic and reported albitic alteration. Phyllic alteration (sericite±pyrite, chlorite, hematite, carbonate) variably overprints the potassic alteration. A supergene enrichment zone follows the sedimentary basin contact for up to 500 m and extends to 70 m depth below the unconformity; both native copper and secondary copper sulfides are observed with grades commonly above 1% CuEq (Fig. 16). In the South Zone, mineralization in strongly altered quartz monzonitic rocks lies within a 2900 x 500 m north-northwest trending fault-bounded corridor about 750 m east of the Pinchi Fault. The property hosts several additional exploration targets as the system remains open to the north and at depth. A series of sedimentary basins extending more than 25 km to the south of the deposit area may host additional supergene enrichment zones.

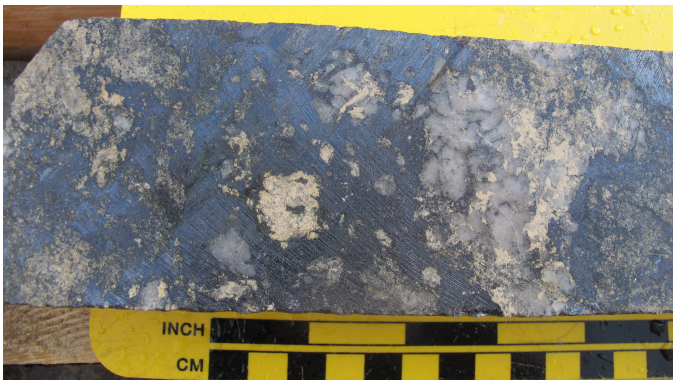

Fig. 16. Supergene chalcocite replacement mineralization in the Kwanika Central Zone (K-16-177).

In 2016, Serengeti Resources completed a deep-penetrating ground IP survey line that confirmed a modeled strong IP chargeability anomaly from a previous survey. The modeled anomaly extends up to 1000 m north of the Central Zone at depth below previous drilling. A three-hole deep drilling program followed to test the lateral continuity of the supergene enrichment in the Central Zone high-grade core, and to test for extensions along its down-dip edge to the north and to greater depth into the chargeability anomaly. Results included a 438 m long mineralized intersection in the Central Zone grading 0.71% copper, 0.83 g/t gold, and 2.0 g/t silver, and a 58 m intersection grading 0.26% Cu and 0.29 g/t Au at the bottom of a hole that tested the down-dip northwest edge of the Central Zone. As well, anomalous copper-gold mineralization in strongly altered andesite was encountered over a 245 m intersection. This potentially represents a downthrown structural block 500 m to the north of the Central Zone above the deep chargeability anomaly.

In November, an updated resource estimate was released (Table 5) for the Central Zone (indicated and inferred, pit constrained and underground components at 0.13% and 0.27% CuEq cut-offs) and South Zone (inferred, pit constrained). It includes a high-grade domain in the Central Zone of 57.7 Mt grading 0.48% Cu, 0.55 g/t Au, and 1.43 g/t Ag at a 0.40% CuEq cut-off. The 2016 drilling was incorporated into the resource estimate. The release of a revised Preliminary Economic Assessment is planned for 2017.

Roughly 7 km to the northeast, the **Kwanika East-Smoke** property (Figs. 1; Table 5) of Serengeti Resources Inc. (95%) and Daewoo Minerals Canada Corp. (5%) is also accessible by logging roads. It 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 Cretaceous).The eastern side of the property is underlain by intermediate volcanic rocks of the Takla Group and Twin Creek succession. The property follows an east-northeast trending topographic lineament that crosses the Central Zone at Kwanika and intersects the eastern contact of the Hogem intrusive complex at a high angle (Clarke, 2014b). Serengeti completed a 14 line-km induced polarization survey over several aeromagnetic anomalies, and identified two target areas for follow-up. Geochemical sampling on the property was also carried out. Exploration work on the Kwanika area properties was funded by Daewoo Minerals Canada Corp. as part of a binding agreement finalized in April.

7.2.10. Jewel, SYL, Milligan West (Serengeti Resources Inc.)

Serengeti Resources Inc. holds tenure on a regional suite of properties in the Quesnel terrane (Quesnel Trough properties; 100% owned except for Milligan West) and several of these

had grassroots to early-stage exploration programs in 2016. The **Jewel** property (Fig. 1; Table 5) is about 135 km north-northwest of Fort St. James and is accessible by helicopter from base camp. It is underlain by fine-grained siliciclastic rocks of the Takla Group at the western margin of the Germansen batholith (Fig. 3). A ground-based induced polarization and electromagnetic survey was completed to follow up the 2015 aeromagnetic survey that identified a 2 km-long ringed cluster of magnetic anomalies. The **SYL** property (Fig. 1; Table 5) is 90 km north of Fort St. James and is accessible by logging road. It is underlain by till-covered Takla Group volcaniclastic rocks along an interpreted east-west trending flexure in the Quesnel terrane (Clarke, 2014c) extending eastward from the southern end of the Hogem intrusive complex (Fig. 2). The **Milligan West** joint venture property (Fig. 1; Table 5) of Serengeti Resources (50% interest) and Fjordland Exploration Inc. (50% interest) is 17 km to the south of SYL and is accessible by a combination of logging road (southern half of property) and trails (northern half). It is underlain by till-covered Takla Group volcaniclastic and fine-grained siliciclastic rocks, Chuchi Lake succession pyroclastic rocks, and sedimentary rocks of a Paleogene half-graben. It similarly lies along the interpreted east-west trending flexure and includes a coincident airborne and ground-based geophysical target with copper-gold anomalous glacial till in the down-ice direction (Clarke, 2014a). The eastern side of the claim block is about 4 km west of the Mt. Milligan mine. In 2016, grassroots exploration and ground-based induced polarization surveys were completed at both SYL and Milligan West.

7.2.11. Later (ML Gold Corp., Pacific Empire Minerals Corp.)

The **Later** property (Figs. 1, 3; Table 5) of private company Pacific Empire Minerals Corp., under option to ML Gold Corp. is about 100 km north of Fort St. James and is accessible by logging roads. The property covers the northeast margin of the southern tail of the Hogem intrusive complex (Early Jurassic suite) where it is in fault contact with gently south-dipping intermediate volcanic units of the Chuchi Lake succession, and where a structural bend or break in the regional fabric intersects an interpreted northeast-trending transverse linear feature. Drilling in 2015 and 2016 tested a coincident geophysical anomaly consisting of a large (3 x 2 km) IP chargeability anomaly on the west side of the Elbow target area and a 2 km scale IP resistivity anomaly on the east side. These anomalies overlap a central magnetic high (Peters and Ritchie, 2015). The 2015 drilling, about 800 m to the west of the 2016 drilling area intersected 94 m grading 0.34 g/t gold with elevated copper values in a zone of phyllic (sericite-pyrite-calcite) altered Chuchi Lake succession volcanic units. Drilling in 2016 expanded the area of elevated gold mineralization to more than 1600 m within the chargeability anomaly, which is still open to the north and west (Table 5). The area is blanketed by glacial till.

7.2.12. Chuchi (Kiska Metals Corporation)

The **Chuchi** property (Figs. 1, 3; Table 5) of Kiska Metals Corporation (100% owned) is about 18 km east of the Later property and is accessible by logging and exploration roads. The claim block is centered on the northeast margin of the Hogem intrusive complex (Early Jurassic suite) at its southeastern end and continues eastward where it is underlain by a cluster of porphyritic monzonite stocks, dikes, and sills (Early Jurassic) that cut Chuchi Lake succession volcanic and sedimentary rocks. A central target (BP zone) of 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 (actinolite-magnetite±K-feldspar) and biotite hornfels (Nelson and Bellefontaine, 1996), and is coincident with an inwardly zoned high-to-moderate ground-based IP chargeability anomaly. Historic drilling 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 and coincident copper and gold soil geochemical anomalies continue eastward across a north-south trending fault-bounded valley that bisects the property. In 2016, a 4000 m core relogging and resampling program was conducted in two east-west cross sections similarly oriented to the 2015 induced polarization geophysical survey across the BP zone. One northeast-southwest long section was also completed. The 2015 survey defined chargeability anomalies coincident with the central magnetic high feature and zones of known mineralization. These chargeability anomalies extend beyond the magnetic feature and known mineralization both laterally and at depth, and to the east across the fault valley.

7.2.13. Q7a (Vale Exploration Canada Inc.)

The **Q7a** property (Fig. 1; Table 5) of Vale Exploration Canada Inc. (100% owned) is about 84 km north of Fort St. James and is accessible by logging roads. It is underlain by gently south-dipping Chuchi Lake succession volcanic and volcaniclastic rocks with dioritic to monzonitic intrusive units (probable Early Jurassic suite), and sedimentary rocks of a Paleogene half-graben (Hicks, 2015). A blanket of glacial till covers the property. In 2016, a three-hole drilling program tested a geophysical target across a strike length of 800 m. The target comprises an airborne magnetic high coincident with a ground IP chargeability anomaly on its eastern side.

In 2015, four unrecorded historic drill holes were found on the property and two of the drill sites were located. The holes were relogged and resampled, returning anomalous copper and gold values (Hicks, 2015). Mineralization with potassic and variable sericite-calcite alteration includes fine disseminated chalcopyrite and pyrite±chalcopyrite, quartz, magnetite, biotite, albite veins.

7.2.14. North Grid (Centerra Gold Inc., formerly Thompson Creek Metals Company Inc.)

The **North Grid** property (Fig. 1; Table 5) of Centerra Gold Inc. (100% owned) is about 5 km northwest of the Mt. Milligan mine and is accessible by exploration roads from the mine. It is underlain by moderately east-dipping Takla Group mafic-intermediate volcaniclastic units less than 2 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 2 km west of an interpreted southeast-trending buried extension of the pluton towards the Mt. Milligan deposit area (Clifford and Berthelsen, 2015). A biotite-magnetite rich unit has previously been interpreted as an amphibolitic schist related to basement uplift (MINFILE 093N 204). In 2016, a multi-year drill program continued. Two drill holes tested an airborne magnetic high anomaly with a coincident ground IP chargeability anomaly on its western side (Mitzi target), and one hole tested a similar coincident geophysical anomaly about 2 km to the west (Snell target). At the Mitzi target, drilling intercepted an interval of pyrite-mineralized silicified and sericite altered chaotic breccia that is visually similar to units in the gold-enriched 66 Zone at the Mt. Milligan mine.

7.2.15. Fran (MGX Minerals Inc., Manto Gold Corp.)

The **Fran** property (Fig. 1; Table 5) of Manto Resources Ltd., optioned by Manto Gold Corp, a wholly-owned subsidiary of MGX Minerals Inc., is about 60 km north of Fort St. James and is accessible by logging roads. It is underlain mainly by Takla Group sedimentary (Inzana Lake succession) rocks, and also volcaniclastic rocks (Witch Lake succession), dioritic intrusive rocks (Late Triassic-Early Jurassic), and a granite stock (Cretaceous-Tertiary). The main target area on the property, the 1.5 km long Bullion Alley zone (MacIntyre, 2013), comprises northwest-trending en-echelon shear zones hosting auriferous quartz-sulphide veins, veinlet stockwork, and replacement mineralization. These are spatially related to a series of steeply north-dipping porphyritic monzodiorite dikes in contact with hornfelsed volcanic siltstones. The zone is open to the southeast. In 2016, grassroots geochemical soil and rock sampling (Table 5) focused on the Fran East zone, east of the Bullion Alley zone. Soils were analyzed by soil gas hydrocarbon (SGH) analysis, a weak extractive procedure proprietary to Activation Laboratories Ltd. used to locate mineralization through cover. Results identified a 1000 x 400 m zone of anomalous copper and gold SGH signatures coincident with a large aeromagnetic anomaly and generated new drill targets.

7.2.16. Captain (Orestone Mining Corp.)

The **Captain** property (Fig. 1; Table 5) of Orestone Mining Corp. is about 50 km north-northeast of the Fort St. James and is accessible by logging and spur roads. It is underlain by Takla Group sedimentary (Inzana Lake succession) and volcanic rocks (Witch Lake succession), dioritic intrusive rocks (Late Triassic-Early Jurassic), paragneiss metamorphic rocks of the western margin of the Wolverine metamorphic complex, Chilcotin Group basaltic volcanic rocks, and is largely blanketed by glacial till generally 20-60 m thick. The property hosts a large northwest-trending central airborne magnetic high interpreted to be a buried dioritic pluton flanked by two greater than 1 x 3 km target areas, the East Magnetic target and West Magnetic target, which host clusters of smaller ground-based magnetic highs with moderate-strong peripheral IP chargeability anomalies including those of the 1 x 1.5 km Admiral target (East Magnetic target area). Copper-gold mineralization is associated with a series of potentially north-south striking subvertical monzonite porphyry dikes and consists of sulphide disseminations, blebs and veinlets with magnetite-rich potassic (K-feldspar-biotite-actinolite) and phyllic (sericite-pyrite-carbonate-chlorite) alteration. In 2016, ground-based induced polarization and magnetic surveys were completed to better define the Admiral target prior to further drilling; the last drilling program was in 2013 (Zawada, 2014).

7.2.17. Orbit (private individual, prospector)

The **Orbit** property (Fig. 1; Table 5) is about 11 km north-northwest of Fraser Lake and is accessible by highway and logging roads. It is predominantly underlain by dioritic intrusive rocks of the Stern Creek plutonic suite (Late Triassic), and by basaltic-andesite of the Endako Formation on its eastern side. Outcrops on the northern part of the property have quartz and epidote veining, and a sheared quartz vein with chalcopyrite mineralization was recently discovered (Rempel, 2012). In 2016, auger drilling was conducted to sample basal till and top of bedrock from 35 pre-disturbed sites.

7.3. Polymetallic base and precious metal projects

In 2016, seven polymetallic base and precious metal projects were tracked in the North Central Region. Two projects were at the advanced exploration stage (Akie and Cirque). The other projects were at the early exploration stage (five projects). Six of the properties are in the Muskwa ranges of the Northern Rocky Mountains, in the western margin of ancestral North America.

7.3.1. Akie (Canada Zinc Metals Corp.)

The **Akie** property (Figs. 1, 3; Table 5) of Canada Zinc Metals Corp. and subsidiary Ecstall Mining Corp. (100% owned) is about 250 km north of Mackenzie and is accessible by logging and exploration roads. Fixed-wing aircraft can use the gravel airstrip at Tsay Keh Dene and Kwadacha. The property is underlain by fine-grained siliciclastic and limestone units of the Kechika Group, Road River Group, and Earn Group. The property includes the Cardiac Creek baritic zinc-lead-silver SEDEX deposit, which is hosted in Gunsteel Formation shale (Earn Group). It is a steeply southwest-dipping tabular mineralized body that averages about 20 m thickness (<35 m thickness) and extends for an approximate strike length of 1,950 m, of which 1,300 m is considered potentially economic to a depth of about 800 m below surface (Sim, 2012; Sim,

2016). From bottom to top, mineralization generally defines a stratiform sequence of: 1) bedded to massive barite and minor quartz-carbonate veining; 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; and 5) fine-grained laminar pyrite and nodular barite. The mineralized zone is commonly interbedded with siliceous Gunsteel Formation shale, can have weakly mineralized pyritic massive sulfide in a footwall zone, and is underlain by marine turbidites of the Paul River Formation (Lower Devonian) that include interbedded black shale and limestone debris flows (MacIntyre, 1998). In 2016, a NI 43-101 technical report was released with an updated resource estimate for the Cardiac Creek deposit that incorporates infill and step-out drilling carried out since 2012. This drilling focused on the central, high-grade part of the deposit and refinement of the deposit model. The resource, a continuous zone at a 5% zinc cut-off grade, increased by 55% in the indicated category from the previous 2012 estimate with little change in average grade (Table 5); it now stands at 19.6 Mt grading 8.17% zinc, 1.58% lead, and 13.6 g/t silver. The additional inferred resource, now 29% of the total, is 8.1 Mt grading 6.81% zinc, 1.16% lead, and 11.2 g/t silver. Environmental baseline monitoring and review of plans for permitted underground exploration via a ramp decline to about 500 m below surface continued.

7.3.2. Cirque, Pie, Cirque East, Yuen (Teck Resources Limited; Korea Zinc Company, Ltd.)

The **Cirque** property (Figs. 1, 3; Table 5) of Cirque Operating Corporation, a joint venture partnership between Teck Resources Limited (50% interest) and Korea Zinc Company, Ltd. (50% interest) is about 20 km northwest of Akie and is also accessible by logging and exploration roads, or by helicopter. It is underlain by similar geology as the Akie property but with different proportions of interfingering sedimentary facies, particularly of the Earn Group. Three major northwest-trending regional thrust panels cut across the property. They are referred to as the Western, Cirque, and Akie panels (Henry and Theissen, 2014). The Cirque panel hosts the South Cirque and North Cirque deposits and the Akie panel hosts the Akie property Cardiac Creek deposit.

The South Cirque deposit is a partially delineated apparent tabular mineralized body that does not outcrop. The better-defined North Cirque deposit does outcrop and is a 1000 x 300 m and <60 m thick, moderately southwest dipping, south plunging lensoid baritic zinc-lead-silver SEDEX deposit with a maximum depth of about 400 m below surface. Zinc-lead-silver mineralization at the Cirque deposits may have a replacement-style component instead of being strictly exhalative, similar to the Red Dog deposit in Alaska where mineralization formed by submarine replacement of a sea-floor barite deposit (Leach et al., 2010). In 2016, the development and refinement of drill targets continued as part of a multi-year exploration program that has integrated airborne gravity gradiometry (AGG) and Versatile Time Domain Electromagnetic (VTEM) geophysics, targeted ground gravity geophysics, soil and rock geochemical sampling, geologic mapping and prospecting. Drilling in 2016 focused on the R-Creek target about a kilometre northwest of North Cirque (Fig. 17). As well, property wide baseline environmental monitoring continued.

A similar integrated exploration strategy is being used on the nearby **Pie**, **Cirque East** and **Yuen** properties (Pie Option properties) optioned from Canada Zinc Metals Corp. In 2016, five high priority target areas on Pie and Yuen were selected for focused exploration, and a target about one kilometre west and down-dip of historic drilling and trenching in the Pie Main area was drilled (Fig. 18). Mineralized showings Pie Main and Pie Breccia (Pie property) and target areas with soil geochemical anomalies at Noel Creek (Yuen property) and Cirque East are hosted in the Akie panel. The West Pie showings (Pie property) and a target area with coincident AGG and soil geochemical

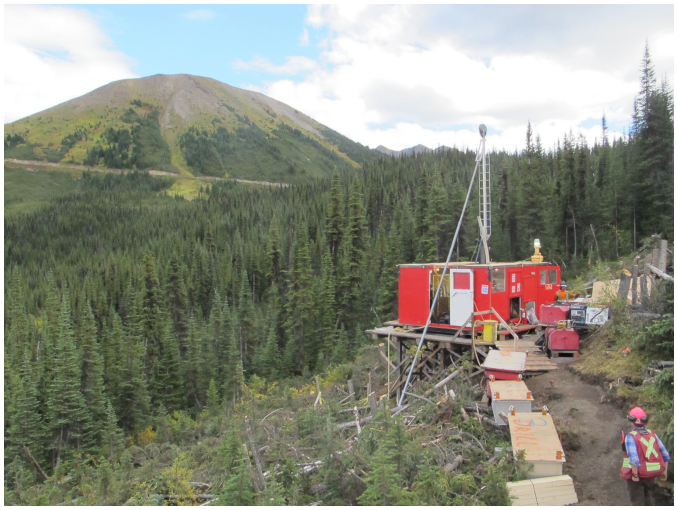

Fig. 17. Drilling the R-Creek target on the Cirque property. View is looking southeast towards the North Cirque deposit.

Fig. 18. Historic trench area at the Pie Main target, about a kilometre east of the 2016 drilling site. View is looking south.

anomalies at China Ridge (Yuen property) are in the Cirque panel. Baseline environmental monitoring for the Pie, Cirque East and Yuen properties continued.

7.3.3. Coral (Minfocus Exploration Corp.)

The **Coral** property (Fig. 1; Table 5) of Minfocus Exploration Corp. (100% owned) is about 92 km north of Mackenzie and is accessible by helicopter only. It is underlain by dolomitic carbonate rocks (Upper Silurian-Lower Devonian) in an east-dipping limb of a fold in the hanging wall of a thrust fault (Thompson, 1986), and hosts a Mississippi Valley-type deposit prospect. Zinc-lead mineralization lies in a northwest-trending irregular stratabound zone of dolomite breccia with sparry dolomite matrix (Haynes and Hardy, 1987) and consists of early stage disseminated fine-grained red sphalerite that is cut by coarse dolomite veinlets, and a later stage of yellow sphalerite (Fig. 19). Several target areas are on the property, including mineralized outcrop, soil geochemical anomalies (including a 600 x 300 m zinc soil anomaly) and stream-sediment anomalies.

In 2016, drilling equipment was barged from near Hudson's Hope (Fig. 1) on the Peace Arm of Williston Reservoir and a nine-hole drilling program, oriented north-south over about 500 m, tested two target areas. New mineralization was also discovered in outcrop less than 100 m from a recently resampled historic trench (deGraff et al., 2015) and the outcrop was sampled over a strike length of seven metres (Table 5).

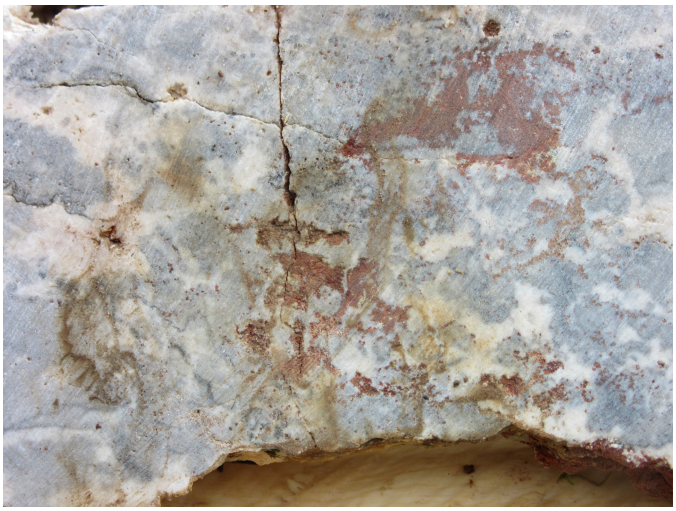

Fig. 19. Sawn sample of dolostone breccia with red sphalerite and wispy galena veinlets at bottom left. Photo courtesy of Minfocus Exploration Corp.

7.3.4. BT (Porpoise Bay Minerals Ltd.)

The **BT** (Bobtail) property of private company Porpoise Bay Minerals Ltd. (100% owned) is accessible by logging roads (Fig. 1; Table 5). It is underlain by serpentinized ultramafic rocks and basaltic volcanic rocks of the Cache Creek complex, and a granite stock (Eocene). Following up the 2015 trenching program, channel sampling of serpentinite bedrock over about 24 m returned high copper values in assay (over 1% Cu; R. Seel, personal communication, November 2016) with anomalous cobalt.

7.4. Coal projects

Two coal projects were tracked in the North Central Region in 2016. One project was at the advanced exploration stage (Groundhog North), and the other was at the early exploration stage (Panorama North). Both projects are in the Groundhog coalfield in the Bowser Basin and Skeena fold and thrust belt.

7.4.1. Groundhog North and Panorama North (Atrum Coal NL)

The Groundhog-Klappan coalfield, in the northcentral part of Bowser Basin, extends across the North Central - Northwest regional boundary. The **Groundhog North** (Figs. 1, 3; Table 5) anthracite coal property of Atrum Coal Groundhog Inc. (100% owned) is accessible by fixed-wing aircraft or helicopter. It lies in a broad, northwest-southeast trending open-folded synclinorium (British Columbia Geological Survey, 2016). The main coal bearing sequence is the Groundhog-Gunanoot assemblage (Evenchick and Thorkelson, 2005), locally known as the Groundhog unit (Upper Jurassic-Lower Cretaceous; Bowser Lake Group), a 600 m-thick alternating marine and non-marine deltaic sequence with 46 modelled coal seams (Atrum Coal, 2014). 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. In 2016, a revised prefeasibility study was completed for the Groundhog North Mining Complex involving a small-scale underground starter mine and a staged development approach. The Phase 1 mine could produce up to 880,000 tonnes-per-year of saleable ultra-high-grade anthracite coal (including 43% inferred resources) over 28 years. Mining would require establishing access to road, rail, and port infrastructure. Fully ramped-up production at a later stage would be 1.6 Mt annually.

Improved washability test results with yields averaging above 80% were received for coal from the eastern part of the property, potentially reducing project costs. In May, permit approval was received for the underground and surface extraction of an up to 100,000 tonne bulk coal sample and special use of an existing railbed subgrade for ground-based access and haulage of the bulk sample to a nearby railway connection point to the southeast. The railbed was built in the 1970s by British Columbia Rail. Engineering design work and site preparation planning followed. The advanced stage project has yet to enter the environmental assessment process but environmental baseline work is continuing. In August Atrum Coal entered into a joint exploration agreement with Japan Oil, Gas and Metals National Corporation (JOGMEC) for the **Panorama North** property, 15 km southwest of Groundhog North, whereby JOGMEC can earn a 35% interest by investing $5 million over three years. Review of historic exploration results was followed by a four-hole drilling program in October. Multiple coal seams, including near-surface seams, were intersected;

the thickest seam ranges from 1.70-2.30 m (Table 5). Down-hole geophysical logging was also completed. Anthracite coal has metallurgical and specialty market industrial mineral applications.

7.5. Industrial mineral projects

In 2016, five industrial mineral projects were tracked in the North Central Region. Ornamental minerals such as nephrite jade are included in this category. One project, Giscome (section 6.3.1.) was at the mine evaluation stage. One project, Pishon Green Jade, was at an advanced exploration stage. The others were at an early exploration stage (two projects) or grassroots stage (one project). Nephrite jade projects are in the Cache Creek terrane; silica and limestone projects are in rocks of ancestral North America.

7.5.1. Longworth (MGX Minerals Inc.)

The **Longworth** property (Fig. 1; Table 5) of MGX Minerals Inc. (100% owned) is about 82 km east of Prince George. The property is in a westernmost range of the Northern Rocky Mountains, adjacent the Northern Rocky Mountain trench, and is accessible by logging roads and trail. It is underlain by greenstone, carbonate and quartzite units of the Nonda Formation (Silurian; Fig. 3.) in a northwest-trending, steeply east-dipping synformal structure (Quartermain, 1986). Four high purity silica target areas 100-300 m wide and up to 400 m thick are in ridges of white quartzite that is intermittently exposed for six kilometres. The quartzite is massive and homogenous with minor impurities including muscovite, limonite and calcite. In 2016, a grassroots geochemical sampling program was completed and metallurgical testing was planned (Fig. 20). In the Snow zone, quartzite samples averaged 99.34% SiO_2, ranging up to 99.9% SiO_2. A high-silica product derived from quartzite could have use as feed material in the production of silicon metal, which has a variety of industrial uses including in construction materials, electronics and healthcare products.

7.5.2. Bowron River (First Amber Mines Inc.)

The **Bowron River** property (Fig. 1; Table 5) of First Amber Mines Inc. is about 56 km east of Prince George and is accessible by logging roads. It is underlain by Slide Mountain Group (Antler Formation) basaltic volcanic rocks and a northwest-trending, 15-km long, roughly 2-km wide, sedimentary basin (Upper Eocene) that follows a meandering section of the Bowron River and hosts the Bowron River coalfield. Basin strata dip moderately to the northeast. Three major coal seams of high volatile B rank with cumulative thickness of about 9 m have been historically identified in the lower 85 m of the more than 700 m thick section. The coals have been described as having an average amber content of 4% based on a visual estimate from the upper seam, but data for the lower seam of about 1% average amber content may be more accurate (Kerr, Dawson & Associates Ltd., 1978). Elongate and flattened blebs of amber resin are hosted in coal lenses, bands and seams, and in shaley partings (Rees, 1982). In 2016, a percussion and core drilling program was completed near two historic adits with the aim of collecting samples for test marketing of the amber.

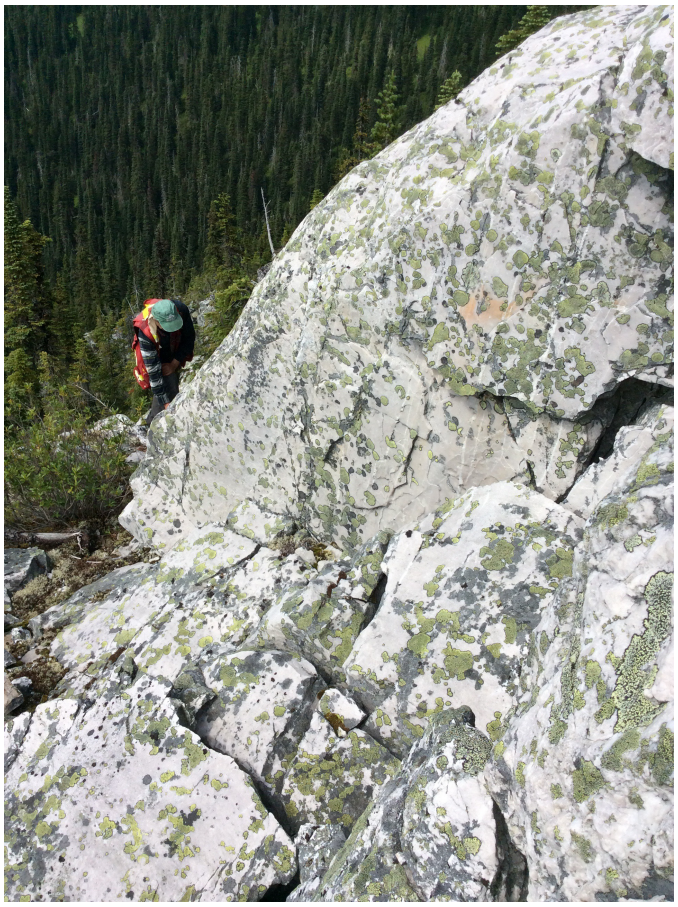

Fig. 20. Quartzite ridge in the Snow zone at Longworth.

7.5.3. Pishon Green Jade (private individual)

The privately owned **Pishon Green Jade** property (Fig. 1; Table 5), is about 96 km northwest of Fort St. James in the Cache Creek terrane and accessed by logging and exploration roads. Northeast-trending, variably dipping lenses of green nephrite jade are hosted in Cache Creek complex metasedimentary rocks near a thrust faulted contact with serpentinized ultramafic rocks of the Trembleur ultramafic unit (McIntyre and McIntyre, 1995). A large granodiorite pluton (Early Cretaceous) lies about 2.5 km to the west. The largest nephrite exposure is known as the jade cliff. A similar zoned alteration sequence as at the Ogden Mountain property is documented with the transition of pure talc to foliated talc-tremolite-chlorite to hard grey tremolite to nephrite. In 2016, a private individual began a surface bulk sample program (Fig. 21).

8. Exploration activities and highlights (Northeast Region)

Six active exploration projects were tracked in the Northeast Region in 2016, up from three in 2015 (Tables 4, 6). Of these six, three were at the mine evaluation stage, two were at the advanced stage, and one was at the grassroots stage. Four properties were for coal, one for industrial minerals, and one for polymetallic base and precious metals.

Fig. 21. Previously sawed bedrock exposure to be bulk sampled using expanding grout at Pishon Green Jade.

8.1. Polymetallic base and precious metal projects

The single polymetallic base and precious metal project is a Cu±Ag quartz vein (Churchill-type vein copper) project at a grassroots exploration stage.

8.1.1. Key (Botco Mining and Exploration)

The **Key** property (Fig. 1; Table 6) of Botco Mining and Exploration (100% owned) is about 163 km west of Fort Nelson in the Muskwa ranges of the Northern Rocky Mountains, in a north-northwest trending anticlinorium. Access is generally by helicopter; an historic exploration road heading south from Highway 97 is ATV accessible. The property is underlain by southwest-dipping fine-grained sedimentary units of the Muskwa assemblage (Aida Formation; Mesoproterozoic; Figs. 2, 3) that are asymmetrically folded with northeast vergence and southeast plunge. These units are cut by subvertical diabase dikes up to 100 m wide that generally strike northeast. A northeast-trending 2.5-km wide belt features northeast-trending subvertical fracture zones and structurally controlled quartz-carbonate veins with massive, semi-massive and disseminated chalcopyrite mineralization. Wallrock margins are altered by silicification, graphite and iron-carbonate. At least five mineralized veins are on the property, with average widths ranging from about 0.5 to 2.5 m (Harrington, 2012). The Eagle vein system, at 1.2 m average width, has been traced over 1,220 m strike length and explored underground to a vertical depth of 460 m. Five kilometres to the south-southeast, the historic Churchill Copper (Magnum) mine milled 498 Kt (549,000 tons) ofore grading 3.00% Cu from 1970 - 1974. In 2016, a grassroots program of geochemical sampling and prospecting was completed.

8.2. Coal projects

All four projects tracked in the Northeast Region in 2016 are in the Peace River coalfield. Two, Murray River (section 6.2.1.) and Sukunka (section 6.2.2.), were at the mine evaluation stage, two, Wapiti River and Huguenot, are at an advanced exploration stage.

8.2.1. Wapiti River (Canadian Dehua International Mines Group Inc.)

The **Wapiti River** property (Fig. 1; Table 6) of Canadian Dehua International Mines Group Inc. (100% ownership) is about 45 km southeast of Tumbler Ridge and is accessible by highway and logging roads. On its western side, the claim block

Table 6. Selected exploration projects, Northeast Region.

Project	Operator	MINFILE	Commodity; Deposit type	Resource (NI 43-101 compliant unless indicated otherwise)	Work Program	Comments
Key	Botco Mining and Exploration	094K 012	Cu, Ag, Co, Pb; Cu±Ag quartz veins	historic non NI 43-101 compliant: 1.248 Mt (1,375,700 tons) at 3.38% Cu; semi-proven and probable reserves Chapman, Wood & Griswold, 1971)	geochemical sampling (rock), prospecting	
Wapiti River	Canadian Dehua Int'l Mines Group Inc.	093I 041	Coal; Bituminous coal	562.6 Mt in situ (Measured and Indicated), 196 Mt (Inferred), No.1 Mine	feasibility study update, resource estimate update	Results of 2015 feasibility study update made public in early 2016.
Huguenot	Colonial Coal Int'l Corporation	093I 036, 093I 014	Coal; Bituminous coal	277.7 Mt in situ (Measured and Indicated), 119.2 Mt in situ (Inferred)	baseline environmental studies, reports	

is underlain by fine- to coarse-grained siliciclastic units in the upper parts of the Fort St. John Group (Lower Cretaceous; Fig. 3) and on its eastern side by Upper Cretaceous units. Seismic interpretations (2D) and drilling log information have resulted in 63 modelled coal seams (main and sub-seam) in the Gates and Gething formations in a syncline-anticline pair cut by east and west-dipping reverse faults. In 2016, results of an updated NI 43-101 technical report completed in 2015 by Norwest Corporation for the No.1 Mine were made public (Canadian Dehua International Mines Group Inc., 2016). A medium volatile bituminous coking coal resource of 562.6 Mt in the measured and indicated categories includes 14 main mineable seams with average cumulative thickness of 29.5 m, extending to 900 m depth. A three-level underground longwall mining operation with coal production capacity of 10 Mt per year over nearly 47 years is envisioned. Infrastructure requirements would include powerline and railway extensions from Tumbler Ridge. The advanced-stage project has yet to initiate an environmental assessment.

8.2.2. Huguenot (Colonial Coal International Corp.)

The **Huguenot** property (Fig. 1; Table 5) of Colonial Coal International Corp. (100% owned) is about 82 km southeast of Tumbler Ridge. It lies in a northwest-trending band of tight to open folds and northeast-vergent thrust faults on the northeast limb of a broad anticlinorium. The average cumulative thickness of Gates Formation coal seams in three separate blocks is about 15 to 19 m. A NI 43-101 compliant preliminary economic assessment study (Evenson, 2013) describes a combined surface and underground longwall mining operation that would produce between 1.4 Mt-5.9 Mt/y, averaging 3.0 Mt/y of saleable coal over 31 years. Total production over the life of mine would be 89 Mt of saleable coal. In 2016, baseline environmental studies and further data compilation were completed.

9. Geological research

Geological research in the North Central Region in 2016 was carried out mainly by Geoscience BC in the Nechako Plateau and Toodoggone River areas of the Stikine terrane, and also focused on the north central Quesnel terrane. The British Columbia Geological Survey completed a study that included a mineral deposit (inactive project) in the ancestral North American margin. In the Northeast Region, Geoscience BC supported studies in the Western Canada Sedimentary Basin.

9.1. Geoscience BC

Geoscience BC continued moving the **TREK** (Targeting Resources through Exploration and Knowledge) program (Clifford and Hart, 2014) through its final stages and deliverables. The program started in 2013 with the aim of integrating geophysical, geological and geochemical data in the northern Interior Plateau, including the Nechako Plateau area, to develop an improved understanding of underlying geology which is largely obscured by Chilcotin Group basalt flows and glacial drift.The study area includes mineral discoveries made during regional mapping by Diakow et al., (1997). Geologic mapping studies focused on correlating geophysical signatures to lithology and structure and identifying new showings and styles of mineralization (Angen et al., 2016), and characterizing Late Cretaceous volcanic suites (Kim et al., 2016). Results of a helicopter-supported biogeochemical survey that collected spruce-top twig and needles were released in April (Jackaman and Sacco, 2016). Coverage is mainly south of the North Central Region but overlaps onto its southwestern margin.

Geoscience BC supported a Mineral Deposit Research Unit (MDRU) project to develop an updated exploration framework for porphyry to epithermal transitions in the Toodoggone River area. The project was conducted by MDRU research associates in 2016 and focused on characterizing several mineralized systems through mineralogical descriptions and geochemical sampling, used to estimate depths of emplacement and exhumation levels as they relate to deposit-type prospectivity.

Geoscience BC also supported a mineral prospectivity mapping study (Granek and Haber, 2016) using advanced spatial-data analysis techniques on the QUEST project dataset that covers much of the Quesnel terrane in the North Central Region, and some sedimentary geology studies related to the energy sector in the Northeast Region that focused on Quaternary geology (Hayes et al., 2016) and the Montney Formation siltstone (Lower Triassic; Gegolick et al., 2016; Prenoslo et al., 2016) which correlates with lower stratigraphic units of the Spray River Group (Sulphur Mountain Formation; Fig. 3).

9.2. British Columbia Geological Survey

The British Columbia Geological Survey did not carry out ground based work in the North Central or Northeast regions in 2016. The Wicheeda (MINFILE 093J 014) carbonatite-related rare earth element deposit, near the margin of ancestral North America in the North Central Region, was included in a fluorite geochemistry study that examined the use of fluorite as an indicator mineral in discriminating different deposit types (Mao et al., 2016).

10. Summary

Challenges associated with low commodities prices and market volatility continued to affect the North Central and Northeast regions in 2016 and four of five operational or fully permitted coal mines, and one metal mine, remained on care and maintenance. One coal mine began restart activities immediately following a rebound in metallurgical coal price that began in August. Although difficulties in raising capital through equity financing in the junior market also continued, more grassroots to early stage exploration activity was tracked in 2016 perhaps indicating the initial stage of an improving cycle for mineral exploration and investment. Underexplored parts of the two regions continue to generate interest for a variety of mineral deposit types including porphyry, epithermal, and stratiform or vein-hosted polymetallic types, and also for

coal and industrial minerals. Placer gold mining continues to be a robust activity in the North Central Region.

Main highlights for 2016 included: the reaching of production capacity and the construction and commissioning of a permanent secondary crusher at the **Mt. Milligan** mine (Centerra Gold Inc.); the restart of the **Brule** mine (Conuma Coal Resources Limited) after being on care and maintenance since mid-2014; the advancement of a final Mines Act permit application review process for development of an underground coal mine at **Murray River** (HD Mining International Ltd.); the advancement of several environmental assessments in the review stage including **Blackwater** (New Gold Inc.), **Kemess Underground** (AuRico Metals Inc.), **Giscome** (Graymont Western Canada Inc.), and **Sukunka** (Glencore plc) and the continued delineation of an ore body through drilling at the advanced exploration **Kemess East** project (AuRico Metals Inc.).

Exploration drilling programs expanded areas of known mineralization at **Lawyers** (PPM Precious Metals Corp; published results from 2015 drilling), **Kwanika** (Serengeti Resources Inc.), **Later** (ML Gold Corp., Pacific Empire Minerals Corp.) and **Coral** (Minfocus Exploration Corp.), and potentially at **Cirque** (Teck Resources Limited). Drilling programs also confirmed metal mineralization at **Thor** (Copper North Mining Corp), and potentially at **North Grid** (Centerra Gold Inc.), **Q7a** (Vale Exploration Canada Inc.), and **Pie** (Teck Resources Limited, Canada Zinc Metals Corp.), and for coal at **Panorama North** (Atrum Coal Panorama Inc.) and **Bowron River** (First Amber Mines Inc.).

New discoveries continue to be made at the grassroots-exploration level such as a northern extension of the epithermal vein system at **2 X Fred** (Kootenay Silver Inc., Theia Resources Ltd.) and newly documented mineralized showings on the expanded **Big Bear** property (Parlane Resource Corp.), at **Coral** (Minfocus Exploration Corp.), and on the **Pil** property (Finlay Minerals Ltd.). New high-priority drill targets were defined through geophysics and/or geochemistry at **Captain** (Orestone Mining Corp.), **Cathedral** (Thane Minerals Inc.), **Chuchi** (Kiska Metals Corporation), **Fran** (MGX Minerals Inc.), **Kwanika East-Smoke** and **UDS** (Serengeti Resources Inc.), and on the **Pie**, **Cirque East** and **Yuen** properties (Teck Resources Limited, Canada Zinc Metals Corp.).

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The information in this report was derived from news releases, quarterly reports, management discussion and analysis 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. 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.

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