000549

April 27/90

TRI-SIL MINERALS INC.

PROPERTY FILE

PROPERTY REPORT, 1990

SUBJECT: WOLLASTONITE (CaSiO3 - SECHELT WOLLASTONITE PROJECT

SUMMARY AND BUSINESS BACKGROUND

The Sechelt B.C. Wollastonite property located on Snake Bay has the potential based on the following criteria to control the local domestic Canadian and U.S. market and to enter the Pacific Rim markets as a source of highly prized Asbestos replacement and performance filler Wollastonite:

1. Preliminary drill testing has indicated a zone 150 metres wide, up to an average 100 metres in depth, traced over 450 metres along strike (and open to the north) estimated to contain in excess of 3.7 million tonnes of Wollastonite at a conservative 20% Wollastonite grade.

2. The deposit can be mined by open pit methods.

3. The deposit is located less than one kilometre from tide water.

4. Preliminary tests have confirmed:

   (a) high quality Wollastonite - (whole rock analysis)

	CaO	SiO2
Sechelt sample -	47.2%	49.8%
Typical Commercial material	47%	50%

   (b) ease of Garnet and Diopside liberation and magnetic benefication

   (c) high aspect acicularity of all size fractions down to a tested minus 100 mesh material. Optical aspect ratios of 20.1 are average with very high aspect ratios up to 35.1 noted.

Box 69, Sechelt, B.C. V0N 3A0 Telephone (604) 885-9824

In 1985, the average price paid by consumers in the U.S. for chemically (surface) modified Wollastonite was $.55/Kilogram or about $600 U.S./short ton. A growing shortage of surface modified Wollastonite in the Pacific Rim (i.e. Japan, Korea Taiwan and Hong Kong) will add greatly to the long term economic viability of developing the Sechelt (Snake Bay) deposits.

The Wollastonite content of deposits varies considerably from one to another and there is no recognized minimum content in order for mining to be economic. In some cases Wollastonite production is viable only as a result of local demand for associated by-products such as Garnet or Limestone; both of which could figure into the overall economics of the Sechelt deposit in light of growing demand for industrial Garnet as a slag replacement for sand-blasting. There are many occurrences of Wollastonite but deposits of sufficient size and purity to be economically viable are rare. The Sechelt deposit appears to be economically viable as of high quality and therefore ranks among only a very few deposits of its type in the world.

Test Programs

The major Wollastonite producer in the world has done laboratory comparative tests and have successfully produced a duplicate of their best seller high aspect ratio Wollastonite with the following specifications:

96.9% passing 325 mesh(30 m) with a 91.2% brightness.

All processing was done by dry methods.

Bench scale benefication tests, being conducted by the B.C. Research Foundation, have shown that both the ease of particle (i.e. Garnet and Diopside) liberation especially at minus 48 mesh and the high degree of acicularity (aspect ratios of up to 20:1) should be anticipated. On-going high intensity magnetic separation tests as well as neutral-PH froth floatation tests will determine the overall viability of benefication. The potential to produce by-product or co-product Garnet appears favourable considering the high degree of particle liberation. Any finer grinding will only improve quality slightly but price significantly so long as a high aspect ratio is maintained.

TRI-SIL MINERALS INC.

SECHELT WOLLASTONITE PROJECT

Introduction

Tri-Sil Minerals Inc., a privately owned B.C. Company, holds title to claims, known as the Mineral Hill claim group, located in the Vancouver Mining Division, 55 Kilometres Northwest of Vancouver, B.C.. Beginning at sea-level on Sechelt Inlet the property rises West to an elevation of 460 metres. The claims include co-ordinates N 49° 31' latitude, W 123° 49' longitude on NTS map sheet 92G/12 W and cover approximately 900 hectares. Access to the property is gained via a 4-wheel-drive road located 11 km West of Sechelt, B.C. on Highway 101. On-going road work will better connect the property to Sechelt via Snake Bay Road and shorten the distance to 8 km.

Work program to date have included surface outcrop mapping to access the area distribution of the Wollastonite bearing assemlages, and an 8 hole drill program aggregating 742.3 m of drilling.

A review of the engineering report describing the above mentioned work indicates Wollastonite in varying grades is located on surface in a zone approximately 150 metres wide, by 450 metres long (and open in a Northern direction) to an average depth of 100 metres which may contain upwards of 3.7 million tonnes of Wollastonite at a conservative 20% Wollastonite grade.

Regional Geology

The property is underlain by a North-South trending Limestone skarn pendant supported by and surrounded by an underlying mass of Coast Crystalline Complex Diorite and Granodiorite.

Property Geology

Wollastonite bearing Limestone skarn occurrences have been surface mapped and are found to cover an area of some 7,000 m^2 in the centre of the claim group. Calc-silicate assemblages of Marble, Garnet, Diopside, and Wollastonite in varying proportions are common but randomly distributed.

Wollastonite grade commonly attains its maximum where it is proximal to near-vertical, East-West trending 1.0 to 2.0 metre mafic dykes that randomly cross-cut the pendant.

Box 69, Sechelt, B.C. V0N 3A0 Telephone (604) 885-9824

TRI-SIL MINERALS INC.

SECHELT WOLLASTONITE PROJECT

Property Geology (Cont'd)

Road exposures across the Wollastonite zone indicate the possibility of selectively mining high grade material found in drilling to attain thickness in excess of 10.0 metres. Drill hole 87-7, for example, reportedly contains two such zones, 12.5 m and 16.3 m thick, separated by a thin (6.5 metre) Garnet coated Andesite dyke.

Color banding representing primary bedding (?)/compositional banding is typical of the Limestone-rich, Wollastonite-poor skarns and results in a ready visual differentiation of the two.

Additional diamond drilling is required to define the Wollastonite deposit reserve that presently is conservatively estimated at 3.7 million tonnes.

TRI-SIL MINERALS INC.

WOLLASTONITE (Calcium Silicate) $CaSiO_3$

Color & Luster: Colorless, white, grayish, may have yellowish, reddish, brownish tint; vitreous, silky, streak white

Hardness: 4½-5

Cleavage: Perfect, two directions at nearly right angles.

Other Data: Specific gravity 2.8 to 2.9 fracture uneven, backly, splintery, transparent to translucent; fluorescent, brittle.

Crystals: Triclinic; usually in fibrous masses of elongated crystals; also cleavage masses, compact.

Best Field marks: Cleavage angels and mineral association.

Similar species: Cleavage angels will aid to distinguish Wollastonite from tremolite, whose cleavage angels are 56 and 125 Pectrolite is usually associated with zeolites in basalt cavities, and with silimanite in schists and gneisses.

Environment: Wollastonite is a product of both contact and regional metamorphism of impure limestones. It generally occurs with calcite and grossular in hornfels.

Occurrence: Large white crystals of Wollastonite have been found at Diana, Lewis Co., New York, and at the Crestmore Quarry near Riverside, California. Beautiful fluorescent Wollastonite has come from Franklin, Sussex Co. New Jersey. The most recent discovery is Mineral Hill, Sechelt, B.C. Also the most beautiful fluorescent Wollastonite (flesh-colored orange) associated with Garnet.

The name is after W.H. Wollaston (1766-1828), British chemist and mineralogist.

*Edited by Helene de Leeuw

Box 69, Sechelt, B.C. V0N 3A0 Telephone (604) 885-9824

TRI-SIL MINERALS INC.

We are proud to present environmentally acceptable and safe alternatives to current users of the suspect carcinogenic materials such as Asbestos, Slag-Grits, Silica Sand and other specific Construction Materials.

Because sustainable development of many community and related industrial projects require special environmental consideration, we offer:

Garnet (Grossularite - a Calcium Garnet) versus:

(A) Silica Sand - considered by the E.P.A. (Environmental Protection Agency) of the U.S.A. as environmentally hazardous product, carcinogenic.

(B) Slag - this product is made from copper smelter slag - heaps, again considered to be environmentally hazardous by he E.P.A. versus our Garnet at a similar pricing structure, offering a higher specific gravity product for lower air consumption, no free silica content low dusting qualities.

Wollastonite

A safe substitute for asbestos due to its Calcium content readily acceptable by the environment certainly not a carcinogenic threat.

Calcium Carbonate (Marble & Limestone)

An agricultural soil sweetner to improve the PH values in our soils threatened by acid contaminants. Also a safe construction material; an alternative for road-stone application reducing the danger of Silica dust exposure, common constituent of sand and gravel.

Dolomite

Again a highly treasured soil treatment only more so because of its Magnesium molecule necessary for the creation of chlorophyll (necessary to all plant life) building function within agricultural applications.

This is probably the most important environment enhancing mineral on this earth helping undo serious environmental damage to forest and other plant cover.

Box 69, Sechelt, B.C. V0N 3A0 Telephone (604) 885-9824

TRI-SIL MINERALS INC.

WOLLASTONITE

Physical and Chemical Properties

The physical and chemical properties of Wollastonite show virtually no differences from deposit to deposit. It is brittle, fibrous even in very small particles, grinds white, and is chemically inert. In comparison with most other extenders, Wollastonite shows a low water and latex adsorption in the same ratio that it shows lower oil adsorption. It is easily separated from magnetic minerals that commonly occur with it, but separated with difficulty from calcite, quartz, and non-magnetic diopside. These minerals need not be removed for certain applications of Wollastonite.

Wollastonite fires white to gray, matures at a slightly lower firing temperature than most conventional ceramic bodies and can be fired at a faster rate. It has a low firing range (cone 06 to cone 5), and certain Wollastonite bodies can be fired along with the glazes, thus eliminating second firings. Ceramic bodies that contain Wollastonite have low shrinkage values, high modulus of rupture, high thermal shock resistance, and high porosity. Wollastonite bodies can be vitrified if desired. Fired Wollastonite bodies do not warp as much conventional bodies and the fibrous structure imparts a high mechanical strength. With proper formulation of glazes, a satisfactory glaze can be obtained on high-Wollastonite bodies without the application of an ebgobe. Fire bodies that contain Wollastonite have high dielectric strength and low electrical loss.

Bonded and baked bodies that contain Wollastonite can worked with ordinary tools. The material can be sawed and drilled nearly as easily as wood and holds nails and screws well.

USES:

Many uses have been suggested both for crude and beneficated Wollastonite, and subsequent research has proved that the mineral can be used successfully in the ceramic industries, as a nonmetallic filler, and for numerous miscellaneous applications. These are mostly potential uses where acceptance will depend largely on the readiness of certain mineral-consuming concerns to use Wollastonite as a substitute for materials, some of which may not be as desirable as Wollastonite, but are less expensive. It commonly could be substituted in some of the uses to which such materials as clay, limestone, steatite, asbestos, serpentine, fibrous talc, and flint-limestone mixtures are put. **For some uses it may become a material for which no satisfactory substitute exists.**

Box 69, Sechelt, B.C. V0N 3A0 Telephone (604) 885-9824
Fax 604 885-4647

In the ceramic industry, beneficiated Wollastonite has proved satisfactory for use in floor and wall tile bodies, in porcelain fixtures, thermal insulation products, acoustical tile, frits for enamelware, glazes, dinnerware, and electrical insulator products. This is attributable principally to the light color after firing, low shrinkage values, low warping values and, for electrical products, to its low electrical loss.

As a paint extender Wollastonite is useful because it absorbs less oil than most extenders, holds pigments at lighter, has less viscous consistency and is more wettable than fibrous talc. Less absorption of oil results in savings to paint producers. he fibrous particles tend to interlock, thereby improving the toughness and durability of paint.

Wollastonite is suitable as a filler in asphalt-based floor tiles. In certain floor tiles that contain serpentine as asbestos fillers, a superior product was obtained when fibrous Wollastonite was substituted for serpentine,even when less asbestos fiber was used.

Wollastonite is used in welding rod coatings and makes an excellent white mineral wool. It has certain applications as coating and filler for paper, as an abrasive, a bond for abrasive wheels, as filler for plastics and cement, and as a filter. Bonded and baked Wollastonite products could be used for wall board and exterior sheathing.

* Edited by Helene de Leeuw

50% of these were used in the cutting of natural stone products, such as granite and marble, 40% in the construction industry for cutting of concrete and asphalt for roads and buildings, and 10% in other industries such as mining.

Garnet — a cutting edge

Garnet is very effective and efficient in several applications, particularly air blast abrasives, polishing, and water filtration. Industrial garnet of high quality is used as an abrasive powder and to manufacture coated abrasives. Lower quality garnet is used principally as hydro- or airblasting media, as well as a bedding material for water filtration equipment.

Consumption of garnet as a blasting medium has grown considerably, especially in line with the many and varied environmental laws that threaten some other abrasives. Garnet is a relatively low cost, silica free abrasive, which avoids the silicosis problem associated with silica sand blasting. Garnet is often compared with copper slag as a blasting media. Copper slag is often used as blasting media but has the inherent problem of leachable heavy metals. The US Navy uses copper and other metal slag airblasting techniques to clean its vessels. To avoid contamination in an open system, where the blasting media are not recycled and fall into the surrounding water, the Navy blends the original copper slag medium with other metal media in order to reduce the levels of contained leachable metals. However, twice as much garnet is required to achieve the same cleaning effect of slags. Garnet is also more expensive and transport costs are often higher. The rarity of garnet mines and the comparative abundance of slag sources make the relative transport costs from mine to end user unfavourable to the garnet supplier. Tonne for tonne garnet is more expensive than slags, but faster cleaning and lower consumption rates promote its competitiveness. Consequently its use as a recyclable abrasive has grown.

Hydro-jet cutting in the textile and plastics industries continue to be growing sectors for garnet. Other materials such as silicon carbide are often used as substitutes. Garnet is generally preferred because, although slightly more expensive it gives a cleaner cut and induces less wear on the spray nozzle.

Applications — cutting a dash

Several grades of garnet are available on the open market, with physical properties and sizing being of particular importance. High quality material is used for the lapping and grinding of glass, ceramics, and for coated and bonded products such as sandpaper, cloth, and abrasive wheels for grinding and finishing various metals, woods, rubber, and plastics. Lower quality material is used for cleaning and conditioning aluminium and other soft metals, particularly by aircraft and other transportation equipment manufacturers. Further applications for this grade include metal cleaning in structural steel fabrication.

Production — the top two

Production of abrasive grade garnet is dominated by Australia and the USA.

USA — and then there were three

There are three garnet producers in the USA. In the Pacific North West, *Emerald Creek Garnet Milling Co.* mines alluvial garnet deposits at Emerald Creek and Carpenter Creek, Benemah County, Idaho. Capacity is about 16,000 tpa mainly for sandblasting, non-skid applications, and water filtration. Emerald Creek Garnet's principal sales agents is *Myers Metals & Minerals* of Seattle. A further operation in New York state, in the town of Lewis, is that of the *NYCO Division of Processed Minerals Inc.*, which produces garnet as a by-product of wollastonite extraction. Current estimates of NYCO's reserves are between 1m. and 2m. tonnes. Capacity is rated at 500 short tpm with current extraction rates in the order of 200 short tpm. The company is set to expand operations this quarter and expects to increase output to near capacity. This plan will be carried out in the wake of constructing improved warehousing facilities and expanding markets. However, much of this increased output is destined for filtration markets, where Europe and south-central USA have increased demand. NYCO sells its garnet product through an agent, New Bern, North Carolina-based *International Garnet.*

Barton Mines Corp. of North Creek, New York operates a mine with capacity estimated to be about 20,000 tpa. Major markets served by the company are coated abrasives and colour television tube manufacture. *Canadian Pacific (US) Inc.*, is currently seeking a buyer for its wholly owned subsidiary, *Processed Minerals Inc.* of Syracuse, New York. Processed Minerals operates the NYCO wollastonite plant and *American Tripoli. Englehard Corp.* were involved in discussions with Canadian Pacific towards the end of last year, however the $110m. deal fell through in December for as yet undisclosed reasons. Canadian Pacific are seeking to divest itself of industrial mineral interests as they were no longer regarded as part of the core business. Thus Canadian Pacific is still seeking a buyer for its industrial mineral subsidiary.

One casualty of financial problems and land disputes is *Industrial Garnet Extractives Inc.* Operations ceased in April 1988 with a loss of 18,000 tpa to the market. The company sold primarily into the sandblasting and water filtration markets. Two mines were closed — in New York state and Rangeley in Maine. The latter plant was sold for salvage but there are no signs of a reopening of either operation. Taking up the slack in the market following Industrial Garnet's exit is *International Garnet Abrasives Inc.* which mines at Platsburgh, Clinton County.

Several preliminary investigations are being carried out in Canada on potentially garnet bearing deposits. One of the most promising sites is said to be at Crystal Peak, Vancouver.

Major US markets for garnet are abrasives and filtration media. Approximately 70–80% of output is sold into the domestic market (35% for filtration and 35–45% for abrasives), the remaining 20–30% is exported for filtration.

Production of crude garnet concentrates from 1978–1988 increased by about 11% in volume and 8% in value. For the same period, average annual production was 28,885 tonnes with a high of 42,498 tonnes in 1988 and a low of 19,265 tonnes in 1979. Consumption of garnet in the USA has been one of steady growth over the past decade with two exceptions. The years 1981 and 1984 saw 4% decreases in consumption. This downturn followed a general pattern observed throughout manufacturing industry. However the general trend has been an average growth of 8% compounded annually. New environment regulations have been responsible for this growth with garnet substituting for materials which contain leachable heavy metals and free silica.

Australia — major force

Australia is now a major producer and international supplier of garnet. *Garnet Millers Australia Pty Ltd*, a wholly-owned subsidiary of *Target Petroleum NL* mines and markets the mineral. The company has developed a garnet beach sand deposit near Port Gregory, Western Australia. A wet concentration plant is situated on the mine site, and damp garnet concentrate is trucked 100km south to either the port of Geraldton for shipment or its plant in Geraldton for further processing. Production for 1989 is estimated to be 20,000 tonnes. This compares with an output of 10,000 tonnes in 1986. The garnet is suitable for and hence sold heavily into, the following markets — powders and lapping compounds for polishing CRT glassware, single pass dry blasting media, and water filtration.

Prices have not altered over the past three years and remain at about $40 per tonne wet concentrate, FOB Geraldton, in bulk shipments and $1,000 per tonne for special products. Sales in Europe and North America are handled by London-and Toronto-based *Amalagamated Metals Corp.*, while Japan and other Asian markets are handled by *Sumitomo Corp.*

An unusual business arrangement was set up in Australia early in 1989 when US garnet producer Barton Mines and Australian operator Garnet Millers Australia Pty Ltd initiated a joint-venture company, *Garnet Millers Associates Pty Ltd*. In US markets, particularly on the east coast, Barton dominates the paper and coated abrasives market with a more round, smooth product derived from an alluvial deposit. On the west coast of the USA, however, the company has little market presence, especially for blasting products. The joint-venture agreement enables Barton to market Garnet Millers' blasting grade material and to cover eastern US markets. Meanwhile, Garnet Millers has access to Barton's paper abrasive grade products. However, the companies still compete for market share when supplying material to the polishing market.

Others – occasional entrants

India and China have extensive reserves which occasionally become available. However due to logistical difficulties and erratic quality this material has not made as much of an impact upon world markets as it might. Product from India is primarily derived from two beach sand mining operations located in the south-western area of Tamil Nadu state. Indian reserves have a reduced range and very few quantities of coarser grades. The major market for Indian product to date has been Japan. China is reported to have a large range of grades, with a predominance of the coarser grades.

World garnet capacity December 1988 *(tpa)*

Country	*Capacity*
USA	68,490
Australia	14,512
Norway	7,256
USSR	907
Turkey	635
China	18,140
India	27,210
Sri Lanka	91
Others	907
World total	133,140

Source: USBM Minerals Yearbook 1988

Values – stability rules

Prices of garnet in the USA have remained stable in the recent past. The average declared customs value per tonne in 1988 of crude garnet concentrates was $91. This compares with an average value for the period 1979–1988 off $76 per tonne. The average value was $64 per tonne in 1980 rising to a high of $93 in 1987 following a continued increase.

With the many grades of garnet supplied prices necessarily vary. Generally however, values are in the region of $240 and $472 per tonne. The average value per tonne of all grades sold in 1989 was $219, an increase of 23% over the 1987 average. An example of a price structure can be seen by looking at the five basic grades of garnet produced by NYCO (see accompanying table). Speciality grades are also produced.

NYCO garnet prices, January 1990 *(US$)*

Mesh size	*20,000–40,000 lbs*
8	200
12	200
16	200
25	190
36	195
50	200

Source: NYCO

Silicon carbide

The first recorded production of silicon carbide (SiC) was in the early 1890s, with first recorded production in 1901 at Niagara Falls, New York. It is synthesised by fusion in electric resistance furnaces, also known as Acheson furnaces, of silica and petroleum coke. Colouring varies from light green to black depending upon the quantity of trace elements present. Extensive use of the material for coated and bonded abrasives resulted from its extreme hardness combined with brittleness. Traditionally SiC has been utilised in metal and quartz finishing, sawing, and lapping.

The purest, green silicon carbide has a typical SiC content of over 99.5% and very low aluminium (<0.01%). More friable than black SiC, it breaks down on cutting to give fresh cutting edges. Black silicon carbide, containing 99% SiC, is more commonly used. Not only is it cheaper, it is also preferred in some applications because of its superior toughness. Lower purities of SiC find limited application in certain countries such as France, Italy, and Norway. Grading 98–99% SiC, this material is used for wire sawing of decorative industrial stones.

The bulk of consumption remains in the macrogrit size range, 8–220 mesh. However, microgrit production is being investigated, particularly in Europe. This market has expanded following increased demand for better finishes for certain metal parts. The price for finer grades is higher since production costs (for fine grinding) are higher than for macrogrit sizes, but competition is strong.

The last six years have seen significant changes in the silicon carbide industry, both in terms of declining market share and corporate changes. The industry has matured for several reasons. Primarily, as in the case of several other polishing and abrasive materials, a dramatic reduction in the finishing requirements of castings for heavy industries, such as in automobile manufacture, has been observed over the last ten years. Basically the foundry industry has increased efficiency and become better at making castings to near final shapes, thus reducing the amount of stock removal required in finishing. Another factor is the increasing substitution of plastics in many applications, again most notably in the automobile industry. For example, in the USA the weight of an average car fell by 573lbs over the ten year period to 1985. In that same period the use of plastic in cars increased from an average of 155lbs to 212.5lbs, whilst steel usage declined from 2,223lbs to 1,728lbs.

North America – an open and shut case

The silicon carbide industry, in common with other abrasive markets, in the early 1980s saw a decline in consumption resulting in the closure of several plants. *The Carborundum Co.* closed four plants at Vancouver, Jacksboro, Ammett, and Niagara Falls, and *Ferro Corp.* shut its one plant in Buffalo, New York.

Abrasive SiC production in North America
(tpa and $'000)

	Quantity	*Value*
1986	42,854	19,973
1987	49,521	23,128
1988	59,191	23,907

Source: USBM

However, output is now on the upswing. Starting with 43,241 tonnes in 1985 and averaging 6.5% growth per year through 1989, there is an expected growth of 8.9% in 1990 over 1989 as well as an increased demand into the 1990s of approximately 4.3% per annum. North America has seen a steady consolidation of operations over the past few years with major corporate restructuring, mergers, and capacity increases. The year 1988