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EXPLORATION AND MINING IN BRITISH COLUMBIA 2012



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Ministry of
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Regional Geologist Summaries
EXPLORATION AND MINING
in British Columbia 2012

EXPLORATION AND MINING IN THE KOOTENAY-BOUNDARY REGION, BRITISH COLUMBIA

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6.1 SUMMARY AND TRENDS

Mineral exploration expenditures were less in 2012 than in the previous year, but the overall exploration expenditures in the Kootenay-Boundary Region increased significantly, due to the high level of activity in the East Kootenay coalfields. Total coal production also increased compared with 2011.

Highlights for the year included:

- major coal exploration drilling programs (Centermount Coal Ltd, Crows Nest Pass Coal Mining Ltd, Jameson Resources Limited, and Teck Coal Limited)
- detailed engineering studies for development of a frac sand operation at the Moberly Mine (Heemskirk Canada Limited)
- a major underground drilling program and resulting resource calculation upgrade for the J&L polymetallic deposit (Huakan International Mining Inc)
- gold exploration drilling programs in the Nelson area (Altair Gold Inc, Anglo Swiss Resources Inc, Emgold Mining Corporation, Excalibur Resources Ltd, and Hellix Ventures Inc)
- continued exploration for sedex mineralization in the Purcell Basin of the East Kootenays (MMG Limited, Omineca Mining and Metals Ltd, Providence Resources Corp/Eagle Plains Resources Ltd, Purcell Resources)
- gold exploration drilling programs in the Cranbrook area (PJX Resources Inc, Turnberry Resources Ltd)

Total exploration expenditures in 2012 are projected to increase to about \$55 million (Fig. 6.1). The commodities with the highest exploration expenditures were coal and gold. Exploration expenditures in 2012 can be broken down into stages as shown in Figure 6.2. An estimated 129 km of exploration drilling was carried out in the Kootenay-Boundary Region in 2012 (Fig. 6.3).

6.2 MINES

The Kootenay-Boundary Region hosts five large open-pit coal mines, and smaller operations for industrial minerals (Fig. 6.4, Table 6.1).

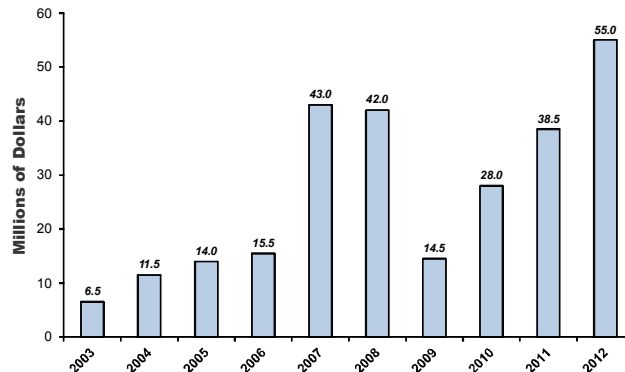


Figure 6.1. Annual exploration spending in millions of dollars, 2003 to 2012, Kootenay-Boundary Region. The Revelstoke area was added to the region in 2010.

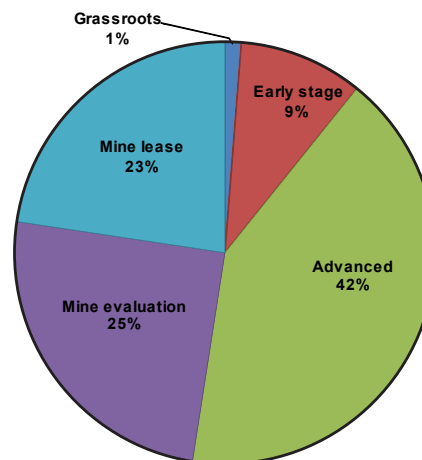


Figure 6.2. 2012 exploration expenditures by category, Kootenay-Boundary Region.

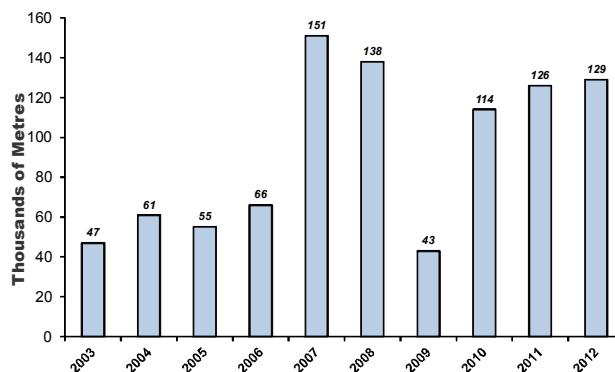


Figure 6.3. Annual exploration drilling in thousands of metres, 2003 to 2012, Kootenay-Boundary Region.

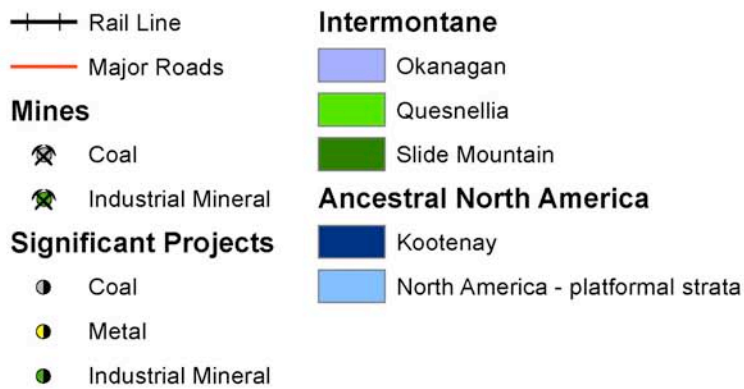
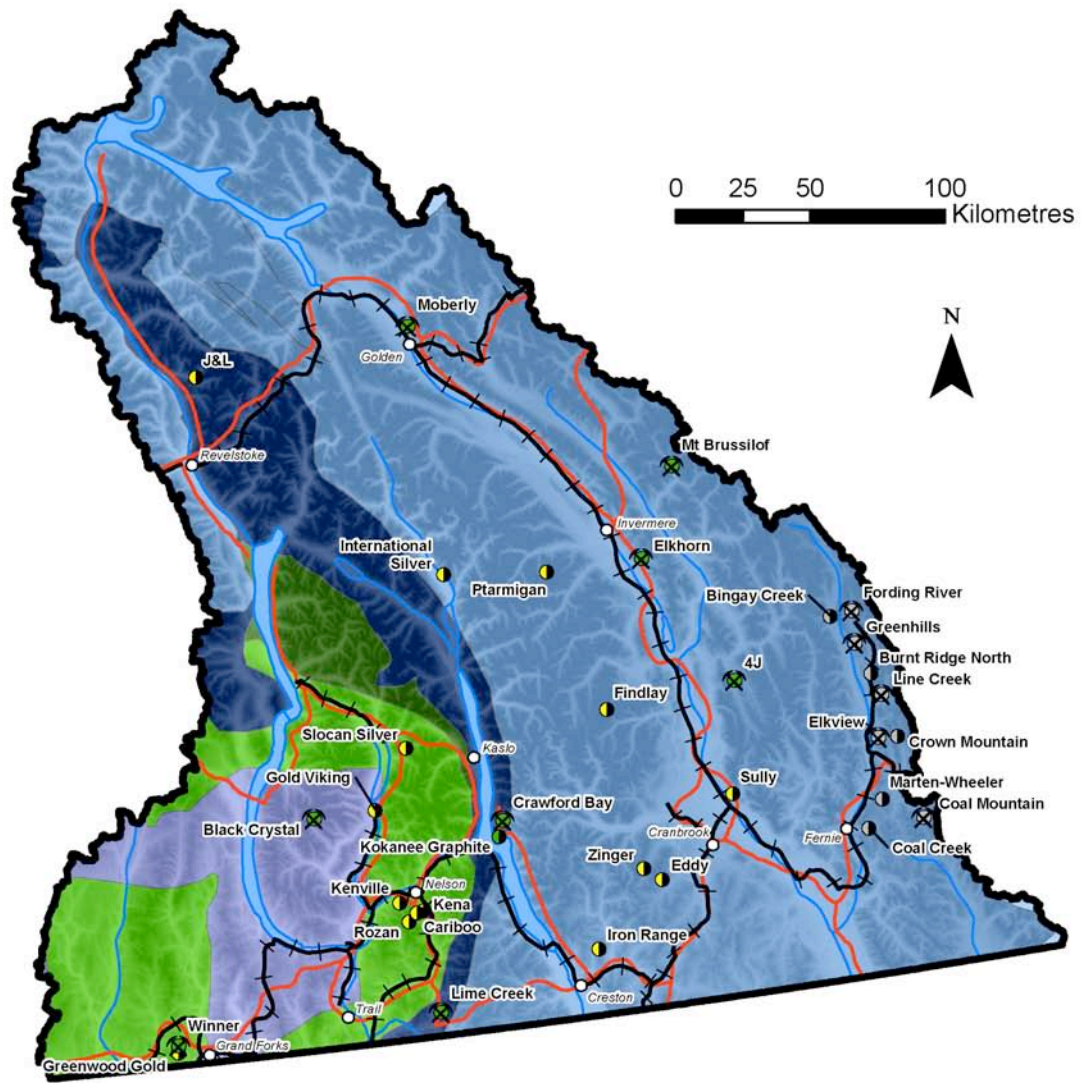


Figure 6.4. Locations of selected operating mines and exploration projects, Kootenay-Boundary Region, 2012. Large on-lease exploration drilling programs at three operating mines (Fording River, Greenhills and Elkview) are not plotted.

TABLE 6.1. SELECTED PRODUCING MINES, KOOTENAY-BOUNDARY REGION, 2012

Mine	Operator	Commodity	Employment	Actual 2011 Production	Projected 2012 Production	Proven and Probable Reserves as of December 31, 2011 or as indicated
Coal						
Coal Mountain	Teck Coal Limited	PCI and thermal coal	319	2.78 Mt	2.687 Mt	15.9 Mt
Elkview	Teck Coal Limited	Metallurgical coal	1067	4.167 Mt	4.653 Mt	215 Mt
Fording River	Teck Coal Limited	Metallurgical and thermal coal	1184	8.320 Mt	8.915 Mt	626.5 Mt
Greenhills	Teck Coal Limited	Metallurgical, PCI and thermal coal	577	4.421 Mt	4.544 Mt	75.3 Mt
Line Creek	Teck Coal Limited	Metallurgical, PCI and thermal coal	518	2.861 Mt	3.4 Mt	67.2 Mt
Industrial Minerals (selected)						
4J	Georgia-Pacific Canada Inc	Gypsum				
Crawford Bay	Imasco Minerals Inc	Dolomite				
Elkhorn	CertainTeed Gypsum Canada	Gypsum	17	423 kt	429 kt	
Lime Creek	Imasco Minerals Inc	Limestone				
Moberly Silica	Heemskirk Canada Limited	Silica sand				13.5 Mt @ 64% frac sand (June 30, 2012)
Mount Brussilof	Baymag Inc	Magnesite	42	190 kt	180 kt	
Winner	Roxul Inc	Gabbro (mineral wool)	2		150 kt	

6.2.1 Coal

Teck Coal Limited, the world's second-largest exporter of metallurgical coal, operates five large open-pit coal mines in the Elk Valley area. **Fording River Operations** (MINFILE 082FSE009, 010 and 012) is 17 km north of Elkford. **Greenhills Operations** (MINFILE 082JSE007) is 7 km northeast of Elkford. **Line Creek Operations** (MINFILE 082GNE020 and 021) is 25 km northeast of Sparwood (Fig. 6.5). **Elkview Operations** (MINFILE 082GNE013 to 017 and 023) is 5 km east of Sparwood (Fig. 6.6). **Coal Mountain Operations** (MINFILE 082GNE001) is 32 km southeast of Sparwood.

The Mist Mountain Formation (Jurassic-Cretaceous Kootenay Group) hosts commercially mineable coals in the Front Ranges of the Rocky Mountains in southeast BC. It occurs in three structurally separated coalfields, known collectively as the East Kootenay coalfields. These include, from north to south, the Elk Valley, Crowsnest and Flathead coalfields. The Elk Valley Coalfield is in the Alexander Creek and Greenhills synclines, and includes the Fording River, Greenhills and Line Creek operations. The Crowsnest Coalfield coincides with the Fernie Basin, a broad north-trending synclinorium. It has hosted coal mining since before the turn of the twentieth century and includes the current Elkview and Coal Mountain operations. The Flathead



Figure 6.5. View looking north of Burnt Ridge South pit highwall at Line Creek Operations (Teck Coal Limited).

Coalfield consists of four relatively small, isolated exposures of Kootenay Group in the extreme southeast corner of the region. Because of provincial legislation that prohibits subsurface resource exploration and development in the Flathead Valley, the Flathead Coalfield and part of the Crowsnest Coalfield are excluded from coal mining activity.

The Mist Mountain Formation averages 500 to 550 m in thickness in the Elk Valley and Crowsnest coalfields, and at almost any location includes several coal seams of potentially mineable thicknesses. With the exception of Coal Mountain Operations, all of the mines produce from multiple seams. Coal seams are typically medium-volatile bituminous in rank, with some high volatile-A bituminous coals near the top of the section. Locally, low-volatile bituminous coals occur in the basal part of the section.

Total 2012 clean coal production at Teck Coal Limited's operations in the East Kootenays is projected to be 24.2 Mt. This compares with an actual production total of 22.55 Mt in 2011. The mines have 3665 full-time employees and make a major contribution to the East Kootenay and provincial economies. Proven and

probable raw coal reserves at the five mines are very significant (Table 6.1).

Hard coking coal is the predominant product at four of the five Elk valley mines, the exception being Coal Mountain Operations. Two or more products are marketed by each of these four operations, generally based on variations in volatile matter and/or ash contents. Products are typically medium-volatile bituminous in rank, and contain 8.6 - 9.5% ash. Sulphur is generally about 0.5%. Other attractive quality parameters include high Coke Strength after Reaction (CSR) test results. In addition to hard coking coal, Teck Coal Limited produces pulverized coal injection (PCI) coal, mainly from Coal Mountain Operations. Oxidized coal is also marketed as thermal coal in some cases.

6.2.2 Industrial Minerals

The Kootenay-Boundary Region continues to be an important source of industrial minerals and related products, including gypsum, magnesite, silica sand, mineral wool, dolomite, limestone, graphite, tufa,



Figure 6.6. View looking southeast at Natal Ridge at Elkview Operations (Teck Coal Limited). Natal 2 pit, now mined out, is in the foreground. Photo by Paul Jago.

flagstone, railroad ballast, rip rap, smelter slag and aggregate, but only selected larger operations are described here (Table 6.1, Fig. 6.4).

Baymag Inc produces high-quality magnesite from its open pit mine near **Mount Brussilof** (MINFILE 082JNW001), in the Rocky Mountains northeast of Radium. The Mount Brussilof deposit represents a large magnesium alteration zone in Cambrian carbonates. The operation has been in production since 1982. Ore is transported by truck to the company's processing facilities in Exshaw, Alberta for production of magnesium oxide (magnesia or MgO) and magnesium hydroxide (MgOH). Production in 2012 is projected to be approximately 180 000 t, a slight decrease compared with 2011. The processed products have a variety of environmental, industrial and agricultural uses.

Two gypsum mines operate in the Rocky Mountains portion of the Kootenay-Boundary region, both producing from an evaporite unit in the Devonian Burnais Formation. CertainTeed Gypsum Canada operates the **Elkhorn** Mine (MINFILE 082JSW021) east of Windermere, where production is mainly from the Elkhorn West Extension Pit. Production is projected to be approximately 429 000 t in 2012, a slight increase compared with 2011. Georgia-Pacific Canada Inc operates the **4J** gypsum mine (MINFILE 082JSW009) and rail load-out facility southeast of Canal Flats. There was no mining activity in 2012, and some shipments of stockpiled material were made from the load-out facility.

Silica sand is produced by Heemskirk Canada Limited at the **Moberly Silica** operation (MINFILE 082N001), in the Rocky Mountains 8 km north of Golden. The nearby plant and load-out facility is adjacent to Highway 1 in the Rocky Mountain Trench. Stockpiled product (previously processed material) was shipped to several markets in 2012.

The Moberly deposit is within a near-vertical quartzite unit in the Ordovician Mt Wilson Formation. It

is about 200 metres thick and is regionally extensive. The deposit itself comprises a 1000 m-long zone of variable friability, related to shearing and/or alteration.

In late 2011 the company reported the outcome of a feasibility study looking into the potential of producing frac sand for the western Canadian oil and gas industry. The study concluded that a commercial frac sand operation at the Moberly Mine and plant site is commercially viable. Estimated project capital cost is \$26 million. The investment is based on redevelopment of the current operation, including upgrading of the haul road and construction of a new processing plant.

In 2012 detailed engineering studies related to redeployment as a frac sand operation were undertaken, and at time of writing a 35-year mine plan had been completed, financing was being arranged, and a company decision was pending. During the year sufficient ore to commission the new plant was extracted and stockpiled at the plant site.

Measured plus indicated resources at the Moberly Silica mine site are estimated at 43.2 Mt of silica suitable for glass making, silica flour and other uses. A separate resource estimation specific to production of 64% frac sand (and 36% residuals suitable for other applications) yields 32.4 Mt in the measured plus indicated category. Ore reserves (proven and probable) of silica suitable for 20-mesh to 140-mesh frac sand are 13.5 million tonnes @ 64% frac sand.

Imasco Minerals Inc produces a variety of crushed and ground rock products at its Creston Operations Plant at **Sirdar** from limestone, dolomite, granite and quartzite rock types. Raw sources for these products include an underground dolomite mine at **Crawford Bay** (MINFILE 082FNE113), a limestone quarry at **Lime Creek** (MINFILE 082FSW307) southeast of Salmo, and a granite quarry at **Sirdar** (MINFILE 082FSE072). The carbonate units are Cambrian in age, whereas the granite is part of the Cretaceous Bayonne batholith.

The **Winner** gabbro quarry (MINFILE 082ESE265) west of Grand Forks supplies feed for the Roxul Inc mineral wool insulation manufacturing plant in Grand Forks. Extraction volumes in 2012 were sufficient for plant operations in 2012 and 2013.

Eagle Graphite Corp operates the **Black Crystal** flake graphite operation (Fig. 6.7). Graphite ore is produced from the quarry on Hoder Creek (MINFILE 082FNW260), 22 km west of Slocan City, and processed at the pilot plant near the confluence of Koch Creek and the Little Slocan River, 10 km west of the Slocan Valley village of Passmore. Host rocks are amphibolite-grade calc-silicates of the Valhalla gneiss complex. Mineralization, consisting of disseminated fine to coarse flake graphite, occurs over an area roughly 500 m square, and appears to occupy a zone with a minimum thickness of 80 metres. It occurs in two zones; a regolith zone overlies the "hard rock" zone. Most of the deposit, especially the regolith zone, is friable and blasting is not



Figure 6.7. Mine geologist Mike Glatiotis examines a trench in flake graphite-bearing calc-silicates on the Black Crystal property (Eagle Graphite Corp).

required. Acid rock drainage is not an issue due to the calcareous nature of the host rock.

In 2012 the company processed stockpiled ore and made a shipment of flake graphite to a customer as part of an off-take agreement. This represents the first such agreement for regular shipment of product.

6.3 MINE DEVELOPMENT AND EVALUATION

6.3.1 Mine Development

Approximately \$51 million was spent on mine development in 2012, predominantly in the Elk Valley, at Teck Coal Limited's five mine operations. Development activities in 2012 included: pre-stripping in permitted mining areas (for example, North Line Creek Extension); in-pit drilling (over 32 000 m) for refinement of reserve definitions, coal quality analysis, geotechnical analysis, and structural interpretation; and access and infrastructure construction.

6.3.2 Mine Evaluation

Mine evaluation refers to the exploration stage in which environmental, social, financial and engineering assessments and studies are undertaken, and applications are prepared and submitted for the Environmental Assessment Process (EAP) and/or the various permits required for statutory approval of a mining project. It includes technical assessment of the project, identification of potential impacts, and design of mitigation measures, and requires studies that examine wildlife, surface water, groundwater, geotechnical and other issues. More detailed

descriptions of some of the projects mentioned in this section are found with the corresponding mine and/or exploration property descriptions.

Two East Kootenay coal mine expansion projects are in the EAP, along with one proposed new mine, as outlined below.

- **Line Creek Phase 2 Expansion** (Teck Coal Limited Line Creek Operations). An application for the Phase 2 Expansion was submitted to the Environmental Assessment Office, and permit applications were submitted to government agencies, in December 2011. This expansion, which encompasses Mount Michael and Burnt Ridge North, will extend Line Creek's production activities to the north of currently active pits. Open pit mining methods are proposed.
- **Swift Project** (Teck Coal Limited Fording River Operations). This project, which entered the EAP in 2011 and is in the pre-application stage, is located west of the Fording River and partially encompasses previous Fording River Mine pits on the Greenhills Range. Open pit mining methods are proposed.
- **Bingay Main** (Centermount Coal Ltd Mine Bingay Creek property). This proposal for a new coal mine entered the EAP near the end of the year. The proposed operation is 20 km north of Elkford in the Elk Valley. It is proposed to be mined by both open-pit and underground methods.

Other projects in the region where mine evaluation studies were carried out in 2012 included: **Marten-Wheeler** (geotechnical drilling related to design of potential open pit highwalls and baseline environmental studies by Teck Coal Limited); **Coal Creek** (baseline environmental studies by Crows Nest Pass Coal Mining Ltd); and **Moberly Silica** (detailed frac sand development engineering studies by Heemskirk Canada Limited).

6.4 EXPLORATION HIGHLIGHTS

Selected 2012 mineral and coal exploration projects in the Kootenay-Boundary Region are listed in Table 6.2, and their locations are shown on Figure 6.4. The selected exploration programs typically expended more than \$250 000 on work that included drilling or trenching or other mechanized ground disturbance. The information in this section was derived mainly from company reports, presentations, press releases, and websites, and discussions with exploration project staff, and was supplemented in some cases with MINFILE descriptions and Assessment Reports.

TABLE 6.2. SELECTED EXPLORATION PROJECTS, KOOTENAY-BOUNDARY REGION, 2012

Property	Operator	MINFILE	Commodities	Target Type	Work program	Metres of drilling (approximate in some cases)
Bingay Creek	Centremount Coal Ltd	082JSE011	coal	sedimentary	RC, TR, G, GP, GC, GD, EN, CQ	2836
Cariboo	Excalibur Resources Ltd		Au, Ag	vein	DD	1500
Coal Creek	Crowsnest Pass Coal Mining Ltd		coal	sedimentary	RC, CQ, EN	6558
Crown Mountain	Jameson Resources Limited	082GNE018	coal	sedimentary	TR, RC, CQ	5707
Eddy	PJX Resources Inc	082FSE029, 095, 116, 118	Au (Cu, Pb, Zn, Ag)	vein	DD	1077
Elkview Operations ()	Teck Coal Limited	082GNE017	coal	sedimentary	RC	14896
Findlay	MMG Limited	082KSE041, 053, 060, 075	Pb, Zn, Ag	sedex, vein	DD	1800 planned
Fording River Operations (includes Swift Project)	Teck Coal Limited	082JSE010	coal	sedimentary	RC, CQ, EN	32408
Gold Viking	Rainbow Resources Inc	082FNW193	Ag, Au,Pb, Zn	vein	DD, AB-EM	1077
Greenhills Operations (includes Cougar North Extension)	Teck Coal Limited	082JSE007	coal	sedimentary	RC, CQ	4800
Greenwood Gold (includes Overlander and P5 targets)	Grizzly Discoveries Inc	082ESE034, 147, 174, 255, 082ESW022, 210, 231	Au, Cu, Ag, Mo, Zn, Pt	vein, skarn, intrusion-related,porphyry	DD	1364
International Silver	Rainbow Resources Inc	082KNE058	Ag, Pb, Zn	vein	DD, AB-EM	773
Iron Range	Providence Resources Corp/Eagle Plains Resources Ltd	082FSE014 to 028	Au, Zn, Pb, Ag, Fe, Cu	sedex, IOCG	DD, G, P	2435
J & L	Merit Mining Corp	082M 003	Au, Ag, Pb, Zn	replacement	UG (275m), UG-DD	9725
Kena	Altair Gold Inc	082FSW237, 332, 379	Au, Cu	porphyry	DD, GC, MG, P	7429

(continued on following page)

TABLE 6.2 (CONTINUED)

Property	Operator	MINFILE	Commodities	Target Type	Work program	Metres of drilling (approximate in some cases)
Kenville	Anglo Swiss Resources Inc	082FSW086	Au, Ag, Cu	vein	DD	2776
Kokanee Graphite	Noram Ventures Inc	082FNE129	flake graphite	metamorphic	DD	1335
Line Creek Phase 2	Teck Coal Limited	082JSE001, 082GNE022	coal	sedimentary	DD, G, CQ	6911
Marten-Wheeler	Teck Coal Limited	082GNE006	coal	sedimentary	RC, GD, A, CQ, EN	13067
Ptarmigan	Silver Mountain Mines Inc	082KSE030, 036	Ag, Au, Cu, Zn	vein, manto	DD, G, GC	4050
Rozan	Emgold Mining Corporation	082FSW179	Au (Ag, Cu, Pb, Zn)	vein, skarn, porphyry	DD, GC	1500
Slocan Silver	Klondike Silver Corp	082FNW050	Ag, Pb, Zn	vein	UG, P	0
Sully	Omineca Mining and Metals Ltd		Pb, Zn, Ag	sedex	DD, GP	1234
Zinger	PJX Resources Inc	082FSE012, 120, 122	Au	vein	DD	284

A = access (trail, road construction on claims; AB-EM = airborne electromagnetics; AB-MG = airborne magnetics; AB-RD = airborne radiometrics; BU (X tonnes) = bulk sample (weight in tonnes if known); CD = condemnation drilling; CQ = coal quality testing; CT = carbonization test (coal); DD (Xm) = diamond drilling totalling X metres; EN = environmental baseline studies/monitoring, remediation work; FS = feasibility studies; G = geology, mapping etc.; GC = geochemical sampling (rock, soil, silt etc.); GD = geotechnical drilling; GP = geophysics (general); IP = induced polarization; 3D-IP; MG = magentics; MK = marketing (primarily for industrial mineral products); MS = metallurgical studies; OB = overburden drilling; OP-BU = open pit bulk sample; P = prospecting; PD = percussion drilling; PF = pre-feasibility studies; PP = pilot plant; R = reclamation; RC (Xm) = reverse circulation drilling totalling X metres; TR = trenching; UG (Xm) = X metres of underground development; UG-BU = underground bulk sample; UT = UTEM;

6.4.1 East Kootenay Coalfield Projects

Teck Coal Limited undertook several programs to outline new coal resources and reserves, as either expansions or replacements of its current operations. All are in areas with potential for open-pit mining, and all represent potential sources of hard coking coal. Three other companies were also exploring for reserves of hard coking coal in the East Kootenay coalfields in 2012: Centremount Coal Ltd, Jameson Resources Limited, and Crows Nest Pass Coal Mining Ltd.

The geology of the East Kootenay coalfields is covered in Section 6.2.1.

6.4.1.1 Elk Valley Coalfield

Exploration drilling at Fording River Operations was carried out at the **Henretta Phase 4** and **Swift Project** areas. The Henretta Phase 4 area is east of the current Henretta Pit footwall, on the east limb of the Alexander Creek Syncline. Exploration drilling is intended to

demonstrate mineable coal reserves down section from the current footwall limit in an area anticipated to contain coals with standard Fording River quality characteristics.

The Swift Project is west of the Fording River and adjacent to current workings and mine facilities (Fig. 6.8). The Swift Project is in the north part of the Greenhills Range (MINFILE 082JSE010), and represents both previously mined and unmined zones in the Greenhills portion of the Fording River property. Swift represents the next major potential expansion area for Fording River Operations, as a replacement for the Eagle Mountain pits, and the project is currently in the Environmental Assessment Process. It is along strike to the north of Teck's Greenhills Operations. Swift Project expansion will be based on mining multiple coal seams on both limbs of the Greenhills Syncline. Mine development will progress to the west and upward from previous open pits. The objectives of the large drilling 2012 program in the Swift Project area were to intersect ultimate pit limits in geologically complex areas, and, in the process, verify the viability of proposed pit limits, and improve resource



Figure 6.8. Exploration drilling in the Swift Project area at Fording River Operations (Teck Coal Limited). Photo by Paul Jago.

confidence levels in areas with lower drill densities. Large-diameter reverse flood drill techniques were also used on the Swift Project to collect bulk samples for coal quality testing.

At Greenhills Operations rotary drilling was carried out in the **Cougar North Extension area**, immediately north of the existing operations. Exploration was planned in conjunction with the ongoing Fording River Operations Swift Project exploration program (see above), adjacent to the north. Cougar North Extension is the proposed expansion area for the Greenhills Operations, and at full development its pits will merge with the Fording River Operations expansion. As with the Greenhills Mine as a whole, Cougar North Extension is part of the Greenhills Range and is underlain by the Greenhills Syncline. Coal seams above 7-seam are current targets for the expansion, with 7-seam and 10-seam most likely representing the greatest potential sources of coal reserves.

Teck Coal Limited's Line Creek Operations drilled the **Burnt Ridge North** area, 2 to 6 km north of currently active pits at the Line Creek Operations and roughly 8 km southeast of Elkford in the Elk Valley Coalfield. On Burnt Ridge North (MINFILE 082JSE001) the Mist Mountain Formation occurs on the west limb of the Alexander Creek Syncline. Coal-bearing strata dip moderately to steeply eastward typically forming dip slopes.

Together with Mount Michael (MINFILE 082GNE022), which is immediately to the east of Burnt Ridge and on the east limb of the Alexander Creek syncline, Burnt Ridge North is in the Environmental Assessment Process as part of the **Line Creek Phase 2 Expansion Project**. Both areas are intended to provide new reserves to replace those in Line Creek Operations' current pits. Exploration rotary drilling in 2012 was targeted at delineating mineable reserves.

The Mist Mountain Formation in the Burnt Ridge North area includes several potentially mineable coal

seams. Coal seams are predominantly medium-volatile bituminous in rank, with some high volatile-A bituminous coals near the top of the section. They are similar to seams currently being extracted at Line Creek Operations in terms of their quality characteristics.

Centremount Coal Ltd continued to evaluate the **Bingay Creek** property in 2012. The focus was on drilling for geotechnical and hydrological data, geological interpretation, and coal quality (Fig. 6.9). As noted above, the project entered the Environmental Assessment Process in 2012 for a proposed open pit and underground coal mine referred to as Bingay Main.

At Bingay Creek (MINFILE 082JSE011) the coal-bearing Mist Mountain Formation of the Jurassic-Cretaceous Kootenay Group is preserved in a tight, asymmetric syncline in the immediate footwall of the west-dipping Bourgeau thrust fault. The west limb of the Bingay Creek syncline is steeply east-dipping to overturned. Strata at Bingay Creek are contiguous with those on the west side of the Greenhills Range, and are separated from the Greenhills syncline by the Fording Mountain anticline.

In comparison to coal-bearing sections in other parts of the Elk Valley Coalfield, the section at Bingay Creek appears to be relatively rich in coal, both in terms of the number of potentially mineable seams and average seam thickness. For example, four seams are consistently

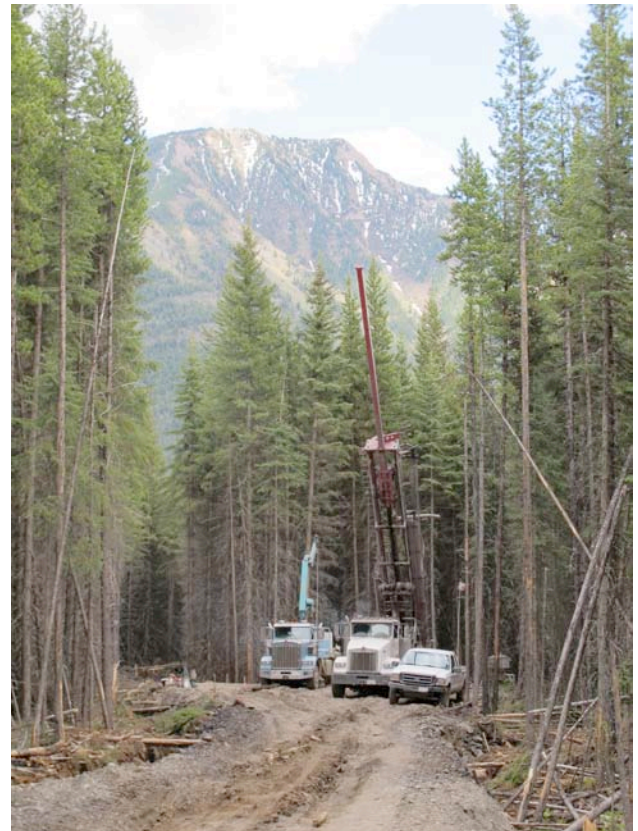


Figure 6.9. Geotechnical exploration drilling on the Bingay Creek coal property (Centremount Coal Ltd). Photo by Paul Jago.

greater than 15 m thick. Coals at Bingay Creek are known to be medium-volatile and high volatile-A bituminous in rank, based on previous exploration results.

Jameson Resources Limited carried out a drilling program on the **Crown Mountain** property (MINFILE 082GNE018), 15 km northeast of Sparwood and only 8 km east of Teck Coal Limited's Elkview Operations (Figs. 6.10 and 6.11). The Crown Mountain property is on strike with, and approximately 12 km south of, Line Creek Operations, and comprises an erosional outlier at the extreme south end of the Elk Valley Coalfield. The lower half of the Mist Mountain Formation is preserved on the main block of the property.

Drilling in 2012 was the first on the Crown Mountain property in about 30 years. The objective was to enable a resource estimate, and to collect samples for coal quality; seam characteristics are expected to be comparable to those at Line Creek and Elkview.

6.4.1.2 Crowsnest Coalfield

Teck Coal drilled at several sites within the general Elkview Operations area immediately east of Sparwood. These included the Natal Phase 2, Baldy Ridge 2, and Baldy Ridge 4 areas. The Baldy Ridge 2 area includes the approved BR-2 pit.

Teck Coal continued to assess the potential of the **Marten-Wheeler** property (MINFILE 082GNE006 & 7), roughly 19 km northeast of Fernie and immediately south of Parcel 73 of the Dominion Coal Block (082GNE008). This site represents a possible expansion area for Coal Mountain Operations. It encompasses Marten and Wheeler ridges in the western part of the Crowsnest Coalfield. A major rotary drilling program was carried out in 2012, along with diamond drilling for geotechnical (mine design) and coal sampling purposes.

Crows Nest Pass Coal Mining Ltd carried out a rotary drilling program on its **Coal Creek** property, 8 km east of Fernie. The Mist Mountain Formation on the property is mainly at depth and is overlain by younger Elk Formation (Kootenay Group) and Blairmore Group strata. Coal seams at Coal Creek are on the west limb of the Fernie Basin in the Crowsnest Coalfield. Individual seams are easterly, down-dip extensions of coal seams which were accessed from their surface outcrops at the underground Coal Creek and Elk River collieries, the latter of which closed in the late 1950s. The company is targeting three seams in the uppermost part of the Mist Mountain Formation (B, 10 and 9), and is evaluating underground room-and-pillar mining potential. The 2012 drilling program was intended to build on the 2011 program by increasing drill density and further defining structure, stratigraphy, and coal quality in the initial potential development area.



Figure 6.10. Exploration drilling on the Crown Mountain coal property (Jameson Resources Limited). Photo by Geraldine FitzGerald.



Figure 6.11. Overview of the north end of the Crown Mountain coal property, looking north. Photo by Geraldine FitzGerald.

6.4.2 Gold Projects

6.4.2.1 Boundary District

Grizzly Discoveries Ltd's extensive **Greenwood Gold** Project was active again this year. The company's holdings extend from east of Greenwood to west of Anarchist Summit, and cover an area roughly 70 km by 30 km. The project area is underlain by a range of rock units, including the Paleozoic Knob Hill and Anarchist groups, Triassic Brooklyn Formation, and Eocene Penticton Group. Intrusions of Jurassic, Cretaceous, and Eocene rocks occur throughout the area.

The project area includes many known mineral occurrences and deposit types, among them gold-quartz veins, polymetallic veins, skarns, and intrusion-related precious metals. A common theme for Grizzly Discoveries' targets is the proximity of intrusive rocks,

notably Eocene syenites. The emphasis has generally been on gold, with or without copper. High gold prices and the proximity to Kinross' Buckhorn Mine and concentrator in northern Washington favour gold exploration in the region.

Activities in 2012 included diamond drilling at the Overlander and P5 gold targets in the **Mount Attwood** area, 9 km southeast of Greenwood. Strong geophysical anomalies spatially associated with gold soil anomalies adjacent to old workings and not previously drilled were targeted in 2012. The Overlander (MINFILE 082ESE174) is known for gold-quartz veins and skarns. In the P5 target area, 2012 drilling encountered gold associated with pyrite-bearing quartz veins hosted by basalt and ultramafic units.

6.4.2.2 West Kootenays

Altair Gold Inc drilled the **Kena** property, 8 km south of Nelson. The property includes the Gold Mountain (MINFILE 082FSW379), Kena Gold (082FSW237), Kena Copper King (082FSW332), and South Gold zones. Porphyry-style gold and gold-copper mineralization is associated with both the Jurassic Elise Formation volcanic rocks (Rossland Group) and the co-magmatic Silver King porphyry intrusions. The belt comprising these zones trends northwest-southeast and is sub-parallel to and east of the Silver King Shear Zone. Gold mineralization occurs in both bulk tonnage (low-grade) and bonanza (high-grade) associations, while gold-copper mineralization occurs in bulk tonnage associations, particularly in the Kena Copper King Zone. Gold mineralization has four distinct settings: a high-grade corridor, associated with volcanics and intrusives; volcanic-intrusive contact areas; bonanza shoots; and, bulk tonnage haloes around shoots. The high-grade corridor has previously been demonstrated to extend over 5.65 km along strike.

New, updated resource estimates, including 10.85 million tonnes measured plus indicated grading 0.71 g/t Au in the Gold Mountain Zone, and 14.68 million tonnes grading 0.64 g/t in the Kena Gold Zone, were prepared this year. This represents a combined measure-plus-indicated gold resource of 549 000 contained ounces in the two zones.

The 2012 drilling program, the first for Altair Gold on the property, was designed to extend known mineralized areas down dip and along strike, and to fill in gaps between the current resource blocks. Results included 95.35m grading 1.37 g/t Au in drillhole 12GM-01 (Gold Mountain Zone).

Excalibur Resources Ltd drilled the **Cariboo** property, 8 km south of Nelson. Highest-grade mineralization on the property occurs in brecciated, quartz vein-bearing shear zones containing variable amounts of pyrite, galena and sphalerite. The Silver King Shear Zone hosts mineralization at the past-producing Silver King

Mine immediately east of the property. On the Cariboo property, two parallel mineralized trends are in metavolcanic and metasedimentary rocks of the Elise Formation (Jurassic Rossland Group). In addition, the contact between Rossland Group rocks and the Jurassic Silver King intrusion appears to host disseminated mineralization which may have bulk tonnage potential. To date, Au and Ag mineralization have been traced throughout a 200-metre trend, with the possibility of additional strike length. Drill results in 2012 included 11.1 g/t Au and 92 g/t Ag over 1.3 m (drillhole 12Car-16).

Anglo Swiss Resources Inc was active again on its **Kenville** property, roughly 6 km west of Nelson. The past-producing Kenville Mine, also known as the Granite-Poorman, operated intermittently between 1890 and 1954, with most production prior to 1912. More than 180 000 t of ore was mined, yielding over 2 t Au and 861 kg Ag, along with significant amounts of copper, lead and zinc. Production averaged more than 17 g/t Au, from a series of northeast-dipping quartz veins.

Host rocks at the Kenville (MINFILE 082FSW086) are within the Jurassic Eagle Creek plutonic complex which is intruded into, and may be the intrusive equivalent of, basalts of the Jurassic Elise Formation of the Rossland Group. Jurassic (Nelson suite) and Tertiary intrusive rocks are also common in the immediate area. The property lies on the Silver King Shear Zone.

The company is exploring for extensions of known ore-grade material and for new mineralization in the vicinity of Kenville Mine, by following up on recent vein intersections at depth to the south and southwest of the underground workings, and testing geophysical anomalies. The 2012 drill program was specifically directed at extending and infilling southerly extensions of veins and, in one case, testing a geophysical target west of the mine. Results in 2012 included 3.08 m grading 14.14 g/t Au in drillhole KE12-01. The same drillhole intersected ten separate gold-bearing veins over a core length of 400 m. Extensions of high-grade gold and silver veins, characteristic of the Kenville, have now been intersected as far as the optioned Ron property, a distance of approximately 800 m to the south.

6.4.2.3 East Kootenays

The **Zinger** property, 28 km west of Cranbrook, is part of the Kimberley Gold Trend and includes a belt of gold-in-rock anomalies covering an area 8 km by 1.5 km. In 2012, PJX Resources Inc followed up 2011 airborne geophysical surveys with a drilling program, targeting zones, including a 4 km-long magnetic trend, that correlate with gold mineralization and which could be related to silicification and alteration. Host rocks are part of the Proterozoic Purcell Supergroup, predominantly quartzites and other metasedimentary rocks of the Creston Formation, along with argillites of the Kitchener Formation and gabbro sills and dikes. The property is

adjacent to the Perry Creek fault. A newly-mapped fold structure also seems to correlate with the gold mineralization.

Known mineralization on the Zinger (MINFILE 082FSE012, 120 and 122), is predominantly vein style. Multiple linear mineralized structures and zones occur *en echelon* and are sometimes associated with shear zones. They appear as bedding-parallel quartz stockworks or quartz veins and stringers with iron carbonate, sericite, and minor sulphides including mainly pyrite (weathered to limonite near the surface), galena and chalcopyrite.

PJX Resources Inc also drilled the **Eddy** property (MINFILE 082FSE029, 095, 116, and 118), approximately 20 km southwest of Cranbrook. The property is part of the Kimberley Gold Trend and is predominantly underlain by the Aldridge and Creston formations and the Moyie sills within the Proterozoic Purcell Supergroup. The property encompasses a 20 km-long northeast-trending shear zone associated with anomalous gold in rock samples. At the surface, silicified shear zones contain narrow quartz veins, locally vuggy, that contain pyrite, partly oxidized to limonite, with rare free gold and galena. 2012 drilling targets were identified through airborne geophysics, focusing on an area where anomalies overlap an area with historical surface showings of Au, Cu, Pb, Zn and Ag.

6.4.3 Polymetallic Projects

6.4.3.1 West Kootenays

Huakan International Mining Inc carried out underground drilling at the **J&L** gold-silver-zinc-lead property, 35 km north of Revelstoke. The property lies in the Selkirk allochthon, and mineralization is hosted by the late Proterozoic to early Cambrian Hamill Group metasedimentary rocks. The polymetallic mineral zones at the J&L (MINFILE 082M 003), known as the Main Zone and the overlying Yellowjacket Zone, are stratabound, massive sulphide-bearing units interpreted as shear-hosted replacements. The Main Zone averages 2.5 m in thickness and has been exposed over 850 m along strike in underground drifting. Previous underground drilling defined the zone over a 1.2 km strike length, while on surface it has been traced for 1.6 km. It has been traced down-dip for 800 m.

Underground drifting over the winter of 2011/2012 was followed by a drilling campaign (Phase 2) totalling 9725 m. Results included 9.41 g/t Au, 101 g/t Ag, 2.17% Pb and 4.31% Zn over 8.48 m in the Main Zone (drillhole 12-10). Information from the Phase 2 drilling campaign was incorporated in a new NI 43-101 resource estimate. The estimate includes 3.953 Mt measured-plus-indicated resources grading 5.68 g/t Au, 56.5 g/t Ag, 1.94% Pb and 3.56% Zn in the Main Zone. This represents 722 000

ounces of gold in the measured and indicated categories. The Yellowjacket Zone, which was included in a resource estimation for the first time, contains 1.003 Mt at 64.1 g/t Ag, 2.77% Pb, 9.08% Zn and 0.21 g/t Au in the indicated category.

Emgold Mining Corporation carried out a diamond drilling program on the **Roza**n property, 11 km south of Nelson. The Roza claims straddle a northwest-southeast trending package of sheared rocks parallel and in close proximity to the Silver King Shear Zone. Host rocks belong to the Jurassic Elise and Archibald formations (Rossland Group), and Jurassic Nelson intrusions. Known mineralization on the property is generally polymetallic (Au, Ag, Cu, Pb, and Zn), but the current exploration focus is on gold, both high-grade veins and bulk-mineable, disseminated zones. 2012 drill sites were selected to test target areas defined in historic and recent exploration on the main part of property. These target areas include the Main Vein at the Roza (also known as the Golden Eagle, MINFILE 082FSW179), which was mined between 1928 and 1972, and the so-called sheeted vein zone, 700m to the east. Target mineralization may be similar to intrusion-hosted quartz vein systems. Other styles of mineralization on the property include polymetallic stockwork veins and skarns, and porphyry and/or shear-hosted systems (see Assessment Report 32592).

Rainbow Resources undertook an initial drilling program on the **Gold Viking** Ag-Au-Pb-Zn property, 2 km northeast of Slocan City. The property is part of Rainbow Resources' large Big Strike Project, which comprises several properties with varying styles of mineralization in different parts of the West Kootenays (see also International Silver, below). The Gold Viking past producer (MINFILE 082FNW193) is hosted by granitic rocks near the western margin of the Jurassic Nelson batholith. Mineralization, comprising galena, sphalerite, pyrite, and chalcopyrite, is associated with quartz veins in north and northeasterly-trending shear zones. Gold is believed to be associated with pyrite. Shipments from 1932 to 1936 totalled 15 t, yielding 4790 g Ag, 373 g Au, and 14 kg Pb.

A pyrite-rich stockwork vein system and breccia zones within altered quartz monzonite were observed in 2012 drill core. Preliminary results included 45 g/t Ag and 0.6 g/t Au over 4.6 m (drillhole GV-12-02).

6.4.3.2 East Kootenays

Providence Capital Corp and Eagle Plains Resources Ltd continued diamond drilling on the **Iron Range** property, about 15 km northeast of Creston. There are two settings for mineralization at the Iron Range. One group of occurrences (MINFILE 082FSE014 to 028) is associated with iron oxide breccias along the Iron Range fault. These have possible affinities with iron oxide-copper-gold (IOCG) mineralization. The second style is

sedimentary exhalative (sedex) mineralization associated with the contact between the lower and middle members of the Aldridge Formation (known as the Sullivan horizon) in the Proterozoic Purcell Supergroup. This latter style is analogous to the Sullivan Mine ore body at Kimberley.

Most recent exploration has been focused on a potential sedex target near the south end of the Iron Range. Results indicate significant levels of gold associated with massive sulphides containing Ag, Pb and Zn at and near the Sullivan horizon, possibly formed in a hydrothermal vent system. This new discovery is termed the Talon Zone, and drilling in 2012 was partly aimed at testing the strike extent of the zone and a series of coincident gravity and geochemical anomalies. The program extended the Talon Zone 120 m along strike to the southwest.

Silver Mountain Mines Inc again drilled the **Ptarmigan** polymetallic property, 27 km west of Invermere in the Purcell Mountains. The property includes the past-producing Ptarmigan (MINFILE 082KSE030) and Iron Cap (082KSE036) occurrences. Mineralization occurs in polymetallic veins or in massive sulphide replacements in carbonates (mantos), and generally consists of pyrite, galena, sphalerite, and tetrahedrite. The Ptarmigan Mine itself consisted of a series of adits driven along the fault contact between Windermere Supergroup strata to the east and the upper Purcell Supergroup strata to the west. Mineralization is stratigraphically below the Windermere unconformity, in strata of the Purcell Supergroup. Selective mining of the Ptarmigan yielded grades of over 4000 g/t Ag, 5.4 g/t Au, 0.6% Cu and 0.5% Zn.

The 2012 drilling campaign was focused on the Ptarmigan Mine and the Upper Ptarmigan and East Ptarmigan zones. The program was designed to define known mineralized zones, and it also identified new silver-bearing veins and semi-massive to massive manto-style mineralization. Drilling results in 2012 included 6.8 m grading 0.52 g/t Au and 452 g/t Ag (drillhole PT12-64).

6.4.4 Base Metals Projects

6.4.4.1 West Kootenays

Rainbow Resources Inc carried out a drilling program on the **International Silver** property, on the east side of Duncan Lake, 65 km north of Kaslo. The property is part of Rainbow Resources' large Big Strike Project, which comprises several properties with varying styles of mineralization in different parts of the West Kootenays (see also Gold Viking, above). The target was the International Ag-Pb-Zn vein (MINFILE 082KNE058), which had not been previously drilled. It is a quartz vein

that contains irregular massive bodies of galena, pyrite, and sphalerite. Host rocks are carbonaceous and micaceous schists of the Proterozoic Horsethief Creek Group. Previous exploration suggested that the mineralization may be continuous over a distance of up to 1.2 km, and geophysical evidence suggests that the mineralized zone may be more extensive. Drilling in 2012 was concentrated in the Cabin Zone, approximately 1 km south of the initial discovery area. Mineralized quartz veining, ranging in drill width from 1.5 to 6 m, was intersected in all 15 holes.

Klondike Silver Corp's **Slocan Silver** Project, east of New Denver, is in a rich historic silver-lead-zinc mining area. Klondike's extensive holdings are divided into various areas, each of which encompasses past producers of vein-style mineralization. These include the Sandon, Hewitt, Silverton Creek, Cody Creek, Payne, and Jackson Basin camps. Mineral occurrences in the Slocan are hosted by sheared and brecciated argillites and slates of the Triassic Slocan Group intruded by granodiorite and quartz monzonite dikes.

There was only minor surface exploration related to the Slocan Silver Project in 2012. The main focus of activity was underground, specifically rehabilitation on the 4000 level in the Silvana past producer (MINFILE 082FNW050) and the location and recovery of remnant ore in the Silvana (4625 level) and Hinckley past producer (MINFILE 082FNW013). Total ore recovery in 2012 was approximately 6000 t. The company's Silvana mill at Sandon, a 100 t/day concentrator, currently operates at an average rate of 40 t/day. The company has an arrangement for a smelter to accept concentrates. The overall goal of the company is to locate sufficient ore to operate the mill at maximum capacity.

6.4.4.2 East Kootenays

MMG Limited carried out a helicopter-supported drill program on the Findlay property (MINFILE 082KSE041, 053, 060, 075), 30 km southwest of Canal Flats and 40 km northwest of Kimberley. The property is underlain by the Proterozoic Purcell Supergroup, including the Aldridge Formation, and Cretaceous intrusions. Targets include the Sullivan horizon in the Aldridge Formation, which corresponds with the contact between the lower and middle members of the formation, and hosts the Sullivan Mine Pb-Zn-Ag ore body at Kimberley. Moreover, typical indicators of Sullivan-style (sedex) mineralization occur throughout the lower to upper Aldridge, indicating potential for Sullivan-style mineralization at multiple stratigraphic levels. These indicators, which are related to hydrothermal venting, include tourmalinized horizons, sections of fragmental sediments, anomalous Pb, Zn, and indicator element geochemistry, and known base metal occurrences, including both stratabound and vein style. This evidence is consistent with the interpretation that this part of the

Purcell Basin may be the northern extension of the Sullivan-North Star structural corridor that includes the Sullivan ore body.

Omineca Mining and Metals Ltd drilled one diamond drillhole on the **Sully** property, located at the base of the Hughes Range on the east side of the Rocky Mountain Trench, 22km northeast of Cranbrook (Fig. 6.12). The objective of the drilling program was to test a significant sub-surface gravity anomaly. This anomaly, when considered in conjunction with other geophysical and geological evidence, suggests potential for a sulphide-bearing mineral occurrence at the same stratigraphic horizon in the Aldridge Formation (Proterozoic Purcell Supergroup) that hosts the Sullivan Mine sedex ore body at Kimberley. The drillhole was collared in the Aldridge Formation and penetrated both Aldridge and underlying Fort Steele Formation strata in the steep limb of a major overturned fold. Significant drill deviation caused the hole to miss the targeted area. However, subsequent to the drilling program the company undertook a reconnaissance surface and down-hole TDEM geophysical survey, followed by more substantial surface geophysical surveys, to further test the gravity anomaly. Omineca subsequently dropped its option, but Gravitas Metals Corp, the optioner, intends to continue drilling next year.

bearing boulders (MINFILE 082FNE129). This year's program represents the first assessment for graphite potential. The graphite is hosted by calcsilicates of the Cambrian to Devonian Index Formation (Lardeau Group). The property is also underlain by older Cambrian rocks and Cretaceous granitic intrusions. The 2012 drilling was conducted in a portion of the main zone, where sampling has confirmed presence of large-flake graphite over an area about 2 km in strike length and 200 to 300m in width, coincident with an EM anomaly.

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6.4.5 Industrial Minerals Projects

6.4.5.1 West Kootenays

Noram Ventures Inc drilled the **Kokanee** flake graphite property 35 km northeast of Nelson, near Crawford Bay on the east side of Kootenay Lake. The property has been explored for base metals since the early 1900s, after the discovery of large massive sulphide-



Figure 6.12. Diamond drilling on the Sully property (Omineca Mining and Metals Ltd).