



THE INDUSTRIAL MINERAL POTENTIAL OF KYANITE AND GARNET IN BRITISH COLUMBIA*

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INTRODUCTION

Garnet, kyanite, sillimanite and andalusite are minerals found in contact and amphibolite facies regional metamorphic rocks. In British Columbia, such metamorphic rocks are confined mainly to two belts, the eastern Omineca crystalline belt and the western Coast Mountain belt (Figure 3-10-1), where they are accompanied by granitic plutons. Garnet, kyanite and the other aluminosilicate minerals which are present throughout these belts have potential industrial applications, although currently there is no production of these commodities in the province, or elsewhere in Canada.

Garnet is used as an abrasive; high-quality garnet, usually the variety almandine, is used in the form of powders and loose grains for grinding and lapping glass, ceramics and other materials. It is also used in coated and bonded abrasives such as sandpaper, and wheels for grinding and finishing wood, metal, rubber and plastic. Lower quality garnet is used for sandblasting aluminum and other soft metals by, among others, the aircraft industry, and for water filtration (Hight, 1983; Smoak, 1985).

Kyanite and the related minerals, sillimanite and andalusite, are prized mainly for their refractory properties. They are used directly, or calcined to form mullite, in the production of high-temperature mortars or cements and castable refractories, kiln furniture, insulating brick, firebrick and similar products. Finely ground kyanite is used in sanitary porcelains, wall tile and miscellaneous special purpose ceramics (Bennett and Castle, 1983; Potter, 1983; 1985). These refractory products are chiefly used by the metallurgical (steel) and glass industries, and secondarily, by the ceramics industry (Varley, 1968).

GARNET – CURRENT WORLD PRODUCTION AND ECONOMIC CONSIDERATIONS

The United States is the world's leading producer and consumer of garnet, accounting for approximately 75 per cent of the world output and 70 per cent of the world consumption (Smoak, 1983, 1985). The remaining production is from Australia, India and the U.S.S.R.; Canada is currently

not a garnet producer. There are four producers of garnet in the U.S., located in New York, Maine and Idaho. In the later two areas, only low-quality garnet used for sandblasting and water filtration is produced. The geographic areas in which garnet occurs are widespread; however, commercially attractive industrial garnet occurrences are relatively few.

Deposits mined in the U.S. grade from 30 to 80 per cent garnet, with crystal sizes reaching in excess of 90 centimetres; however, on average grains are less than 10 centimetres in diameter. The best abrasive garnets are almandines (hardness 7.5), but pyrope, andradite and grossular, which are all softer, are also used (Smoak, 1985). The presence of incipient fractures or mineral inclusions reduces the usefulness of the garnet (Hight, 1983). As with most industrial minerals, location of deposits and transportation costs are factors of paramount importance in determining viability. Studies by the U.S. Bureau of Mines (Smoak, 1985) indicate world reserves should be adequate to supply world demand for garnet at least until the year 2000; therefore, any new deposits would have to be extremely high grade, high quality and well located in order to break into the market.

KYANITE – CURRENT WORLD PRODUCTION AND ECONOMIC CONSIDERATIONS

The United States, the Republic of South Africa and India are the leading world producers of aluminosilicate minerals (Potter, 1983). There is currently no production of sillimanite, andalusite or kyanite in Canada, although, in the past, attempts were made to recover kyanite from schists in the Timiskaming area (Bennett and Castle, 1983). The consumption of kyanite is concentrated in a relatively few highly industrialized areas, which are typically close to the major iron and steel producing regions in northern Europe, eastern U.S., England and Japan (Bennett and Castle, 1983).

The majority of U.S. production comes from quartzites in Virginia and Georgia which contain 15 to 40 per cent kyanite. No schists are currently being mined for kyanite (Bennett and Castle, 1983); beneficiation of kyanite from schists has traditionally proved problematic, due largely to the presence of iron-rich mineral inclusions. Massive sillimanite is produced in India and coarse sillimanite from schists could potentially be produced; however, the beneficiation of fibrolitic sillimanite is usually impossible. An-

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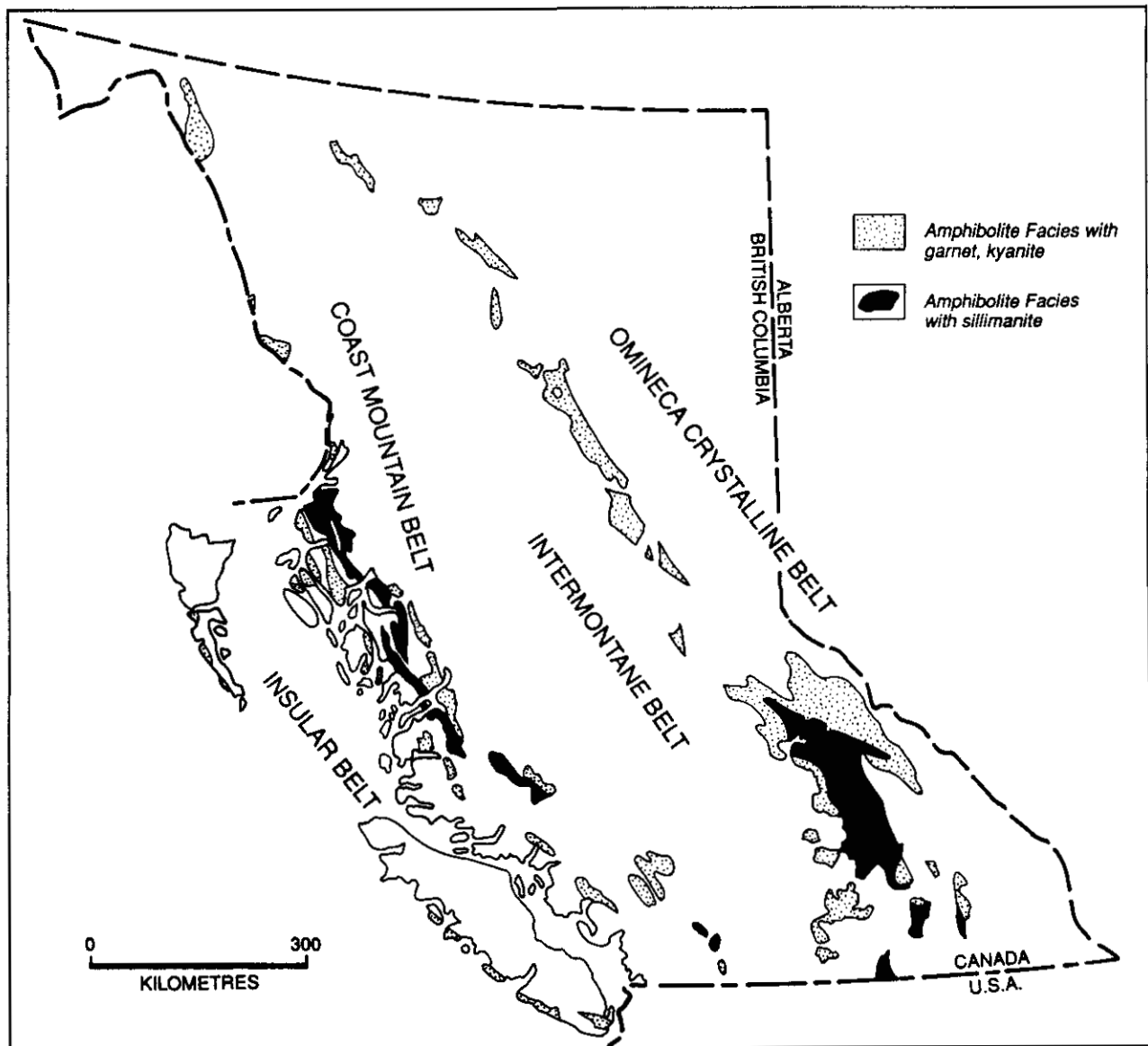


Figure 3-10-1. Distribution of amphibolite facies of classical regional metamorphism in British Columbia (from Monger and Hutchison, 1970).

dalusite is being mined from weathered schists in France and from alluvial deposits in South Africa (Bennett and Castle, 1983).

The potential supply of kyanite group minerals from regional metamorphic terranes vastly exceeds the potential market; therefore, an important preliminary consideration in any exploration project is the cost of delivering kyanite to the geographically limited markets. Also, grade and size of crystals must be considered; an economic kyanite deposit is one from which a -35 to -28 mesh concentrate can be produced which contains less than 2 per cent combined impurities (Fe_2O_3 , TiO_2 , CaO , MgO , etc.) (Bennett and Castle, 1983). As with garnet, studies indicate that an ample supply of kyanite group minerals is likely to exist at least until the year 2000 (Potter, 1985).

GARNET AND KYANITE LOCALITIES IN BRITISH COLUMBIA

Garnet and kyanite group minerals occur mainly in two belts in the Cordillera, the Omineca crystalline belt and the Coast Mountain belt, with minor occurrences elsewhere (Figure 3-10-1). Within these belts, pelitic metasedimentary rocks containing small amounts (that is, less than 5 per cent) of these minerals are extremely abundant. Rocks containing significant concentrations of these minerals, however, are found considerably less frequently. The scope of this study is to identify areas of potential economic grade, for example, greater than 10 to 15 per cent kyanite group minerals and greater than 25 per cent garnet; economic viability as a function of transportation costs, market access, beneficiation possibilities and other factors will not be addressed.

SOUTHERN SHUSWAP – OKANAGAN AREA (82F), OMINECA BELT

Coarse metapelitic schists containing abundant sillimanite and garnet are reported from the Valhalla and Passmore dome area, west of Slocan Lake (Reesor, 1965). Valhalla and Passmore are two of a series of domal structures containing gneisses which form the core of the Shuswap metamorphic complex. Sillimanite locally comprises 20 to 25 per cent of the sillimanite-garnet-biotite schists, and may be very coarse. In the vicinity of the Passmore dome, sillimanite occurs in knots or groups of crystals over 2.5 centimetres long and 1 centimetre wide. These schists also locally contain up to 30 per cent garnet, with an average crystal size of 0.5 centimetre or less. Garnet is also present in interbedded amphibolitic rocks in amounts up to 40 per cent (Reesor, 1965).

Coarse-grained kyanite has been reported from the Creston area (McCammon, 1965). It forms clean, bladed crystals in clumps 10 to 15 centimetres in diameter associated with the pegmatites, and is disseminated throughout schists and micaceous quartzites, where crystals vary from small needles to 1 to 5 centimetres in size (McCammon, 1964).

REVELSTOKE – FRENCHMAN CAP – BIG BEND AREA (82M, N), OMINICA BELT

Coarse, kyanite-rich schists have long been known to exist in rocks of the Shuswap complex in the Revelstoke – Frenchman Cap – Big Bend area (O'Grady and Richmond, 1932; Carnochan and Rogers, 1934; Cummings, 1948; Eichelberger, 1953). Locally, kyanite may constitute 20 to 30 per cent of the micaceous schists, and individual crystals may be over 3 centimetres in length (T. Höy, personal communication, 1987). Areas particularly noted for kyanite are: the Death Rapids – Priest Rapids area, along the west side of the Columbia River, approximately 60 kilometres north of Revelstoke (O'Grady and Richmond, 1932; Carnochan and Rogers, 1934; Cummings, 1948); the Big Bend (Mica Creek) – Kinbasket Lake area underlain by Horsethief Creek Group strata, 100 kilometres to the north and northeast of Revelstoke (Eichelberger, 1953; T. Höy, personal communication, 1987); the Trident Mountain area, 15 kilometres east-southeast of Mica Creek (Perkins, 1983); and the mantling gneisses on the north and northwestern margin of Frenchman Cap dome in the vicinity of Ratchford Creek, the headwaters of Perry River and Kirbyville Creek (Wheeler, 1965; T. Höy, personal communication, 1987). Sillimanite is also locally abundant in the latter localities.

CANOE RIVER – VALEMONT AREA (83D), OMINECA BELT

Horsethief Creek Group strata in the Canoe River area were locally sufficiently pelitic to produce abundant garnet and aluminosilicate minerals when subjected to high-grade regional metamorphism. In the southeastern Cariboo Mountains, approximately 30 kilometres southwest of Valemont, pelitic schists locally contain 20 to 25 per cent kyanite, with or without fibrolitic sillimanite, and 15 to 25 per cent garnet (Pell, 1984). Kyanite grains are commonly more than 2

centimetres in length. Pelitic schists in this region also frequently contain quartz-kyanite-rich segregation lenses. In the northern Monashee Mountains approximately 30 kilometres southeast of Valemont, near the headwaters of Howard Creek, Horsethief Creek Group schists contain 20 to 25 per cent coarse garnets which range from 2 to 6 centimetres in diameter. Kyanite is also present, but not abundant at this locality. Abundant coarse kyanite has been noted in the vicinity of Albreda, on the main line of the Canadian National Railway, approximately 25 kilometres south of Valemont (Cummings, 1948).

HOPE – YALE – HARRISON LAKE AREA (92G, H), COAST MOUNTAIN BELT

Pelitic schists crop out in a number of localities in the Hope – Yale – Harrison Lake area of southwestern British Columbia and locally contain abundant kyanite, sillimanite and garnet. The Settler schist, of uncertain age, is found between Harrison Lake and Yale. Locally, it contains up to 30 per cent garnet and 23 per cent kyanite, 24 per cent fibrolitic sillimanite or 15 per cent coarse sillimanite in prisms more than 4 centimetres long (Lowe, 1972; Pigage, 1973). Sillimanite is generally present adjacent to granitic plutons, notably along the ridge north of Cogburn Creek and Zofka Ridge (Lowe, 1972).

Pelitic schists and gneisses of the Breakenridge and Cairn Needle formations of Late Paleozoic and Mesozoic age also crop out in the Harrison Lake area. Schists of the Breakenridge Formation are extremely pelitic and may contain up to 50 per cent garnet (average approximately 20 per cent) and up to 40 per cent coarse-grained kyanite (average approximately 15 per cent) (Reamsbottom, 1971). Schists of the Cairn Needle Formation are slightly less pelitic, containing from 4 to 50 per cent garnet, with averages of approximately 10 to 15 per cent, minor kyanite or andalusite and from 0 to 20 per cent sillimanite (Reamsbottom, 1971).

PRINCE RUPERT – SKEENA RIVER – DOUGLAS CHANNEL AREA (103H, I, J), COAST MOUNTAIN BELT

Pelitic schists and gneisses of uncertain age and affiliation occur in abundance as inliers and adjacent to granitic plutons in the Prince Rupert – Skeena River – Douglas Channel area, northwestern British Columbia (see Hutchison, 1982). The Central Gneiss Complex of the Prince Rupert – Skeena map area contains zones of biotite-garnet-sillimanite-muscovite gneisses 30 to 300 metres thick in the Mount Ponder, Redcap Mountain, Kwinamass Peak and Kateen River areas. Within these zones sillimanite comprises up to 50 per cent of the rock and garnets up to 0.75 centimetre in diameter form an additional 15 to 20 per cent. On Highway 16, 1 kilometre east of Kwinitsa, excellent exposures of garnet-sillimanite-biotite-quartz-feldspar gneiss contain 5 to 30 per cent garnet and 5 to 30 per cent sillimanite; the sillimanite is generally present in densely felted layers from 0.2 to 2.5 centimetres thick (Hutchison, 1982). Numerous other garnet and sillimanite localities are present in the Prince Rupert – Skeena area.

Kyanite-staurolite-almandine schists are exposed on Hawksbury Island, south of Prince Rupert and contain up to 20 per cent almandine garnet and up to 20 per cent kyanite (Money, 1959). The garnet is present as subhedral to euhedral grains up to 5 centimetres in diameter or as anhedral rounded aggregates, 7.5 centimetres across. Kyanite may be extremely coarse; blades reach 20 centimetres by 1 centimetre in size. Sillimanite is reported from only one locality on Hawksbury Island (Fishtrap Bay), where it is present as rounded knots in gneiss and comprises up to 15 per cent of the rock (Money, 1959). In the Douglas Channel – Ecstall River area, south of Prince Rupert, extremely garnetiferous schists and gneisses have been reported. Euhedral garnets 1 to 2 centimetres in diameter locally comprise up to 20 per cent of the rocks; some schists from the shores of Douglas Channel contain 50 per cent garnet with an average grain size of 0.25 centimetre (Padgham, 1959).

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