000548

PROPERTY FILE

A SUMMARY REPORT

ON THE

GEOLOGY AND EXPLORATION POTENTIAL

OF THE

MINERAL HILL PROPERTY

SECHELT AREA, B.C.
NTS: 092 G / 12W

COVERING THE NONMETALLIC MINERALS

WOLLASTONITE and GARNET
with
GABBRO and CARBONATES

ON BEHALF OF

CLEARVIEW MINERAL RESOURCES CORP.

711 – 475 HOWE STREET
VANCOUVER, BRITISH COLUMBIA
V6C 2B3

BY

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AUGUST 15TH, 2002
Revised: December 11th, 2002

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To: Clearview Mineral Resources Corp.

SUMMARY

The Mineral Hill Property near Sechelt, B.C., which covers an area of approximately 1,725 hectares, is held under option by Clearview Mineral Resources Corp. The eastern side of the claims covers a favorable section of the shore of Sechelt Inlet where a barge loading facility may be located. The property has been explored for over 30 years for wollastonite, garnet, limestone, dolostone, gabbro, sand and gravel and base metals. To date, it is reported that in excess of $4 million has been spent on exploration and development.

The area is underlain by Jurassic granitic rocks of the Coast Plutonic Complex which contain roof pendants of Triassic carbonates. These carbonates have been altered to marbles and skarn along the margins of the plutonic rocks. On the Mineral Hill Property the plutonic rocks consist of gabbro, diorite and granodiorite. The skarn mineralization consists of locally developed concentrations of wollastonite and garnet within sections of calcitic marble and dolomitic marble. Late stage andesitic and basic dykes intrude the pendant units and appear to be structurally controlled.

Early stages of intensive exploration in 1987 and 1988 consisted of 1,719.54 m of diamond drilling in 24 holes, extensive road building, detailed mapping and trenching over a portion of the skarn zone. This work identified a potential resource of readily extractable wollastonite and garnet. In the wollastonite zone of the central part of the drilled area 196,580 cubic metres of "indicated reserves" were found of which 102,230 cubic metres or 52% wollastonite by volume would yield 291,000 tonnes of recovered wollastonite (Goldsmith, L.B. and Kallock, P., 1988). [Terminology used in earlier published reserve and resource estimates may not be acceptable under the currently acceptable definitions.] Calcitic and dolomitic marble sections associated with the skarn may be extracted concurrently. A diamond drill program comprising 705.33 metres in 5 holes was conducted on behalf of Clearview during February, 2002.

Exploration has also identified a fine-grained black gabbro that extends over more than 1.5 kilometres by 1 kilometre and has a vertical dimension of over 100 metres. When crushed, this material is ideally suited for use as manufactured aggregate and that is in demand for special construction applications. The potential of the gabbro presents a large resource that is easily amenable for bulk testing and sales. An untested sand and gravel resource has also been indicated on the property. Base metal sulphides have been noted in the skarn, in shear structures and disseminated in the intrusive rocks.

The Mineral Hill Property contains wollastonite-garnet and gabbro resources which warrant serious exploration, testing and development. The topography favors ready and inexpensive quarrying, while the location, close to tidewater, assures inexpensive transportation.

A two-phase, success-contingent program of exploration is proposed to further define and evaluate the wollastonite-garnet resources of the property. Phase 1 would consist of mapping, diamond drilling, collection of a bulk sample, testing and marketing studies and is estimated to cost $1,000,000. Contingent upon the success of this program, a second phase including test mining, product processing and market testing and estimated to cost $2,200,000 would be warranted. Furtherance of this phased work program is strongly recommended.

Respectfully submitted,
Sanguinetti Engineering Ltd.

per: Michael H. Sanguinetti, P.Eng.

December 11th, 2002
Vancouver, B.C.

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INTRODUCTION and TERMS of REFERENCE

This report has been written at the request of the Directors of Clearview Mineral Resources Corp. and describes the geology, work conducted and potential mineral resources of the Mineral Hill Property. The writer visited the southern claims area on August 14th, and December 19th, 2001 and on July 26th, 2002.

The property is located approximately 5 kilometres northwest of Sechelt, B.C. on the Sechelt Peninsula and is easily accessible on a network of well-maintained gravel roads. A potential marine barge loading site on the east side of the claims at Snake Bay in Sechelt Inlet could be utilized for bulk commodity shipping. The portion of the Mineral Hill Property held under option to Clearview Mineral Resources Corp. consists of fourteen claims comprising 73 units and one surveyed Mining Lease covering a net area of approximately 1,725 hectares.

The simplified geology is described as Jurassic age basic and acidic plutons which intrude and surround a series of supracrustal carbonate rocks of possible Triassic age, as a roof pendant, along the contacts of which exoskarn units have formed. The carbonates, both limestone and dolostone, have locally been altered to marbles. Later faulting provided a focus for further alteration and minor sulphide mineralization.

Industrial mineral (non-metallic) resources of potential economic values, which have been identified within this portion of the Mineral Hill Property, consist of wollastonite, grossularite garnet, gabbro, carbonates (dolostone and limestone, marble) and alluvial (glacial origin) aggregate. Wollastonite (calcium silicate) is used as a cement additive, as filler in paint and plastics, as a substitute for fine fibre asbestos and in the glass and ceramics industries. Garnet is used as an environmentally safe abrasive for sand-blasting, for polishing and as an additive in cement. Gabbro is used as dimension stone ("black granite") and as specialty crushed aggregate in building construction and road surfacing. The two carbonate rock types are used in construction, in agriculture, as dimension stone and as landscape rock.

Previous exploration has focused on the wollastonite-garnet mineralization. A 1987 and 1988 diamond drill program identified a 'drill-indicated' "resource" equivalent to 291,000 tonnes of wollastonite in the Mineral Hill zone. Significant intersections of garnetite and wollastonite were encountered in zones both north and south of this area. During 1991 – 1992 a shipment of 20,000 tonnes of crushed wollastonite-garnet mix rock was made to the Tilbury cement plant in Delta, B.C. for test use as a cement additive (Ray and Kilby, 1996).

A two phase, success-contingent exploration program is recommended to further evaluate the wollastonite and garnet occurrences on this property. Total estimated cost of this proposed work is $3,200,000.

The revised (August, 2000) and accepted definitions of the terms "reserve" and "resource" are appended (Appendix "D") to this report; previous usage of these words by other authors is in parentheses.

This report has been prepared for the exclusive use of Clearview Mineral Resources Corp. and shall not be reproduced, distributed or made available to any other persons or companies without the knowledge and / or written consent of the writer.

DISCLAIMER

This report contains references to mineral resource estimates prepared by other Professional Engineers and by previous operators of the Mineral Hill and adjoining properties. Much of the data and none of the core upon which these estimates were made were available to the writer, and these estimates cannot be verified by the writer.

LOCATION AND ACCESS

(Figures 1, 2, 4 and 6)

The Mineral Hill Property is located in the south-central part of the Sechelt Peninsula at the south end of the Caren Mountain Range approximately 5 kilometres north of the Town of Sechelt. The property is on mapsheets 92G / 12W and 92G / 05W at coordinates 49° 31' North 123° 49' West.

The property is roughly 55 kilometres northwest of the City of Vancouver. Paved highways and the B.C. Ferry system connect Vancouver with Sechelt. From Sechelt excellent access over the claims is by a network of well-maintained gravel roads constructed by Tri-Sil Minerals Inc., logging companies and Mr. Riepe

PROPERTY

(Figures 3 and 4)

The southern portion of the Mineral Hill Property controlled by Clearview Mineral Resources Corp. consists of one Mining Lease and 14 contiguous mineral claims in the Vancouver Mining Division comprising 73 units and covering a net area of approximately 1,725 hectares. With the exception of Black Granite #2 and #3 which are on Map Number 092G05W, all of the claims are on Map Number 092G12W. These are all in good standing and are held under option from Mr. Rudolph C. Riepe of Sechelt and Tri-Sil Minerals Inc. Title to claims on the north, which cover similar geology, are held by Mr. Riepe and are reportedly available for option by the company. A review of the option agreement concerning the transfers of title on this property is beyond the scope of this report.

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LOCATION MAP

MINERAL HILL PROPERTY

Sechelt Area, B.C. NTS: 92G / 12W

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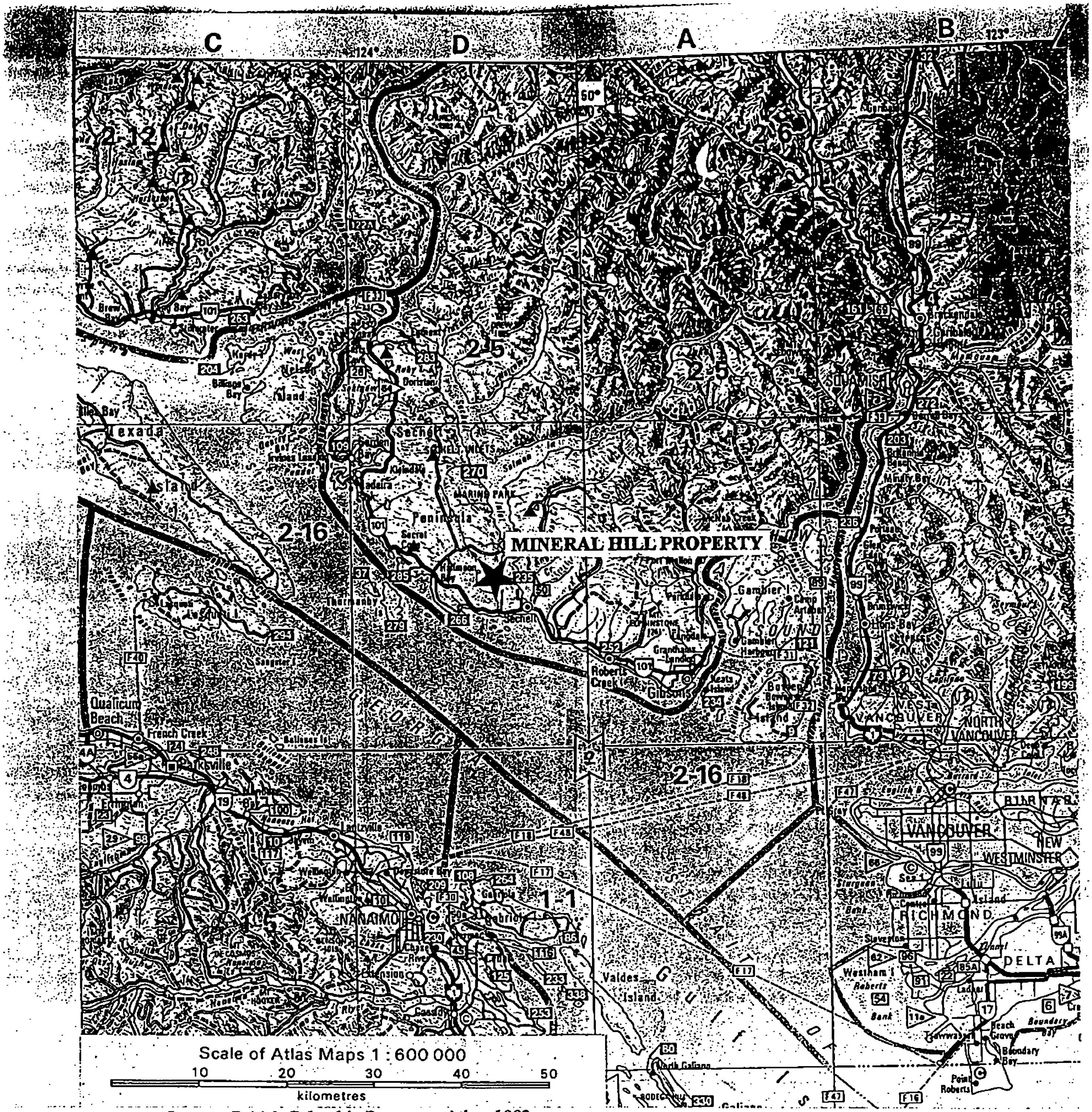
August, 2002 **FIGURE 1**



Source: British Columbia Resources Atlas, 1993.

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LOCATION and ACCESS MAP

MINERAL HILL PROPERTY

Sechelt Area, B.C. NTS: 92G / 12W

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August, 2002 **FIGURE 2**

Mineral tenures are held in the name of Clearview Mineral Resources Corp., Tri-Sil Minerals Inc. or R.C. Riepe and are recorded on the Ministry of Energy and Mines web site as follows:

Tenure No.	Claim Name	No. of Units	Status
391695	Mining Lease	82.56 Ha	2003 05 29
258386	Diorite	1	2002 12 31
258387	Alaskite	1	2002 12 31
258388	Garnetite	1	2002 12 31
315372	Black Granite #2	1	2003 12 31
315627	Black Granite #3	1	2003 12 31
325518	Krysta	1	2005 12 31
325519	Hanna	1	2005 12 31
325520	Nadine	1	2005 12 31
366933	Mineral Hill #2	18	2002 12 31
368144	Mineral Hill #1	15	2003 12 31
373870	Queen Anne	1	2002 12 31
374115	Black Granite	1	2003 12 31
384347	Mineral Point	12	2004 12 31
385352	Mineral Point #2	18	2003 12 31

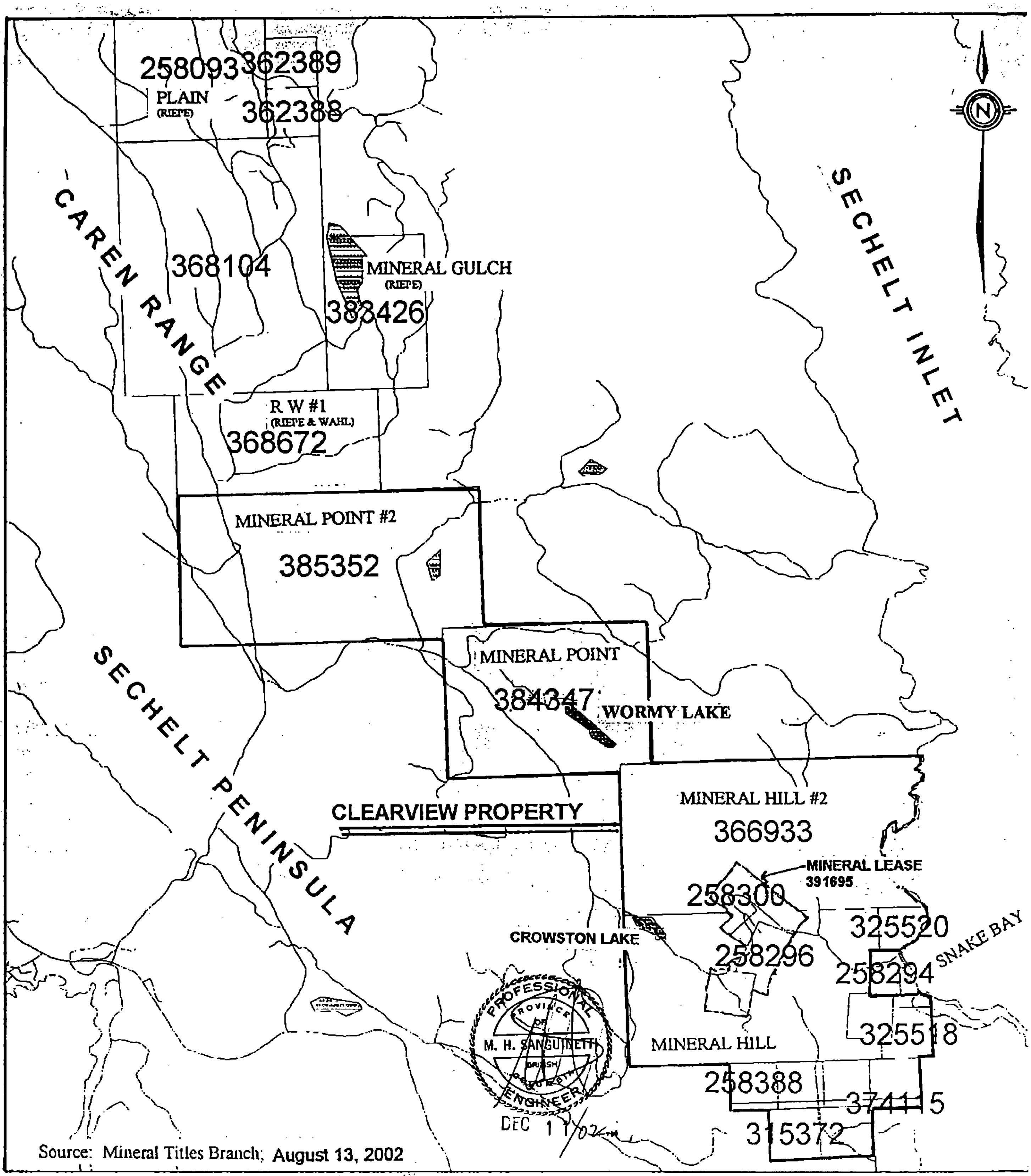
The Mining Lease (391695) is held in the name of Tri-Sil Minerals Inc. and is comprised of Reverted Crown Granted Claims Kelvin/Horley (258296), Langside/Joker/Detroit (258297), Sechelt/Success Fr. (258300), and Thorne (258301). These Lots were surveyed during 2001 and taken to mining lease on May 29, 2002. The Mineral Point and Mineral Point #2 mineral claims are held in the name of Rudolph C. Riepe; all other tenures on this group are held in the name of Clearview Mineral Resources Corp.

The expiry dates shown under the Status in the above table are abstracted from the Mineral Titles Tenure web site of the Ministry on 29 July, 2002 and reflect the filing of the 2002 diamond drilling assessment work, only a portion of which has been applied.

Work and environmental permitting has been applied for and carried out on behalf of Clearview by R. Riepe and Tri-Sil Minerals Inc. A review of these permits is beyond the scope of this report.

PHYSIOGRAPHY, VEGETATION, CLIMATE and INFRASTRUCTURE

Relief is moderate to steep with elevations ranging from sea level to 470 metres above sea level. Steep northwest trending cliffs with sharp relief of more than 50 metres occur in the central part of the claims exposing the various lithological units (Figures 4 and 6).



SCALE 1 : 50,000

1 0 1 2 3

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CLAIM MAP
MINERAL HILL PROPERTY

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FIGURE 3

(After: Wahl, H.J., 2000)

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TOPOGRAPHY

MINERAL HILL PROPERTY

Sechelt Area, B.C. **NTS: 92G / 12W**

To accompany a report by Sanguinetti Engineering Ltd.

August, 2002 **FIGURE 4**

Potential marine barge loading facilities could be constructed on Sechelt Inlet at Snake Bay or Carlson Point.

Most of the area has been logged and is covered by immature or secondary growth Douglas fir, balsam fir and cedar. Small-time active logging is ongoing. Undergrowth of alder, willows and immature conifers is locally dense. Fresh water is available from a number of small creeks and from two small lakes. The mild coastal climate permits year round access to the property except at the higher elevations where winter snow accumulations may require plowing.

The community of Sechelt is a source of labour, accommodation, communications and supplies necessary to establish a commercial operation. Industrial quality electricity, gas and municipal water lie within 1 kilometre of the southern property boundary.

HISTORY AND PREVIOUS WORK

Early work in the Sechelt Area and along the Caren Range was directed towards discovery and evaluation of base and precious metal sulphide deposits associated with Upper Triassic metavolcanic-sedimentary roof pendants which are surrounded by a variety of Jurassic plutonic rocks. Such deposits are typified by the Cambrian Chieftain Mine that produced 682 tons of copper-gold-silver bearing ore during 1949 to 1952. Numerous other occurrences within the Sechelt Peninsula, including minor showings of copper and zinc on the Clearview and Tri-Sil claims, have been mapped and sampled. The industrial mineral potentials, specifically wollastonite, garnet, gabbro, dolostone, limestone and sand and gravel, have been intermittently tested since the mid-1960's. To date, it is reported that in excess of $4 million has been spent on the exploration and development of the mineral resources of the Mineral Hill Property (Riepe, Pers. Comm., 2001).

The wollastonite potential of the Mineral Hill area was recognized by Mr. R. Riepe in 1986 and a program of mapping, trenching and road construction was started to explore this commodity. In excess of 20 kilometres of road have been built by Tri-Sil Minerals Inc. and other companies under the direction of Mr. Riepe. In 1987 and 1988 Tri-Sil commissioned Arctex Engineering Services to conduct mapping, diamond drilling and reserve estimation on an area of wollastonite-garnetite bearing skarn on the reverted Crown-Granted claims (now surveyed Mining Lease 391695) referred to as the Snake Bay deposit. In 1987 eight diamond drill holes were cored for a total of 742.38m and in 1988 an additional 16 holes totalling 977.15m were drilled. Core from this work has been vandalized and is no longer available for inspection. The percentages of wollastonite and garnet in core samples and on surface outcrops were visually estimated. While a larger percentage of garnet was recorded in the drill core, estimates were not correlated thus no resource calculations of garnet were made. Stripping and detailed geological mapping were carried out along a strike length of approximately 500 metres.

The results of this work showed that, in the wollastonite zone of the central part of the drill area, 196,580 cubic metres of "indicated reserves" were found, of which 102,230 cubic metres, or 52% wollastonite by volume, would yield 291,000 tonnes of recovered wollastonite (Murphy, K.G., 1999 and Goldsmith, L.B. and Kallock, P., 1988).

A diamond drill program on the Snake Bay deposit on Mineral Hill consisting of 705.33 metres in 5 holes was undertaken by Clearview in February, 2002. This drilling was directed to test the metallic component of the skarn along its contact area with the dioritic intrusive and to also test a portion of the previously identified wollastonite-garnet skarn. Core from this program is stored in the yard of Mr. Riepe in Sechelt. Figure 8 indicates the relative positions of the diamond drill holes on the Snake Bay deposit and Appendix "E" summarizes the statistics of the holes.

Work by provincial government geologists in 1988 detailed wollastonite mineralization approximately 2.5 kilometres north of the previously identified Snake Bay deposit which they referred to as the Wormy Lake occurrence (White, G.V., 1989). In 1991-1992 a bulk sample of 30,000 tonnes was quarried from the Snake Bay deposit and crushed. Approximately 20,000 tonnes of this mixed wollastonite-garnet rock were shipped by Tri-Sil to the Tilbury cement plant in Delta for use as a cement additive. The entire skarn area on the claims was mapped and sampled by the British Columbia Geological Survey Branch (Ray and Kilby, OF 1996-6).

Preliminary metallurgical work was conducted in 1988 by B.C. Research Council and by Bacon Donaldson and Associates. Their work centered on wollastonite identification and separation and on preliminary garnet testing respectively. A progress report by Process Research Associates on work conducted in 1993 and 1994 summarizes the processing and separation procedures and results to that time (Klein, B. and He, Y., 1984).

The "Peninsula Lime" occurrence of Mr. Riepe (Tri-Sil Minerals Inc.), located 7 miles north of Mineral Hill, was sampled and reported on by numerous geologists and engineers in the mid-1960's. In the period 1975 to 1976 Weymark Engineering commissioned B.H. Levelton and Associates to conduct engineering tests on dolomitic limestone (dolostone) samples for asphalt paving and architectural concrete and in 1980, Kaiser Resources Ltd. reported an "indicated and inferred reserve" of 117,500,000 tons (106,818,180 tonnes) of dolomitic marble (Murphy, K.G., 1999). In 1985 to 1987 Candol Developments Ltd. optioned the property from Mr. Riepe and evaluated both dolostone and the limestone potential within the calcareous rocks of this area. In 1986, after initial diamond drilling and sampling, they repeated the resource estimates of Kaiser Resources as "...a "geologic reserve" of 117,500,000 tons [*106.6 million tonnes*] of magnesium-rich dolomite, and 27,000,000 tons [*24.5 million tonnes*] of calcite ..." being indicated (Fraser, M.B., 1987). Note: Writer's conversions in italics. Also at that time, a 1986 report by Bechtel Inc. was prepared which showed a "possible resource" of more than 53.5 million tonnes of calcitic marble and 95.4 million tonnes of dolomitic marble (limestone).

GEOLOGY and DEPOSIT TYPE
(Figures 5, 6, 7 and 8)

The geology of the Sechelt Peninsula and the Mineral Hill Property in particular have been described by White, 1989 and by Ray and Kilby, 1996 of the Department of Mines and in a compilation by Murphy, 1999 for Lafarge Canada Inc. Detailed geology of the wollastonite mineralized zone was described and mapped in detail by Goldsmith, Logan and Kallock (Goldsmith, L.B., and Kallock, P., 1988). Portions of the following description are extracted from these reports.

The Sechelt Peninsula is at the southern end of the Coast Plutonic Belt. Elongate and deformed roof pendants of calcareous and metavolcanic rocks, possibly of the Upper Triassic Quatsino Formation, are surrounded by a variety of Jurassic plutonic rocks that range in composition from gabbro to granodiorite. The calcareous units have been metasomatically altered by the intrusives to calcitic and dolomitic marbles and calcareous exoskarn bearing wollastonite and grossularite garnet. Exoskarn is defined as skarn material formed by alteration within the intruded host sediments by an external or outside sourced intrusive.

Detailed mapping by Goldsmith, Logan and Kallock in 1987 and 1988 showed plastic flow in the limestones as a result of the deformation caused by regional metamorphism and the intrusion. Thin-bedded, siliceous layers have been boudinaged, brecciated and locally strung out and rotated forming augen-limestone. The augen are composed of coarse calcite, garnet, silica and garnet intergrown with wollastonite. Large (0.5m) breccia fragments of wollastonite occupy intervals within massive crystalline limestone. Banding/layering of striped maroon, green and yellowish-white coloured skarn assemblages may represent primary compositional layering. Mineral assemblages consist primarily of garnets, diopside, plagioclase +/- wollastonite +/- sulphides of Fe, Zn and Cu. The garnetite rock occurs peripheral to diorite and is dark purple, green or reddish brown in colour and composed of greater than 85% massive garnet (Goldsmith, L.B. and Kallock, P., 1988).

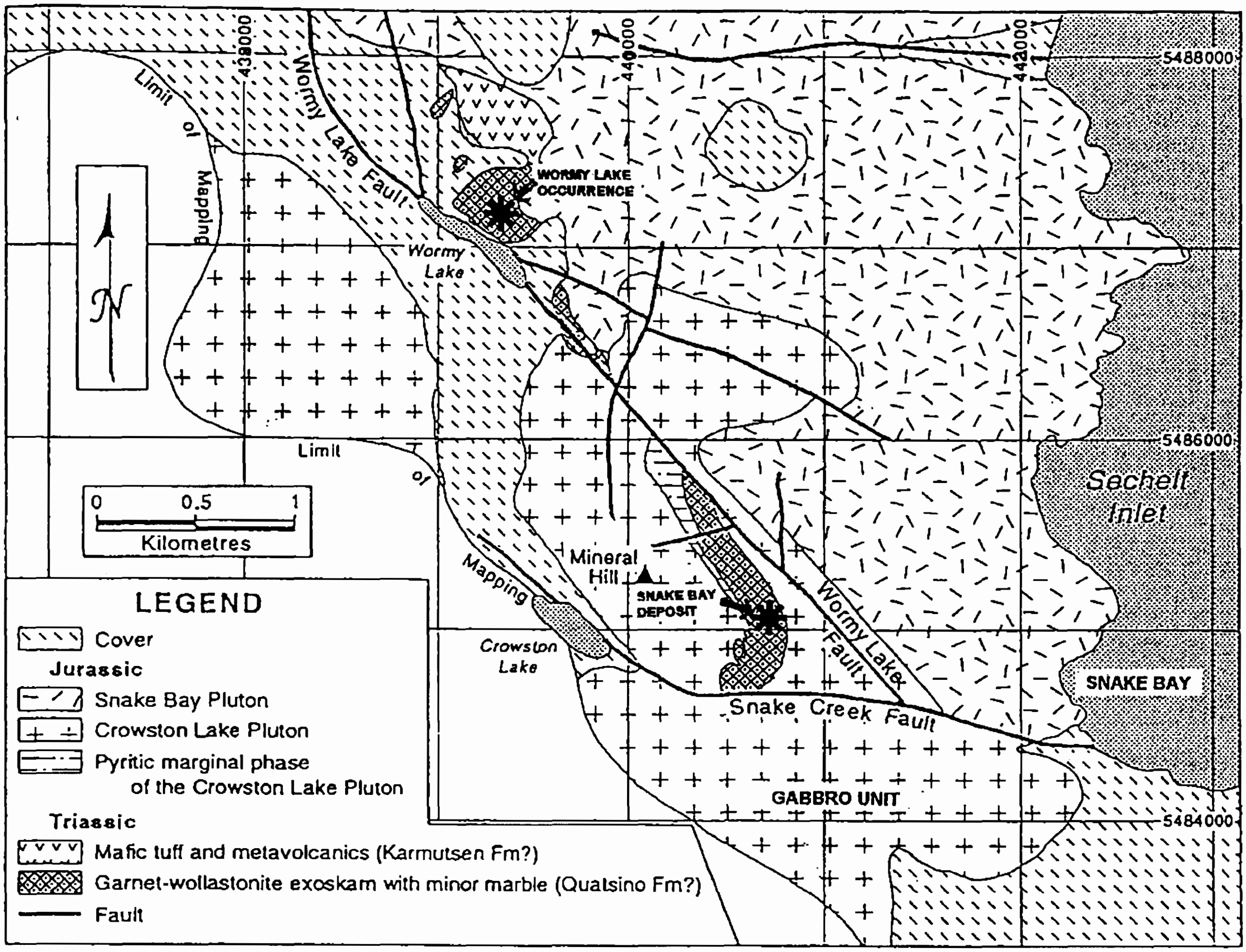
In their 1987 report, Goldsmith and Logan (1987) discuss the formation of wollastonite from limestone by addition of silica or the metamorphism of siliceous limestone:

"Wollastonite is a contact metamorphic mineral formed by metamorphism of siliceous limestone (admixed quartz) or by silica metasomatism (introduction of silica) of a pure limestone as follows:

$$CaCO_3 + SiO_2 \rightarrow CaSiO_3 + CO_2$$

Calcium Carbonate + Silica → Wollastonite + Carbon Dioxide

Laboratory investigation indicates the reaction takes place at about 500-600°C, provided the carbon dioxide can escape. Higher temperature is required if the carbon dioxide is trapped. Any calcium carbonate (calcite) remaining after all the silica has been combined into wollastonite will simply recrystallize, forming a wollastonite marble. The



Geology of the Mineral Hill - Wormy Lake area (adapted from Ray and Kilby, 1995).

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GEOLOGY of the MINERAL HILL – WORMY LAKE AREA
MINERAL HILL PROPERTY
Sechelt Area, B.C. **NTS: 92G / 12W**

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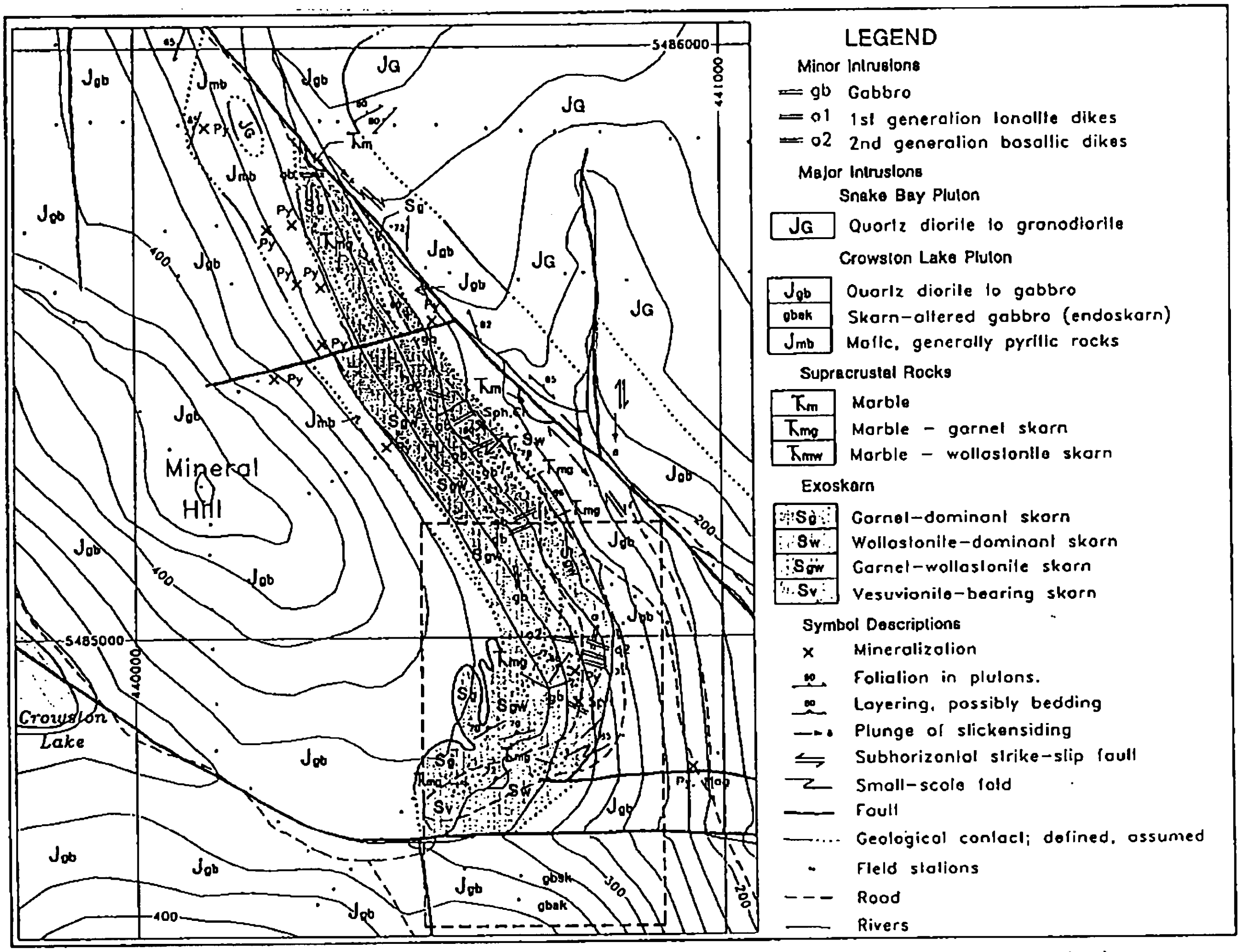
August, 2002 **FIGURE 5**

(From Ray and Kilby, 1996, OF 1996-6)



Map of the wollastonite skarn (zone 1) southeast of Mineral Hill (adapted from Ray and Kilby, 1995). Dashed box in lower right-hand corner is approximate boundary of mapping and drilling reported on by Goldsmith and Logan (1987) and Goldsmith and Kallock (1988). Mineralization includes; Py = pyrite, Sph = sphalerite, Ch = chalcopyrite, and Mag = magnetite.

(From Ray and Kilby, 1996, OF 1996-6)

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SCALE

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MAP of the WOLLASTONITE SKARN SOUTHEAST of MINERAL HILL
MINERAL HILL PROPERTY

Sechelt Area, B.C. **NTS: 92G / 12W**

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August, 2002 **FIGURE 6**

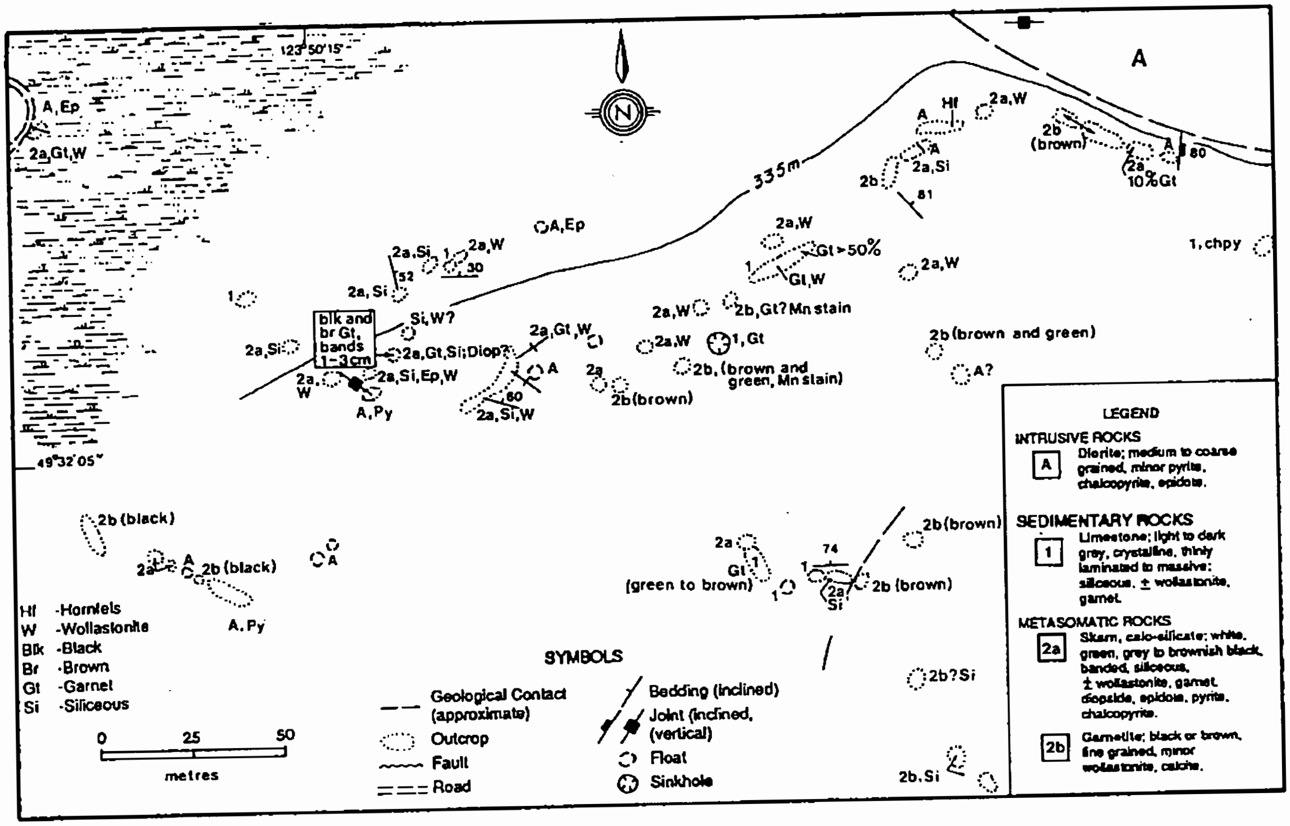

Figure 3-3-3. Wormy Lake – geological ourcrop map.

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(From White, 1989, Paper 1989-1)

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WORMY LAKE OCCURRENCE
MINERAL HILL PROPERTY

Sechelt Area, B.C. NTS: 92G / 12W

To accompany a report by Sanguinetti Engineering Ltd.

August, 2002 FIGURE 7

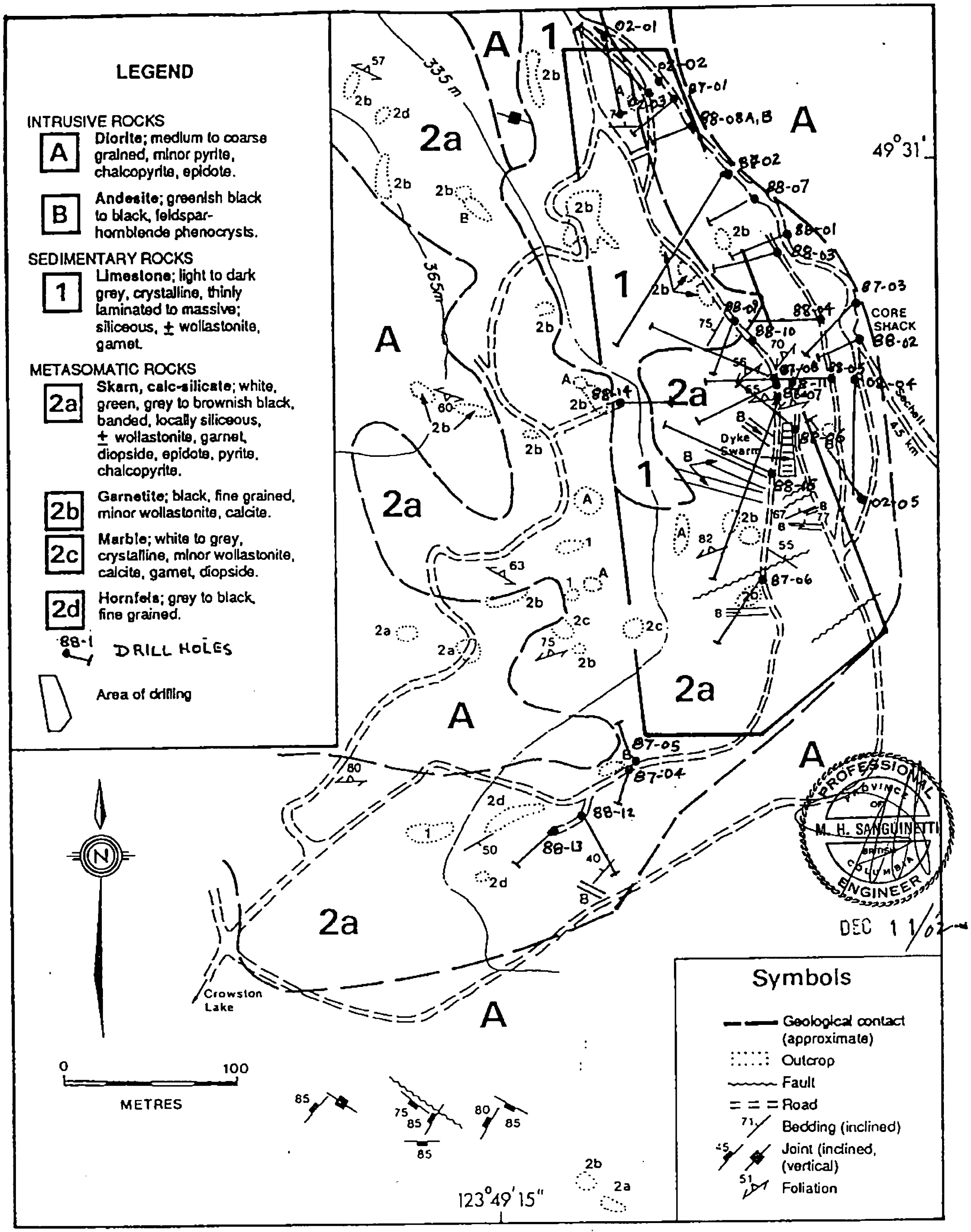

Figure 3-3-2. Snake Bay wollastonite-garnet skarn.

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GENERALIZED GEOLOGY of the SNAKE BAY DEPOSIT

(After G.V White, 1988)

Showing drill hole locations

MINERAL HILL PROPERTY

Sechelt Area, B.C. **NTS: 92G / 12W**

August, 2002 **FIGURE 8**

presence of alumina results in the formation of feldspar, garnet, or idocrase in place of wollastonite."

Two major faults, the Wormy Lake Fault and the Snake Creek Fault, as well as a number of northeast and southwest trending conjugate fault sets, have cut along and through the calcareous units producing linear zones of ductile and brittle deformation. The skarn-altered and deformed calcareous sediments form narrow, discontinuous units that lie close to and are partly controlled by the Wormy Lake Fault zone (Figures 5 and 6).

Three bodies of exoskarn material have been identified by geological mapping and trenching. Within the calc-silicate rock wollastonite and garnet occur in parallel alternating bands. The more siliceous units of calc-silicate form wollastonite and the argillaceous beds are replaced by garnet (White, 1989). The southern skarn body, which was drilled in 1987 – 1988, contains what is referred to as the Snake Bay deposit. The most northerly body, lying on the northeast side of Wormy Lake contains what is called the Wormy Lake occurrence (Figure 7). A third skarn body is exposed intermittently over 600 metres along the road between the two larger bodies (Figure 5).

Two separate Jurassic plutons lie within Mineral Hill area. The rocks of the Snake Bay Pluton are of quartz diorite to granodiorite composition. Rocks of the Crowston Lake Pluton are quartz diorite to gabbro with local sections of skarn-altered gabbro and more mafic, pyritic rocks (Figures 5, 6 and 8). It is suggested that silica from the quartz diorite may have been available to combine with the limestone to form skarn minerals in general and wollastonite in particular leaving a more basic gabbroic rock as the residual along the contact perimeter of the carbonate pendant.

Glacial deposits cover significant areas of the claims. While these have been superficially identified, the potential value of the contained sand and gravel resource has not yet been tested. Extensive sand and gravel aggregate deposits across Porpoise Bay on the east side of Sechelt Inlet are being exploited and may prove to be one of the largest aggregate deposits in production in Canada.

POTENTIAL RESOURCES: MINERALIZATION

(Figures 5, 6 and 8; Appendices "C" and "E")

The Mineral Hill Property hosts a number of potentially economic units consisting of wollastonite, garnet, gabbro (or "black granite"), calcitic and dolomitic marbles, and sand and gravel. Metallic mineralization that has been identified on the property is not discussed in this report. This mineralization consists of zinc (sphalerite), copper (chalcopyrite), gold and silver.

The potentially economic non-metallic commodities occur in the carbonate (calc-silicate) skarn zones and the adjacent mafic Crowston Lake Pluton as well as in the overlying glacial deposits. Because of their generally low unit value, mining methods and transportation are important elements in the economics of exploiting such deposits. On the Mineral Hill Property the steep relief of the topography is favorable for inexpensive quarrying of the wollastonite-garnet skarn, the gabbro and the enclosing calcitic and dolomitic marbles while the lower, gently sloping bench land is favorable for pitting the glacial sand and gravel material. The proximity of a designated marine barge loading site on the east side of the claims on Sechelt Inlet would provide a suitable inexpensive method for bulk transport of material.

Commodities which represent potential resources of the property are defined in Appendix "C" and are noted in the following paragraphs.

WOLLASTONITE

Wollastonite is a white acicular calcium silicate mineral which is used primarily as a filler in plastics, paints, rubber and other materials. It has been used as a replacement for short fibre asbestos. The addition of wollastonite to ceramic mixtures has been shown to shorten the baking time required in ovens resulting in a significant saving in fuel. As well, these additions increase the strength of the finished products. Important characteristics of wollastonite are colour, brightness, and aspect ratio (ratio between length of the crystal and its width).

The calc-silicate mineral wollastonite occurs within the northwest-southeast trending skarn body which is in contact with the gabbroic Crowston Lake Pluton and the dioritic Snake Bay Pluton (Figures 5, 6 and 8). The mineral is frequently intimately associated with grossularite garnet and is widespread throughout the skarn rocks. It has been visually estimated at grades which range from less than 0.5% to more than 80%. Wollastonite has replaced carbonate randomly and occurs in bands up to 8 centimetres wide with fibres less than 1 millimetre long (White, 1989). In local veins, wollastonite is coarser grained and fibrous with crystals to 3 centimetres. Float samples with crystals to 11 centimetres have been reported (Ray and Kilby, 1996).

In 1991 – 1992 Tri-Sil quarried 30,000 tonnes and shipped approximately 20,000 tonnes of crushed wollastonite-garnet mix material to the Tilbury cement plant in Delta, B.C. for use as a cement additive. While the results of this test shipment are not known, wollastonite additions of up to 10% reportedly improve the properties of cement (Murphy, 1999). Process testing for the separation and concentration of wollastonite was conducted in 1994. Initial results from one sample showed that a satisfactory separation and concentration of wollastonite (in the range of 90 to 97%) and garnet could be accomplished (Klein and He, 1994). Further testing is warranted.

The wollastonite-garnet bearing skarn zone extends for over 1,000 metres along strike on the southern skarn body, with an average width of approximately 200 metres. Drilling and surface exposures suggest that the skarn mineralization has a vertical depth of more than 100 metres in this central section. Detailed mapping, diamond drilling and reserve estimates were part of the work program conducted by Arctex Engineering Services in 1987 and 1988. The limits of the geologic mapping and drilling during this program extended along a strike length of approximately 500 metres and are noted on Figures 6 and 8. This work in the central part of the explored area delineated a continuous body of wollastonite mineralization. The results of the drilling described a body of 196,580 cubic metres is found within the wollastonite zone, of which 102,230 cubic metres or 52% wollastonite by volume is equivalent to 291,000 tonnes of recovered wollastonite (Goldsmith and Kallock, 1988). A favorable stripping ratio is indicated due to the steep topography. Reconnaissance diamond drilling (DDH 88-12) 250 metres southwest of the outlined deposit intersected high grade mineralization. This hole intersected a 14.63 m length of core containing an estimated 85% wollastonite within a 39.84 m length of estimated 52% wollastonite (Goldsmith and Kallock, 1988). Further mineralization north on the projected trend has been observed and mapped but not tested.

GARNET

The garnet within the Mineral Hill Property occurs primarily as fine-grained, light brown, euhedral grossularite garnet closely associated with wollastonite in the three mapped skarn zones (Figure 5). The Wormy Lake occurrence is the most northerly and is approximately 2.5 kilometres north of the Snake Bay deposit which was drilled in 1987-88. Garnet composition of rocks at the Wormy Lake occurrence is reportedly similar to that at the Snake Bay deposit, with brown to green garnet (grossularite?) forming bands up to 20 centimetres thick and a fine-grained black variety (andradite?) occurring in isolated pods and lenses of garnetite (White, 1989). Testing of samples from the Snake Bay deposit by Process Research Associates Ltd. in 1994 showed that an adequate separation of garnet and wollastonite products could be achieved (Klein and He, 1994). The fine crystalline grain size, averaging 60 to 80 mesh (0.25 – 0.18 mm), makes this material ideally suited for jet cutting industries (Tri-Sil, 1998). Smaller crystals which are liberated from the crushing and screening process are of a size widely used in the abrasives industry. Portions of the skarn are composed of banded carbonate, wollastonite and massive garnetite. This garnetite is composed of a mixture of almandine (red to orange) and andradite (purple to black) garnets with grossularite garnet. When crushed, washed and sized, this garnet material is ideal for a non free-silica sandblast medium because of its higher specific gravity (3.45 to 4.0) and angular grain shape. It is the preferred medium in the sandblasting industry since the lack of dust and free silica, as well as its recyclable characteristic, make it "environmentally friendly".

The results of detailed geological mapping, surface stripping, trenching and diamond drilling at the Snake Bay deposit show that wollastonite-garnet bearing skarn material is exposed along a north-south length of approximately 1,000 metres, across a width of 50 to 250 metres. The central part of this zone has been drill tested to a vertical depth of in excess of 100 metres. A 1998 report (Tri-Sil, 1998) described an estimate of "..2 million tonnes of grossularite (fine) garnet, … 10 million tonnes potential massive andradite garnet", however, a portion of this may be contained in the Wormy Lake occurrence and the 600 metre long skarn body lying between the two larger zones. Regardless, the ability to identify an economically significant garnet resource within the three exposed wollastonite-garnet skarn bodies could be accomplished within one field season by detailed mapping, sampling and by review of the existing results.

GABBRO ("Black Granite")
The Crowston Lake Pluton extends over a distance of almost 5 kilometres in a northwest-southeast direction with a width of 1 to 1.5 kilometres. The two rock types making up the pluton are gabbro and dioritic gabbro; descriptions of these are reproduced from the 1999 report by Murphy who reproduced them from work by Granitic Contacts Ltd. (1995).

"**Gabbro:** Fine to medium grained: black on fresh surface, weathers green-grey with dioritic texture resulting from buff-weathering feldspar and green weathering amphibole and pyroxene; weakly magnetic; 60-70% dark grey plagioclase, 30-40% ferromagnesians.
Dioritic Gabbro: Medium grained; medium to dark grey on fresh surface, weathers green grey; very similar to gabbro on weathered surface, but coarser grain size and higher feldspar content give a more dioritic texture; probably represents a gradational variation within the gabbroic intrusion."

Sulphides are rare in these units and thus the crushed materials would be suitable for concrete or asphalt (road metal) applications. The fine grain size and high specific gravity, measured at 3.2, makes the gabbro an ideal material for ballast, for a high-density road base, as airport runway aggregate and for specialty applications which require strength, weight and angularity.

Earlier quarrying operations for dimension stone resulted in the production of a small number of 20 tonne blocks, several of which are still on the property. Numerous large talus boulders and much fractured rock are present along the worked face and at the base of the exposed cliffs. This material is ideal for Nos. 1 and 2 rip-rap and for landscape rock while smaller fragments make ideal crusher feed for aggregate. There is a large volume of the gabbro which can be readily exploited. In excess of 1,500 metres along the cliff and the road at the quarry site and a vertical dimension of 100 to 150 metres is apparent. Taking into account the topography extending to the west, a block of this material 1,000 metres square by 100 metres high would yield a minimum volume of 100,000,000 cubic metres of potential pre-crushed material (Murphy, 1999 and Personal Observations, 2001).

CALCITIC MARBLE (LIMESTONE) and DOLOMITIC MARBLE (DOLOSTONE)
The deformed calcareous units of the roof pendant lie close to and are partly controlled by the Wormy Lake Fault. These units contain discontinuous but extensive marble units which are marked by surface features of karst topography. The marbles are coarse-grained, white to grey rocks that vary from massive to well-foliated and layered, they form discrete pockets within the skarn (Ray and Kilby, 1996). The calcareous units approximately10 kilometres north of Mineral Hill (Plain claim, Figure 3) are reported to be "...117,500,000 tons of magnesium-rich dolomite, and 27,000,000 tons of calcite...." (Fraser, 1987). Specimens of white, medium- to fine-grained limestone were collected by the writer from outcrops immediately adjacent to the wollastonite-garnet skarn shear. Outcroppings of massive grey and white calcitic and or dolomitic marble were noted at the both the Skidder zone and on the Wollastonite-garnet skarn zone . Stripping followed by mapping would be required to determine the surficial extent of this rock away from the exposed cliff faces. As yet no resource tonnage has been estimated for the limestone and dolostone within and adjacent to the skarn bodies on the southern half of the Mineral

Hill Property. However, where interlayered with the calc-silicate materials, these commodities would be separated out during exploitation of this unit.

SAND AND GRAVEL

Several small areas of glacial moraine material on the property were pointed out to the writer. While none were examined in detail, one area was closely observed by the writer and was examined and described by Murphy in 1999. This area is located at the southern gated access point to the property where an area of approximately 100 metres by 50 metres has been cleared on gravel. Murphy reported that "…the depth was only tested to a depth of 10 – 15 centimetres, so volume calculation would be highly speculative…" (Murphy, 1999). Detailed examination and testing are warranted.

SAMPLING METHOD AND APPROACH

Estimates of the wollastonite content in diamond drill core, in outcrop areas and in hand samples has been by visual estimates only on a percentage basis. This method was employed in all estimates done during the work by Goldsmith and Kallock as well as by government geologists.

In the area of the Snake Bay Deposit an area of over 500 metres along the north-south road with a vertical extent of approximately 50 metres was stripped and exposed prior to mapping and the mineralized outcrop was visually estimated by Goldsmith (Goldsmith and Kallock, 1988). This area was also examined by the writer. The 30,000 tonne bulk sample was mined from this area. In 1995 Tri-Sil Minerals Inc. commissioned Process Research Associates to do initial testwork on separation of eight wollastonite/garnet samples. Test results showed that on floatation tests a product of from 91.8% to 98.7% wollastonite could be produced from the crushed material passing the 16, 30 and 50 mesh screens (Klein, 1995).

No samples collected by the writer were submitted for testing or analysis by commercial laboratories.

SAMPLE PREPARATION, ANALYSES, SECURITY AND DATA VERIFICATION

The sampling procedure used by Goldsmith and Kallock was based upon the visual recognition of wollastonite in hand samples of both drill core and outcrop exposures. For purposes of their estimates they used the term "waste rock" to include material with a wollastonite content below 40%. They noted that considerable values in garnet, limestone and wollastonite were contained in sections of waste which are other than diorite.

The writer does not know the nature of any verification of this data or specific quality control measures or security procedures such as would be used on a precious metal deposit.

INTERPRETATION and CONCLUSIONS

The Mineral Hill Property contains a number of commercially exploitable industrial minerals which warrant exploration and development. Exploitation of the wollastonite and garnet skarn materials is dependent upon the results of further exploration to define the full extent of the deposit. While work to date has defined a potentially economic resource within the Snake Bay deposit, results of the 1988 drilling demonstrated that potential exists to more than double the defined quantities in the southern skarn zone. Preliminary work on the Wormy Lake occurrence suggests that wollastonite grade is at least equal that in the Snake Bay deposit. In addition, further testing is required to perfect the separation and concentration of the various components into readily saleable commodities of wollastonite and garnet. Testing of methods to separate the calcitic and dolomitic marble pods within the skarn zone by mining or by milling is warranted. Marketing studies are imperative. It is observed that in order to define a "reserve" of an industrial mineral, in addition to positive technical attributes of the commodity, a viable market for the product must exist and the product is able to be mined and sold at a profit. A sales contract is required if a "reserve" is to be defined.

The potential of the gabbro or "black granite" deposit presents an additional possible resource and one easily amenable to bulk testing. Small samples of this material have been tested by some of the major users (such as Lafarge Canada Inc.) for application in specialty aggregate situations. Airport runways, road surfacing in heavily used traffic zones and other applications which require strong, high specific gravity, angular aggregate are among the many uses for manufactured aggregate from this type of gabbro deposit. While there is a ready market for the natural boulders in the talus slopes for rip-rap and landscape rock, possibly the greatest potential for the gabbro is in use of the crushed material as specialty aggregate.

The sand and gravel resource on the property is of lesser value but should not be ignored. Testing and stripping of the indicated site at the south end of the property could be accomplished within a short time period. This material is readily saleable in both the domestic and the export markets.

The topography of the property favors ready and inexpensive quarrying of the wollastonite-garnet and gabbro commodities. The location of the property close to tidewater assures an inexpensive means of transportation of the products to markets.

RECOMMENDATIONS

A two-phase, success-contingent, exploration program is recommended to define and expand the identified wollastonite-garnet resource on the Mineral Hill Property and to investigate the economic potential of the black granite / gabbro body.

At this point in time it is strongly advised that the company concentrate and focus its efforts and funds on developing the wollastonite-garnet skarn and the gabbro body because of potential market value, risk-reward and competition factors. The costs required to initiate sampling and marketing studies of the gabbro material are significantly less than those required for the wollastonite-garnet resources.

PHASE I

The Phase I program will consist of detailed geological mapping and 1,500 m of diamond drilling to define the lateral and vertical limits of the wollastonite-garnet skarn zones in the Snake Bay deposit area and 1,000 m of diamond drilling as an initial evaluation of the Wormy Lake occurrence. A bulk sample of the various materials at the Snake Bay deposit area will be collected and tested to determine the optimum methods of separation into component products. Testing of the resultant materials will be carried out, followed by marketing research for sales of these products. Baseline environmental studies will be initiated. This work must be carefully planned and carried out under the direct supervision of qualified personnel.

Diamond Drilling: 2,500m NQWL including site preparation and reporting	$150,000
Assays and analyses (Process Research Laboratories)	75,000
Engineering, supervision and personnel	100,000
Environmental Baseline Studies and reporting	75,000
Bulk Sample	100,000
Product Research and Mineral Evaluation	150,000
Marketing Studies	200,000
Permitting, Surveys and Mapping	50,000
Contingency	100,000
Total Phase I	**$1,000,000**

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PHASE II

a). Contingent upon the success of Phase I in defining economically viable products in the Snake Bay deposit of the Mineral Hill Property, a second phase consisting of test mining, combined with product processing and market testing, would be warranted. All mining and processing is to be conducted by contractors and would use leased equipment.

b). Concurrently with the work at the Snake Bay deposit area, further drilling and sampling would be conducted at the Wormy Lake occurrence.

a) Snake Bay Area	
Mine	$300,000
Primary Processing	350,000
Secondary Processing	700,000
Miscellaneous	100,000
Engineering and Civil Works	150,000
Operating Capital	300,000
Contingency	100,000
Sub Total	**$2,000,000**
b) Wormy Lake Area	
Diamond drilling and mapping: 1,500 metres NQWL	$100,000
Surveys and mapping, engineering	100,000
Sub Total	**$200,000**
Total Phase II	**$2,200,000**
TOTAL PROPOSED PHASES I & II PROGRAM	**$3,200,000**

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APPENDIX "A i"

WRITER'S CERTIFICATE and DISCLAIMER

I, Michael H. Sanguinetti, P. Eng., of West Vancouver, British Columbia, hereby certify that:

1. I am a geologist residing at 5479 Keith Road and employed by Sanguinetti Engineering Ltd. of #429 – 470 Granville Street, Vancouver, British Columbia.

2. I am a graduate of the University of British Columbia with a Bachelor of Science degree in geology in 1965 and I have practiced my profession continuously since 1965.

3. I am a member of the Association of Professional Engineers and Geoscientists of the Province of British Columbia.

4. Since 1962 I have been involved in mineral exploration for base and precious metals; graphite, wollastonite, diamonds, barite and evaluations for aggregate and dimension stone. I have been involved in testing, evaluation and supervision of alluvial gold and diamond projects. I have conducted this work in British Columbia, Yukon, Northwest Territories, Nunavut, Ontario, Manitoba, Quebec, western states of the U.S.A., Mexico, Central America, Venezuela, Bolivia and Peru.

5. I am presently a Consulting Geologist and have been so since March, 1973.

6. As a result of my experience and qualification I am a Qualified Person as defined in National Instrument 43-101.

7. I am the author of this report and my compensation for this report is strictly on a professional fee basis.

8. I visited the Mineral Hill Property of Clearview Mineral Resources Corp. and examined the mineralized showings in the Snake Bay deposit area and gabbro, on August 14th, 2001, December 19th, 2001 and July 26th, 2002; prior to the date of this first visit I had no involvement with the property.

9. I have no personal interest, direct or indirect, in the Mineral Hill Property, in the property ownership or in the securities of Clearview Mineral Resources Corp., nor do I expect to receive such interest. I am independent of Clearview Mineral Resources Corp. in accordance with the application of Section 1.5 of National Instrument 43-101.

10. I have read National Instrument 43-101, Form 43-101F1 and this report has been prepared in compliance with NI 43-101 and Form 43-101F1.

11. I hereby grant Clearview Mineral Resources Corp. permission to use this report in support of documents submitted to the British Columbia Securities Commission, the Alberta Securities Commission and the TSX Venture Exchange or for other corporate purposes in accordance with applicable government regulations. Written excerpts may be quoted from this report provided no statements are taken out of context and are approved by the author in writing as required by securities regulations.

12. I am not aware of any material fact or material change with respect to the subject matter of this technical report which is not reflected in this report, the omission to disclose which would make this report misleading.

Dated at Vancouver, British Columbia, this 11th day of December, 2002.

SANGUINETTI ENGINEERING LTD.

Michael H. Sanguinetti, P. Eng.
Reg. No. 8805 Association of Professional Engineers and Geoscientists of the Province of British Columbia

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APPENDIX "B"

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APPENDIX "C"

Mineral Definitions
(Data from U.S. Geological Survey)

1. Wollastonite.

2. Industrial Garnet.

3. Stone, Crushed. This includes Granite (gabbro), Limestone, Dolomite and Marble.

4. Sand and Gravel (Construction).

WOLLASTONITE

By Robert L. Virta

Domestic survey data were prepared by Raymond I. Eldridge III, statistical assistant.

Wollastonite, a calcium metasilicate ($CaSiO_3$), has a theoretical composition of 48.3% calcium oxide and 51.7% silicon dioxide but may contain trace to minor amounts of aluminum, iron, magnesium, manganese, potassium, and sodium. It occurs as prismatic crystals that break into massive-to-acicular fragments. It is usually white, but also may be gray, brown, or red depending on its composition.

Wollastonite forms when impure limestones are metamorphosed (subjected to heat and pressure) or silica-bearing fluids are introduced into calcareous sediments during metamorphic processes. In both cases, calcite reacts with silica to produce wollastonite and carbon dioxide. Wollastonite also can crystallize directly from a magma that has an unusually high carbon content, but this is a more rare occurrence.

Deposits of wollastonite have been found in Arizona, California, Idaho, Nevada, New Mexico, New York, and Utah. These deposits also may contain calcite, diopside, garnet, idocrase, and quartz as minor components.

Wollastonite is used primarily in ceramics, friction products (brakes and clutches), metallurgy, paint, and plastics. Some of the properties that make it so useful are its high brightness and whiteness, low moisture and oil absorption, low volatile content, and the acicular nature of some wollastonite.

Production

Wollastonite has been mined commercially in California and New York. The California deposits, which are in Inyo, Kern, and Riverside Counties, were mined between 1930 and 1970. These operations were limited in size, producing only a few thousand metric tons per year for ceramics, decorative stone, paint, and mineral wool production.

Wollastonite deposits in New York have been mined for more than 50 years. Two companies currently are mining wollastonite: NYCO Minerals Inc., a subsidiary of Fording Inc., operates a mine in Essex County, and R.T. Vanderbilt Co. Inc. operates a mine in Lewis County. The NYCO Minerals deposit contains wollastonite, garnet, and diopside. Parts of the deposit are composed of up to 60% wollastonite. The ore is processed at the Willsboro plant where the garnet is removed by using high-intensity magnetic separators. NYCO also chemically modifies the surfaces of some of its wollastonite products to improve their performance. The R.T. Vanderbilt deposit in Lewis County consists primarily of wollastonite, minor amounts of calcite and prehnite, and trace amounts of diopside. The ore is processed at its Balmat plant where it is milled and air classified.

Domestic wollastonite production decreased from that of 1999. Much of the decrease occurred because NYCO Minerals began supplying powder-grade wollastonite to some of its North American customers from its operation in Sonora, Mexico, instead of its New York operation. This change permitted the company's New York operation to effectively increase its capacity for its higher value products and made better use of the company's ore reserves. Additionally, NYCO Minerals added a stirred-media grinding mill and new magnetic separators to its

Wollastonite in the 20th Century

Domestic mining of wollastonite has had a rather short history compared to many other mineral commodities. There was essentially no commercial mining of wollastonite in 1900. Small scale mining did not begin until the 1930s, and annual production was only on the order of a few thousand tons. Weathered wollastonite that looks like petrified wood was a popular product for landscaping. Wollastonite also was sold to the ceramics, mineral wool, and paint industries in small quantities. This level of production continued through the 1950s with all domestic production occurring in California. In the 1950s, a large wollastonite deposit was developed in New York, and large-scale production of wollastonite began in the United States. The high demand for housing following World War II resulted in the expansion of construction-related markets and provided a ready outlet for the increased production capacities. By 1960, U.S. wollastonite production and sales were about 35,000 metric tons; ceramics and paints were the major markets.

In 2000, production was estimated to be about 130,000 tons. Between 1960 and 1990, production and sales of wollastonite increased steadily as ceramic and paint markets expanded. Wollastonite sales also received a boost when the debate over the health risks posed by asbestos intensified during the 1970s and early 1980s. It was during this time that asbestos substitute markets, for which wollastonite was well suited, opened up. By 1990, production was estimated to be about 110,000 tons. In 2000, plastics comprised an estimated 37% of wollastonite sales, followed by ceramics (28%), metallurgical applications (10%), paint (10%), friction products (9%), and other applications (6%). Some other applications for wollastonite were abrasive wheel bond, adhesives, joint compounds, refractories, rubber filler, and welding rods. Wollastonite has been used as an asbestos substitute in such products as floor tiles, friction products, insulating board and panels, paint, plastics, and roofing products.

Willsboro plant and began pilot studies for pelletizing wollastonite fines (Fording Inc., 2000, p. 26-28). Although data collected by the U.S. Geological Survey are withheld to avoid revealing proprietary information, U.S. production was estimated to be on the order of 130,000 metric tons per year (t/yr) (Rieger, 2000).

Consumption

The use of wollastonite in the United States declined slightly from that of 1999. Sales probably were slightly lower for ceramic, metallurgy, and paint applications. Plastics markets, however, appear to have remained strong.

Major domestic uses of wollastonite were in plastics (37%), ceramics (28%), metallurgy (10%), paint (10%), friction products (9%), and miscellaneous (6%) (Industrial Minerals, 1999). Wollastonite also was used in adhesives, joint compounds, refractories, rubber, and wallboard applications.

In ceramics, wollastonite decreases shrinkage and gas evolution during firing, increases green and fired strength, permits fast firing, and reduces crazing, cracking, and glaze defects. In metallurgical applications, wollastonite serves as a flux for welding and to protect the surface of the molten metal during the continuous casting of steel. As a filler in paint, it reinforces the paint film, acts as a pH buffer, improves its resistance to weathering, reduces pigment consumption, and acts as a flatting and suspending agent. In plastics, it improves tensile and flexural strength, reduces resin consumption, and improves thermal and dimensional stability at elevated temperatures. Surface treatments are used to improve the adhesion between the wollastonite and the polymers to which it is added. As a substitute for asbestos in floor tiles, friction products, insulating board and panels, paint, plastics, and roofing products, wollastonite is resistant to chemical attack, inert, stable at high temperatures, and a good reinforcer.

Prices

Prices per metric ton for domestically produced acicular wollastonite, ex-works, were $209 for 200 mesh, $258 for 325 mesh, and $284 for 400 mesh. The price per ton, ex-works, for acicular, high-aspect-ratio wollastonite was $351 and for ground (10-micrometer) wollastonite was $694. Prices per ton for wollastonite, free on board, in bulk, were $209 for 200 mesh and $253 for 325 mesh (Industrial Minerals, 2000). Quoted prices should be used only as a guideline because actual prices depend on the terms of the contract between the seller and the buyer.

Foreign Trade

Foreign trade data were not available from the U.S. Census Bureau for wollastonite. Imports previously were estimated to be between 2,500 t and 5,000 t. The revised estimate is between 10,000 t and 12,000 t, mainly because NYCO Minerals began supplying some of its North American customers from its operation in Mexico. Imports from China also were believed to have increased in 2000 compared with those of 1999. Most of the imports are thought to be lower-value wollastonite grades. Some wollastonite also was imported from Finland and India. Exports were estimated to be between 5,000 t and 8,000 t in 2000.

World Review

Worldwide production of wollastonite was estimated to be between 500,000 t and 550,000 t in 2000. China again was an unknown factor with regard to wollastonite production and sales. Production estimates for China typically have been in the 200,000-t/yr to 300,000-t/yr range. One source estimated exports from China to be between 100,000 t/yr and 150,000 t/yr and domestic consumption to be 100,000 t/yr, placing production in the 200,000-t/yr to 250,000-t/yr range (Roskill Information Services Ltd., 1996, p. 18). Production for Finland, India, and Mexico was estimated to be 20,000 t, 100,000 t, and 75,000 t, respectively. With the closure of the only Canadian producer, production from Canada was estimated to be at most a few hundred tons. Small tonnages probably also were produced in Chile (reported as 270 t in 1996), Namibia (reported as 347 t in 1999), North Korea, Pakistan, South Africa (reported as 200 t in 1999), and Turkey.

Canada.—The board of directors of Orleans Resources Inc. suspended production at the Lac St.-Jean plant in July 2000. A build-up of inventory, the company's financial situation, and lack of a partner prompted the action. The company planned to meet client needs from inventory (Orleans Resources Inc., 2000). Orleans Resources also hired the consulting firm KPMG International to locate a business partner for Orleans or conduct a sale of the company's assets (North American Minerals News, 2000).

Outlook

The decline of the U.S. economy, which began in 2000, probably will continue to hamper sales in the United States, causing a stagnation or slight decline in sales and consumption. Markets most likely to be affected will be in ceramics, metallurgy, and paint. Sales for friction products also may decline slightly. Decreases such as these would be expected during an economic slowdown with associated downturns in housing starts (ceramic and paint markets), automobile sales (friction products), and steel output (metallurgical applications). The most promising market is plastics; sales should increase in the coming years. Despite economic slowdowns faced by some other countries, worldwide sales of wollastonite should increase slightly as more durable goods are required for growing populations.

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INDUSTRIAL GARNET

By Donald W. Olson

Domestic survey data and tables were prepared by Christine Pisut, statistical assistant.

The angular fractures and high hardness of garnet and its ability to be recycled make it desirable for a variety of abrasive purposes. The complex mineralogy of garnet determines its utility for a variety of uses ranging from a filtration medium to a waterjet abrasive.

Garnet is the general name for a group of complex silicate minerals with similar crystalline structures and diverse chemical compositions. The general chemical formula is $A_3B_2(SiO_4)_3$, where "A" can be calcium, magnesium, ferrous iron, or manganese, and "B" can be aluminum, chromium, ferric iron, or rarely, titanium. Garnet occurs worldwide in many rock types, principally gneisses and schists; other sources include contact metamorphic rocks, crystalline limestones, pegmatites, and serpentinites. Alluvial garnet is associated with heavy mineral sand and gravel deposits in many parts of the world. Occurrences of garnet are large and numerous; however, relatively few commercially viable garnet deposits have been discovered.

Mine output of industrial garnet in the United States decreased slightly in 2000 compared with that of 1999, while the value of U.S. industrial garnet production increased by about 14% over that of 1999. The one mining operation in the United States that had closed down in 1999 was purchased during 2000 and began producing from stocks.

Production

The U.S. industrial garnet industry is dominated by a few major producers. The industrial garnet market is influenced by the size and grade of reserves, the type and quality of garnet mined, the proximity of deposits to infrastructure and consumers, and the milling costs. Pricing within the U.S. garnet industry is very competitive, and suppliers must provide a high level of customer service. Most industrial-grade garnet mined in the United States is almandine (iron-aluminum silicate) and pyrope (magnesium-aluminum silicate), although andradite (calcium-iron silicate) is also a domestic source for industrial uses.

The United States produced approximately 20% of the industrial garnet mined worldwide in 2000. According to a survey conducted by the U.S. Geological Survey (USGS), five U.S. companies in Idaho, Montana, and New York accounted for all domestic output. Production decreased slightly to 60,200 metric tons (t), whereas the value of the annual production grew by 14% to about $7.1 million in 2000 (table 1). The producers were Barton Mines Co. LLC in Warren County, NY; Emerald Creek Garnet Co. in Benewah County, ID; Montana-Oregon Investment Group LLC in Madison County, MT; NYCO Minerals, Inc. in Essex County, NY; Patterson Materials Corp. in Dutchess County, NY; and Sweetwater Garnet Inc. in

Industrial Garnet in the 20th Century

Garnet is mined as a gemstone and an industrial material, but it is valued primarily for its many industrial applications. The United States developed substantial garnet abrasive technology and applications earlier than other countries mainly because of the large deposits of high-quality abrasive garnet in New York. The deposits were first commercially developed in 1878. In 1900, annual production of industrial garnet in the United States was about 2,890 metric tons valued at about $123,000. Production was primarily in Maine, New York, North Carolina, Pennsylvania, and Virginia. There are no data to indicate that the United States had any foreign trade in industrial garnet in 1900. The price at the mine varied from $25 to $60 per ton. The main use for industrial garnet was in the sandpaper industry. At the end of World War II in 1945, U.S. industrial garnet production and consumption began a steady rise that roughly paralleled the rise in new home starts. The most significant jump in U.S. garnet production and consumption began in 1987, when health risks were first associated with the inhalation of airborne crystalline silica dust, and garnet began to replace crystalline silica as a sand blasting medium.

In 2000, domestic crude garnet production was estimated to be 60,200 tons, with an estimated value of more than $7 million; the value of refined garnet material was estimated to be $14 million. Garnet for industrial use was mined in 2000 by five firms: three in New York, one in Idaho, and one in Montana. In 2000, U.S. imports and exports of industrial garnet were about 23,000 tons and 10,000 tons, respectively. Imports were mostly from Australia, India, and China. Domestic consumption of garnet was estimated to be about 25,000 tons. Values for crude concentrates ranged from about $53 to $254 per ton, and values for refined garnet ranged from $61 to $441 per ton. By the end of the 20th century, major end uses for industrial garnet in the United States were abrasive sand blasting media, filtration media, precision abrasive powders, waterjet abrasives, and other miscellaneous abrasive uses, ranging from nonskid surfaces to finishing of plastic and wood products. In 2000, industrial garnet was still gradually displacing crystalline silica sand in the blast cleaning market, due to the health risks associated with the use of crystalline silica and due to garnet's ability to be recycled for reuse several times.

Madison County, MT. All but one of the producers reported their output and sales to the USGS, and production and values for the nonreporting company were estimated. In addition to the producers cited above, International Garnet Abrasive Inc. in Clinton County, NY, processed and sold all of the garnet mined by NYCO Minerals in 2000.

Sweetwater Garnet, which had shut down in 1999, was sold in July 2000 to Stansbury Holdings Corporation. In the fall of 2000, Stansbury resumed operations at Sweetwater after upgrading the mill and was producing from stocks.

Consumption

The United States was the world's largest consumer of industrial garnet, accounting for 20% to 25% of global consumption (Harris, 2000). In 2000, the U.S. apparent consumption of industrial garnet was estimated to be 25,400 t, which was a 45% decrease from the 1999 apparent consumption. This apparent consumption decrease was due to a 75% increase in U.S. producer stocks. Most of these stocks were concentrated in two of the U.S. industry's five producers.

Major end uses in the United States and their estimated market share were abrasive blasting media, 45%; water filtration, 15%; abrasive powders, 10%; waterjet cutting, 10%; and other miscellaneous abrasive uses, 20%. Domestic consumption approximated world demand patterns, except that filtration uses abroad accounted for a greater market share. U.S. industries that consumed industrial garnet included aircraft manufacturers, ceramics and glass producers, electronic component manufacturers, motor vehicle manufacturers, the petroleum industry, shipbuilders, water filtration plants, and wood-furniture-finishing operations.

The majority of industrial garnet is used as a loose-grain abrasive because of its hardness, which ranges from 6 to 7.5 on the Mohs scale. Lower-quality industrial garnet is used as a filtration medium in water-purification systems because of its relative inertness and chemical degradation resistance. High-quality, high-value garnet grain has been used principally for such applications as optical lens grinding and plate-glass grinding for more than a century; industrial diamond and fused aluminum oxide are competitors in this application. In recent years, industrial garnet powders have been used for high-quality, scratch-free lapping of semiconductor materials and other metals. Other applications include the manufacture of coated abrasives; hydrocutting; and the finishing of wood, leather, hard rubber, felt, and plastics. Garnet has been slowly replacing silica sand in the blast cleaning market. This market displacement is happening because of the health risks associated with the inhalation of airborne crystalline silica dust having curtailed its use, but silica sand and slag are still the most widely used media in blasting (Harris, 2000).

The U.S. petroleum industry is one of the largest garnet-consuming industries, using garnet for cleaning drill pipes and well casings. Huge crude oil price increases during 2000 allowed for the performance of previously deferred equipment maintenance activities and increased the petroleum industry's use of industrial garnet (Frank Alsobrook, President, Alsobrook and Company, Inc., oral commun., November 8, 2000).

The shipbuilding and aluminum aircraft industries use garnet for blast cleaning and for finishing metal surfaces. Similar uses include the cleaning and conditioning of aluminum and other soft metals, as well as metal cleaning by structural steel fabrication shops. Mixed-media water filtration, using a mixture of sand, anthracite, and garnet, has displaced older filtration methods because it is more reliable and provides better water quality; ilmenite, magnetite, and plastics compete as filtration media. Garnet entrained in high-pressure streams of water is also used to cut many different materials. The garnet powders generally are used for glass/ceramic polishes, antislip paints, and antiskid surfaces.

In the coated-abrasive market, garnet has an intermediate place between low-cost quartz sand or staurolite and such more costly manufactured abrasives as silicon carbide and fused alumina; garnet is more efficient than quartz sand in most coated-abrasive applications. Because of its friable nature and lower hardness, garnet cannot compete with manufactured abrasives in metalworking applications that require substantial metal removal.

Prices

The wide price range of industrial garnet was based on the type, source, quantity purchased, quality, and application. In 2000, average values for crude concentrates ranged from about $53 to $254 per ton, and average values for refined garnet sold during the year ranged from $61 to $265 per ton. However, spot prices reached as high as $441 per ton. Quantities sold by U.S. producers increased by approximately 17%, and the value of sales increased by about 21% during 2000.

Foreign Trade

The U.S. Government no longer compiles trade data that can be used to identify garnet exports and imports specifically. Based on reports from some producers and other industry sources, however, exports and imports of industrial garnet were estimated to be about 10,000 t and 23,000 t, respectively, in 2000. Some of the imports were not consumed during the year. Most U.S. garnet exports went to Asian and European markets.

About 40% to 45% of the U.S. garnet imports were from Australia, 35% to 40% from India, and 15% from China (Frank Alsobrook, President, Alsobrook and Company, Inc., oral commun., November 8, 2000). Australia historically has accounted for most of the industrial garnet imported by the United States. Imports of garnet from India are increasing, and both China and India have the potential to gain a significant share of the U.S. market (Frank Alsobrook, President, Alsobrook and Company, Inc., oral commun., November 8, 2000).

World Review

Total world industrial garnet production was estimated to be 335,000 t (Roskill Information Services Ltd., 2000). Australia, China, India, and the United States were the most significant producers in 2000. The United States produced approximately 20% of the industrial garnet mined worldwide. Australia and India exceeded U.S. production. Russia and Turkey have been mining garnet in recent years, primarily for domestic markets. Additional garnet resources with small mining operations are located in Canada, Chile, the Czech Republic, Pakistan, South Africa, Spain, Thailand, and Ukraine. Output in most of these countries is for domestic use (Frank Alsobrook, President, Alsobrook and Company, Inc., oral commun., November 8, 2000).

Australian exports of garnet are expected to continue to increase. China and India also have increased garnet output and are likely to become more significant garnet sources for other countries.

Outlook

Industrial garnet sold by U.S. producers increased by about 17% during 2000, and some forecasts indicate that domestic markets for industrial garnet may continue to grow in the next several years. Worldwide industrial garnet demand is expected to grow over the next 5 years at a rate of 3% to 5% per year. Markets for waterjet cutting and blasting media are expected to exhibit the highest growth (Roskill Information Services Ltd., 2000). With recent worldwide increases in petroleum prices, there has been an increase in petroleum exploration and in the use of garnet blasting media for cleaning drill pipe by the oil and gas industry. Increased defense spending in the United States could lead to increased garnet demand, since the aircraft manufacturing and shipbuilding industries use significant amounts for blast cleaning and finishing of metal surfaces. Substitution for silica sand by garnet in abrasive blasting markets will also continue but at a pace slower than expected by the most optimistic forecasts because silica sand has a price advantage and is more accessible to consumers. Growing world demand encourages new companies to enter the garnet industry, but the current major producers will continue to be the dominant suppliers in the first decade of the 21st century.

Increased producer stocks are being reported in the United States, and significant stocks of industrial garnet are held in Australia and India. These excess production stocks coupled with possible future expansions will not only meet anticipated market needs, but may also result in widespread garnet price decreases until supply and demand come into balance.

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TABLE 1
SALIENT U.S. INDUSTRIAL GARNET STATISTICS 1/

	Crude production		Sold or used 2/	
Year	Quantity (metric tons)	Value (thousands)	Quantity (metric tons)	Value (thousands)
1996	60,900	$5,630	46,200	$11,200
1997	64,900	6,050	53,600	12,500
1998	74,000	7,070	51,900	12,600
1999	60,700	6,170	43,900	11,600
2000	60,200	7,060	51,300	14,000

1/ Data are rounded to no more than three significant digits.
2/ May exclude some unreported exports.

GARNET, INDUSTRIAL

Events, Trends, and Issues: During 2000, U.S. garnet consumption grew significantly; demand was met by imports and by sales of producer stocks. Sweetwater Garnet, Inc. shut down in 1999 and continued to be offered for sale in 2000. The sale of the Cominco American Mine to Montana-Oregon Investment Group LLC took effect December 31, 1999, and the name was changed to the Ruby Garnet Mine. Although U.S. producer sales increased only slightly during 2000, some forecasts indicate that domestic and foreign markets for industrial garnet may continue to grow in the next several years. Markets for waterjet cutting and blasting media are expected to exhibit the highest demand. With the worldwide increases in petroleum prices, there has been an increase in the use of garnet for cleaning drillpipe by the oil and gas industry. China has now joined Australia and India as an important garnet exporter.

World Mine Production, Reserves, and Reserve Base:

	Mine production		Reserves[4]	Reserve base[4]
	1999	2000[e]		
United States	60,700	50,000	5,000,000	25,000,000
Australia	116,000	125,000	1,000,000	7,000,000
China	20,000	25,000	Moderate to Large	Moderate to Large
India	55,000	60,000	500,000	20,000,000
Other countries	20,300	30,000	6,500,000	20,000,000
World total (rounded)	272,000	290,000	Moderate	Large

World Resources: World resources of garnet are large and occur in a wide variety of rocks, particularly gneisses and schists. Garnet also occurs as contact-metamorphic deposits in crystalline limestones, pegmatites, serpentinites, and vein deposits. In addition, alluvial garnet is present in many heavy mineral sand and gravel deposits throughout the world. Large domestic resources of garnet also are concentrated in coarsely crystalline gneiss near North Creek, NY, and other significant domestic resources of garnet occur in Idaho, Maine, Montana, New Hampshire, North Carolina, and Oregon. In addition to the United States, major garnet deposits exist in Australia, China, and India, where they are mined for foreign and domestic markets; deposits in Russia and Turkey also have been mined in recent years, primarily for internal markets. Additional garnet resources are located in Canada, Chile, Czech Republic, Pakistan, South Africa, Spain, Thailand, and Ukraine; small mining operations have been reported in most of these areas.

Substitutes: Other natural and manufactured abrasives can substitute to some extent for all major end uses of garnet. In many cases, however, the substitutes would entail sacrifices in quality or cost. Fused aluminum oxide and staurolite compete with garnet as a sandblasting material. Ilmenite, magnetite, and plastics compete as filtration media. Diamond, corundum, and fused aluminum oxide compete for lens grinding and for many lapping operations. Emery is a substitute in nonskid surfaces. Finally, quartz sand, silicon carbide, and fused aluminum oxide compete for the finishing of plastics, wood furniture, and other products.

[e]Estimated. E Net exporter.
[1]Excludes gem and synthetic garnet.
[2]Includes both crude and refined garnet; most crude concentrate is $50 to $100 per ton, and most refined material is $150 to $400 per ton.
[3]Defined as imports - exports + adjustments for industry stock changes.
[4]See Appendix C for definitions.

STONE, CRUSHED

By Valentin V. Tepordei

Domestic survey data and tables were prepared by Susan M. Copeland and John G. Durand, statistical assistants.

Crushed stone, one of the most accessible natural resources, is a major basic raw material used by construction, agriculture, and other industries that use complex chemical and metallurgical processes. Despite the low value of its basic products, the crushed stone industry is a major contributor to and an indicator of the economic well-being of the Nation.

A total of 1.54 billion metric tons of crushed stone was produced for consumption in the United States in 1999, a 30-million-metric-ton (Mt) increase, or 2.0%, compared with the total production of 1998. This tonnage represents the highest production level ever recorded in the United States, indicating a continued increase in the demand for construction aggregates (table 1).

About 70% of the crushed stone production continued to be limestone and dolomite, followed, in descending order of tonnage, by granite, traprock, sandstone and quartzite, miscellaneous stone, marble, slate, calcareous marl, shell, and volcanic cinder and scoria (table 2).

Foreign trade of crushed stone continued to remain small. Exports decreased by 5.7% to 4.1 Mt, and the value decreased by 25.8% to $30.8 million compared with that of 1998 (table 25).

Imports of crushed stone, including calcium carbonate, decreased by 9.6% to 12.3 Mt, and the value decreased by 8.6% to $106 million (table 26). Domestic apparent consumption of crushed stone, which is defined as production for consumption (sold or used) plus imports minus exports, was 1.55 billion tons (tables 1, 25-26).

Legislation

On September 3, 1999, the Mine Safety and Health Administration (MSHA) published "Health Standards for Occupational Noise Exposure - 30 CFR Parts 56, 57, 62, 70, and 71." This final comprehensive rule replaces MSHA's existing standards for occupational noise exposure in coal mines and metal and nonmetal mines. The final rule establishes uniform requirements to protect the Nation's miners from occupational noise-induced hearing loss. The rule is derived in part from existing MSHA noise standards and from the Department of Labor's existing occupational noise exposure standard for general industry promulgated by the Occupational Safety and Health Administration. As a result of the Agency's ongoing review of its safety and health standards, MSHA determined that its noise standards, which are more than 20 years old, do not adequately protect miners from occupational noise-induced hearing loss. The final rule became effective on September 13, 2000.

On September 30, 1999, MSHA published a final rule regarding "Training and Retraining of Miners Engaged in Shell Dredging or Employed at Sand, Gravel, Surface Stone, Surface Clay, Colloidal Phosphate, or Surface Limestone Mines - 30 CFR Part 46 and 48." Two corrections to the final rule were published on September 13, 1999, and on November 8, 2000. This final rule amends MSHA's existing health and safety training regulations by establishing new training requirements for shell dredging, sand, gravel, surface stone, surface clay, colloidal phosphate, and surface limestone mines. This final rule implements the training requirements of section 115 of the Federal Mine Safety and Health Act of 1997 and provides for effective miner training at the affected mines. At the same time, the final rule allows mine operators the flexibility to tailor their training programs to the specific needs of their miners and operations. This regulation becomes effective on October 2, 2000.

Under a broad Bureau of Land Management (BLM) proposal that will impose new environmental and financial responsibility requirements at surface mining operations on public lands, sand, gravel, and building stone operations would be restricted. The intent of the new rules is to prevent undue degradation of public land resources. The provisions affecting "common variety minerals" will apply to mining claims located on public lands on or after July 23, 1955, and would restrict mining of sand, gravel, and building stone until BLM has prepared a mineral examination report. Requiring a mineral report before allowing companies to extract common variety minerals "would help ensure the public interest and the federal treasury are protected because it would avoid giving away for free what the law on common varieties says must be disposed of for fair market value" (Rock Products, 1999a).

Production

Domestic production data for crushed stone are derived by the U.S. Geological Survey (USGS) from voluntary surveys of U.S. producers. Of the 4,270 crushed stone operations on the mailing list, 3,467 operations with 3,803 quarries owned by 1,475 companies were active. Of the 3,467 active operations, 2,673 operations with 2,989 quarries, representing 77.1% of the total number of active operations, reported to the USGS. Their total production represented 85.6% of the total U.S. crushed stone output. Of the 2,673 reporting operations, 839 operations with 940 quarries owned by 171 companies did not report a breakdown by end use. Their production represented 28.1% of the U.S. total and is included in table 13 under "Unspecified, reported" uses. The nonrespondents' production was estimated by using employment data and/or adjusted production reports from prior years. The estimated production from 794 nonresponding operations with 814 quarries owned by 597 companies represented 14.4% of the U.S. total and is included in table 13 under "Unspecified, estimated" uses.

A total of 80 underground mines that are included in the total number of active operations produced 47.3 Mt of crushed stone in 1999. Underground mines were in 16 States. The leading States were, in descending order of tonnage, Kentucky, Nebraska, Iowa, Missouri, and Indiana. Their production represented 25.8% of the total U.S. crushed stone produced from underground mines.

A total of 875 quarries were either idle or presumed to have been idle in 1999 because no information was available to estimate their production. Since the 1998 survey, 117 operations were closed down. Most of the idle or closed operations were small, temporary quarries, some of them operated by State or local governments. Operations in U.S. territories are not included in the above count.

Of the total 1.54 billion tons of crushed stone produced for consumption in the United States in 1999, 1.08 Mt, or 70.4%, was limestone and dolomite; 246 Mt, or 16.0%, was granite; and 114 Mt, or 7.4%, was traprock. The remaining 96 Mt, or 6.2%, was shared, in descending order of quantity, by sandstone and quartzite, miscellaneous stone, marble, slate, calcareous marl, shell, and volcanic cinder and scoria (table 2).

A comparison of the four geographic regions of the United States indicates that, in 1999, the South continued to lead the Nation in the production of crushed stone with 722 Mt, or 46.9%, of the total; followed by the Midwest with 453 Mt, or 29.4%; and the Northeast with 198.6 Mt, or 12.9%. About 76% of the total U.S. crushed stone output was produced in the South and the Midwest (table 3).

Of the nine geographic divisions, as shown in figure 1, the South Atlantic led the Nation in the production of crushed stone with 370 Mt, or 24.0%, of the U.S. total. It was followed by the East North Central division with 287 Mt, or 18.6%, and the West South Central with 177 Mt, or 11.5%.

A comparison of the production data by the nine geographic divisions for 1998 and 1999 indicates that the output of crushed stone increased in all divisions except New England and Middle Atlantic. The largest percentage increases were recorded in the Mountain division, 8.7%; the Pacific division, 5.7%; and the West North Central division, 4.4%.

Crushed stone was produced in every State except Delaware. The 10 leading producing States, in descending order of tonnage, were Texas, Pennsylvania, Florida, Illinois, Georgia, Missouri, Ohio, North Carolina, Virginia, and Tennessee. Their combined production represented 51.2% of the national total.

Crushed stone was produced by 1,475 companies at 3,467 operations with 3,803 quarries. Information regarding the number of active operations, active quarries, type of processing plants, and number of sales yards by State is provided in table 24. Leading U.S. producing companies in descending order of tonnage, were Vulcan Materials Co., Martin Marietta Aggregates, Hanson Building Materials America, Oldcastle, Inc./Materials Group, and Lafarge Corporation.

A review of production by size of operation at the national level indicates that in 1999, 833.6 Mt, or 54.1% of total crushed stone was produced by 478 operations reporting more than 1 million metric tons per year (Mt/yr), 367.5 Mt, or 23.9%, was produced by 561 operations reporting between 500,000 and 999,999 Mt/yr, and 338.5 Mt or 22.0%, was produced by operations reporting less than 500,000 Mt/yr (table 7).

In 1999, consolidation in the aggregates industry continued. The majority of the acquisitions were made by the major producers of aggregates, most of which were publicly owned. These companies tried to expand their base of operations in new areas of the country or acquired operations or companies with significant amounts of reserves. Stricter environmental and permitting regulations make it more difficult to start a new operation than to acquire an existing one. Some of the acquired companies continue to operate as semi-independent organizations, but with the benefit of financial and management support provided by the larger new owner.

In an effort to unify its corporate structure, Hanson PLC of London, UK, announced in January that it changed the name of its U.S. subsidiary Cornerstone Construction and Materials Inc. to Hanson Building Materials America. One of its divisions, Hanson Aggregates is the third largest aggregates producing company in the United States. (Rock Products, 1999b).

Pioneer USA of Houston, TX, a subsidiary of Australia based Pioneer International, Ltd., announced that it changed the names of Davison Sand & Gravel Co. and Beckley Stone to Pioneer Mid-Atlantic. Davison has operations in Pennsylvania, South Carolina and West Virginia and (Rock Products, 1999d).

In February, Vulcan Materials Co., of Birmingham, AL, completed the purchase of five stone quarries in Arkansas from Rock Products Inc. The operations will become part of Vulcan's southern division. Vulcan also completed the purchase from Southdown, Inc., of Houston, TX, of a quarry near Lenoir, NC. This operation will become part of Vulcan's Mideast Division (Rock Products, 1999e).

In March, Pioneer announced the purchase of one quarry in Prescott, AZ, and another quarry near Salt Lake City, UT. In the last 18 months, Pioneer acquired 11 quarries and 40 concrete plants located mainly in the southwest (Rock Products, 1999c). Also in March, Vulcan purchased from Maryland Stone Co., a granite quarry near Spruce Pine, NC. The quarry will be part of Vulcan's Mideast Division, headquartered in Winston-Salem, NC (Rock Products, 1999c).

In April, Material Services Corp., Chicago, IL, a subsidiary of General Dynamics, purchased from Ward Stone Co. two quarries in the northwestern part of Indiana (Rock Products, 1999d).

In July, Hanson Building Materials America of Neptune, NJ, acquired an aggregates quarry in Opelika, AL, from Opelika Materials L.L.C., a privately held company based in Birmingham, AL. The Opelika Quarry, in Lee County, will complement Hanson's existing aggregates operation of Alexander City, AL. In another transaction, Hanson acquired a stone quarry in Greenwood County, SC, from Morgan Corp. (Pit & Quarry, 1999b).

In August, Martin Marietta Aggregates of Raleigh, NC, announced the purchase of a limestone quarry located near Lewisburg, WV, from Acme Limestone Co., Inc. The transaction also includes three rail distribution yards (Pit & Quarry, 1999a).

Limestone.—The 1999 output of crushed limestone, including some dolomite, increased by 3% to 978 Mt valued at $4.8 billion compared with the revised 1998 totals (table 2).

Only limestone was produced by 836 companies at 1,972 operations with 2,067 quarries in 48 States. In addition, 36 companies with 50 operations and 53 quarries reported producing limestone and dolomite from the same quarries. Their production of 27.8 Mt, is included with the limestone shown in table 2. The limestone totals shown in this chapter, therefore, include an undetermined amount of dolomite in addition to the dolomite reported separately.

The leading producing States were, in descending order of tonnage, Texas, Florida, Missouri, Ohio, and Kentucky; these five States accounted for 39% of the total U.S. output (table 8). The leading producers were, in descending order of tonnage, Vulcan Materials Co., Martin Marietta Aggregates, Hanson Building Materials America, Rogers Group, Inc., and Southdown, Inc.

Dolomite.—Production of dolomite increased by 1% to 106 Mt valued at $549 million, compared with the revised 1998 totals (table 2). Crushed dolomite was reportedly produced by 104 companies at 186 operations with 194 quarries in 29 States. An additional undetermined amount of dolomite is included in the total crushed limestone, as explained above.

The leading producing States were, in descending order of tonnage, Illinois, Indiana, Pennsylvania, Michigan, and Ohio; these five States accounted for 56% of the total U.S. output (table 8). The leading producers were Oldcastle, Inc./Materials Group, Hanson Building Materials America, General Dynamics Corp., S.E. Johnson Companies, Inc., and Vulcan Materials Co.

Marble.—Production of crushed marble increased by 27.1% to 10.6 Mt valued at $140 million, compared with that of 1998 (table 2). Crushed marble was produced by 17 companies with 27 operations and 41 quarries in 12 States (table 9). The leading producers of crushed marble were, in descending order of tonnage, Florida Rock Industries, Inc., Dry Branch Kaolin, ECC International, Pluess Staufer, Inc., and Vulcan Materials Co.

Calcareous Marl.—Output of marl increased by 6.5% to 3.6 Mt valued at $16 million compared with the revised 1998 totals (table 2). Marl was produced by eight companies with eight operations and eight quarries in six States (table 9). The leading producers were, in descending order of tonnage, Holderbank/Holman, Inc., Capitol Aggregates Inc., and Giant Group Ltd.

Shell.—Shell is derived mainly from fossil reefs or oyster shell. The output of crushed shell increased by 10.2% to 2.7 Mt, valued at $12.4 million compared with the revised 1998 totals (table 2). Crushed shell was produced by 12 companies with 13 operations in 6 States. The leading producers were, in descending order of tonnage, Schroeder Manatee, Inc., Caloosa Shell Corp., and Southwest Aggregates.

Granite.—The output of crushed granite decreased by only 1.2% to 246 Mt, valued at $1.5 billion, compared with the revised 1998 totals (table 2). Crushed granite was produced by 142 companies at 361 operations with 402 quarries in 35 States.

The leading States were, in descending order of tonnage, Georgia, North Carolina, Virginia, South Carolina, and California; these five States accounted for 71% of the U.S. output (table 10). The leading producers were, in descending order of tonnage, Vulcan Materials Co., Martin Marietta Aggregates, Hanson Building Materials America, Meridian Aggregates Co., and Florida Rock Industries, Inc.

Traprock.—Production of crushed traprock increased by 6.5% to 114 Mt, valued at $722 million, compared with the revised 1998 total (table 2). Traprock was produced by 246 companies at 366 operations with 497 quarries in 24 States.

The leading States were, in descending order of tonnage, Oregon, Virginia, New Jersey, California, and Washington; these five States accounted for 62.2% of U.S. output (table 10). Leading producers were, in descending order of tonnage, Oldcastle, Inc./Materials Group, Vulcan Materials Co., Luck Stone Corp., Eucon Co., and Stavola, Inc.

Sandstone and Quartzite.—The combined output of crushed sandstone and quartzite increased by 3.4% to 39.6 Mt, valued at $231 million compared with the revised 1998 totals (table 2). Crushed sandstone was produced by 118 companies at 153 operations with 157 quarries in 27 States, and crushed quartzite was produced by 39 companies at 47 operations with 51 quarries in 19 States.

The leading producing States were, in descending order of tonnage of sandstone and quartzite, Arkansas, Pennsylvania, California, South Dakota, and Oklahoma; their combined production accounted for 56% of the U.S. output (table 10). The leading producers of sandstone were, in descending order of tonnage, Ashland Oil, Inc./ APAC, Inc., Meridian Aggregates Co., and Martin Marietta Aggregates; leading producers of quartzite were Martin Marietta Aggregates, Sweetman Construction Co., and County Line Quarry, Inc.

Slate.—The output of crushed slate decreased by 12.9% to 4.2 Mt, valued at $27.9 million, compared with the revised 1998 totals (table 2). Crushed slate was produced by 15 companies at 17 operations with 21 quarries in 11 States.

Most of the crushed slate was produced in North Carolina. The leading producers were, in descending order of tonnage, Martin Marietta Aggregates, Vulcan Materials Co., and Gohman Asphalt & Construction, Inc.

Volcanic Cinder and Scoria.—Production of volcanic cinder and scoria decreased 17.9% to 2.1 Mt, valued at $13.3 million compared with the revised 1998 totals (table 2). Volcanic cinder and scoria were produced by 25 companies from 39 operations with 41 quarries in 13 States.

The leading producing States were, in descending order of tonnage, New Mexico, Arizona, and California; their combined production accounted for 35% of the total U.S. output (table 11). Leading producers were, in descending order of tonnage, Martin Marietta Aggregates, H.G. Byley & Sons Construction, Inc., and Peter Kiewit & Sons, Inc.

Miscellaneous Stone.—Output of other kinds of crushed stone decreased by 7.1% to 33.8 Mt, valued at $181 million, compared with the revised 1998 totals (table 2). Miscellaneous stone was produced by 127 companies at 227 operations with 256 quarries in 29 States.

The leading producing States were, in descending order of tonnage, Pennsylvania, California, and Washington; their combined production accounted for 44% of the total U.S. output. Leading producers were, in descending order of tonnage, U.S. Bureau of Land Management, Hanson Building Materials America, Better Materials Corp., Peter Kiewit & Sons, Inc., U.S. Department of Agriculture Forest Service, and U.S. Silica Co.

Consumption and Uses

Crushed stone production reported to the USGS is actually material that was either sold or used by producers. Stockpiled production is not included in the reported quantities. The "sold or used" tonnage, therefore, represents the amount of production released for domestic consumption or export in a given year. Because some of the crushed stone producers did not report a breakdown by end use, their total production is included in "Unspecified, reported" use. The estimated production of nonrespondents is included in "Unspecified, estimated" use.

In 1999, U.S. consumption of crushed stone was 1.54 billion tons, a 2.0% increase compared with that of 1998. This total is slightly different from the "apparent consumption" of crushed stone that is defined as "U.S. production plus imports minus exports." Of the 1.54 billion tons of crushed stone consumed, 655 Mt, or 42.5% of the total, was "Unspecified, reported and estimated" uses. Of the remaining 886 Mt reported by uses, about 83.9% was used as construction aggregates, mostly for highway and road construction and maintenance; 13.4% for chemical and metallurgical uses, including cement and lime manufacture; 1.7% for agricultural uses; and 0.8% for special uses and products (table 13). To provide a more accurate estimation of the consumption patterns for crushed stone, the "Unspecified" uses are not included in the above percentages. In any use pattern study or marketing analysis, the quantities included in "Unspecified" uses should be distributed among the reported uses by applying the above percentages to the "Unspecified" uses, total.

Limestone.—Of the 978 Mt of crushed limestone consumed, 402 Mt, or 41.1%, was "Unspecified, reported and estimated" uses. Of the remaining 577 Mt of crushed limestone reported by uses, 77.1% was used as construction aggregates; 19.7%, for chemical and metallurgical applications including cement and lime manufacturing; 2.2%, for agricultural uses; and 0.8%, for special uses and products (table 14).

Dolomite.—Of the 106 Mt of crushed dolomite consumed, 49.9 Mt, or 47.1%, was "Unspecified, reported and estimated" uses. Of the remaining 56.1 Mt of crushed dolomite reported by uses, 91.5% was used as construction aggregates; 4.5% for chemical and metallurgical applications, and 3.8%, for agricultural uses. An additional undefined amount of dolomite consumed in a variety of uses, mostly construction aggregates, is reported with the limestone (table 14).

Marble.—Of the 10.6 Mt of crushed marble consumed, 6.7 Mt, or 63.2%, was reported as "Unspecified, reported and estimated" uses. Of the remaining 3.9 Mt of crushed marble reported by uses, 1.9 Mt, or 48.7%, was used for special and miscellaneous uses, including fillers and extenders, and 1.8 Mt, or 47.5%, was used as construction aggregates (table 16).

Calcareous Marl.—Of the 3.6 Mt of crushed calcareous marl consumed, 2.5 Mt, or 69.4%, was reported as "Unspecified, reported and estimated" uses. Of the remaining crushed calcareous marl consumed, 1 Mt, or 29%, was used for cement manufacturing.

Shell.—Of the 2.7 Mt of crushed shell consumed, 765,000 tons, or 28.4%, was reported as "Unspecified, reported and estimated" uses. Of the remaining 1.9 Mt, most was used as construction aggregates.

Granite.—Of the 246 Mt of crushed granite consumed, 97.7 Mt, or 39.7%, was reported as "Unspecified, reported and estimated" uses. Of the remaining 148 Mt, most was used as construction aggregates (table 17).

Traprock.—Of the 114 Mt of crushed traprock consumed, 49.9 Mt, or 43.8%, was reported as "Unspecified, reported and estimated" uses. Of the remaining 63.7 Mt, most was used as construction aggregates (table 17).

Sandstone and Quartzite.—Of the 28.1 Mt of crushed sandstone consumed, 14.4 Mt, or 51.2%, was reported as "Unspecified, reported and estimated" uses. Of the remaining 13.4 Mt of crushed sandstone reported by uses, 12.7 Mt, or 94.8%, was used as construction aggregates (table 18).

Of the 11.5 Mt of crushed quartzite consumed, 4.7 Mt, or 41%, was reported as "Unspecified, reported and estimated" uses. Of the remaining 6.7 Mt of crushed quartzite reported by uses, 5.9 Mt, or 87.9%, was used as construction aggregates (table 18).

Volcanic Cinder and Scoria.—Of the 2.1 Mt of volcanic cinder and scoria consumed, 940,000 tons, or 45.6%, was reported as "Unspecified, reported and estimated" uses. Most of the remaining 1.1 Mt of crushed volcanic cinder and scoria was used as construction aggregates (table 19).

Miscellaneous Stone.—Of the 33.8 Mt of miscellaneous crushed stone consumed, 22.5 Mt, or 66.6%, was reported as "Unspecified, reported and estimated" uses. Of the remaining 11.3 Mt reported by uses, most of it was used as construction aggregates and 439,000 t, or 3.9%, was used for cement manufacturing.

Additional information regarding production and consumption of crushed stone by type of rock and major uses in each State and the State districts may be found in the USGS "Minerals Yearbook, Volume II, Area Reports: Domestic."

Recycling

As the recycling of most waste materials increases, aggregates producers are recycling more cement concrete and asphalt concrete materials recovered from construction projects to produce concrete aggregates and asphalt aggregates. The annual survey of crushed stone producers now collects information on recycling of cement and asphalt concretes

SAND AND GRAVEL (CONSTRUCTION)[1]

(Data in million metric tons, unless otherwise noted)[2]

Domestic Production and Use: Construction sand and gravel valued at $5.7 billion was produced by an estimated 4,000 companies from 6,100 operations in 50 States. Leading States, in order of tonnage, were California, Texas, Michigan, Arizona, Ohio, Washington, and Colorado, which combined accounted for about 46% of the total output. It is estimated that about 48% of the 1.17 billion metric tons of construction sand and gravel produced in 2000 was for unspecified uses. Of the remaining total, about 41% was used as concrete aggregates; 25% for road base and coverings and road stabilization; 14% as asphaltic concrete aggregates and other bituminous mixtures; 13% as construction fill; 2% for concrete products, such as blocks, bricks, pipes, etc.; 2% for plaster and gunite sands; and the remainder for snow and ice control, railroad ballast, roofing granules, filtration, and other miscellaneous uses.

The estimated output of construction sand and gravel in the 48 conterminous States shipped for consumption in the first 9 months of 2000 was about 860 million tons, which represents an increase of 4.1% compared with the same period of 1999. The estimated output of crushed stone in the 48 conterminous States shipped for consumption in the first 9 months of 2000 was 1.18 billion tons, which represents an increase of 3.1% compared with the same period of 1999. Additional production information by quarter for each State, geographic region, and the United States is published by the U.S. Geological Survey in its quarterly Mineral Industry Surveys for Crushed Stone and Sand and Gravel.

Salient Statistics—United States:	1996	1997	1998	1999	2000[e]
Production	[3]914	952	1,070	1,110	1,170
Imports for consumption	1	2	1	2	2
Exports	1	2	2	2	2
Consumption, apparent	914	952	1,070	1,110	1,170
Price, average value, dollars per ton	4.38	4.47	4.57	4.73	4.87
Stocks, yearend	NA	NA	NA	NA	NA
Employment, quarry and mill, number[e]	33,200	33,900	35,600	37,300	37,500
Net import reliance[4] as a percent of apparent consumption	—	—	—	—	—

Recycling: Asphalt road surfaces and cement concrete surfaces and structures were recycled on an increasing basis.

Import Sources (1996-99): Canada, 71%; The Bahamas, 11%; Mexico, 8%; and other, 10%.

Tariff: Item	Number	Normal Trade Relations 12/31/00
Sand, construction	2505.90.0000	Free.
Gravel, construction	2517.10.0000	Free.

Depletion Allowance: Common varieties, 5% (Domestic and foreign).

Government Stockpile: None.

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SAND AND GRAVEL (CONSTRUCTION)

Events, Trends, and Issues: Construction sand and gravel output increased 5.4% in 2000. It is estimated that 2001 domestic production and U.S. apparent consumption will be about 1.2 billion tons each, a 2.6% increase. Aggregate consumption is expected to continue growing because of increased outlays for highway construction and maintenance provided by the Transportation Equity Act for the 21st Century (Public Law 105-178). The law guarantees that $165 billion will be obligated for highways and $35 billion for transit work through 2003.

The construction sand and gravel industry continued to be concerned with safety and health regulations and environmental restrictions. Shortages in urban and industrialized areas were expected to continue to increase because of local zoning regulations and land development. For these reasons, movement of sand and gravel operations away from highly populated centers is expected to continue.

World Mine Production, Reserves, and Reserve Base:

	Mine production		Reserves and reserve base[5]
	1999	2000[e]	
United States	1,110	1,170	The reserves and reserve base are controlled largely by land use and/or environmental constraints.
Other countries	NA	NA	
World total	NA	NA	

World Resources: Sand and gravel resources of the world are large. However, because of their geographic distribution, environmental restrictions, and quality requirements for some uses, their extraction is uneconomic in some cases. The most important commercial sources of sand and gravel have been river flood plains, river channels, and glacial deposits. Offshore deposits are being used presently in the United States, mostly for beach erosion control. Other countries mine offshore deposits of aggregates for onshore construction projects.

Substitutes: Crushed stone remains the predominant choice for construction aggregate use.

[e]Estimated. NA Not available.
[1]See also Sand and Gravel (Industrial).
[2]See Appendix A for conversion to short tons.
[3]Excludes Hawaii.
[4]Defined as imports - exports + adjustments for Government and industry stock changes; changes in stocks not available and assumed to be zero.
[5]See Appendix C for definitions.

Canadian Institute of Mining, Metallurgy and Petroleum - Definitions
Adopted by CIM Council August 20, 2000

Mineral Resource

Mineral Resources are sub-divided, in order of increasing geological confidence, into Inferred, Indicated and Measured categories. An Inferred Mineral Resource has a lower level of confidence than that applied to an Indicated Mineral Resource. An Indicated Mineral Resource has a higher level of confidence than an Inferred Mineral Resource but has a lower level of confidence than a Measured Mineral Resource.

A Mineral Resource is a concentration or occurrence of natural, solid, inorganic or fossilized organic material in or on the Earth's crust in such form and quantity and of such a grade or quality that it has reasonable prospects for economic extraction. The location, quantity, grade, geological characteristics and continuity of a Mineral Resource are known, estimated or interpreted from specific geological evidence and knowledge.

The term Mineral Resource covers mineralization and natural material of intrinsic economic interest which has been identified and estimated through exploration and sampling and within which Mineral Reserves may subsequently be defined by the consideration and application of technical, economic, legal, environmental, socio-economic and governmental factors. The phrase 'reasonable prospects for economic extraction' implies a judgement by the Qualified Person in respect of the technical and economic factors likely to influence the prospect of economic extraction. A Mineral Resource is an inventory of mineralization that under realistically assumed and justifiable technical and economic conditions, might become economically extractable. These assumptions must be presented explicitly in both public and technical reports.

Inferred Mineral Resource

An 'Inferred Mineral Resource' is that part of a Mineral Resource for which quantity and grade or quality can be estimated on the basis of geological evidence and limited sampling and reasonably assumed, but not verified, geological and grade continuity. The estimate is based on limited information and sampling gathered through appropriate techniques from locations such as outcrops, trenches, pits, workings and drill holes.

Due to the uncertainty which may attach to Inferred Mineral Resources, it cannot be assumed that all or any part of an Inferred Mineral Resource will be upgraded to an Indicated or Measured Mineral Resource as a result of continued exploration. Confidence in the estimate is insufficient to allow the meaningful application of technical and economic parameters or to enable an evaluation of economic viability worthy of public disclosure. Inferred Mineral Resources must be excluded from estimates forming the basis of feasibility or other economic studies.

Indicated Mineral Resource

An 'Indicated Mineral Resource' is that part of a Mineral Resource for which quantity, grade or quality, densities, shape and physical characteristics, can be estimated with a level of confidence sufficient to allow the appropriate application of technical and economic parameters, to support mine planning and evaluation of the economic viability of the deposit. The estimate is based on detailed and reliable exploration and testing information gathered through appropriate techniques from locations such as outcrops, trenches, pits, workings and drill holes that are spaced closely enough for geological and grade continuity to be reasonably assumed.

Mineralization may be classified as an Indicated Mineral Resource by the Qualified Person when the nature, quality, quantity and distribution of data are such as to allow confident interpretation of the geological framework and to reasonably assume the continuity of mineralization. The Qualified Person must recognize the importance of the Indicated Mineral Resource category to the advancement of the feasibility of the project. An Indicated Mineral Resource estimate is of sufficient quality to support a Preliminary Feasibility Study which can serve as the basis for major development decisions.

Measured Mineral Resource

A 'Measured Mineral Resource' is that part of a Mineral Resource for which quantity, grade or quality, densities, shape, physical characteristics are so well established that they can be estimated with confidence sufficient to allow the appropriate application of technical and economic parameters, to support production planning and evaluation of the economic viability of the deposit. The estimate is based on detailed and reliable exploration, sampling and testing information gathered through appropriate techniques from locations such as outcrops, trenches, pits, workings and drill holes that are spaced closely enough to confirm both geological and grade continuity.

Mineralization or other natural material of economic interest may be classified as a Measured Mineral Resource by the Qualified Person when the nature, quality, quantity and distribution of data are such that the tonnage and grade of the mineralization can be estimated to within close limits and that variation from the estimate would not significantly affect potential economic viability. This category requires a high level of confidence in, and understanding of, the geology and controls of the mineral deposit.

Mineral Reserve

Mineral Reserves are sub-divided in order of increasing confidence into Probable Mineral Reserves and Proven Mineral Reserves. A Probable Mineral Reserve has a lower level of confidence than a Proven Mineral Reserve.

A Mineral Reserve is the economically mineable part of a Measured or Indicated Mineral Resource demonstrated by at least a Preliminary Feasibility Study. This Study must include adequate information on mining, processing, metallurgical, economic and other relevant factors that demonstrate, at the time of reporting, that economic extraction can be justified. A Mineral Reserve includes diluting materials and allowances for losses that may occur when the material is mined.

Mineral Reserves are those parts of Mineral Resources which, after the application of all mining factors, result in an estimated tonnage and grade which, in the opinion of the Qualified Person(s) making the estimates, is the basis of an economically viable project after taking account of all relevant processing, metallurgical, economic, marketing, legal, environment, socio-economic and government factors. Mineral Reserves are inclusive of diluting material that will be mined in conjunction with the Mineral Reserves and delivered to the treatment plant or equivalent facility. The term 'Mineral Reserve' need not necessarily signify that extraction facilities are in place or operative or that all governmental approvals have been received. It does signify that there are reasonable expectations of such approvals.

Probable Mineral Reserve

A 'Probable Mineral Reserve' is the economically mineable part of an Indicated, and in some circumstances a Measured Mineral Resource demonstrated by at least a Preliminary Feasibility Study. This Study must include adequate information on mining, processing, metallurgical, economic, and other relevant factors that demonstrate, at the time of reporting, that economic extraction can be justified.

Proven Mineral Reserve

A 'Proven Mineral Reserve' is the economically mineable part of a Measured Mineral Resource demonstrated by at least a Preliminary Feasibility Study. This Study must include adequate information on mining, processing, metallurgical, economic, and other relevant factors that demonstrate, at the time of reporting, that economic extraction is justified.

Application of the Proven Mineral reserve category implies that the Qualified Person has the highest degree of confidence in the estimate with the consequent expectation in the minds of the readers of the report. The term should be restricted to that part of the deposit where production planning is taking place and for which any variation in the estimate would not significantly affect potential economic viability.

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1.5 **Non-Metallic Mineral Deposits** - Issuers making disclosure regarding the following commodities are encouraged to follow these additional guidelines:

(a) Industrial Minerals - For an industrial mineral deposit to be classified as a mineral resource, there should be recognition by the qualified person preparing the quantity and quality estimate that there is a viable market for the product or that a market can be reasonably developed. For an industrial mineral deposit to be classified as a mineral reserve, the qualified person preparing the estimate should be satisfied, following a thorough review of specific and identifiable markets for the product, that there is, at the date of the technical report, a viable market for the product and that the product can be mined and sold at a profit.

APPENDIX "E"

DIAMOND DRILL HOLE DATA

1987	**HOLE No. MH 87-1 to MH 87-8**
1988	**HOLE No. 88-1 to 88-8(A), 88-8(B) to 88-15**
2002	**HOLE No. MH02-01 to MH02-05**

Appendix "E"

HOLE NO.	LENGTH (m)	GRID AZ.	DIP
MH 87-1	93.60	249° 02'	-40°
MH 87-2	152.44	230° 30'	-40
MH 87-3	98.48	246° 20'	-42° 31'
MH 87-4	45.73	220° 00'	-40°
MH 87-5	70.55	346° 11'	-41° 11'
MH 87-6	64.94	226° 12'	-39° 12'
MH 87-7	139.02	217° 00'	-40°
MH 87-8	107.62	323° 07'	-43° 02'
88-1	60.98	265° 27'	-42° 43'
88-2	74.70	266° 10'	-46° 50'
88-3	64.33	271° 35'	-42° 57'
88-4	62.50	285° 32'	-41° 06'
88-5	70.43	283° 53'	-40° 29'
88-6	76.52	320° 28'	-40° 51'
88-7	38.41	267° 45'	-45° 28'
88-8(A)	12.20	274° 55'	-60°
88-8(B)	63.72	274° 55'	-40° 38'
88-9	67.38	227° 14'	-43° 12'
88-10	81.40		-90°
88-11	44.21	274° 52'	-41° 08'
88-12	50.91	165° 23'	-56° 24'
88-13	44.82	243° 58'	-42° 13'
88-14	60.98	105° 38'	-43° 25'
88-15	103.66	328° 22'	-42° 08'
MH02-01	157.89	175°	-45°
MH02-02	99.98		-90°
MH02-03	142.05	320°	-45°
MH02-04	138.99	180°	-45°
MH02-05	166.42	325°	-45°
TOTAL	2,424.86		