

INDUSTRIAL MINERALS

Australian lithium
First dibs on the Asian battery market?

Fertiliser minerals
Niche opportunities for suppliers

Processing
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Russian soda ash
Sourcing from nepheline syenite

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Canada's mineral industry

Has been, or will be?

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Industrial minerals in British Columbia. Industrial
Minerals, London, March 2016 issue, pp. 26-28.



Industrial minerals in British Columbia

Canada's most southwesterly province is one of its most active in terms of industrial minerals. *George Simandl* and *Michaela Neetz* of the British Columbia Geological Survey at the BC Ministry of Energy and Mines give a detailed overview of its non-metallic mineral activity and potential.

Situated on the west coast of Canada, British Columbia (BC) is served by several deepwater ports, a modern highway system and a network of rail lines, linking the province's industrial centres to the rest of North America and the Pacific Rim countries.

The main industrial minerals produced in BC (see *Figure 1*) are magnesite, limestone, gypsum, crushed rock, silica, dimension stone and white calcium carbonate. Industrial minerals produced in lesser quantities include jade (nephrite), magnetite, dolomite, barite, pumice, flagstone, clay, tufa, bentonite, fuller's earth and zeolites.

The value of solid mineral production in 2015 is estimated at Canadian dollar (C\$) 7bn (\$5.11bn*) (see *Figure 2*). Although coal (43%)

accounted for the largest share of revenue, the contributions of industrial minerals (6%, or C\$414m) and aggregates (5%, or C\$345m) are also significant. The value of sulphur, recovered as a by-product of oil and natural gas processing, is estimated at C\$135m (FOB Vancouver).

Metals, metal ore concentrates and coal produced in BC are largely exported; however, a substantial portion of industrial minerals are processed locally and incorporated or transformed into finished products, such as cement, lime, wallboard, paper, paint, absorbents, soil conditioners, fertilisers and refractory materials. Consequently, industrial minerals and aggregates have a much larger economic importance for BC than is suggested by *Figure 2*.

For example, total production capacity at BC's three cement plants is 2.62m tonnes. Assuming these plants operated at 90% of capacity and the price of cement was C\$170/tonne, the estimated value of cement produced in BC was over C\$400m last year. This is equivalent to the total worth of BC's industrial mineral production for 2015 and illustrates the importance of value-added processing.

Similar to coal and metals markets, demand for industrial minerals and aggregates is cyclic. However, the maxima and minima of the industrial mineral and aggregate cycles are commonly less pronounced and are not coincidental with the metals cycle. Thus, during global economic downturns, companies that normally explore for metals consider non-metallic mineral targets.

Recent changes in markets present opportunities for newcomers to industrial minerals. Reduced availability of fly ash and synthetic gypsum, related to lower use of coal for electricity generation in the US and Canada, may create new opportunities for pozzolanic materials and natural gypsum. It remains to be seen if BC will benefit from increased demand for materials required for reduction of greenhouse gas emissions (e.g., solar grade silicon, rare earths and graphite). Additionally, the effects of the proposed infrastructure programme announced by the Canadian federal government may benefit BC producers of cement and construction materials.

Review of industrial mineral activity

More than 30 industrial mineral mines or quarries (*Figure 1*), at least 20 major sites where industrial minerals were upgraded into value-added products and over 1,000 aggregate mining operations were active in BC in 2015.

Minerals produced in 2015

Barite

Fireside Minerals Ltd was the only barite (barytes) producer in BC last year, with output of less than 30,000 tonnes barite. This came mostly from the Bear pit and is expected to shift to the Moose pit in 2016, both located in northern BC.

Besides Fireside, more than 200 barite occurrences have been reported in BC, the largest of which are linked with undeveloped zinc-lead deposits in the Gataga district (*Figure 3*).

Carbonates

Magnesite, limestone, white calcium carbonate (including filler-grade high calcium carbonate) and dolostone, represent an important portion of BC's industrial mineral production.

Magnesite

BC hosts more than 60 known occurrences and resources of magnesite. The Mount Brussilof deposit in southeast BC is owned by Baymag Inc., and was the only deposit in production in 2015 (*Figure 4*). Over the past few years, the production rate has been about 220,000 tpa magnesite. Most of the ore is transported to the company's processing plant in Exshaw, Alberta, where it is

Figure 1: Selected industrial mineral mines, quarries and projects in British Columbia.





converted into calcined magnesia. The Driftwood Creek deposit, owned by MGX minerals Inc., also in southeast BC, is currently the most active magnesite exploration project in the province.

Limestone and lime

There are more than 400 limestone and calcium carbonate occurrences in BC. The Gillies Bay (Texada Quarrying Ltd), Blubber Bay (Ash Grove Cement Co.) and Van Anda (Imperial Limestone Co. Ltd), are the main quarries on Texada Island (see *Figure 1*). Production is traditionally shipped to the lower mainland of BC, and to the US (to Washington State, Oregon and California), for cement, chemical and, more recently, agricultural and construction use. In 2015, 3.9m tonnes were shipped from Gillies Bay and 360,000 tonnes from Van Anda.

In addition to pulp mills, which produce lime internally, three cement plants and two lime plants process limestone. Graymont Western Canada Inc.'s Pavilion Lake limestone quarry and lime plant near Cache Creek has a production capacity of about 190,000 tpa lime. The company is also proposing to quarry limestone and operate a lime plant, near Giscome, with an extraction rate of 600,000-1.2 m tpa limestone. Lhoist North America of Canada Inc. operates a lime plant in Langley, near Vancouver and owns a limestone quarry 5km southeast of Giscome.

White calcium carbonate

White, ground calcium carbonate, used as a filler and extender, is produced by Imperial Limestone Co. Ltd. (Van Anda quarry) and IMASCO Minerals Inc. (Benson Lake quarry). In 2015, Benson Lake produced 56,000 tonnes white calcium carbonate and 250,000 tonnes were extracted from Van Anda.

Dolostone (dolomite)

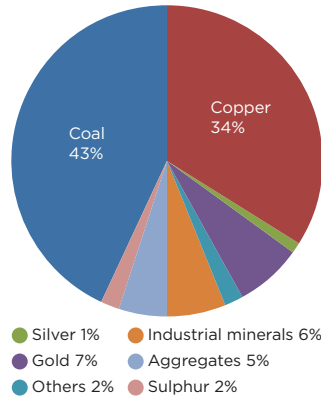
More than 40 dolomite occurrences are known in BC. Most are in the Rocky Mountains, but a few are near the coast. In 2015, Ash Grove Cement shipped approximately 10,000 tonnes of limy dolostone from an area adjacent to its dormant Blubber Bay limestone quarry.

Clay, shale and related raw materials Cement materials

The three cement plants in BC producing Portland cement have a combined production capacity of 2.62m tpa. Limestone from Texada island is used at the Lafarge Canada Inc. plant in Richmond and the Lehigh Cement, a Division of Lehigh Hanson Materials Ltd, plant in Delta. Sumas Shale Ltd produces about 500,000 tpa raw materials (including clay/shale, conglomerate and sandstone) from its Sumas Mountain quarries for lower mainland cement plants.

The Decor pit (*Figure 5*), in the Hat Creek area, owned by Pacific Bentonite Ltd. produced over 170,000 tonnes burnt shale for Lafarge's cement plant in Kamloops, south central BC in 2015.

Figure 2: Estimated solid mineral production in BC for the year 2015 (estimates do not reflect value-added processing).



Source: Modified from Clarke, 2016

Bentonite and fuller's earth clays

Absorbent Products Ltd produced domestic and industrial absorbents at its processing plant in Kamloops. Raw materials were sourced principally from the Red Lake fuller's earth deposit north of Kamloops and from the Bud bentonite deposit near Princeton. Several of the 34 other bentonite occurrences, such as deposits owned by Pacific Bentonite near Hat Creek (*Figure 6*), and the HK deposit, owned by Tillava Mining Corp., are technically promising.

Clays for brick and medical uses

The province has over 100 clay deposits and occurrences. Some of these were historically used in brick making, but BC currently does not have any brick production. Most products marketed as medical and cosmetic clays in BC are low crystallinity glacial clays. The Ironwood Clay Company Inc. is the best established producer in BC. It seasonally extracts clay from the De Cosmos Lagoon on Hunter Island, west of Bella Coola, and in 2015 also produced similar material from the Bute Inlet area.

Gypsum

BC contains over 40 gypsum occurrences. Certainteed Gypsum Canada's operation, based in Windermere, produced more than 340,000 tonnes from the Elkhorn mine complex last year. The company also continued environmental and design studies at the Kootenay West gypsum deposit. The



Figure 4: Mount Brussilof magnesite mine.



Suzanne Paradis (Geological Survey of Canada)

Figure 3: A thick zone of zinc-lead mineralisation containing >40% barite, in northern BC.

4J quarry of Georgia-Pacific Canada Inc. was inactive in 2015, but shipped material from stockpiles to its wallboard plant near Edmonton, Alberta. Lafarge Canada typically mines up to 6,000 tpa gypsum from the Falkland deposit for its Kamloops cement plant.

Magnetite

More than 300 occurrences of magnetite are known in BC. M-Seven Industries Inc. has historically produced 40,000-70,000 tpa magnetite annually from old mine tailings for dense media separation (coal processing) and water treatment plants. In 2014, Craigmont Industries opened a magnetite plant at Imperial Metal's Mount Polley (Cu-Au-Ag) mine near Likely. Dormant in 2015, the operation resumed in 2016.

Phosphate

BC has 80 known phosphate occurrences. HighBrix Manufacturing Inc. shipped phosphate for agricultural spreading from its Crow deposit in 2015. Currently, Fertoz Ltd is trying to develop some deposits previously explored by Pacific Ridge Exploration Ltd. The company recently applied for a small mine permit for its Wapiti East project and conducted environmental baseline studies at the Marten deposit.

Pumice, scoria, tephra and expanding shale

The Mount Meager operation, owned by Great Pacific Pumice Ltd, north of Pemberton in southwest BC, provided approximately 1,000 cubic metres of pumice last year. The material from this deposit was tested as a pozzolanic additive by a major cement producer. Garibaldi Pumice Ltd produced approximately 18,000 cubic metres of pumice from the nearby Garibaldi deposit. Lightweight Advanced Volcanic Aggregates Inc. and its predecessor companies typically produced about 20,000 cubic metres per year of tephra from the



Figure 5: Decor deposit from where Pacific Bentonite Ltd ships burnt shale (natural clinker).

Nazko quarry, located 100km west of Quesnel. The operation ceased a few years ago, with significant resources remaining. Five occurrences of expanding shale, including two past producers, are on Vancouver, Salt Spring and Saturna islands.

Silica

There are more than 30 significant silica occurrences in BC, but only a few are currently in production. Heemskirk Canada Ltd historically extracted and processed friable quartzite from the Moberly mine near Golden, mainly for the glass industry. This operation is under reconstruction to supply frac sand for BC's shale gas industry. At the Horse Creek Silica mine (HiTest Sand Inc.), quartzite is intermittently mined from the same geological unit for construction purposes. Historically, both operations also supplied silica for metallurgical grade silicon and ferrosilicon.

Clay-bearing siliceous materials, historically mined at Monteith Bay and currently at Apple Bay, are in high demand for cement production in the US Pacific Northwest. In 2015, Electra Stone shipped over 60,000 tonnes silica-rich material from Apple Bay.

Slag

There are three active slag operations in BC. Pacific Abrasives & Supply Inc. is producing and processing slag from the historical Granby smelter (Grand Forks). Slag was shipped from Anyox by Tru-Grit for use as cement raw material, roofing granules and abrasive applications. Teck is the major slag producer at its Trail smelter, where it produces approximately 250,000 tpa.

Sulphur

Sulphur recovery as a by-product of oil and gas processing debuted in the 1950s and satisfies more than 70% of the global market. The remainder is covered by native-, frash well-, or roasting of iron sulphides and base metal ores-derived sulphur. Although 12 occurrences of sulphur are known in BC, all sulphur produced in the province is a by-product of natural gas processing.

Zeolite group minerals

Most of the 26 known BC zeolite occurrences consist of clinoptilolite. Recently, Canadian Mining Inc. signed an agreement with Absorbent Products Ltd, which may pave the way to mining the Bromley Creek zeolite quarry, originally operated by



Figure 6: Typical "popcorn" texture of Hat Creek bentonite.

Heemskirk Canada Ltd. A few other zeolite deposits are under consideration for development by junior exploration companies.

Minerals available, but not mined

Brucite and hydromagnesite

Brucite ($Mg(OH)_2$) has a number of industrial and environmental applications, while hydromagnesite ($Mg_5(CO_3)_4(OH)_2 \cdot 4(H_2O)$) is used largely as a flame retardant.

Diatomite

There are at least 45 known diatomaceous earth occurrences in BC. Examples of past producers are the Crownite deposit and Clayburn excavation near Quesnel.

Fluorite (fluorspar)

The province has at least 67 known fluorite occurrences. The Rock Candy mine, north of Grand Forks, is the only past producer of fluorite. It supplied ore to the Trail smelter and small historical reserves remain underground.

Garnet

There are 40 known garnet occurrences in BC, of which the Stitt Creek placer deposit near Revelstoke and the Crystal Peak deposit near Penticton have received the most attention.

Graphite

There are 44 known occurrences of graphite in the province. Regions of BC underlain by amphibolite or granulite grade metasedimentary rocks, have potential to host crystalline flake or vein type graphite deposits. Some coal beds may have been converted to amorphous graphite by low grade or contact metamorphism.

"High-tech" minerals

The Aley carbonatite is the largest and most developed niobium (Nb) deposit in BC. Current resources are estimated at 285.8m tonnes at 0.37% niobium pentoxide (Nb_2O_5) measured and indicated. The Upper Fir carbonatite near Blue River contains an indicated resource of 48.4m tonnes at 197 ppm tantalum pentoxide (Ta_2O_5) and 1,610 ppm Nb_2O_5 and an inferred resource of 5.4m tonnes at 191 ppm Ta_2O_5 and 1760 ppm Nb_2O_5 . The Wicheeda Lake carbonatite (Spectrum Minerals Corp.) was drilled in 2008 and 2009, and is the most developed rare earths project in BC. The

lesser known Rock Canyon Creek REE-fluorspar prospect is another deposit with significant rare earths intersections. Fifty five other REE occurrences are known in the province.

Kyanite and andalusite

More than 50 kyanite, andalusite and sillimanite occurrences are known in BC.

Leonardite

Leonardite was documented at the Red Lake fuller's earth deposit, however, oxidised coal seams elsewhere in BC may contain higher concentrations of humic acid and be more extensive.

Nepheline syenite and feldspar

There are at least 10 significant feldspar and nepheline syenite occurrences in BC, several of which have been investigated by metallurgical studies.

Olivine

An unserpentinised portion of the Tulameen ultramafic complex is a potential source of foundry sand. A fresh dunite deposit near Hope, referred to as the Cogburn magnesium project, may also contain foundry sand grade olivine.

Perlite and vermiculite

There are 25 perlite and five vermiculite occurrences known in BC. Frenier and Francois Lake are the best known perlite deposits in BC.

Talc

Most of the 60 known talc occurrences in BC are either carbonate- or ultramafic rock-hosted. The most recent carbonate-hosted talc showing was identified in the Bridesville area.

Wollastonite

Eleven wollastonite occurrences are known in BC. Historically, exploration was aimed at deposits to supply a high-quality acicular filler for the plastic industry and concentrates used in ceramics. It can also be used as a source of silica and calcium in cement production to reduce CO_2 emissions.

For further information on BC minerals, please consult BC MINFILE, accessible free of charge at <http://minfile.gov.bc.ca>. Information on industrial minerals and specialty metals in the province and the complete list of references can be obtained from George.Simandl@gov.bc.ca. An overview of exploration and mining in BC for 2015 is available at <http://www.empr.gov.bc.ca/Mining/Geoscience/PublicationsCatalogue/InformationCirculars/Pages/IC2016-1.aspx>

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