Selected Industrial Minerals Trends in British Columbia, 2006

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INVESTMENT CLIMATE

British Columbia has significant potential and opportunity for new industrial minerals exploration and development. Industrial minerals are less vulnerable than metals to abrupt commodity price swings related to global economic cycles. Nevertheless, such cycles do influence supply and demand for industrial minerals, including construction materials. The following discussion highlights some aspects relevant to successful development of industrial minerals deposits in the province. BC's infrastructure, its industrial minerals endowment, exploration and development trends, and initiatives, which could benefit developers, are reviewed, as well as current production levels and new development opportunities.

Decisions regarding coal-fired electrical generation and possible new developments surrounding offshore oil and gas resources may have important effects on the province's industrial minerals markets.

INFRASTRUCTURE

Industrial minerals are an increasingly significant component of international trade. BC is strategically located on the west coast of North America (Fig 1) with easy access, particularly to Pacific Rim countries. It has a well-developed transportation and industrial infrastructure in the southern third of the province, where population and industry are concentrated. It has several deepwater ports and well-maintained all-weather highway systems that permit efficient, long-distance trucking. Rail lines link BC's industrial centres to terminal points across Canada and the United States. The province has a significant and underdeveloped industrial minerals potential.

INDUSTRIAL MINERALS PRODUCTION AND UNTAPPED RESOURCES

BC's nonmetal production for 2006 is estimated at over $676.3 million. This is considered a conservative projection based on 2005 estimates published by Natural Resources Canada in combination with 2006 growth rates and cost increases reported in the United States. Cement production for 2006 is estimated at $323.7 million, sand and aggregate at $191.9 million, stone at $78.3 million and all other industrial minerals combined account for $82.4 million. Natural Resources Canada does not provide a detailed breakdown due to confidentiality issues, but takes extra care to ensure nonduplication of the statistics, for example, limestone used for chemical applications will be part of the $82.4 million and will not be counted also as crushed rock or cement raw material. In terms of sulphur production, there were 853 820 tonnes of sulphur produced in BC in 2005 at an estimated average price at the plant gate of $41.26/t, therefore sulphur alone would have accounted for more than $35.2 million of the 2005 nonmetal production. BC's sulphur production for 2006 will be similar to that of 2005 in terms of tonnage, but its dollar value will likely be lower reflecting a decrease in sulphur prices during 2006.

Figure 1. Strategic geographic location of British Columbia.

Apart from raw materials used for cement production, aggregate, crushed stone and sulphur, the most economically significant industrial minerals commodities produced in BC are magnesite, white calcium carbonate, limestone, silica, dimension stone and gypsum. Commodities produced in lesser quantities include jade (nephrite), magnetite, dolomite, barite, volcanic cinder, pumice, dimension stone (including flagstone and ornamental stones), clay and related high-alumina products used in applications other than cement, tufa, slag, fuller's earth and zeolites. There are

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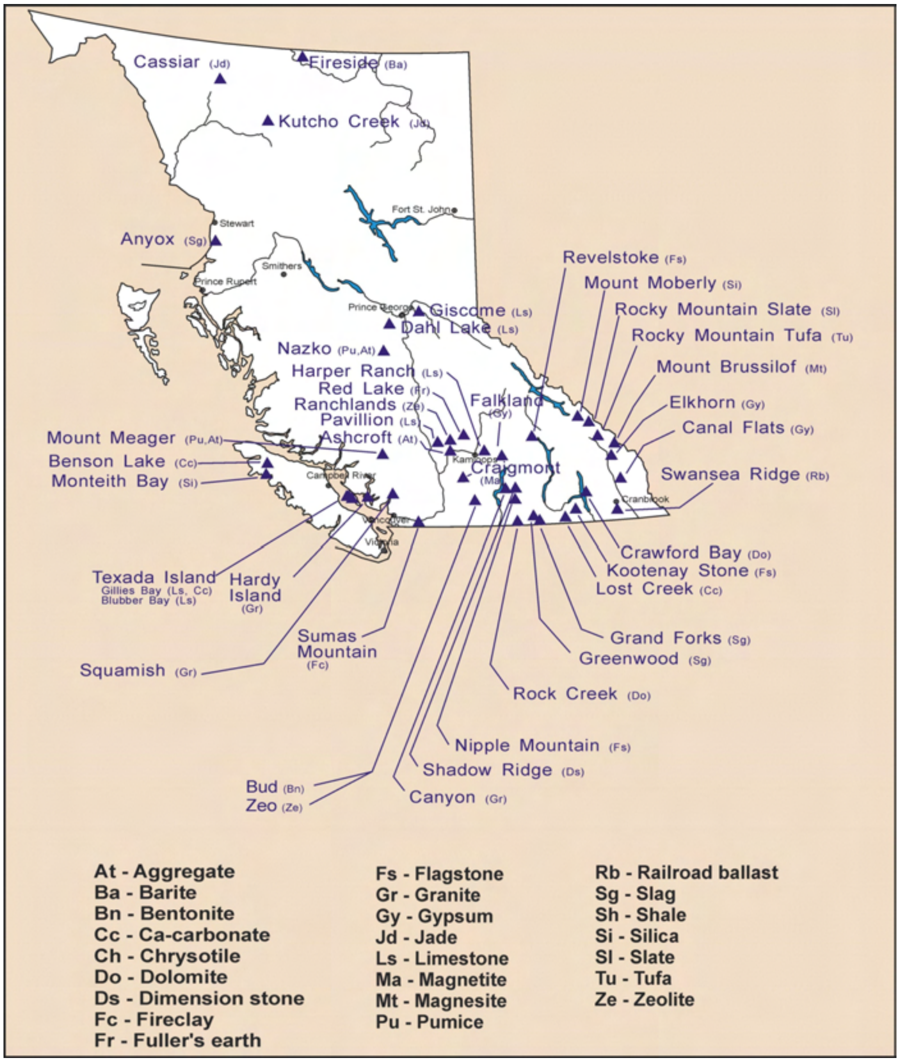

Figure 2. Selected industrial minerals mines in British Columbia.

more than 40 mines or quarries and at least 20 major sites where upgrading of industrial minerals into value-added products takes place (Simandl *et al*., 2004). Although the value of industrial minerals pales in comparison to the value of BC's gas and coal production (Schroeter *et al*., 2006), these minerals are essential for chemical, electronic, glass, pulp and paper, and refractory industries and coal processing. Selected industrial minerals mining operations, except for aggregate operations, are shown on Figure 2, and processing plants are depicted on Figure 3. Most operations are concentrated close to existing infrastructure and markets.

The most recent review of industrial minerals production in BC was produced by Simandl *et al*. (2004). Major sand and gravel operations are listed on the website of the British Columbia Aggregate Producers Association <http://www.gravelbc.ca/members/member_list.html>.

DEPOSITS AND GEOLOGICAL POTENTIAL

BC has excellent geological potential to host a variety of industrial minerals. There are over 40 industrial minerals commodities recognized for the province (Simandl *et al*., 2004) and there are over 2400 industrial minerals occurrences documented in the MINFILE database (MINFILE, 2006). MINFILE is available free of charge from the ministry website at <http://www.em.gov.bc.ca/Mining/Geolsurv/Minfile/>. The website also contains selected technical papers describing specific industrial minerals commodities and deposits (http://www.em.gov.bc.ca/Mining/Geolsurv/IndustrialMinerals/default.htm).

Deposit types directly applicable to BC have been listed and classified by Simandl *et al*. (1999). The same document also contains selected industrial minerals and gemstone descriptive deposit profiles.

INITIATIVES

The BC Geological Survey directly supports industrial minerals research and developments with its field programs, participation in meetings related to industrial minerals and other activities. In addition, there are a number of government initiatives available to industrial minerals developers, including the BC Mining Exploration Tax Credit Program, the federal government's flow-through share program and the Geoscience BC program. Geoscience BC (http://www.geosciencebc.com) funds appropriate applied geoscience within the province and periodically invites proposals from the public, universities and industry. The BC Ministry of Energy, Mines and Petroleum Resources has a specialist available to assist in planning programs related to industrial minerals and developments.

EXISTING AND EMERGING TRENDS

The following material identifies some of the more significant trends affecting the province's industrial minerals industry.

China Syndrome

Until recently, China dominated industrial minerals export markets and kept consolidating its influence. China's strength is due to the combination of inexpensive labour and energy, lack of costly environmental restrictions, government encouragements driven by the need for hard currencies, and local availability of extensive natural resources. Over the last ten years, unprecedented industrial expansion has taken place in China driven by its access to markets in industrialized countries and by rapid expansion of its own infrastructure and industrial capacity.

The strength of the Chinese economy is a driving force behind the price increases of iron ore and base metals, however, it also has effects on industrial minerals economics. For example, Chinese domestic demand for fluorite and hydrofluoric acid increased dramatically over the last two years and this led directly to reductions in Chinese fluorspar exports, presenting a market opportunity for western fluorite producers and opened the opportunity for developing new deposits outside of China. The Chinese government had also started to address the new and previously existing environmental challenges related to resource development and value-added processing. As a result, several small magnesium metal, magnesia, ferrosilicon and silicon metal producing plants in China were forced to close.

BC has important magnesite resources (Simandl, 2002b) but their development is still hampered by inexpensive magnesia and magnesium metal exports from China. China does not report reserves in accordance with Canada's National Instrument 43-101, and therefore the reported Chinese reserves are likely overestimated. Also, on the positive side, a number of magnesia-based construction materials are being introduced into the North American market and although most of these products are sourced in China, there is a possibility of new production out of BC.

BC also has important lump silica (quartzite) deposits, which used to supply the currently closed silicon metal and ferrosilicon producers in the United States. Should the Chinese influence in this domain decline over the next few years, BC's silica suppliers may benefit from the start-up of United States silicon metal and ferrosilicon operations.

Exports of Chinese raw talc were halted to avoid antidumping penalties and to help attract foreign investment needed for value-added processing. In the long-term, this may have a positive effect on the economic potential for BC's talc resources. Similar reasoning may apply to other commodities.

China's rapid growth can't continue indefinitely. As the country becomes more industrialized and the standard of living increases, availability of inexpensive energy resources which could be allocated to industry will shrink. The first manifestations that indicate that China has already reached this stage are surfacing. In November 2006, China introduced a 10% tax on selected silicon metal products. In addition, in late November 2006, there have been suggestions that China may start to implement a new export tax (5 and 15%) on magnesium and silicon in early 2007. The apparent objective of this tax is to reduce internal industrial energy requirements and to moderate exports of highly energy-intensive products.

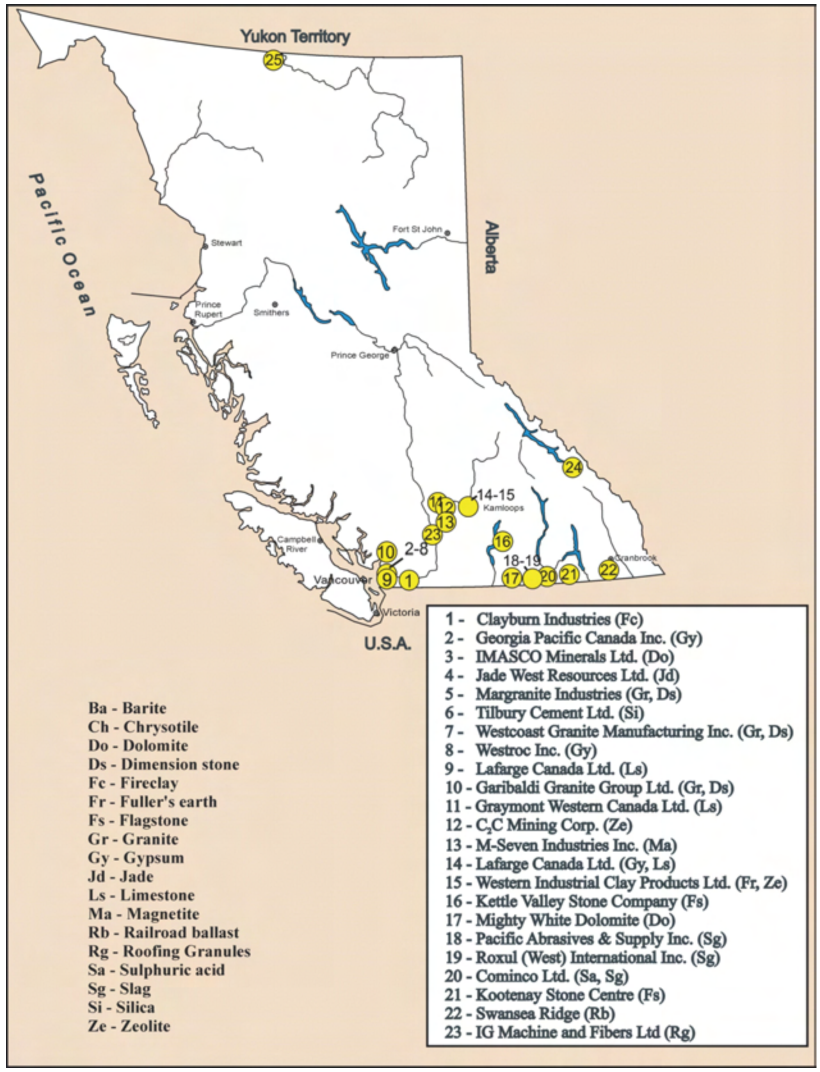

Figure 3. Selected industrial minerals processing plants in British Columbia.

Value-Added Processing

Another important trend, which propagated into BC in the 1990s, is the increase in value-added processing of industrial minerals. The process of turning raw materials into more highly sought after finished products results in a price per tonne increase of several times.

Examples from BC include the IG Machine & Fibers Ltd. (a subsidiary of IKO Industries Ltd.) roofing granule plant, located in the Ashcroft area of BC. This plant was constructed in 2001 with the intention to gradually ramp-up production. In mid-July 2002, it reached 50% of its capacity of 500 000 tonnes and currently it is running at over 70% of its designed capacity. While the raw material is a relatively common rock of basaltic composition, granules produced from that rock are exported to IKO's roof tile manufacturing plants all over western North America.

In addition, the rockwool (thermal insulation) plant located in Grand Forks is a focus of continuous investment by Roxul (West) International Inc. and recently reached full production capacity. Raw materials used by Roxul are low-cost industrial minerals such as dolomite, diorite rock and even mine wastes such as slag, while the highly priced thermal insulation (end product) is exported internationally.

Green Minerals

New opportunities are arising in the field of 'green' minerals along the west coast. Green minerals are those that can be used in environmental clean-up, agriculture, waste disposal or otherwise to improve the environment. Depending on specifications, some of these deposits could supply material for linings and barriers in waste disposal applications. Use of lime, caustic magnesia, dolomitic lime and limestone for environmental rehabilitation and soil conditioning is slowly rising but it is partially balanced by a decline in demand from the pulp and paper industry within the province. Zeolites, bentonite, perlite and vermiculite are examples of other minerals with environmental applications (Simandl, 2003).

The Impact of Clean Coal Technology

Over the last 20 years, BC gradually changed from a large electricity exporter to a net electricity importer. BC currently produces approximately 27 million tonnes of coal annually, with a value of $2 billion and most of it is exported (Schroeter *et al*., 2006). Recent developments in clean coal technology (Australian Coal Association, 2006) make the use of coal in BC one of the possible options to make the province self-sufficient in electricity.

This year, BC Hydro awarded 38 contracts, aimed to add 7000 GW·h/a to its system by 2010. The contracts include 29 hydro, three wind, two biomass, two waste heat and two coal-biomass projects.

The proposed AESWapiti Energy Corporation's coal-biomass project is near Tumbler Ridge with a projected capacity of 196 MW with total energy production of 702 GW·h/a. Compliance Power Corporation's project (Princeton Power Project) is smaller, with a plant capacity of 56 MW and total energy production of 421 GW·h/a.

Flue gas released during electricity generation in a modern coal-fired plant goes through a complex system which extracts particulate emissions, produces fly ash and converts sulphur emissions into gypsum or similar products. Flue gas desulphurization (FGD) gypsum, bottom ash and fly ash are commonly recovered and used in the construction industry or other applications in the United States and Europe. Figure 4 illustrates the process and quantities of limestone, fly ash and gypsum involved (Pearson, 1998; Simandl, 2003). Fly ash could be an excellent and inexpensive raw material for cement, and FGD gypsum is a substitute for the natural gypsum used in wallboard and cement applications. In the future, in more advanced systems, sulphur may be recovered in its elemental form rather than as gypsum. If coal is used for electricity generation in BC, these artificial materials could significantly reduce the market for natural gypsum and some of the raw materials currently mined for making cement. On the positive side, calcium carbonate, lime or magnesia are needed to extract sulphur from the flue gas (Simandl, 2003), unless the flue gases are stored underground (Vormeij and Simandl, 2004).

Similarly, if the recently proposed gas-burning, electrical generating plant proposed for Red Deer, Alberta, goes into production, it may reduce demand for exports of BC's natural gypsum to Alberta. If the objectives of the US Department of Energy (2006) are achieved, by 2020 virtually 100% of products generated by clean, coal-fired, electrical plants will be used in industrial or construction applications. The same standards will likely apply in Canada.

CONSTRUCTION RAW MATERIALS

The construction industry in North America is booming and demand for construction materials is rising. Concrete, one of the most widely used construction materials, consists of a mixture of aggregate (crushed rock or natural), sand and cement.

Sand, Gravel and Crushed Rock

Over the last seven to twelve years, during the deep downturn in metal prices, several junior mining companies started to look at alternative exploration and development targets including industrial minerals. Some juniors concentrated their efforts on what was recognized as a looming shortage of aggregate materials and one of the most significant industrial minerals trends in BC, the export of crushed stone and natural aggregate to urban centres along the west coast of the United States and lower mainland of BC, was born. The report of the Aggregate Advisory Panel (2001) summarized and highlighted the need for long-term aggregate resource planning and added credibility to a number of aggregate projects promoted by junior mining companies looking for public financing. The demand for aggregates and crushed stone has further increased since 2001 and California and the lower mainland of BC still represent major markets. However, these markets may become very competitive. Currently, several junior companies are advancing their crushed stone and aggregate projects simultaneously and at the same time existing producers along coastal North America are increasing their capacity. It remains to be determined if in the short to mid-term, aggregate markets can support all of the proposed projects in various stages of development within BC, Mexico and elsewhere. Correction in the construction market, combined with an increased production capacity may have an adverse effect on aggregate and crushed stone prices and negatively affect the viability of some of these new projects.

Polaris Minerals Corporation, in cooperation with Namgis First Nation, is currently developing their Orca

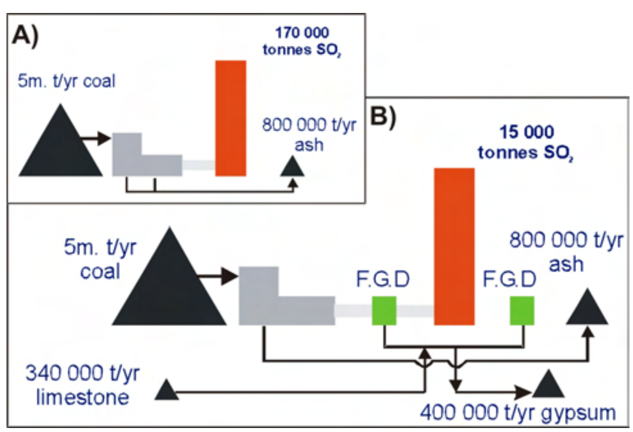

Figure 4. Flue gas desulphurization (FGD) concept (*modified from* Pearson, 1998; Simandl, 2003).

project located 3.8 km from Port McNeil. This aggregate deposit is believed to have reserves of 121 million tonnes and there is a planned production capacity of 6 million tonnes per year. The project requires US$94.5 million development capital for the quarry and for the Richmond, California, terminal.

Ascot Resources Ltd. was granted a permit which allows it to begin development of its Swamp Point aggregate deposit located 50 km south of Stewart. Construction for the first phase of production started in October 2006. The company indicates that they have 18 years of reserves at a maximum capacity of 3.3 million tonnes per year. Reported capital cost of the project is $27.5 million.

Currently there are at least 20 other aggregate sites in the permitting process in BC. These include both new projects as well as established producers increasing their reserves and production capacity.

Newcomers to the aggregate market have to compete with well established producers that work hard to keep a competitive advantage. For example, Texada Quarrying Ltd. is currently Canada's biggest aggregate operation. The company spent $2.5 million in 2006 just on two large hauling trucks and an excavator. By 2007, Texada Quarrying plans to optimize its transloading capacity and to provide efficient service to clients such as Quinsam Coal Corporation and some of the sand and gravel operations. Canada's second largest aggregate producer, Construction Aggregates Ltd.'s Sechelt also invested to increase its productivity in 2005 and in 2006 it will spend $4 million to double its primary source capacity and increase its screening capacity. The third example is the Construction Aggregates Ltd.'s Producers Pit, which supplies about 2.2 million tonnes of sand and gravel to the Victoria area. In 2005, this operation spent over $2 million in new plant and mobile equipment in spite the fact that it is expected to close by 2007. The company plans to absorb up to 1 million tonnes of the lost production when Producers closes. Lehigh Northwest Cement Limited is also considering new projects.

The primary challenge for most industrial minerals investors in BC, and elsewhere, is identifying if there is a sufficient market to absorb new production. One scenario is that newcomers to the aggregate business, who will be continuously challenged by the established producers, is that they secure long-term contracts for a substantial proportion of their anticipated production, or form joint ventures with aggregate end-users.

Cement

Lafarge Canada Inc.'s plant in Richmond and Lehigh Northwest Cement Limited's plants in Delta are state-of-the-art cement operations in the lower mainland. Lafarge's plant has a reported capacity of 1.15 million tonnes of cement, but production for 2006 will most likely exceed that design capacity. According to the company, Lafarge Canada will be able to satisfy its clients in BC, however, some cement demand in Washington State, which was traditionally filled by the Richmond plant, will have to be replaced by imports from elsewhere.

The Kamloops cement plant of Lafarge Canada Inc. is forecast to mine over 300 000 tonnes of rock from the Harper Ranch quarry, and to produce about 220 000 tonnes of cement.

As it was the case over the last few years, Lehigh Northwest Cement Limited's plant in Delta, south of Vancouver, also operated at its maximum design capacity of 1.15 million tonnes of clinker per year. Ash Grove Cement announced early this year that it had acquired a 54 000 tonnes capacity import terminal from Goldendale Aluminum on the Willamette River in Portland, Oregon. The facility will be connected to the company's adjacent terminal on North Port Center Way, and combined storage capacity will be about 72 000 tonnes, enabling Ash Grove to supply as much as 800 000 tonnes of cement to customers in the greater northwest United States as well as some inland markets. The terminal will be serviced by ocean-going vessels and should be distributing cement by fall of this year.

Markets currently include at least eight varieties of grey Portland cement, white Portland cement and increasingly popular blended cements. Blended cements consist of Portland cement with one or more additives, such as ground granulated blast furnace slag (25–70% by weight), fly ash, natural pozzolans (15–40% by weight) and silica fume. In the past, blended cements were popular mainly in Europe and Asia, however, as environmental problems and energy concerns in North America rise, the popularity of the blended cements is increasing. Depending on specifications, cement may also contain interground limestone as an additive. The use of natural pozzolans, slag and fly ash, reduces energy consumption and greenhouse gas emissions and this trend is expected to continue.

As opposed to sand and gravel pits, cement plants require much larger venture capital to start, a greater technical expertise to run, and continuous research and development efforts are associated with evolving specifications and environmental regulations. There appears to be room for an increase in cement production capacity in BC, but such ventures may be of interest only to large, established and vertically integrated cement-producing companies. Expansion of production capacity elsewhere may well fill demand.

Fortunately, there is currently a strong international market demand for industrial minerals, particularly along the western seaboard of the United States. Access to low-cost transportation is key, and BC limestone and cement-grade silica producers are currently able to take advantage of markets along the west coast of North America.

Dimension Stone

In general, BC's strategic position on the west coast of North America favours the export of local industrial minerals. In terms of dimension stone, this coastal location acts as a double-edged sword. Raw or partially processed dimension stone is solid, dense and easy to handle. It is an ideal cargo for transoceanic ships where it is used as ballast. Some smaller BC dimension stone producers feel vulnerable to imports of inexpensive dimension stone from Asia and would like to restrict import of such low-cost product. Local stone importers and larger granite and marble processors and retailers consider the imports essential to provide their North American clients with a required variety of products. Margranite Industries in Surrey, Westcoast Granite Manufacturing Inc. in Delta, and Matrix Marble Corporation in Duncan are well-established BC stone processors. These companies rely to a large extent on imports for stone variety, but they also use local stones.

Margranite also processes nine granite varieties, from at least three of its quarries located in the East Anderson River, Beaverdell and Skagit Valley areas of BC. Matrix Marble Ltd., which is extracting blue and white marble from its Tahsis quarry in Tlupana Bay, just expanded its operation by installing the polishing line for their marble slabs, and will be selling Vancouver Island Marble in slabs 2 by 2.7 m (5.5 by 9 ft) in 1.9, 3.2 and 3.8 cm (¾, 1¼ and 1½ in) thicknesses.

Quadra Stone Company Ltd. relies extensively on the Fox Island granite, imported stones and variety of flagstone products. It also periodically produces a small tonnage of Cascade coral blocks from quarries near Beaverdell.

Bedrock Granite Sales & Stone Veneers primarily carries the Hardy Island granite, Haddington andesite and a variety of basalt and rhyolite products mined in the lower mainland. Kettle Valley Stone Company is renowned for its beige rhyodacitic tuff flagstone, ashlar and thin veneer, but it also mines and processes basalt with mantle-derived xenoliths and a number of landscape rock products of granite affinity.

Kettle Valley Stone Company and Kooteney Stone Center are the best known producers of locally derived flagstone. They started a trend that has strengthened since the last review of dimension stone in BC by Simandl and Gunning (2002). At least 15 new producers fitting this category were formed or emerged from obscurity over the last 10 years. Most of these producers are family-type operations with minimal capital, selling mostly to local markets. A few of the well-established or new operations with good financial backing, such as Golden Rock Products Inc., rapidly became mechanized and expanded their market share. Marketing over the internet and sales through stone distributors is a common practice.

Other significant producers are Huckleberry Stone Supply Ltd. of Burnaby and Mountain High Properties Ltd. of Pemberton which produce basalt from small quarries in the Whistler area. Rocky Mountain Tufa produced around 3500 tonnes of tufa, mainly for landscaping applications and an attractive red-purple slaty shale for flagstone applications. On Vancouver Island, K2 Stone Quarries Inc., San Juan Quarries Ltd. and Van Isle Slate produce and market flagstone.

Specialty fossiliferous limestone is test quarried in the Prince George area and a newly identified flagstone deposit consisting of attractive beige-yellow tuff, possibly partially zeolitized, was discovered by D. Sandberg about 10 km east of Beaverdell.

DRILLING MATERIALS

Oil prices reached record highs during early 2006 resulting in increased exploration and production drilling worldwide. In 2005, world production of barite was estimated at 7.8 million tonnes. Small barite operations in BC contributed about $2.2 million in economic activity to the provincial economy. Assuming current trends hold, additional barite production from BC could be absorbed by the BC, Alberta and Alaska markets. Bentonite and zeolite are other minerals used by the oil and gas drilling industry that could benefit from this trend.

In the long-term, the BC offshore oil and gas exploration and development sector may become a substantial market for local industrial minerals and heavy aggregate producers.

OTHER OPPORTUNITIES

Dolomite and magnetite resources along the coast of BC and potential markets for these minerals were described by Simandl (2006a, b). Magnesite resources were reviewed by Simandl (2002). There are numerous silica deposits documented in southeastern BC, however, large high-purity silica deposits, which could supply an expanding glass industry in the Pacific Northwest, are yet to be discovered along the BC coast.

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