Newly Recognized White Talc-Carbonate Filler Potential of the Greenwood – Bridesville Area, British Columbia (NTS 082E), and Brief Talc Market Review

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INTRODUCTION

British Columbia has over 40 talc deposits, at least seven of which are carbonate-hosted (MacLean, 1988; Benvenuto, 1993). Most economic talc deposits in the world can be classified as either sedimentary hosted (Simandl and Paradis, 1999) or ultramafic hosted (Simandl and Ogden, 1999).

The recently recognized Bridesville talc-carbonate deposit, in the Greenwood – Bridesville area of southern BC, is the sedimentary-hosted variety. It has a lower grade than most traditional high-grade carbonate-hosted talc deposits, such as Henderson, Conley and East deposits located in Ontario (Simandl, 1985b) and those in Montana, United States. However, a parallel may be made between the Bridesville deposit and the New Conley deposit, Ontario. White fillers containing talc, derived from the New Conley orebody (talc-bearing dolomite), were successfully marketed in the past by Canada Talc Industries Ltd. under the trademarks Dolfil and Talfil. The possibility that there is a market for 'talc-carbonate filler' in western North America should be investigated. If the results of the investigation are positive, the talc-carbonate zone of the Bridesville deposit may provide sellable product without need for upgrading. The need for capital cost-intensive processing (such as flotation), to achieve a marketable product, would lower the development potential of this deposit. Even if there was no market for the talc-carbonate filler, the identification of the Bridesville deposit is significant. Carbonate-hosted talc deposits typically occur in clusters. A higher grade extension of this deposit, or another higher grade carbonate-hosted deposit (characterized by high brightness and whiteness talc ore), could be discovered in southern BC.

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THE TALC MARKET

The combined world production of talc and pyrophyllite is estimated at 8.3 million tonnes for 2006 (Virta, 2007). More than one third of it originates from China. Most of the world talc production is used in the paper, ceramics, plastics and paint/coating industries. The cosmetic-grade talc market is very small but talc concentrates that meet these tight specifications have a very high unit value. If pyrophyllite is eliminated from these statistics, the talc production alone is probably close to 7 million tonnes. United States' talc markets have been declining since they attained a high of 1.05 million tonnes in 1990. In 2004, they reached a low of 857 000 tonnes, but markets are currently recovering. United States' consumption is expected to vary within the 875 000 to 925 000 tonne range for the next few years (Virta, 2007). Canadian shipments of talc and pyrophyllite combined were estimated at 66 000 tonnes in 2005 (Dumont, 2005), though detailed breakdown by province is not available. However, Ontario, which produces talc from both sedimentary and ultramafic-hosted deposits, is the main producer.

China's exports of high-purity, lump-talc ore may be curtailed because of the elimination of China's export tax rebates, the implementation of new export taxes and its shrinking reserves of high-grade ores. A substantial proportion of the high-grade, Chinese, lump talc was traditionally produced from small operations by highly selective mining and hand sorting. Therefore, in the medium term, Canadian talc producers have the potential to increase their share of total market. However, in the short term, any talc producer located along the west coast of North America has to compete with Chinese exports and with talc from Madison County, Montana.

A review of the talc industry by Virta (2007) includes a discussion of the uses and value of talc products. The primary user of talc is the paper industry. A study of the paper industry market along the west coast of North America by Harris and Ionides (1994) indicates that most of the talc products used in pulp and paper, paint and plastics production are nearly monomineralic and have tighter specifications than the concentrates used in ceramic, coating or plastic filler applications. Examples of talc product specifications used in the paper industry are provided by Harris and Ionides (1994). The second most important use of talc in terms of tonnage is probably in the asphalt industry, which consumes off-colour and low-grade products. A small amount of soapstone talc is extracted but it is primarily artisanal, there is only one commercial soapstone operation near East Broughton, Quebec. There are special circumstances, other than in asphalt use, where material containing talc-carbonate mixtures may become a sellable product assuming that physical and chemical homogeneity of the product can be maintained over a prolonged period of time. This has been demonstrated by the successful marketing of products derived from the New Conley deposit in Ontario (see below). This possibility should be investigated in the case of the Bridesville deposit, which has a potential to supply high whiteness product.

LOCATION AND HISTORY

The newly recognized talc-carbonate deposit in BC is located south of Bridesville in southern BC (342948E, 5432972N, elevation 1080 m asl; Fig 1). P. Chaput, of Mighty White Dolomite Ltd. (Mighty White), provided the author with a sample for mineral identification. Talc and carbonate were tentatively identified as the two main constituents. P. Chaput reported that this deposit was previously considered as a source of high-purity dolomite for agricultural and environmental applications. However, the material did not pass the neutralizing tests and the project was abandoned.

A brief reconnaissance-type examination and sampling program of the excavation was undertaken by the author. This investigation confirmed the location of the occurrence, the dimension of the excavation, and the width, orientation and mineralogy of the talc-carbonate zone and host rock.

REGIONAL GEOLOGICAL SETTING

The Bridesville talc-carbonate deposit lies within the Permian and/or Triassic Anarchist Group as defined by Little (1961), consisting of greenstone, quartzite, greywacke, limestone and locally paragneiss. Tempelman-Kluit (1989) also mapped the deposit area at a scale of 1:250 000, but a more detailed map is not currently available. The Bridesville talc-carbonate deposit may be stratigraphically related to the Rock Creek dolomite mine, also called Dolo (MINFILE 082ESE200; MINFILE, 2007), which is operated by Mighty White.

Figure 1. Location of the sedimentary-hosted Bridesville talc-carbonate deposit, southern BC.

The Rock Creek dolomite mine is located approximately 5 km southeast of the community of Rock Creek. It occurs within the Permian to Carboniferous Knob Hill Group (MINFILE 082ESE200). This terminology is in line with a suggestion by Little (1983) not to use the Anarchist Group term within the Greenwood area; however, MacLean (1988) reiterates that the dolomite mined near Rock Creek is part of the Anarchist Group. Massey (2007) included the Rock Creek dolomite in the Anarchist schist but stated that the relationship between this unit and the rest of the Anarchist schist is enigmatic.

The high-quality dolomite from Rock Creek mine is similar in chemical composition and colour to the dolomite that is hosting the Bridesville talc-carbonate deposit. However, the Rock Creek dolomite contains traces of serpentine rather than traces of talc. Mafic dikes crosscutting the dolomite at Rock Creek have sharp and predictable contacts with the dolomite, although in places they are schistose. It is therefore possible that the Rock Creek and Bridesville dolomite zones are stratigraphically related, differing only in degree of deformation. The highly schistose greenstone exposed in the Bridesville excavation is a postdeformational equivalent of the mafic dikes. A detailed re-examination of the Rock Creek dolomite is justified. MacLean (1988) reports a talc-bearing zone near the base of dolomite ore. This zone was not exposed, or at least not observed, at the time of the author's brief visit to the minesite as part of an industry monitoring program in 2001.

The clarification of the exact stratigraphic relationship between the rocks hosting the Bridesville and the Rock Creek deposits is very relevant for dolomite exploration. It may be less critical for talc exploration, especially if mineralization-controlling structures are very recent relative to dolostone units (chemical composition of dolomites being equal).

DEPOSIT DESCRIPTION

The exposure of the talc-carbonate deposit is limited to the isolated quarry; no other outcrops were observed in immediate proximity of the excavation (Fig 2). The excavation is approximately 60 m in length, 20 m in width and, in places, is more than 6 m deep. The overburden in the excavation area varies from 0 to >1 m thick (Fig 3). It contains white fragments of underlying talc-bearing rock. Three main rock types are exposed within the excavation: a) talc-bearing schistose carbonate, b) greenstone and c) massive dolostone. The talc-bearing zone has a strongly developed schistosity and is exposed on the eastern wall of the excavation (Fig 3).

The talc-bearing zone is several metres thick, striking approximately north-south and dipping 20 to 40° eastwards, assuming that the orientation of the schistosity approximates that of the talc zone. Contacts of the talc zone and dolomite are wavy and they are marked by an abrupt disappearance of the schistosity. Talc accounts for approximately half of the rock within the talc-carbonate zone, based on visual estimates. The talc is concentrated along schistosity planes. Calcite is the main carbonate mineral with minor dolomite. Systematic sampling and laboratory work are needed to better constrain the talc content and relative proportion of calcite and dolomite. The talc-bearing zone is described in more detail in the next section.

The greenstone is characterized by its green colour on both fresh and weathered surfaces. The contact between the

Figure 2. View of the excavation at Bridesville talc-carbonate deposit, southern BC; looking north (truck for scale). Abbreviations: Do, dolostone; Ta-Ca, talc-carbonate zone.

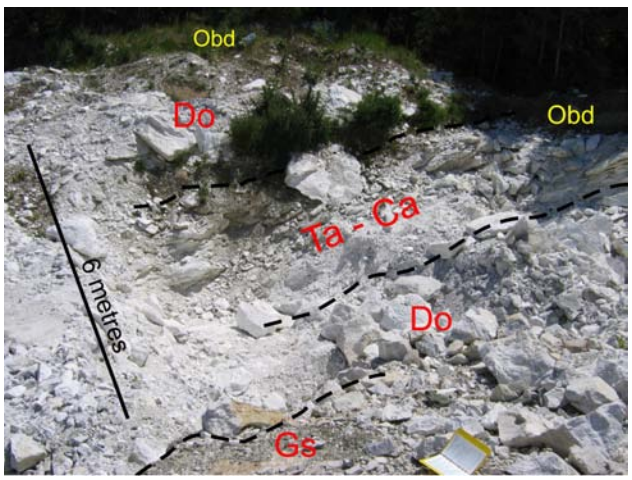

Figure 3. View of the excavation at Bridesville talc-carbonate deposit, southern BC; looking at the eastern wall (notebook for scale). Abbreviations: Ta-Ca, talc-carbonate zone; Do, dolostone; Gs, greenstone; Obd, overburden.

steeply dipping greenstone unit and the surrounding marble is sharp and highly irregular. Similarly to the talc-bearing zone, the greenstone is also characterized by a strong schistose fabric; however, it consists largely of chlorite (>60%). Carbonates, dominantly calcite, account for less than 40% of this rock. Calcite is either intergrown with chlorite or forms veinlets. Quartz forms decimetre-scale, irregularly

Figure 4. Weathered surface of dolostone showing nearly random fracturing, Bridesville talc-carbonate deposit, southern BC. Fracture pattern is enhanced by preferential weathering. Five-cent coin for scale.

distributed pods and veins constituting <5% of the exposure. Quartz is also present as fine-grained aggregates in contact with chlorite or calcite. Quartz veins and pods do not appear to extend from the greenstone into the dolostone. Sulphides (mostly pyrite) are restricted to localized zones within the greenstone and occur as disseminations, typically constituting <1% of the rock; rarely 1–3%. Talc, hematite and tentatively identified albite are trace constituents. The greenstone fabric is strongly discordant to the schistosity of the talc-bearing zone, but their intersection is not exposed within the excavation. The greenstone's protolith may have been a mafic dike or sill (such dikes and sills are visible in the dolomite quarry operated by Mighty White); however, it could have also been a lava flow, tuff or volcanic rock-derived sediment.

The dolostone, the third lithological unit within the excavation, is massive, pale grey on weathered surfaces (Fig 4) and very pale grey to white (locally mottled) on fresh surfaces. Healed fractures that are hard to discern on the fresh surface are enhanced on the weathered surface by preferential weathering. The dolostone consists predominantly of dolomite (>95%) with minor concentrations of calcite, talc and trace pyrite. Talc (<1%) is observed in veinlets in association with coarser carbonate (calcite?) within the mottled variety of dolomite. The chemical composition of the dolostone is given in Table 1.

TABLE 1. CHEMICAL COMPOSITION OF TALC-CARBONATE ZONE AND DOLOMITE FROM THE BRIDESVILLE DEPOSIT, SOUTHERN BC. THE CO_2 CONTENT WAS CALCULATED FROM TOTAL CARBON (TOT-C X 44/12 = CO_2). IN THE CASE OF THE TALC-BEARING ZONE, CO_2 IS HIGHER THAN LOSS-ON-IGNITION; THIS SHOULD NOT HAPPEN. TALC IS A HYDRATED MINERAL CONTAINING APPROXIMATELY 4.75% OF H_2O, AND THIS DISCREPANCY MAY BE ATTRIBUTED TO LOW ANALYTICAL PRECISION.

	SiO_2	Al_2O_3	Fe_2O_3	MgO	CaO	Na_2O	K_2O	TiO_2	P_2O_5	MnO	Cr_2O_3	LOI	TOT-C	CO_2	TOT-S	SUM
Talc-carbonate zone	35.01	<0.03	0.13	18.58	25.62	0.01	<0.04	<0.01	0.05	0.03	<0.001	20.6	5.92	21.7	<0.01	100
Grey carbonate, dolostone (limy)	2.08	0.15	0.11	17.9	34.26	0.01	0.04	0.01	0.03	0.01	0.001	45.4	12.07	44.26	0.01	99.97
Mottled dolomite	2.46	0.05	0.07	19.45	32.57	0.01	0.04	0.01	0.03	0.01	0.001	45.3	12.38	45.39	0.01	99.97

Physical and Chemical Properties of the Talc-Bearing Zone

The talc-bearing zone is very pale grey on weathered surfaces and is characterized by its flaky texture (Fig 5), which distinguishes it from the massive dolomitic hostrock (Fig 4). It is highly schistose where exposed in the excavation, suggesting that it would be relatively easy to crush. It is snow white on the fresh surface, suggesting that the processed material will most likely be very white and bright (as required in the most demanding filler applications). The talc-bearing dolomite shows a strong planar fabric (Fig 6) and breaks easily into sheets and lenses (typically <1cm thick). However, these sheets may be paper thin within the most schistose portions of the zone. The talc-bearing zone was visually estimated to consist of 50–65% talc and 35–50% carbonate, most of which is calcite {$CaCO_3$} and possibly minor dolomite {$CaMg(CO_3)_2$}. Pyrite is present in some parts of the zone as a trace constituent. Plagioclase may be present as traces. Talc platelets are concentrated along the schistosity planes. They are oriented (elongated) parallel to the schistosity planes, suggesting that talc is predeformational, or most likely syndeformational, and that it is formed by the interaction of metasomatic/metamorphic fluids with dolomite hostrock. Neither tremolite nor chrysotile was observed within the talc-bearing zone; however, the absence of these minerals should be confirmed. The talc content and composition of the carbonate of the talc-bearing zone should be better constrained by systematic sampling and related laboratory work. Chemical composition of the talc-carbonate zone is given in Table 1.

New Conley, Henderson and View Deposits

The following section describes materials from New Conley and Henderson talc-carbonate deposits located in eastern Ontario and from the View deposit in southeast BC. These descriptions are essential to understand the similarities and differences between these deposits and the newly discovered Bridesville deposit. In the discussion section below, the parallel is drawn with the materials derived from the New Conley deposit.

The property on which the Henderson (in operation since 1896), Conley (Old Conley), New Conley and East deposits (discovered in 1981) are located, has changed hands numerous times and is currently owned by Dynatec Corporation. It is located near Madoc, southeastern Ontario (Simandl, 1985a). In the 1970s and the early 1980s, three of these deposits were exploited by Canada Talc Ltd.

New Conley had a much lower talc content than its famous neighbour, the high-grade Henderson talc deposit (Simandl, 1982; Simandl, 1985b). Crushed material from the New Conley deposit consisted mainly of dolomite. Talc (≅10%), tremolite (≅10%), phlogopite (<10%) and antigorite (1.5%) were the remaining identified constituents (Goldberg and Wehrung, 1981). The crushed material was successfully commercialized and marketed under the names Dolfil™ and Talfil™ (Simandl, 1985a, b). Chemically, these products consisted of 20–24% MgO, 26–30% CaO, 16–18% SiO_2, 0.5–1% Al_2O_3, 0.5–1% Fe_2O_3 and 30–35% loss-on-ignition (LOI). These products were marketed as functional fillers for sealants, putties and adhesives, paint and coatings, plastics and stucco/drywall construction products. Top of the line varieties of these products were also marketed as inert carriers for commercial pesticides, fertilizers and insecticides. The raw material for this product was extracted from underground workings connected to the Conley #3 shaft, but the plans existed to start mining at the surface as well.

The main product line of Canada Talc Industries Ltd., called CANTAL™, was derived from the Henderson orebody. According to Goldberg and Wehrung (1981), in the 1970s and 1980s, this product consisted of talc (>70%), dolomite (24%), prismatic tremolite (0.2%), antigorite (2.6%) and phlogopite (1.8%). Richardson (1981) indicates that its typical chemical composition was 42–45% SiO_2, 25–28% MgO, 9–12% CaO, 2–3% Al_2O_3, 0.5–1% Fe_2O_3 and 10–12% LOI. This data is in line with the analyses of grab samples reported by Simandl (1985a).

The specifications of the main line of talc-rich products currently produced by Dynatec Corporation are still referred to as CANTAL but specifications evolved. The company's website (Dynatec Corporation, 2007a) indicates that in addition to its CANTAL™ line of products, the company produces a dolomite-rich product under the trademark DYNAFIL. The product safety sheets for DYNAFIL™ are currently identical to those of Dolfil™, as indicated by Canada Colors and Chemicals Limited's website (Canada

Figure 5. Weathered surface of the talc-bearing zone, Bridesville talc-carbonate deposit, southern BC, characterized by "flaky" texture (strong preferential planar fabric). Five-cent coin for scale.

Figure 6. Strong preferential fabric and snow white colour characterizes talc-bearing zone, Bridesville, southern BC. Hammer for scale.

Colors and Chemicals Limited, 2007) and Dynatec Corporation's website (Dynatec Corporation, 2007b). DYNAFIL™ and Dolfil™ products are reported to contain 90–93% dolomite, 3–4% calcite and 1–3% non-asbestiform tremolite. Today, the raw material for DYNAFIL™ (Dolfil™'s functional equivalent) may be coming from the open pit operation rather than from underground because it differs in mineralogy from the sample analyzed by Goldberg and Wehrung (1981).

The View deposit (MINFILE 082FSE070), located approximately 30 km west of Creston, BC, is also known to contain low-grade talc, dolomite, muscovite and calcite; however, the mineralization is not white, whereas Bridesville ore is white. Here, impure talc was considered for commercial use without upgrading. It was explored and developed in 1964 (Olson, 1965). A trial shipment was extracted from this deposit in 1983 by International Marble and Stone Company Ltd. This low whiteness and low brightness material was intended as low-cost filler and dusting component in asphalt (Hora, 1984).

DISCUSSION

Similarities between the Bridesville white talc-carbonate zone and the previously described New Conley white talc-dolomite deposit near Madoc, Ontario, suggest that the recently discovered Bridesville deposit may be of economic interest. Both the New Conley and Bridesville deposits have relatively low talc contents, which could make talc-carbonate separation difficult to justify. A high-quality dolomite product is already commercially available in the Bridesville area from the Mighty White operation (Simandl et al., 2006, 2007). However, there is the possibility that the crushed or micronized white talc-carbonate ore may be sold at a premium over straight dolomite or straight high-calcium carbonate as a specialty mineral filler. A low-cost market study, aiming to identify potential buyers for the talc-carbonate product is justified. The talc content of the Bridesville zone is intermediate between ores from the New Conley and Henderson deposits. The presence of calcite (rather than dolomite) as the main carbonate within the Bridesville talc-bearing zone is a positive feature. Calcite is preferred to dolomite in most filler applications. The existing mill located at Rock Creek, currently being used to process dolomite, could possibly handle the processing of the talc-carbonate ore for filler applications (with some modifications or additions).

Carbonate-hosted talc deposits typically occur in clusters (Simandl, 1985a; Simandl and Paradis, 1999), as illustrated by spatial association of several talc-bearing deposits near Madoc, Ontario, and higher grade dolomite-hosted talc deposits may also be discovered in the Bridesville area. A descriptive model for carbonate-hosted talc deposits (Simandl and Paradis, 1999) provides leads for future exploration. However, a preliminary market study and more detailed laboratory analyses of the talc-carbonate zone are recommended before additional exploration work is carried out either to establish reserves, or to find high-grade talc deposits.

In this particular case, the laboratory work should include both physical and chemical parameters of the talc-bearing zone including detailed mineralogy, whiteness and brightness, surface area, oil adsorption and abrasion. The detailed mineralogy of several representative samples is essential, as the talc ores that do not contain acicular or fibrous amphiboles have a major marketing advantage over talc products that contain acicular or fibrous constituents. Products containing fibrous minerals attract intense scrutiny from environmental and health authorities worldwide.

Origin

Any hypothesis proposed to explain the origin of the Bridesville talc deposit must be in accordance with observed structural control on the talc-calcite zone and the abrupt contact of the talc-calcite zone with the dolostone. It should also be in agreement with the mineralogy of the talc-bearing zone (talc-calcite) and the mineralogy of the host rock (nearly monomineralic dolomite) and with subgreenschist or greenschist metamorphic conditions.

The following reaction explains the formation of talc $\{Si_4O_{10}Mg_3(OH)_2\}$ and satisfies all of the above listed constrains:

$$3CaMg(CO_3)_2 + 4SiO_2(aq) + H_2O \rightarrow Si_4O_{10}Mg_3(OH)_2 + 3CaCO_3 + 3CO_2(g)$$

This reaction was proposed by Page (1951) and Zwart (1954) and experimentally studied by Metz and Puhan (1970). According to the experimental work of Metz and Puhan (1970) on dolomite-quartz equilibrium, assuming the mole fraction of CO_2 ($XCO_2 \cong 0.5$) and depending on the lithostatic pressure (P), talc may form at temperatures below 550°C (at P = 5 kbar) and well below 400°C (at P = 0.5 kbar). At lower XCO_2, the temperatures needed to form talc are even lower. Therefore, if a hydrothermal talc deposit is discovered in unmetamorphosed carbonate, or in carbonate that was subject to metamorphic conditions inferior to those needed to form tremolite during the prograde metamorphic phase, then the chances the talc ore is amphibole free are excellent. Amphiboles that form during the prograde phase of contact or regional metamorphism are commonly destabilized during the retrograde metamorphic phase, resulting in the formation of talc pseudomorphs after tremolite. However, the talcification of amphiboles is rarely complete. No rigorous metamorphic study has been done in the Bridesville area. Based strictly on the combination of mineral assemblages in the greenstone and marble, the rocks were most likely affected by greenschist (or subgreenschist) metamorphism. At this stage, there is no strong evidence to conclude if the Bridesville deposit was formed during the prograde or the retrograde phase of the thermal event, but talc-forming fluids were focused along a structural weakness plane. The source of heat driving the hydrothermal system may have been local or regional. If the talc-forming fluids were related to regional greenschist facies metamorphism, then sediment-hosted talc deposits in the Bridesville area could also be located along the contacts of dolostone with siliceous units (both silica and magnesia would be *in situ*, only water would be needed). Greenschist facies conditions, suggested by mineralogy of the greenstone, are also favourable for the formation of ultramafic-hosted talc deposits (Simandl and Ogden, 1999).

SUMMARY

The presence of the dolomite-hosted, talc-calcite mineralization at the Bridesville deposit is important from a talc exploration perspective. This occurrence fits the sedimentary-hosted talc deposit model (Simandl and Paradis, 1999). It can be considered as an analogue to the obscure, yet economic, low-grade sedimentary-hosted, talc-carbonate (dolomite) New Conley deposit in Ontario.

The results of this investigation are sufficiently encouraging to recommend additional work, including a preliminary market investigation and systematic characterization of the talc-carbonate rock within the excavation to determine if a more comprehensive deposit evaluation is justified.

The Bridesville talc-carbonate deposit could be of economic interest if there is a market for white talc-carbonate filler on the west coast. The need for upgrading the Bridesville talc-bearing rock would significantly increase capital cost requirements. There is also a possibility that the Bridesville deposit has a higher-grade extension, or that additional dolomite-hosted talc deposits will be discovered in the area. Although the Greenwood – Bridesville area was prospected intensively for precious and base metals for more than a century, the documentation of this deposit demonstrates that the area is far from maturity in terms of exploration for industrial minerals.

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REFERENCES

Benvenuto, G. (1993): Geology of several talc occurrences in Middle Cambrian dolomites, southern Rocky Mountains, British Columbia (82N1/E, 820/4W); *in* Geological Fieldwork 1992, *BC Ministry of Energy, Mines and Petroleum Resources*, Paper 1993-1, pages 361–379.

Canada Colors and Chemicals Limited (2007): Material safety data sheet dolomite; *Canada Colors and Chemicals Limited*, URL <http://www.canadacolors.com/canadacolors/docs/msds/english/395902.pdf>, 7 pages [November 2007].

Dumont, M. (2005): Talc and pyrophyllite; *Natural Resources Canada*, Canadian Mines Yearbook 2005, pages 54.1–54.9.

Dynatec Corporation (2007a): Material safety data sheet, dolomite; *Dynatec Corporation*, URL <http:// www.dynatecminerals.com/en/PDF/msds-dolomite.pdf>, 6 pages [November 2007].

Dynatec Corporation (2007b): Technical data sheets; *Dynatec Corporation,* URL <http://www.dynatecminerals.com/en/techdata.html>, 1 page [November 2007].

Goldberg, E.J. and Wehrung, J.M. (1981): Analysis of two talc samples by SEM, EDXA; consultant report to *W.R. Barnes Company Ltd.*, Waterdown, Ontario, 18 pages.

Harris, M. and Ionides, G.N. (1994): Update of a market study for talc; *BC Ministry of Energy, Mines and Petroleum Resources*, Open File 1994-24, 63 pages.

Hora, Z.D. (1984): British Columbia; *in* Industrial Minerals in Canada – A Review of Recent Developments, *Industrial Minerals*, Number 200, pages 111–117.

Little, H.W. (1961): Kettle River (west half), British Columbia; *Geological Survey of Canada*, Map 15-1961, scale 1:253 440.

Little, H.W. (1983): Geology of the Greenwood map area, British Columbia; *Geological Survey of Canada*, Paper 79-29, 37 pages, 1 map at 1:50 000 scale.

MacLean, M. (1988): Talc and pyrophyllite in British Columbia; *BC Ministry of Energy, Mines and Petroleum Resources*, Open File 1988-19, 108 pages.

Massey, N.W.D. (2007): Geology and mineral deposits of the Rock Creek area of BC (082E/2W, 082E/3E); *BC Ministry of Energy, Mines and Petroleum Resources*, Open File 2007-07, scale 1:25 000.

Metz, P. and Puhan, D. (1970): Experimentelle Untersuchung der Metamorphose von kieseling dolomitischen Sedimenten; *Contributions to Mineralogy and Petrology*, Volume 26, pages 302–314.

MINFILE (2007): MINFILE BC mineral deposits database; *BC Ministry of Energy, Mines and Petroleum Resources*, URL <http://www.em.gov.bc.ca/Mining/Geolsurv/Minfile/> [November 2007].

Olson, P.E. (1965): View 1, 2, 3; *in* Minister of Mines Annual Report, *BC Ministry of Energy, Mines and Petroleum Resources*, page 278.

Page, B.M. (1951): Talc deposits of steatite grade, Inyo County, California; *California Division of Mines*, Special Report 8, 35 pages.

Richardson, J.A. (1981): Cantal 325, product data; *Canada Talc Industries Ltd.*, 1 page.

Simandl, G.J. (1982): Industrial mineral potential of the unique high-grade Madoc talc deposit, Ontario; *Canadian Institute of Mining and Metallurgy*, 84th Annual General Meeting, General Program, pages 51–52.

Simandl, G.J. (1985a): Geology and geochemistry of talc deposits in the Madoc area, Ontario; unpublished MSc thesis, *Carleton University*, 154 pages.

Simandl, G.J. (1985b): Geology of the Henderson talc deposit, Madoc, Ontario; *Geological Association of Canada-Mineralogical Association of Canada*, Annual Meeting, Abstract, Volume 10, page A-56.

Simandl, G.J., Irvine, M.L., Grieve, D., Lane, R., Wojdak, P., Madu, B., Webster, I., Northcote, B. and Schroeter, T. (2007): Industrial minerals in British Columbia – 2006 overview; *BC Ministry of Energy, Mines and Petroleum Resources*, Information Circular 2007-2, 12 pages.

Simandl, G.J. and Ogden, D. (1999): Ultramafic-hosted talc-magnesite; *in* Selected British Columbia Mineral Deposit Profiles, Volume 3, Industrial Minerals and Gemstones, Simandl, G.J., Hora, Z.D. and Lefebure, D.V., Editors, *BC Ministry of Energy, Mines and Petroleum Resources*, pages 65–68.

Simandl, G.J. and Paradis, S. (1999): Carbonate-hosted talc; *in* Selected British Columbia Mineral Deposit Profiles, Volume 3, Industrial Minerals and Gemstones, Simandl, G.J., Hora, Z.D. and Lefebure, D.V., Editors, *BC Ministry of Energy, Mines and Petroleum Resources*, pages 35–38.

Simandl, G.J., Robinson, N.D. and Paradis, S. (2006): Dolomite in BC: geology, current producers and possible development opportunities along the west coast; *in* Geological Fieldwork 2005, *BC Ministry of Energy, Mines and Petroleum Resources*, Paper 2006-1, pages 197–207.

Tempelman-Kluit, D.J. (1989): Geological map with mineral occurrences, fossil localities, radiometric ages and gravity field for Penticton map area (NTS 82E), southern British Columbia; *Geological Survey of Canada*, Open File 1969, 17 pages, 5 maps at 1:250 000 scale.

Virta, R.L. (2007): Talc and pyrophyllite; *United States Geological Survey*, Mineral Commodity Summaries, January 2007, pages 162–163.

Zwart, H.J. (1954): La géologie du Massif du Saint-Barthelemy, Pyrénées, France; *Ryksmuseum van Geologie en Mineralogie,* Leidse Geologische Mededelingen, Leyden, Netherlands, 228 pages.