# MARKET STUDY FOR BRITISH COLUMBIA MICA

**Prepared by:** 

McNeal & Associates Consultants Ltd. and Donald F. Gunning, P.Eng.

February 1995



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Prepared for: Natural Resource Canada Mining Sector **Regional and Intergovernmental Affairs** 405, 101 22nd Street East Saskatoon, Saskatchewan S7K 0E1

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# 1.0 INTRODUCTION

# 1.1 <u>Background</u>

McNeal & Associates Consultants Ltd. were retained by Natural Resources Canada to conduct a market study of the demand for British Columbia (B.C.) mica. Market research assistance was provided by Donald Gunning, P. Eng. and John Chapman, P. Eng., both of whom have extensive backgrounds in industrial minerals and their applications.

This study has been prepared in order to supplement the industrial mineral resource database of the Geological Survey Branch of the Ministry of Energy, Mines & Petroleum Resources (MEMPR) of the Province of British Columbia, which has identified a number of potentially economic deposits of mica within the province.

Funding for this project was provided by the Canada-British Columbia Agreement on Mineral Development (M.D.A.) through National Resources Canada.

#### 1.2 Study Objective

The Market Study objective was to produce an evaluation and assessment of the domestic and foreign markets for British Columbia mica products to serve as a basis for evaluating the feasibility of mica production in British Columbia.

The main focus of the study is a description of the market potential for a range of mica and mica based products, the identification of products and market opportunities for a British Columbia producer of mica and an assessment of the quantity and quality of mica available from B.C. sources, to supply the demand identified.

1.3 Geographic Market Area

The geographic market area accessible to a B.C. mica producer depends on the costs of production and transportation as well as the type and grades of products offered. Mica used in oil well drilling mud, for example, can be coarse-grained and low grade. The low selling price and relatively high transportation costs dictate a market area restricted to B.C., Alberta and some northern States. Mica used in reinforced plastics, on the other hand, can command high selling prices in which transportation costs are relatively low; the market area expands to include other parts of North America and perhaps Asia due to the valueadded nature of these specialized products.

## 1.4 <u>Mica Definition</u>

The generic term "mica" describes a group of complex hydrous alumino-silicate minerals (Source: Dana & Shaw) which exhibit strong basal cleavage and considerable chemical composition variations within the group. They all belong to the monoclinic crystal system.

Muscovite and phlogopite are the most important commercial mica minerals. Muscovite  $[KAl_2(AlSi_3O_{10})(OH)_2]$  is a potassium alumino-silicate (sometimes called white mica) with a specific gravity of between 2.8 and 2.9 and a hardness of 2.8 to 3.2 on the Moh's scale. It has a vitreous to pearly lustre and is transparent and colourless in thin sheets. Phlogopite  $[KMg_3(AlSi_3O_{10})(OH)_2]$  is a magnesium alumino-silicate with a pearly lustre and a yellowish brown colour. It has a much higher temperature of decomposition than muscovite. Pure muscovite and phlogopite can both be split into very thin, tough, flexible sheets, ideal for electrical insulating applications. Biotite, a very common iron-rich mica found in igneous-rocks such as granite, and sericite, a fine grained mica abundant in schistose rocks are both of negligible commercial importance, although sericite can be utilized as a source of fine-grained muscovite for micronized products.

Muscovite is preferred in applications requiring high brightness; phlogopite's darker colour prevents its use in such markets. It has greater ductility than muscovite, however, which is a significant advantage to some users.

Sheet mica consists of flat sheets or "books" of mica that are mined from either hard rock (pegmatites) or weathered material, and can be split into film or splittings. There is limited quality sheet mica available in the world and none currently mined in North America. Scrap mica includes all sheet mica residue and mica from mines which have no sheet-quality mica runs. Scrap mica is usually ground before use in industrial applications. Flake mica is finer material extracted from or recovered as a co-product or by-product in the production of kaolin, lithium, or feldspar. It, like scrap mica, is also generally ground before use. 1 shows the main physical properties of muscovite, phlogopite, and biotite.

Mica: February, 1995

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# Table I

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# Chemistry and Selected Properties of Various Micas

	% BY WEIGHT						
CHEMICAL CONSTITUENTS	MUSCOVITE	PHLOGOPITE	BIOTITE				
	46.5	40.0	37.0				
1 51203	34.0	17.0	18.0				
K20	10.0	10.0	9.0				
Na <sub>2</sub> O	0.8	0.5	1.0				
MgO	0.5 0.3	26.0	8.0				
$C_{aO}$ = $F_{e2O_3}$ ( $F_{e2O_3}$ ), $F_{e2O_3}$ ( $F_{e2O_3}$ ) ( $F_{e2O_3}$ ), $F_{e2O_3}$ ( $F_{e2O_3}$ ) ( $F_$	2.5		 2.0				
FeO	1.0	2.8	2.0 21.0				
Minor Elements	1.0	0.5	1.0				
H <sub>2</sub> O	4.5	3.0	3.0				
04 <b>111</b> a baile a shi ta shi bi sa kasa	7.0	<b>5.0</b>					
Total and the second second second second	100.0	100.0	100.0				
Properties							
Specific gravity	2.77-2.88	2.76-2.90	2.70-3.30				
Mohs hardness	2.8-3.2	2.5-3.0	2.5-4.0				
Shore hardness	80-150	70-100					
Specific heat (at 25°C) Volume resistivity (ohms/cm³)	$\begin{array}{c} 0.207 \\ 2 \times 10^{13} \cdot 1 \times 10^{17} \end{array}$	0.207 less	ni oraș <u>E</u> ssen se				
Modulus of elasticity (Pa)	172 x 10 <sup>9</sup>	172 × 10 <sup>9</sup>	la ser a ser esta se				
Compression strength (Pa)	221 × 10 <sup>6</sup>	221 × 10 <sup>6</sup>	-				
Volume resistivity in ohms/cm3 @ 25°C	5 x 10 <sup>13</sup>	a dharan a shekara a shekara s	1월 <b>2일 - 고</b> 화 가지 것				
Optical axial angle (2V)	38°-47°	0-10°	0-25°				
Temperature of decomposition	400-500°C	850-1000°C					
Dielectric constant	6.5-9.0	5.0-6.0					
Linear coefficient of expansion x 10 <sup>-6</sup> cms/°C; range 20°-600°C	58-79	79-97	an an an Ara <u>n</u> a da Ara				
Coefficient of expansion per °C	15-25	$1-1 \times 10^{-3}$					
perpendicular to cleavage 20°-100°C (10°)	10 M.C. L. 440 (M) 3						
Coefficient of expansion per °C parallel to cleavage 0°200°C (10°)	8-9	13-14.5	alter set geen				
Tensile strength Pa x 10 <sup>6</sup>	225-297	255-297	lasse d'a 🗕 🖉 🤅				
Modulus of elasticity Pa x 109	172	172	and the second sec				
Dielectric strength (0.025-0.030 mm thick) volts/cm × 10 <sup>6</sup>	2.4-11.2	1.7-0.8					
Resistivity ohms-cm	1012-1015	1010-1013					
Thermal conductivity perpendicular to	0.57	0.57					
cleavage @ 100°C (K cal/m²/hr/°C)							

18 22

## 2.0 B.C. MICA DEPOSITS

# 2.1 <u>History</u>

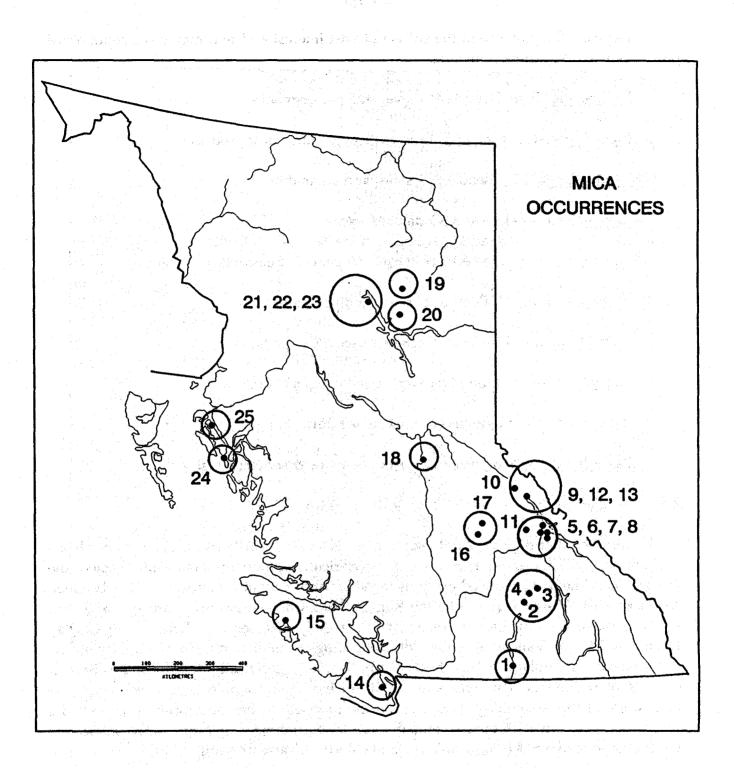
While mica has not been produced on a significant commercial scale in British Columbia since 1961, there are many well-documented primary occurrences of the mineral throughout the province, and numerous potential secondary sources in high tonnage cooper mine waste-dumps. Additionally, some siliceous and feldspathic sands in the interior of the province have been noted to exhibit macroscopic flake mica contents, and several large sericite schist bodies exist that contain significant levels of fine-grained muscovite that might be suitable for some fine-ground markets.

Reports of "commercial size" occurrences of muscovite in pegmatite dikes date back to as early as 1886 in the Provincial Minister of Mines Reports. J.W. McCammon compiled a list of 25 known B.C. mica deposits in 1979, as shown in 1. This had followed a broad exploration program carried out in the late 1970's by H.S. Haslam and Associates for M.I.T.S. Development Co. Ltd. of Richmond, B.C., who concluded that markets were inadequate to justify production at that time. These properties were concentrated in the Big Bend area north of Revelstoke, the Tete Jaune Cache region of the North Thompson River, the north and south Okanagan, and the Finlay River area north of Mackenzie, now partly covered by Williston Lake. Only four deposits were noted on or near the Pacific Coast.

## 2.2 Minfile Data

An up-to-date compilation of 36 mica occurrences is included here in Appendix I, namely, the mica listings from the B.C. MEMPR "Minfile" system. It includes some secondary deposits, but as can be seen on page one of the listings, most are primary mica showings.

Actual mica production in the province between the years 1904 and 1961 (total-todate in fact) is reported in the 1970 B.C. Minster of Mines Annual Report to have been 12,822,050 lbs. with a value of \$185,818. In the last year of production, 1961, the 250,000 lbs. sold had a value of \$8,025, which converts to 3.2 cents per pound, or \$64 per tonne. The last recorded producing mine was at Cedarside, near Valemount, on the North Thompson River. It operated for only a year or two, shipping a few hundred tonnes to joint cement manufacturers. The ore was a muscovite-quartz schist that was dried, crushed, screened, and then air-separated to produce five sizes of mica. The owner was Georgian Mineral Industries Ltd. of Calgary. It is thought that this schist contains significant levels of biotite, an undesirable contaminant, which might have contributed to the early closure of the mine.



Deposits that have been the subject of past interest and that may have commercial potential (from Appendix I) include:

Hellroaring Creek - Cranbrook area, feldspar pegmatite

Brett-Bird - Armstrong area, muscovite pegmatite - past producer

Yellow Creek - Big Bend area - schist and pegmatite

Canoe North - Valemount (Cedarside) - schist

- drilled & developed in the '60's, '70's, and '80's

- large reserves at up to 60 per cent muscovite with biotite

Albreda - south of Valemount - schist and pegmatite

Mica Mountain - Tete Jaune Cache - muscovite in pegmatite

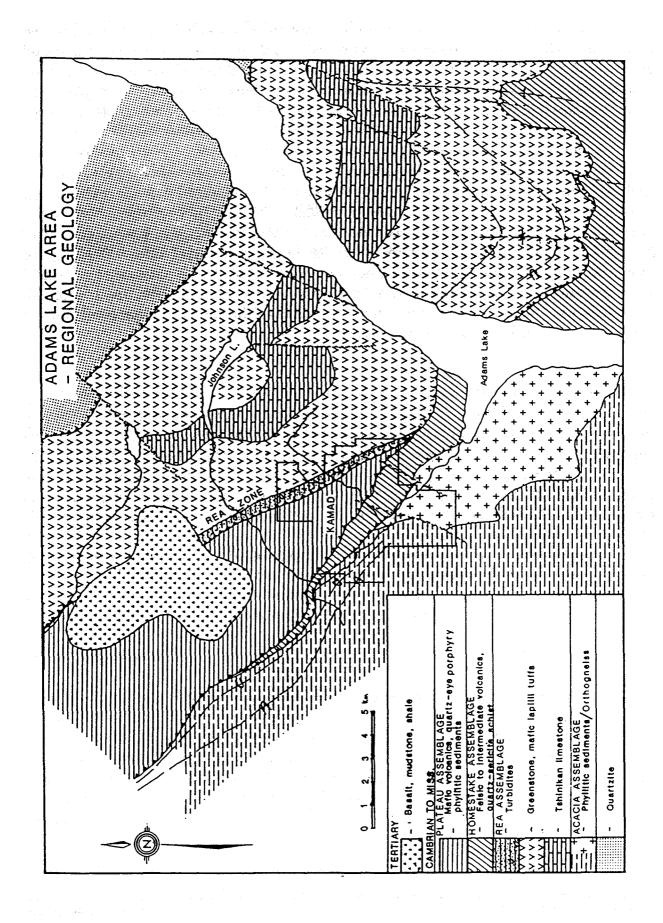
North Blue River - Blue River area - sheet mica in pegmatite

Rafferty - north of Blue River - muscovite schist

Baker Inlet - south of Prince Rupert - pegmatite & sericite schist

2.3 Sericite

Another mica deposit of potential interest is located at Adams Lake, 60 km northeast of Kamloops. This area of gold- and silver-rich sulphide mineralisation hosted the Homestake Mine that produced precious metal ore and concentrates intermittently between 1893 and 1984. It was acquired by the Kamad Silver Co. over twenty years ago, and then by Homestake Canada Ltd. in 1989. It is currently 100 per cent held by Agate Bay Resources Ltd. of Vancouver. One of the geological units within the property is the "Homestake Assemblage" which hosts the old mine mineralization (Ag, Pb, Zn, Ba). It consists of sediments, volcanics and schists including a massive sericite section. The magnitude of this assemblage is shown on the map (2). It has never been pursued as a source of mica, but it doubtless contains substantial reserves of fine-grained muscovite within the sericite schist (quartz ankerite and chlorite are also present).



A second sericite deposit under current investigation is located near Lumby, just east of Vernon. The Quinto Mining Corporation is considering the production of a mixed graphite-mica product for application as a filler in automotive plastics. The schistose sericite ore is rich in very fine-grained muscovite intimately entwined with graphite. Considerable exploration and development has taken place at this very accessible property.

A third potential sericite source could reside in any one of the province's large porphyry copper mines, several of which process sericite-bearing ore. Many years ago, one of these operations conducted a small-scale test to recover mica from the mill tailings stream. It was determined that a clean (high grade) sericite product could be obtained at a 20 percent recovery rate. Given a feed rate of 30,000 tonnes per day of pit-run ore at five percent sericite, and a 20 per cent recovery, 300 tonnes per day of mica would accrue, sufficient to supply the entire North American market. Few, if any, base-metal producers seem interested in pursuing this kind of by-product recovery, presumably for a variety of good reasons. Reclamation of mica from old tailings dumps would probably not be economic, given the low grades and high costs of re-processing.

## 2.4 Conclusions

In summary, British Columbia does possess significant reserves of mica, including some sheet mica in pegmatite dikes, substantial quantities of high grade (50 percent plus) muscovite schists, and large zones of fine-grained sericite. Many of these deposits have been well explored; some were producers in the past. Several of the occurrences are close to main line railways and highways, facilitating effective transportation of products to markets in the Northwest. At least one deposit is on deep water (Baker Inlet).

Insufficient regional market demand is probably the only reason for the absence of a producing mica mine in B.C. today.

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#### 3.0 OVERVIEW OF MICA SUPPLY AND DEMAND

This section discusses the supply and demand of several types of mica, each with several end uses. Sheet mica, for example, can be referred to as blocks, splittings, scrap, and has industrial end uses such as electric insulators. Ground mica is derived from scrap and flake mica and is ground into a powder. There are two types of ground mica: dry and wet.

Dry-ground mica normally has a coarser mesh and is used for a variety of industrial applications including joint cement, oil drilling muds, rubber moulds and roofing products. Wet-ground mica normally has a finer mesh and may be coated. It is used both as a bulk and functional filler in paints and coatings and the plastics industry. Micronized mica is extremely fine ground mica produced by steam disintegration and is usually coated (Roskill). It is used in specialized paints and high technology plastics. These various mica forms are referenced throughout this section.

#### 3.1 World Summary

The following sub-sections summarize the major production and uses of mica by selected countries as outlined by Roskill in <u>The Economics of Mica</u>, 1991 and supplemented by Lawrence L. Davis's later paper (US Bureau of Mines, 1994). James T. Tanner's 1994 paper <u>Industrial Minerals and Rocks</u>, AIME was also used as a reference.

It is estimated by Roskill Information Services that some 305,000 tonnes of crude mica were produced by countries around the world in 1990. The U.S. Bureau of Mines estimates only 214,000 tonnes. The U.S. produced 40 per cent of the total, followed by Russia at 17 per cent. Other significant producers include Brazil, Canada, China, Finland, France, India, the Republic of Korea, Australia, and South Africa. Davis of the US Bureau of Mines reports that world production decreased to 190,000 tonnes in 1993, excluding output from China, Norway, Pakistan, Romania and Sweden.

#### 3.1.1 Australia

Commercial Minerals Ltd. (previously Pilbara Mica Corporation) produces 2,000 tonnes per annum (t.p.a.) of muscovite mica in Western Australia, 30 per cent of which is used in oil well drilling and the remainder is shipped to industrial markets. James Hardie Manufacturing Industry is a significant consumer of Australian mica, using it to produce fire-resistant construction board. Australia also imports about 500 tonnes of mica annually from India, South Africa, China and the U.S., most of which is used in the industrial filler markets.

#### 3.1.2 Brazil

This country produces about 5,000 t.p.a. of mica. The domestic market consumes mica for use in electrical insulation, drilling fluids, and joint cement. Their main export market is Europe (mostly the UK) and their chief product is scrap mica.

# 3.1.3 China

Roskill estimates Chinese production at 12,000 t.p.a. However, this appears low as Japan imports at least 17,000 tonnes per year from China.<sup>1</sup> Chinese exports have increased significantly over the past few years, particularly to Japan and European markets. Very little worked mica is exported.

# 3.1.4 <u>Finland</u>

Kemira Oy produces phlogopite mica from an apatite mine. The mica had been discarded as waste, but in 1985 a mica production plant was opened. The plant has a production capacity of 10,000 t.p.a. Kemira Oy markets strongly in European countries to the oil well drilling, construction, sound insulation and plastics markets. In 1986, Kemira built a pearlescent pigment plant that produces a mica based paint termed "Flonac". Flonac's big markets are Japan and Western Europe. Davis reports that Kemira Oy is planning to increase the capacity of its pearlescent pigment facilities in Pori and also to increase production of its mine at Siilinjarvi.

## 3.1.5 France

Mica production is a by-product of kaolin mining in France. The country has the capacity to process 20,000 t.p.a., but current demand is about 6,000 t.p.a. The largest producer, Micarec, a subsidiary of English China Clay, supplies 80-90 per cent of the domestic market. About half of the output is dry-ground mica for surface coatings, joint cements and electrodes. Micronised and wet-ground mica account for 30 per cent of output and are used in the paint industry. The remainder of the mica is used for North Sea oil well drilling applications. Plastics reinforcement is a new area of sales for Micarec. Kaolin du Finistere, also a subsidiary of English China Clay of the U.K., ships its mica to Fordamin Co. in the U.K. for processing. The largest U.K. user of French mica is Artex Product Manufacturing, a subsidiary of British Gypsum. About 1,000 t.p.a. of the Kaolin du Finistere output is shipped to the U.K. Sciama SA, also of France, does not mine mica, but does operate a wet-grinding plant for imported scrap mica from India, South Africa and Brazil. France also acts as a mica trader, importing and exporting mica. Exports are mainly to the U.K., West Germany and Switzerland.

<sup>&</sup>lt;sup>1</sup> Imports By Commodity, Dec 93

# 3.1.6 West Germany

There are no mica mines in West Germany, but Mikromineral Micafine operates a processing plant which has a capacity of 3,500 t.p.a. Friedrich Geffers Glimmermahleverk also operates a 1,500-t.p.a. grinding plant. West Germany imports over 5,000 t.p.a. of scrap mica from China, India and Brazil. It also imports 500 t.p.a. of ground mica from France and Belgium. Naintsche GmbH, and Merck (Germany) have entered the pearlescent pigment market and use mica in their paint formulations.

# 3.1.7 <u>India</u>

The reserves of sheet mica in India are the largest in the world, but production of sheet mica has fallen from over 16,000 annual tonnes in the 1970's to 7,000 tonnes in the early 1990s. Waste mica production has been steady at about 4,000 t.p.a. There are over 60 processors of mica in India, most of which are small operations. India Bartes and Chemicals, with a capacity to produce 3,600 t.p.a. of mica powder, is the largest. A major portion of India's mica is exported. The government established the Mica Trading Corporation of India Ltd. (MITCO) to handle mica export sales and to set prices. It has also organized and undertaken mica processing throughout India and maintains quality control. Japan is the largest export market for Indian mica. India also exports to Eastern Europe, Russia, West Germany, Norway and Saudi Arabia, and the U.S.A., for whom it is a vital source of raw sheet mica.

# 3.1.8 Japan

There is no mica production in Japan; however, Japanese companies have interests in mica reserves in other countries. Kurraray has a marketing and technical association with Suzorite Mica Products Inc. of Boucherville, Quebec, to import mica for the Japanese plastic filler markets. Most of the imported ground mica is consumed domestically, but some processed mica is re-exported to Hong Kong and Taiwan. A major new market in Japan is pearlescent pigments. Automotive paints, in Japan, account for 19 per cent of paint consumption (compared to 5 per cent in the U.S.) and pearlescent paints containing mica is a growing market.

In 1993, imports of mica to Japan were reported to be 2,000 tonnes from Canada, 8,000 tonnes from India, 300 tonnes from Malaysia, 600 tonnes from the Republic of South Korea, 1,000 tonnes from the U.S.A., 17,000 tonnes from China and 300 tonnes from South Africa.<sup>2</sup> Japan Mica Industrial Co. Ltd. is the largest mica processor, using blocks, splittings

<sup>2</sup> Imports Of Commodity By Country - JETRO publication

and scrap for powder and flake production. Their production capacity is about 2,700 tonnes per year.

In 1993, Japan imported 34,571 tonnes of mica, 53 per cent of this from China. 19,000 tonnes were imported as mica powder at an average delivered cost of US\$291/tonne. Overall, the average delivered cost paid for the 34,571 tonnes was US\$347/tonne. Japan's imports of mica have been growing dramatically. For example, in 1982, only 15,000 tonnes were imported and in 1990, 26,000 tonnes were imported. Five potential importers of mica in Japan are listed in Appendix II (JETRO), namely: 1) Nippon Rika Kogyosho Co., 2) Matsushita Trading Co. Ltd., 3) M. Watanabe Co. Ltd., 4) Tamaki Mica Co. Itd., and 5) Shizaki Mica Co. Ltd. Matsushita specializes in high priced cosmetic mica.

#### 3.1.9 South Korea

The mine production of South Korean mica from feldspar and kaolin operations has increased significantly. In 1993, production was 7,500 tonnes according to Davis but Tanner and Roskill both quote 30,000 tonnes. Most of South Korea's mica is exported to Southeast Asian countries, Japan and Europe. A pearlescent pigment supplier is now producing in South Korea for the Korean automobile industry.

3.1.10 Mexico

Mexico mined about 6,100 tonnes in 1993 of mica, Technica Mineral SA being the major producer. Most of Mexico's imported mica is from the U.S.; Davis reported 400 tonnes in 1993. The principal end users in Mexico are the rubber, paint and oil drilling industries.

# 3.1.11 <u>Norway</u>

Until 1978, Norway mined its own crude mica. A/S Norwegian Talc now imports mica for micronisation, mostly from India. About 1,600 t.p.a. is imported and 90 per cent is re-exported to other Western European countries. The micronised mica is used in plastics, paint industries and, uniquely, high gloss paper.

# 3.1.12 South Africa

South Africa produces about 2,000 tonnes of mica annually according to Roskill. Davis, however, reports the 1993 production as only 1,050 tonnes. Gelletich Mining Industries Pty. Ltd., located in the Transvaal, is the major producer, wet-grinding about 1,200 t.p.a.; the plant has a 3,500-t.p.a. capacity. Mica is used mainly in paints, rubber tires, wallpaper and as a mould-releasing agent and in some cosmetic manufacturing. About 90 per cent of Gelletich's production is exported to Australia, Europe and Japan.

Garieb Minerale (Pty) Ltd., Pegmin (Pty) Ltd., Interesteel Ore (Pty), PN Touw Mica, Mailn and Robson (Pty) Ltd. and Otavi Mining Co. also mine mica in South Africa which in addition to Gelletich would support Roskill's figure of 2,000 t.p.a..

## 3.1.13 <u>Russia</u>

Russia has extensive reserves of mica and is a major producer. The U.S. Bureau of Mines estimates that in 1991, some 40,000 tonnes of all grades of mica were produced. Davis estimates 1994 production to be 29,000 tonnes excluding production from the former Soviet Union states. There are four principal mines in the Russia, of which the main mica complex near Irkutsk Oblast is the largest, producing over 70 per cent of Russia's output. Russia also imports mica from India, principally for use in its electronics and related industries.

# 3.1.14 <u>Canada</u>

Canada is the world's leading producer of ground and flake phlogopite mica. Production for some time has been from only one mica mine located at lac Letondal near Suzor Township, Laviolette County in Quebec. The deposit contains 90 per cent phlogopite mica, 8 per cent pyroxene and 2 per cent feldspar. Its proven reserves exceed 27 million tonnes. The Quebec Department of Mines discovered the deposit in 1936 but commercial interest did not begin until 1960 when Laviolette Mining and Metallurgical Corporation began exploration. In 1976, Marietta Corporation of the U.S.A., formed a joint venture with Societe Mineralurgique Laviolette Inc. which developed the mine and established a flake processing plant in Boucherville, near Montreal, to produce "Suzorite" mica for worldwide markets. In late 1985, Lacana Mines Inc. of Toronto, Ontario, (now International Corona) purchased the Marietta Suzorite operation. In September 1994, Zemex Corp. of Toronto purchased the company from Whittaker Clark and Daniels of New Jersey. Zemex also controls the Feldspar Corporation in Spruce Pine, North Carolina.

The mica is mined by open-pit methods and crushed on site. Twice a year, the crushed ore is transported to the treatment plant at Boucherville and is further crushed and mica flakes floated off from other granular material throughout a separation process. The

mica is delaminated and screened. A recent expansion of the Boucherville processing plant increased the production capacity from 12,000 t.p.a. to 25,000 t.p.a. and the company can now produce various screenings and grades of mica, including surface-coated mica for plastic uses. The Suzorite mica has a high purity and high aspect ratio sought by the plastics industry. It also has low combined water content, ease of delamination, high chemical resistance and relatively low cost. Its main drawback is its dark brown colour, due to iron and magnesium in the mica composition. In 1989, Suzorite dropped their nickel coated E-mica (for EMA Shielding in electronics) from their product lines due to the high price of nickel. 2 shows the end uses for Suzorite mica, and Appendix IV contains several Suzorite product specification sheets.

The Suzorite operation is successful and is seen as a strong cash generator and profits are increasing. The reasons include 1) acceptance of their new 1993 surface modified mica grades, 2) increased demand for amphiboles (asbestos) replacement reinforced plastics, and 3) use of their mica in the grilles of heavy trucks<sup>3</sup>. Last year, the Suzorite mine is reported to have produced 24,000 tonnes of mica. Davis puts the figure at 17,500 tonnes in '93. Natural Resources Canada in the 1993 Canadian Minerals Yearbook gives average total Canadian mica production of 17,000 tonnes per year for the period 1989 through 1993, and an average value of \$412.00 per tonne, implying considerable value-added content in sales, (ie: coated product).

In addition to the Suzorite deposit, mica has been discovered at several other sites in Canada, principally in Quebec, Ontario, and British Columbia. Most of the mica is muscovite, except for the northeast (Grenville) area of Quebec.

A muscovite mica mine was in production at Chelator, Ontario, until the late 1980's jointly operated by Kozumi of Japan and Soquem, Quebec, a provincial crown corporation. All the output was shipped to Japan for use by the parent company. Lacana Mining was offered the Chelator muscovite deposit to complement their Quebec phlogopite mica production and sales but declined. Rights reverted to the Crown.

Also, Stratmin Inc. of Montreal, Quebec is considering producing 10-18,000 tonnes of mica per year as a by-product of its graphite operation in Lac-des-Iles, Quebec.<sup>4</sup>

<sup>3</sup> Industrial Minerals, May 1994

<sup>4</sup> industrial Specialities News, December 26, 1994

# Table II

TONNES	USE
8,400	Plastics
7,200	Asbestos Replacement
4,800	Joint Cement
3,600	Other
<b>24,000</b>	TOTAL

# End Use For Suzorite Mica (1991)

Source: Canadian Mining Journal

Since Suzorite is the only mica mine currently in production, statistics on Canadian production are no longer published due to confidentiality reasons.

The last Canadian Minerals Yearbook (1987) which contained mica statistics estimated Canada's apparent consumption of mica at just over 13,000 tonnes in 1985 and 1986. The same reference also estimated Canadian mica production at 12,000 tonnes and total imports at 1,700 - 2,200 tonnes, virtually all from the U.S. Tanner estimated Canada's production at 17,000 tonnes in 1989. Davis of the U.S. Bureau of Mines cites the same figure for 1989, rising to 17,500 tonnes in 1993 and 18,000 tonnes in 1994. These figures differ from the 24,000 tonnes as noted in the Canadian Mining Journal for the Suzorite Mine.

Mica is primarily consumed in Canada by the construction industry of which 83 per cent is used in gypsum caulking (joint cement) products and paints. The rubber, plastics and drilling mud industries share the remaining 15 per cent.

Nearly all the mica imported by Canada is ground muscovite from the U.S. which is used for gypsum products. Imported ground-mica is consumed in Ontario (43 per cent), Alberta (30 per cent), British Columbia (16 per cent) and Quebec (6 per cent). Other countries from which Canada imports mica include India and France. Davis shows a total of 2,257 tonnes of mica (all forms), exported from the U.S. to Canada during 1993, with a total value of \$4.8 million (U.S.).

Clearly, most of Canada's mica production is exported. 3 details the export tonnages and their international destinations. The total figure corresponds to the earlier reference by the Canadian Mining Journal for total Suzorite Mine production.

## Table III

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TONNES	DESTINATION
13,920	U.S.
<b>4,5</b> 60	Canada
4,320	Asia
1,200	Europe
24,000	TOTAL

#### Canadian Mica (1991)

Source: Canadian Mining Journal

# 3.1.15 <u>U.S.A.</u>

The principal source of overview and information on the U.S. mica market is the 1993 U.S. Bureau of Mines' Annual Report on Mica by L. L. Davis. This information was supplemented with a telephone discussion with James Hedrick, who is the new mica specialist with the U.S. Bureau of Mines. Information was also obtained from other industry publications.

4 shows the export and import statistics from 1989 through till 1993 for scrap and flake mica, and for worked and unworked sheet mica.

U.S. production and processing of scrap and flake mica is concentrated in North Carolina which accounts for 58 per cent of the total U.S. production. Other states which produce mica include Connecticut, Georgia, New Mexico, South Carolina, and South Dakota. Most U.S. mica is recovered from mica schist, high quality sericite schist, and as a by-product of kaolin, feldspar and lithium beneficiation.

Franklin Industrial Minerals (owns KMG now) (TN), Zemex (owns Feldspar Corp.), Franklin Mineral Products (GA), United States Gypsum (NC) and The Lithium Corp. of America (NC) are the five largest mica producers in the U.S. (all described more fully later in this section). Virtually all scrap and flake mica sold is in ground form; 91 percent of it dry-ground, the balance wet-ground. Ten companies operate 12 grinding plants in 6 states; of these, 8 produce dry-ground and 4 produce wet-ground mica.

3 contains a map of reported North American mica producers.

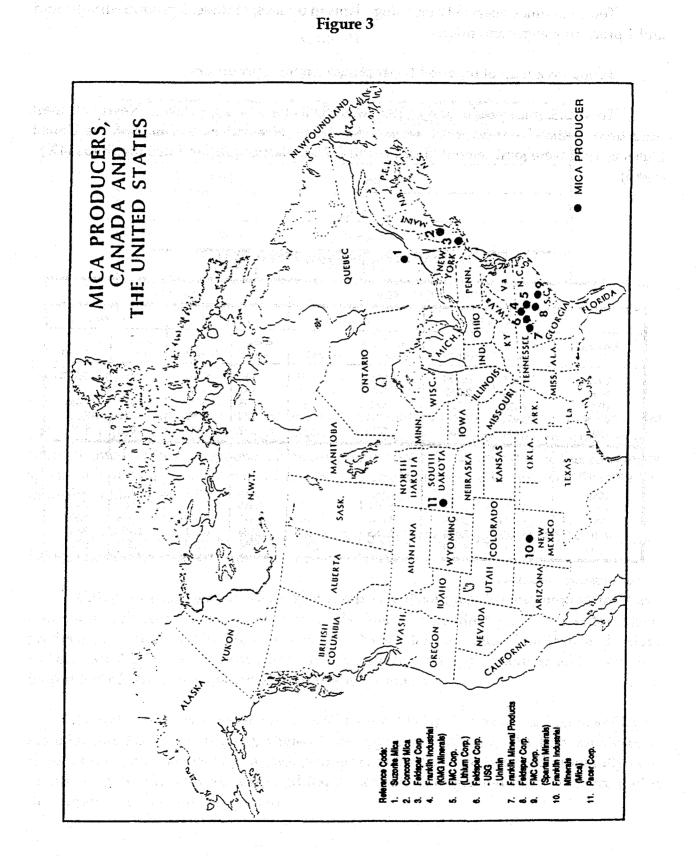
Total U.S. mica production in 1993 was 88,000 tons (scrap + flake). Nearly all sheet mica used in the U.S. is imported from India. The major end uses of mica in the United States in 1993 were joint cement (53%), paints (17%), plastics (4%) and drilling fluids (4%). (see 5)

## Table IV

		SCRAP AND	FLAKE MIC	A.		SHEET	SHEET MICA		
	Po	wder	w	Waste		Unworked		orked	
Exports	metric tons	(US\$000)	metric tons	(US\$000)	metric tons	(US\$000)	metric tons	(US <b>\$00</b> 0)	
1989 1990 1991 1992 1993	3,628 4,319 3,420 3,954 4,614	\$1,634 2,050 1,717 2,054 2,504	1,224 580 874 475 335	555 646 331 204 99	60 148 205 170 292	\$156 272 309 307 511	415 612 411 436 617	\$7,227 7,568 7,454 7,180 9,019	
Imports for consumption:									
1989 1990 1991 1992 1993	8,902 9,142 9,725 11,568 13,098	4,971 5,133 5,219 7,479 8,080	4,185 4,034 3,630 3,786 4,765	1,256 987 996 974 1,307	1,616 1,615 1,422 2,054 2,956	2,054 2,051 1,608 2,011 2,524	1,129 1,085 918 1,407 1,352	6,711 7,431 6,835 9,011 9,338	

# U.S. Trade in Mica, by Type, 1989 to 1993

Source: USBM Mica Annual Report



## Table V

# Ground Mica Sold Or Used By Producers In The U.S. By End Use and Method Of Grinding<sup>1</sup>

		1992			1993	radian ang
	Quantity	Value	Unit value²	Quantity	Value	Unit value²
End use:						
Joint cement	43	6,819	157	49	7,549	155
Paint	16	5,227		16	5,416	348
Plastics	<b>.</b>	1,347	357	4	1,647	396
Well-drilling mud	2	281	123	4	560	209
Other <sup>3</sup>	19	8,082	432	a - 19 a sec	11,814	616
Total	84	<sup>4</sup> 21,755	258	92	26,986	293
Method of grinding:						
Dry	W	w	168	W	W	152
Wet	la vel <b>w</b> e de	W	745	Webse	w.	838

#### (Thousand metric tons and thousand dollars)

W: Withheld to avoid disclosing company proprietary data.

<sup>1</sup>Domestic and some imported scrap. Low-quality sericite is not included.

<sup>2</sup>Based on unrounded dollars and thousand metric tons.

<sup>3</sup>Includes mica used for molded electrical insulation, roofing, rubber, textile and decorative coatings, welding rods, and miscellaneous.

4Data do not add to total shown because of independent rounding.

Source: Mica By L.L. Davis, 1993

The following summarizes information on the U.S. mica producers:

<u>Asheville Mica Corporation</u> - Located in Asheville, North Carolina, it can produce up to 6,000 t.p.a. of dry-ground mica. It uses scrap mica purchased from Indusmin Inc., Foote Minerals and others. All the production is consumed in joint cement application.

<u>Aspect Mining Co.</u>- this company recently purchased and is operating the plant facilities of the J.M. Huber Co. at Spruce Pine, North Carolina, and is negotiating to purchase their nearby mica deposit as well.

<u>Concord Mica</u> - is a small New Hampshire company which can produce according to Roskill about 453 t.p.a. of wet-ground mica for use in the domestic cosmetic industry. Raw material comes from India. Tanner's paper reports the company produces 1,633 tonnes.

<u>Deneen Mica Co. Inc.</u> - has a mining and processing operation near Spruce Pine, N.C., where sand is produced as a by-product. The plant had a capacity of 25,000 t.p.a.; 52 are employed in the mine and plant. Up to 90 per cent of the production is used in oil drilling mud, most of this by one customer – Caldoch Minerals of Salt Lake. The remainder of the production was used in roofing applications. Tanner noted that this producer closed production in 1991, but the Glidden Company reported in the mica survey to still buy Deneen 3 x mica for their paint products.

<u>Feldspar Corporation</u> - is a subsidiary of Zemex Corp. Its primary product is feldspar for glass, ceramics and latex paint fillers, with mica, sand, and kaolin (at Edgar, Florida) as by-products. It has 5 million tonnes of mica reserves and processing plants at Spruce Pine, N.C. (900 t.p.a. capacity), Middletown, CT (500 t.p.a. capacity), and at Monticello, GA. Almost all output is sold to USG Corporation under a contract which extends until 1999.

<u>Foote Mineral Co</u>. - is a subsidiary of Newmont Mining Corporation, employing about 100 people at Kings Mountain, N.C. Lithium ore is the principal product mined, but fluorspar, sodium sulphate, feldspar, quartz and mica are also produced as by-products. The plant has a total capacity of 7,000 t.p.a. Most of the mica is sold to the joint cement market.

<u>Franklin Industrial Minerals Co. (of Nashville, Tenn.</u>)- operates a muscovite mica mine and mill at Velarde, New Mexico,<sup>5</sup> previously owned by the "MICA" company. The company is aggressively selling its MICA White and MICA S dry-ground products in the Western U.S., primarily to joint cement and oil well drilling mud manufacturers, but also to paint and plaster manufacturers. The MICA White product would be a direct competitor to British Columbia mica, and is already well-established in the Western U.S. market. In 1989, production reached 9,100 tonnes. Franklin recently bought KMG Minerals Inc. of Kings Mountain, N.C. and merged the Velarde operations with KMG. The resultant merged unit is the largest mica producer in the U.S., with combined outputs of over 40,000 tonnes per year<sup>6</sup> (see also KMG description later in this section).

<sup>5</sup> Industrial Specialities News, Dec. 26, 1994

<sup>6</sup> Industrial Minerals, Nov. 1994

<u>Franklin Mineral Products</u> - is a subsidiary of the Mearl Corporation of Ossinine, N.Y. The company has mines and plants at Hartwell, GA, and at Franklin, N.C. It has the capacity to produce up to 4,000 t.p.a. of wet ground mica. Mica is sold to the paint, rubber and plastics industries. Mearl Corporation (parent company), a cosmetic manufacturer, uses some wet-ground mica for production of pearlescent pigments and cosmetics.

<u>FMC Corporation</u> - In 1980, FMC bought the Lithium Corporation of America and its mica plants in Cherryville, N.C., and Pacolet, S.C. (Spartan Minerals Corp.). The mine at Cherryville, NC, supplies flake mica to both grinding mills. The total average output is 15,000 t.p.a. Most of Spartan's mica is used in joint compounds; however, the plastics market is being pursued. The Cherryville product is sold mainly to oil well drilling fluid compounders.

<u>Gross Mineral Corporation</u> - This corporation mines sericite at Fairfield, PA and has a plant at Asura with a capacity to process 8,000 t.p.a. of ore. 25 percent is sold to the auto industry as a filler for plastic.

<u>Indusmin Inc.</u> - Indusmin, until recently was a subsidiary of Falconbridge Ltd. of Toronto but is now reported to be a subsidiary of Zemex Corp. This company mines silica and mica as by-products of feldspar and processed 8,000 tonnes in 1987 at Spruce Pine, NC. They also supply scrap mica to Asheville Mica Co. in Asheville, N.C.

<u>KMG Minerals</u> - KMG Minerals was formed in 1986 when King's Mountain Mica Company Inc. merged with US Mica Company and English Mica Company. In 1994, KMG was purchased by Franklin Industrial Minerals of Nashville, Tennessee. KMG mines mica, feldspar, quartz, and kaolin at King's Mountain, NC. Their capacity for wet, dry, and micronised mica is 45,000 t.p.a. Their wet ground grades are used mostly in coatings (paints), rubber, and plastics while the dry ground mica is used in construction materials and drilling muds. Some KMG product specifications are shown in Appendix V.

<u>Mineral Mining Co. Inc.</u> - MMC is a subsidiary of Piedmont Mining Co. A sericite mixed ore of mica, feldspar, clay, and silica is processed in Kershaw, S. Carolina and the mica is marketed as "Mineralite" to the paint and plastics industry.

<u>Pacer Corporation</u> - operates several mines in South Dakota. The mica is low-grade with 70 per cent muscovite and 30 per cent biotite. In addition to mica, the operation recovers potash, feldspar, silica sand, and tin and tantalum concentrates. The Custer, S.D., plant has an overall reported capacity of 100,000 t.p.a. for all minerals and the capability to produce 40-50,000 t.p.a. of specialized mica screenings for the paint and plastics markets. The principal market in the past has been for oil drilling mud use. The large capacity of the Pacer Corporation operation could be a competitor to B.C. mica in the North-western U.S. <u>Unimin Corp</u> - Unimin purchased Harris Mining Company in 1986. They mine and process at Spruce Pine, NC. Their main markets are drilling muds, paints, and joint cement compounds. Their reported total (wet- and dry- ground) capacity is over 20,000 t.p.a.

<u>USG (United States Gypsum) Corporation</u> - is a large producer and user of mica. The company employs over 20,000 and has extensive gypsum operations as well as deposits of hi-calcium limestone, dolomite, perlite and mica. The company currently operates a mica mine and grinding plant at Spruce Pine, N.C., with a capacity of 30,000 t.p.a. The company also purchases scrap mica from the Feldspar Corp. Most of their production is used internally for the production of building products, mainly joint cement. There is a substantial amount, however, sold on the open market for use in joint compounds. Since USG manufactures primarily gypsum plasterboard and markets joint cement to complement the use of plasterboard, it is very competitive in most joint cement markets and is often the price leader. USG is very strong in marketing joint cement in the Western and Southern States. USG is also examining other uses of mica, including high value-added applications in plastics. In 1993, USG produced 24,500 tonnes of mica.

To conclude this section, the world production and consumption of mica have been dropping gradually over the last few years (see 6 below). Demand is relatively low in comparison to mine and plant capacities in most countries. International mica trade is very competitive in terms of both price and quality. While tonnages may continue to drop in the years ahead, average prices could increase significantly as more sophisticated applications demand more value-added (surface treated) mica products, particularly in automotive plastics.

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# Table VI

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agente d'Agente, a collette availante agente	it will be first-	Statistics	ant angle	ale de la sec	a dente como como	jba	
an a	1989	1990	1991	1992	1993	1994 <sup>.</sup>	
World Production (tonnes)	228,000	214,000	207,000	200,000	180,000	190,000	
U.S. Production of Scrap & Flake Mica (tonnes)	119,000	109,000	103,000	85,000	88,000	96,000	
As Mined Production Value: (million dollars)	6.27	5.84	5.54	4.64	4.45	4.90	
Highligh	ts From U.S	5. Mineral ( 1994	Commodity	Summaries	•		
Tonnes mined	alah sering	epa de la contanse <del>Secondo esta contanse</del>	96,000 (58	8% North C	arolina)		
Tonnes ground	95,000						
Tonnes imported	1、 主要问题	nes na g	22,000 (5	71% from C	anada)		
Tonnes exported	a a tha an			6,000		e golaria de	
Ave. scrap + flake price		US\$51/tonne					
Ave. wet ground price	US\$840/tonne						
Ave. dry ground price		US\$160/tonne					
Total ground mica sales	US\$28 million						
Number of producing mines	and a second second			9			

Source: Davis, US Bureau of Mines

(a) Mineral Commodity Summaries for 1994(b) Annual Report 1993

\* estimated

## 4.0 MICA APPLICATIONS

The applications of mica are considerable. Sheet mica, for example, has end uses in the electrical industry due to its superior electrical insulation properties. It is used in the manufacture of vacuum tubes, capacitators, direct current motors and generators, electric heating appliances, electric lamps, diaphragms and transformer coils. Wet- and dryground mica products are used in joint cement, oil well drilling muds, paint, plastics, rubber and other filler applications. The following sub-sections discuss some of the main uses of dry- and wet-ground mica.

# 4.1 **Building Products**

The largest market for dry-ground mica is in the building products industry.

## 4.1.1 Joint Cement

Mica is used as a filler and extender in drywall joint cement which is used to fill joints and other irregularities in interior gypsum plasterboard surfaces. Mica particles are insoluble and impenetrable to water and can therefore protect the wall surface from moisture penetration. Mica also gives a smooth edge and enhances the decorative effect of the wall surface. Joint cement is primarily used on wall surfaces, but similar formulations have some decorative ceiling applications as well.

Mica used in joint cement is typically dry-ground to about 70 per cent passing 325 mesh. The use of gypsum plaster board is dominant in North America, and is finding increasing popularity in Japan. The colour of the mica product required varies considerably from region to region. Some manufacturers insist on a very white muscovite product; others will accept a yellowy-brown phlogopite material.

#### 4.1.2 Asphalt Roofing

In roofing products, mica is used as an inert filler and a surfacing agent. As a filler, mica is added to asphalt and bituminous compositions to increase hardness and resistance to mechanical stress and weathering. Applied as a coating, mica prevents sticking of adjacent surfaces of the material during manufacture and storage. Because of the platy structure of mica, the coating is not absorbed. Mica used in roofing products is ground to between 10 and 80-mesh. Mica was used more widely in roofing products in the early 1970's, but substitute products (e.g. talc) and changes in roofing materials have significantly reduced the consumption of mica in roofing products.

# 4.1.3 Insulating Wallboard

Mica is used in the production of insulating and fireproof wallboards, particularly in the United Kingdom. It can be an asbestos substitute because of its similar insulating and fire-resistant physical properties. Dry-ground mica in the 30-40 mesh range is used. It is expected that this application of mica in wallboard will expand in the next decade in Europe, North America and Japan.

# 4.1.4 Brick Manufacture

A low quality mica (sericite) can be used in brick manufacture as a colouring agent and filler. Normally sericite purchases such as this are not included in mica consumption statistics.

# 4.2 Oil-Drilling Muds

Some drilling muds are supplemented with mica when "lost circulation" is detected. Drilling muds have a natural tendency to flow into permeable formations and fractured zones, since the bore hole pressure is generally quite high. The loss of hydrostatic pressure can allow the influx of natural formation fluids and possible loss of oil well control. Mica is added to the mud to seal off the lost circulation zones. The platy structure of mica facilitates the overlapping of particles to form a layer or wall, thereby preventing further fluid loss. Mica also helps to keep solids in suspension. Low quality mica is satisfactory for these applications; purity and colour are not important. Coarse ground mica passing 30mesh is the most common screen size used.

Rock formations in North America are more fractured and therefore more susceptible to circulation loss than oil drilling areas in the Middle East and the North Sea. Consumption of mica in drilling muds is related to oil drilling activity and the availability and cost of substitute products. Consumption by the oil and gas industry has been depressed for the last several years but with the recently renewed oil and gas exploration activity, consumption of mica in drilling muds will likely increase.

# 4.3 Paint and Coatings

In paint, mica acts both as a bulk and functional filler as it reduces the consumption of more expensive fillers and improves the optical and mechanical properties of paint. Exterior paints are the main areas of use due to mica's reinforcing properties. Due to the mineral's good suspension characteristics, the mica particles prevent sagging and settling of paint. Traditionally, consumers used 325 mesh wet-ground mica. In recent years, as a result of the high cost of wet-ground mica, there is increasing use of dry ground mica with mean particle sizes of 5 to 20 microns. There are several other filler materials used in paint including talc, barytes, kaolin, calcium carbonate and diatomite. Talc fillers are the strongest competitor to mica due to talc's low cost and wide availability. The consumption of mica in paints and coatings is related to both new construction and retrofit construction markets, and to the demand for specialty paints where mica's specific properties are desired (e.g. exterior surfaces and high traffic surface areas). Despite static or decreasing consumption in exterior paints a new market has appeared that relies on mica as a unique product: pearlescent pigments for sophisticated coatings used in the automotive industry, particularly by Japanese automobile manufacturers.

## 4.4 Plastics

Mica is used both as a bulk filler to reduce the quantity of plastic resin needed and as a functional filler to impart desirable physical, electrical and processing properties to the plastic. The following are the most important properties in mineral fillers used by the plastics industry:

DENSITY Low density preferred to reduce weight and maximize resin savings. COLOUR High degree of whiteness desired. HARDNESS Hard minerals can cause abrasion on processing equipment but can be beneficial in plastic products. PARTICLE SIZE Fine particles of similar size distribution are important. PARTICLE SHAPE Fibrous minerals reinforce plastic. ABSORPTION Absorption of resins increases filling cost and mixture viscosity. MOISTURE Should be free of moisture; moisture absorption should be low. DISPERSION Good dispersion and "wetting out" needed; affected by particle size and use of surface treatment.

Mica competes with talc, asbestos and calcium carbonate as a filler in thermoplastics. Mineral fillers are used in a variety of resins but particularly in polypropylene (PP), phenolics and nylon. Mica is also used in polyester, and high-density polyethylene (HDPE). Many mica products are surface-coated with silanes and titanates in order to improve the properties of the mica in thermoplastics and to reduce possible fracture cracks. Mica-filled plastics are mainly used in the automobile industry but applications are found in the appliance, moulded luggage and acoustic industries as well. Thermoplastics has proven to be an important new application for mica because of its heat resistant properties. PVC pipe manufacturers were interviewed in the market survey but none reported the use of mica.

# 4.5 <u>Rubber</u>

Mica is used as a dusting agent and an inert filler in the production of rubber. It can be applied either as a powder or in a water/soap solution. Mica is suitable as an antifriction and anti-sticking agent in moulds and in valcanizing compounds. The main application for mica in rubber is as a dusting agent in the production of rubber tires. Mica, however, has only a small share of the rubber market as less expensive minerals such as kaolin, and carbon black are more extensively used. In the rubber industry, mica is normally wet-ground to a mesh size of between 160 and 325-mesh. Dry-ground powder is used as the dusting agent. This consumption appears to grow in accordance with the tire industry. However, consolidation within the industry and discontinued use by large firms such as Goodyear and Bridgestone appear to threaten this tradition.

## 4.6 Amphiboles Substitute Products

There could be a developing market for mica as a substitute for amphiboles such as asbestos. Amphiboles, especially tremolite asbestos, are subject to environmental concerns which limit its use in a number of products where its high tensile strength and high temperature resistance have made it the mineral of choice in hundreds of applications, some of which could use mica. These products include mortar mixes, brake linings, asphalt roof shingles, calcium silicate products, caulking compounds, and fireproof spray-on textures. There are, however, other minerals ready to compete with mica in these markets.

### 4.7 Other End Uses

There are a variety of other end uses for mica but most consume only low volumes of the mineral. These applications include:

WELDING RODS

Dry-ground 50-mesh mica is used in the flux coating of arc welding electrodes.

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PAPER

Mica-filled paper is being developed for its opacity in mechanical printing paper. It is also added to improve decorative coating qualities of wall paper, greeting cards and art finishes. The mica particles provide a silvery sheen on the paper.

COSMETICS Mica provides a pearly lustre and glittering effect in nail varnishes, lipsticks, eye shadows and barrier creams. Mica has the advantage of ultra-violet light stability, lubricity, skin adhesion and compressibility.

#### LUBRICANTS

Mica can be used as a dry lubricant to prevent hot bearings from seizing up and be incorporated into special greases which operate at high temperatures.

ELECTROMAGNETIC

The use of electro-plated mica flakes as an electromagnetic shield for certain appliance uses is reported.

SHIELDING

Interference shielding material is sold by firms such as Suzorite. It competes with more expensive aluminum film.

## 5.0 MARKET SURVEY

A market survey was conducted to determine the demand for mica products by industry sector in the Western states and provinces. The survey also collected information on suppliers, quality, price and other market factors. Supplementary to an extensive literature search, a facsimile questionnaire and telephone follow-up program was also initiated within the market area which could be served by a potential B.C. mica mine. Interviews were held with government industrial mineral experts, suppliers and distributors and others knowledgeable with regard to the mica market and market trends.

## 5.1 Paints and Coatings

Mica is used by paint and coatings manufacturers as a filler and an extender. It acts both as a bulk and functional filler and reduces the consumption of other more expensive fillers. It also improves the optical and mechanical properties of paint. Other minerals commonly utilized as paint fillers include: talc, calcium carbonate, kaolin, feldspar, and wollastonite. Calcium carbonate is used in much greater quantities than mica, accounting for approximately 30 per cent of the total paint filler market.<sup>7</sup> Roskill estimates some 58,000 tonnes of mica is used annually in the world production of paint, including 20,000 tonnes in the U.S.

Mica is used in a wide variety of paints and surface coatings, including traffic paint, marine paint, aluminum paint, cement paint, floor paint, interior wall and ceiling paint, exterior paints and primers, flat paints, translucent and opaque window varnishes and finishing lacquers. Exterior and heat resistant paints are the key areas of use for mica because of the material's insulating, reinforcing, and flattening properties. In exterior paints, mica increases corrosion resistance by providing protection against the sun's ultraviolet rays and rain with no detrimental effect on other paint properties.

In 1988, world sales of paint reportedly hit 19.1 million tonnes.<sup>8</sup> The 1993 estimate is 21.5 million tonnes. Growth is predicted at an annual rate of 2.4 per cent throughout the 1990s. Projected North American use in the year 2000 is 6.2 million tonnes while Western Europe will use 5.9 million tonnes. Japan will use 3.1 million tonnes<sup>9</sup> and South East Asia 2.6 million tonnes. The former Soviet republics and Eastern Europe are expected to use 3.8 million tonnes of paint in the year 2000.<sup>10</sup> Paint is mainly consumed by the construction

- <sup>8</sup> Ibid
- <sup>9</sup> Ibid
- <sup>10</sup> Ibid

<sup>7</sup> Roskill

and automobile industries. In some countries automobiles account for 20 per cent of paint consumption (example: Japan). Demand for mica fillers and extenders is expected to grow at a slightly higher rate than paint production, as manufacturers concentrate on cutting production costs to remain competitive and use more fillers and extenders. There is also a shift from oil- based to water-based paints. These paints, mainly emulsions, can benefit from the addition of mica, as the mica acts as a suspension agent and facilitates sediment dispersion. Closely controlled particle-size distribution of the mica material is needed for automotive paints, exterior coatings and electrophoretic paints. Marine paint is another application where mica can provide corrosion resistance.

The U.S. Industrial Outlook 1994 has forecast that total new construction in the U.S will increase at 2 per cent annually in constant dollars. Fortunately for the paint industry, the repair and remodelling sector will experience higher gains between 1993 and 1998 (4 per cent). Housing starts are projected to grow at a 3 per cent rate. These should all provide a stable demand for mica in the construction paint sector.<sup>11</sup>

The automobile industry market for mica-based paint and specialty plastics appears very favourable. The U.S. automobile industry is becoming profitable once again and new models are gaining increasing market share. Furthermore, Japanese manufacturers are becoming global corporations that not only purchase in North America, but produce in North America. This is important if one considers shipping costs of mica in relation to the final delivered price. Enormous potential (for mica) is evident in the popular pearlescent pigment market for automobile paints. This is due to the fact that there are no alternatives for mica. Pearlescent pigments are created by sandwiching mica platelets between layers of titanium dioxide. Thin layers of titanium dioxide create a white pigment while thicker layers increase the refractive indices and hence create translucent colors. Iron oxides can also be added to the pigments to increase or modify color. Pearlescent pigments are mainly used in automotive coatings. Since Korea and Japan produce many automobiles and pearlescent paints are popular with their glossy, metallic finish - these countries consume and produce a lot of pearlescent pigments. Already KDK Automotive Coatings has a pearlescent pigment plant in South Korea and Shiseido Company is a producer in Japan. Globally, the Mearl Corporation and Merck (of Germany) dominate the market. Naintsche (of Germany), EM Industries, and Kemira Oy (Finland) also supply large amounts of pearlescent pigments.

For example, EM Industries reportedly uses so much mica that this company has integrated a mica mine into their operations.<sup>12</sup> This corporation sells pearlescent pigments

<sup>12</sup> Based on interview with Donna McGee of EM Industries

<sup>&</sup>lt;sup>11</sup> US Industrial Outlook 1994

under the trade name "Afflair". Kemira Oy is one of the main suppliers to the Japanese automotive paint manufacturers.

# 5.1.1 <u>Consumers</u>

Other paint manufacturers which use mica include:

<u>The Mearl Corporation</u> - based in New York, this company owns the mica producer, Franklin Mineral Corp. (not to be confused with Franklin Industrial Minerals). The Mearl Corporation uses wet-ground mica (for both cosmetics and pearlescent pigments) from Franklin Minerals. Tonnage figures are not available.

<u>The Glidden Company</u> - this is one of the largest paint manufacturers in North America. They use 500 tonnes per year of mica direct from suppliers. They incorporate three brands into their paint products: Franklin's Alsibronz 12, KMG Micro C-3000, and Deneen 3X Mica. Their consumption, based on a telephone interview, is expected to remain static for the next 5 years.

<u>E.I. Du Pont</u>- this producer uses 152 tonnes of wet ground mica a year at US\$550 per tonne. They expect consumption to increase 10 per cent over the next 5 years.

<u>Cloverdale Paint Inc.</u> - locally (Vancouver), this company uses 38 tonnes annually of wet ground KMG C-3000 supplied by the distributor Cascade Marketing. They require an off-white 325 mesh wet ground mica that is in local inventory. They would be willing to switch brands if the mica was of the same quality they are presently using. They expect their consumption to increase between 10 and 20 per cent over the next five years according to company officials interviewed.

<u>Acheson Colloids</u> - based in Michigan, this corporation uses 30,000 lbs. per year of mica, primarily for automobile paints according to a questionnaire response from this paint company.

<u>General Paint Ltd</u>. - locally (Vancouver), this company only uses 200 lbs. of mica per year purchased from Franklin Minerals.

<u>Consolidated Coatings Corp.</u> - locally (Vancouver), this company uses 2,200 lbs per year of 325 mesh wet-ground mica from Franklin Minerals.

<u>Bonder International</u> - based in Missouri, this company uses 80 tonnes of mica per year, for automotive and specialty paints.

This is only a small sampling of the companies that produce paints in North America. The telephone and fax survey was intended to produce a brief description of volume and quality of mica used and forecasts from the consumers. Many corporations would not reveal information on their consumption due to confidentiality and some do not use any mica in their formulations (approximately 15 per cent of those contacted).

#### 5.1.2 Conclusions

In the United States, Franklin Industrial Minerals (just acquired KMG minerals) is easily the largest supplier of mica to the paint industry. This is due to the fact that they possess wet- grinding facilities. Franklin's operations are based in New Mexico and North Carolina, enabling them to have close access to most of the paint producers and low transportation costs to the Great Lakes region which has a large number of paint producers based there as well as in California. In Western Europe, Micarec, Microfine and A/S Norwegian Talc supply micronised mica to the paint industries; Gelletich (of S.Africa) supplies the UK market. Slow growth is predicted for Western Europe, while Eastern Europe and Asia will experience increased demand for paints according to Roskill. There is clearly room for new suppliers in these growing areas, particularly Asia. However, transportation costs to these regions could be a significant hurdle. However, wet-ground mica, used in the paint industry, is priced at US\$600 per tonne, and transport costs may be viewed as being reasonable in relation to the selling price of the mica.

A new western supplier of wet-ground mica to the paint and coating industries would face several market entry challenges, such as:

- 1. wet-ground is more expensive to produce than dry-ground mica due to additional processing costs.
- 2. high delivered cost of mica in the past has prompted mica consumers in the paint industry to discontinue use or integrate mica mining operations into the company. For example, pearlescent pigment manufacturers have no alternative for mica, so companies such as EM Industries and Mearl have their own mica extraction and production operations. Essentially, the pearlescent pigment market must have its own assured supply of mica.
- 3. apparent very low level of demand in the region, likely less than necessary to be viable, unless new sources of demand should arise.

However, despite these market entry obstacles, a wet-grinding facility may be successful in British Columbia. The Asian market could be penetrated upon arrangements with a Japanese or Korean trading house or a pearlescent pigment manufacturer in Asia. Also, there is a strong paint producer presence in the State of California. Roskill reports that about 2,550 tonnes of mica are consumed by California paint manufacturers. B.C.produced mica would have a freight advantage relative to North Carolina producers (but not to Franklin's wet-grinding facility in New Mexico). This advantage combined with a weak Canadian dollar, could allow a mica producer in B.C. to penetrate this substantial regional California market as well as Asia.

#### 5.2 Plastics

Mica is used as a filler and a reinforcing agent in plastics. Density is important in the mica when used as a filler, as it will determine the reduction in resin weight that can be achieved. Particle size, size distribution, particle shape and surface area also affect filler performance, as do dispersion and absorption properties. In addition, deflection temperature is a factor in styrenes, polypropylene and polyolefins plastics. Dimensional stability is required in phenolic moulding compounds and flame resistance is required in automotive and construction plastics.

A number of other materials including asbestos, silica, wollastonite, talc, kaolin, and calcium carbonate are also used as resin extenders in plastics. Mica competes principally against asbestos, silica and kaolin due to their slightly lower specific gravities. Mica also competes with the resin itself, which has a lower density than mineral fillers. The higher the price of a polymer, the greater the incentive to add a mineral filler. Higher priced resins including nylon are compounded with minerals as fillers. Lower priced thermoplastics such as polypropylene are normally compounded with mica to increase flexural strength rather than to reduce costs. In this respect, mica is a functional filler, not a bulk filler. In the 1990's mica has moved away from being a bulk filler to solely a functional filler due to cheaper alternative products. This shift prompted additional research and development into the properties mica can impart by such companies as Suzorite to take advantage of these special market niches.

When used as a reinforcer in thermoplastics, mica improves their electrical properties, flexural strength and modulus, stiffness, heat deflection temperature and heat resistance. It also absorbs ultra-violet radiation. Furthermore, it has a low hardness, and hence does not have an abrasive effect on process machinery. It is chemically inert to acids, alkalis and solvents.

Both wet- and dry-ground mica are used in plastics. Wet-ground mica provides thin flakes with a high aspect ratio. Delaminated dry-ground mica, where the individual flakes have been separated to yield a high aspect ratio, are also used, particularly for reinforcement uses. High aspect ratio is sought in both wet and dry mica since its laminar structure can provide reinforcement in a plane instead of just along a single axis, as is the case with glass fibre and asbestos. Because wet-ground mica is naturally more delaminated, it is more sought after than dry ground for use in plastic compounds. Two of the main disadvantages of using mica in plastics is poor impact strength and poor strength along weld lines. Incorporating elastometric impact modifiers or low loadings of glass fibre into the mica- reinforced compound can assist the process. More recent research has found that PET (an organic fibre called polyethylene terephthalate) increases impact strength significantly and low loadings at 5-10 per cent is recommended as a better solution than the first two since they can have detrimental side effects such as warpage. To improve weld strength, PET reinforcement along with moulding and mixing improvements improve weld strength.<sup>13</sup> Mica is not recommended as a filler for plastics with large weld areas. Phlogopite mica (Suzorite mica) cannot, for example, be used in plastics with any weld lines.

Surface-treated minerals have been developed to allow higher filler loadings and to reduce uneven shrinkage, porosity and fractures caused by poor impact strength. Surface-modified mica has higher composite strength, lower viscosity, improved rheology and lower sensitivity to water. The coating agents react with both resin and filler to provide a good bond between the two. Silanes are the most common surface- coating agents used with mica. It is expected that a significant portion of mineral fillers will be surface-treated in the future (Some reports such as the Kline survey report that surface treated mica accounts for 70 per cent of mica fillers used in plastics). This is evidenced by the growing list of specialty micas offered by producers.

In the early 1980's many resin and plastic compounders experimented with the use of mica but experienced impact strength problems due to a lack of technical information on the application of mica. Many dropped the use of mica in their products, particularly with the decrease in resin cost due to falling petroleum prices. More recent research on the improved properties of mica with surface treatment agents and additional technical information on its use, has, however, renewed interest by the resin and plastic compounders.

Mica is used in thermoplastics chiefly because of its heat resisting properties. Mica can effectively fill many plastics but is most effective in polypropylene (PP), polyethylene (PE), polyurethane (PU), polyethylene terephthalate (PET), polybutylene terephthalate (PBT), and nylon (PA) types of plastics. The following describes these plastics and the use of mica in the various compounds.

#### 5.2.1 <u>Resins</u>

<sup>13</sup> Roskill

POLYPROPYLENE (PP)

## POLYETHYLENE (PE)

POLYURETHANE (PU)

POLYETHYLENE (PET)

TEREPHTHATE (PBT)

<sup>14</sup> Roskill

<sup>15</sup> Roskill

This easily represents the largest market for mica fillers. This is because a loading with 30 per cent mica and 5 per cent PET reinforcement can triple the strength of standard polypropylene that would normally be filled with fibre glass. Furthermore, PP is quickly diversifying into many uses and is one of the cheaper resins. This is extremely advantageous for mica. Polypropylene is mainly used in the automobile industry and for appliance parts.

Polyethylene's main application is in blowmoulded bottles (30%). However mica is used only in high density polyethylene (HDPE) and PE for packaging that must be aesthetic. Filled PE's are being marketed as an alternative to expensive acrylonitrile butadiene styrene (ABS) which are also used in automobile parts, moulded luggage and appliances. Interestingly, the largest growth market for filled PE appears to be HDPE fuel tanks. Already, most European cars have plastic fuel tanks and by 1998, 50-90 per cent of US fuel tanks are expected to be HDPE.<sup>14</sup>

Mica is not used in large amounts in this plastic. However, mica filled PU is being tested as an alternative to metals in exterior automobile parts, such as doors. If successful, there may be huge growth potential. Dow Chemical Co. is developing these polymers.

As already stated earlier polyethylene fibres are and POLYBUTYLENE mixed with mica to improve impact strength in low loadings (5-10%).<sup>15</sup> However, mica can also fill combined PET and PBT fibres (60% PET load) to impart very desirable electrical properties. Sixty per cent of these filled resins are used in the electronics sector alone. But, this electronics market is small, whereas most PET is used for packaging (where mica is not useful).

Reinforcement with mica (preferably silane coated) provides rigidity, low abrasion, increased flexural strength as well as minimal warpage. It is also easily painted and baked. Nylon in the automobile industry is used for grill opening panels, under-the-hood parts and headlight covers.

The biggest market for mica filled plastics is in automobiles. Currently, these applications are being developed for use with mica filled plastics: 1) air conditioner fan blades, 2) grill assemblies, 3) dashboard panels, 4) head lamp assemblies, 5) fan shrouds and floor panels, 6) seat backs, 7) load floors, 8) ignition system parts, 9) air conditioner and heater valve housings, 10) exterior panels, 11) brake linings (replacing asbestos). The desire for lighter and more fuel efficient cars is forcing manufacturers to use plastics that significantly lighten an automobile. However, resins such as polypropylene, alone, cannot withstand the high temperatures and abrasion common in automotive applications. Mica filled resins have stood up to high temperatures (even in the engine compartment) and high impact stress. Coupled with mica's enhancement of plastics is the auto industry's ability to develop and produce more innovative automobile components in terms of shape and design.

E

NYLON (PA)

#### 5.2.2 Conclusions

Despite the potential growth for mica filled plastics, there are problems to consider for mica producers who wish to enter this specialized market. Easily the largest is the research and capital investment it takes to develop and process specialty mica for the plastics industry. Once a specialty grade has been developed, processing costs can be enormous. For instance, delamination itself can add US\$200 per tonne to the cost of processing.<sup>16</sup> Furthermore, once a market is tapped, ongoing technical assistance must be made available to the customer at considerable expenses. A selling price of over US\$1000 per tonne may be required to cover all of the costs. Also, there may be future environmental problems for filled plastics.<sup>17</sup> Non-filled plastics can be reclaimed, whereas filled plastics are burnt after use. This factor could be important in the auto industry where manufacturers are trying to increase the percentage of a car that can be recycled. Competition also is increasing in the mica specialty grade industry. In 1980, Marietta Resources (Suzorite) controlled 85 per cent of this market. Six years later, mica suppliers realised that profits could be large in this growing market. As of 1991, in the USA, at least nine firms supplied mica to the plastics industry and the market may be now saturated.

However, Suzorite Mica products of Boucherville, Quebec, has maintained profits in the face of this growing competition. Seen as a strong cash generator, the company was purchased by Zemex Corporation from Lacana Inc. in 1993.<sup>18</sup> Both of its previous owners (Marietta Resources and Lacana Petroleum) invested heavily in Suzorite's future. In 1985 CDN\$14 million dollars was spent on facilities that ultimately produced delaminated HAR (high aspect ratio)mica grades for the plastics industry.<sup>19</sup> With capital, proper technical expertise, and aggressive marketing its profitability can be maintained. With mica's use changing from that of a bulk filler to a functional filler, it is no longer subject to falling resin prices. Also, mica becomes a necessity rather than a mineral that can be substituted with cheaper alternatives. Lastly, mica is a necessity in most polypropylene applications. Polypropylene is poised to dominate the resin market. In October of 1994, "Modern Plastics International" reported that polypropylene is set to capture a large share of the resin market due to its low price. But perhaps the best attribute of polypropylene is its diversity of applications (Roskill notes that in Europe polypropylene has the fastest growing resin market share).

<sup>16</sup> Hawley

<sup>17</sup> Hawley

<sup>18</sup> Canadian Minerals Yearbook, 1987

<sup>19</sup> Canadian Minerals Yearbook, 1987

#### 5.2.3 Consumers and suppliers in the plastics industry

Zemex Corp. - owns the Suzorite operations which markets three silane treated mica grades suitable for PP and PE. It also markets two grades suitable for acrylonitrile butadiene styrenes as well. This operation is recognized as the market leader in profits and research.

<u>NYCO. Minerals Inc</u>. - markets "MicaCoat" to the auto and construction industry. This chemically modified mica is suitable with PU and PE.

<u>Eagle Quality Products Co.</u> - markets two series: the M series and the "MicaFlex" series. Their products are suitable with PP, PBT, PVC, PE, and nylon. They have developed applications for retort packages, microwave food packaging and kitchen appliances.

<u>U.S. Gypsum</u> Co. - markets treated (with Hercules silanes) and untreated delaminated mica grades.

<u>MICA</u> (now owned by Franklin Industrial Minerals) - market a titanate treated mica grade. Franklin recently purchased KMG minerals who produced 3 wet ground grades and 3 micronised grades suitable for plastics.

<u>Franklin Mineral Products</u> - produces surface treated grades suitable for PP and PE. <u>PQ Corp.</u> - supply mica flakes coated with metal.

Polifil - produce mica filled PP's for use in ceiling fan blades.

LNP Corp. - produces mica filled PP's, PBT's.

<u>Plascoat Corp.</u>- produces PP with 60 per cent mica, chalk, and talc.

Ferruzi (Italy) - have and are building polypropylene plants in Russia.

Sheller Globe - use mica filled PP in their door panels.

<u>Tec-Air</u> - produce mica filed PP fan blades.

<u>General Motors</u> - use mica filled PP in seatbacks and their Saturn model has an all plastic body.

Volkswagen - uses PP extensively in their products.

Washington Penn Plastics - investigated mica filled PP foam.

BASF - markets PP foam for bumpers used on autos in Europe.

<u>Mitshubishi Ltd</u>. - developed a mica filled HDPE fuel tank.

<u>Hercules</u> - sells silanes which couple mica.

<u>DuPont</u> - markets mineral filled plastic food containers.

General Electric - produces mica-filled PBT's marketed under the name"Valox".

<u>Celanese Corporation</u> - produces mica-filled PBT's.

GAF Corp. - produces mica-filled PBT's.

<u>Dow Chemical Co</u>. - developed mica filled PU polymers suitable for exterior auto parts.

## 5.3 <u>Rubber</u>

Mica is used as a dusting agent and an inert filler in the production of rubber. When used as a filler, mica increases the hardness, tensile strength and tear resistance of rubber particles. As a compounding ingredient, mica prevents massing and reduces gas penetration. Mica also acts as an anti-friction and anti-sticking agent in rubber moulds. The main application for mica in rubber is as a dusting agent in the production of rubber tires where it is placed between the inner tube and casing of the tire. Mica prevents the inside of the tires from sticking to the mould during vulcanization and also prevents the outmigration of sulphur, while permitting air bubbles to escape.

The total rubber industry demand for mica, however, is minimal. Roskill noted that rubber accounted for only 4 per cent of mica consumption in the U.S. (1991). In 1994, this share is likely less than 3 per cent. As a rubber filler, it competes with less expensive industrial minerals such as carbon black, sulphur, kaolin, barite, calcium carbonate and silica. Talc is the principal competitor as a dusting agent. These cheaper competing products and improved manufacturing techniques have reduced the volume of mica used in the rubber industry by half within the last five years.

Mica used in the rubber industry is wet ground to a mesh size between 160 and 325 mesh. It must be free of grit as impurities reduce the rubber's tensile strength and cause premature flex-cracking. When used as a dusting agent it must not contain impurities.

In 1991, it was estimated that 16 million tonnes of natural and synthetic rubber were produced in the world, with two-thirds of it being synthetic. The U.S. is the largest rubber producer at 2.7 million tonnes, followed by the U.K. at about 2 million tonnes. Indonesia, Malaysia, and Thailand are also large producers of natural rubber (1.5 million tonnes each). In the rubber industry, two-thirds of natural rubber and 42 per cent of synthetic rubber are used in the tire industry, easily the largest consumer sector.

In 1990, the world tire industry was worth US\$46 billion dollars. Michelin holds 22 per cent of this market share while Bridgestone and Goodyear each control 17 per cent.<sup>20</sup> In recent years there has been a lot of consolidation and rationalisation, resulting in mergers and takeovers. There have been six large mergers or takeovers, each involving an overseas producer purchasing an American producer to secure their position in the American market (which represents half the world tire production).

Three major producers of tires were contacted to determine their consumption of mica. Goodyear Tires has not use mica since 1987 and has not resumed use, while Firestone (now Bridgestone), also has discontinued its use since 1987. Michelin did not respond to our questionnaire follow-up attempts. Other manufacturers, such as local Big O Tires, do not produce their own tires. Instead, they contract out the production to several small firms.

Since 1986, rubber production has been steadily increasing due to increasing tire sales. For example, replacement tire sales increased from 155 million units in 1991 to 164 million units in 1994(7). Tire industry analysts such as Saul Ludwig are optimistic about the tire industry in North America. Reports such as Roskill (1991) indicate that mica consumption should follow tire production. However, this view may be overly optimistic based on our responses from Goodyear and Bridgestone. Mica consumption in the rubber industry has already experienced a significant decrease and it is possible that it may decline even further.

#### <sup>20</sup> Roskill

#### Table VII

YEAR	REPLACEMENT UNITS (millions)	ORIGINAL EQUIPMENT (millions)		
1991	155.4			
1992	161.5	46		
1994	163.5			

#### **Tire Production Statistics**

Source: Rubber World, February 1993

#### 5.4 Dry-Wall Joint Cement, Plasterboard, Wallboard

Dry-ground mica (approx. 200 mesh particle size) is used as a filler and extender in joint cement (which is used to fill joints between sheets of gypsum plasterboard), the major components of which are calcium carbonate and cement. Mica acts as a reinforcing agent and prevents cracking and peeling, as well as reducing shrinkage. The amount of mica used in joint cement ("mud") varies according to the compound ingredients desired but averages about 10 per cent of the total joint cement volume. The product is sold to drywall contractors either wet or dry. The wet (water included) saves the contractor time in mixing and is also much more convenient. A white colour is desired by contractors, but wall paint can cover darker types of cement. However, suppliers of darker mica, such as Suzorite, are having problems retaining some joint cement customers. The bulk density of mica should be in the 14-16 lb. per cubic foot range. Light weight joint cement, made with coated perlite filler is becoming very popular with contractors.

Formulations similar to joint cement are also used in ceiling textures and for decorative effects, many of which also contain mica. The market survey revealed that mica is extensively used in the drier areas of the Southern and Southwest U.S. since the platy structure of mica retains moisture, so that the contractors can "trowel on" the joint cement without the mixture drying out before the application is complete.

There are some partial substitutes for mica in joint cement. The most common is platy talc which is mined and processed in Montana. This talc meets most of the desired qualities and is considerably cheaper than mica. Gypsum itself has been used by USG Corp., but this apparently has not been a satisfactory alternative to mica in joint cement. Also, a cellulose product which imparts some of the same qualities as mica is being used by companies such as Synkoloid Canada. Treated perlite is fast becoming a popular filler in light weight joint cement; a lower bulk density is attained in the "mud" at no increase in volumetric cost. Lastly, sericite, is a cheaper substitute for mica, while it is still very similar to mica in its properties but typically has impurities. However, many joint cement producers will not use low grade sericite due to quality problems and darker colour.

Roskill estimated that 71,000 tonnes of mica per year was used worldwide in joint cement in 1990. This represented nearly 30 per cent of the total consumption of mica. North America was by far the largest market, accounting for over 90 per cent of world consumption (62,000 tonnes). In North America, this 62,000 tonnes represented over 50 per cent of the total mica market. Davis reports in 1992 that joint cement consumption of mica dipped to 43,000 tonnes but in 1993 had increased to 49,000 tonnes. The use of prefabricated gypsum plasterboard is much less widespread outside of North America, and other countries have different construction practices.

The use of gypsum plasterboard expanded rapidly in the 1960's in North America. It provided fireproof construction and required less time and skill to construct than the traditional two-coat plaster wall. Over the last twenty years, gypsum plasterboard has become the leading interior wall-cladding material in North America. It is reported that Mica is sometimes used in plaster board to lend heat resistance and strength. U.S. Gypsum, the largest manufacturer, however, does not use mica in its plaster board.

Wallboard manufactured in the U.K. and Australia uses mica to provide insulating and fireproof characteristics. Pure mica with a minimum quantity of fines, dry ground to 30 or 40 mesh is preferred. Wallboard production has been increasing in Europe due to the increased use of insulation with fire proof standards incorporated into the wallboard. Cape Boards (UK) is the world's largest supplier of wallboards and uses about 8,000 tonnes of mica a year in the production of their products.

Since mica is incorporated in three construction products (joint cement, plasterboard, and wallboard) it is reasonable that the consumption of mica in these products follows the health of the construction industry.

In 1993, the total value of all U. S. construction increased 4 per cent to 460 billion dollars.<sup>21</sup> However, this is 8 per cent lower than the 1987 adjusted value. The U.S. Industrial Outlook 1994 forecast 2 per cent growth overall. The repair and remodelling industries experienced better growth than commercial construction overall. Housing starts are expected to increase 4 per cent in 1994 to 1.3 million units in the U.S.

42

<sup>&</sup>lt;sup>21</sup> Manufacturing USA, 1994

Due to the migration of Americans moving to the sun-belt, regional variation in new construction starts has occurred. From the Econometric Forecasting Service, 8 shows that from 1989 to 1992, the South has fared the best in housing starts while Midwest housing starts have remained relatively static. House starts have declined in the West moderately while starts in the Northeast have declined steadily. Roskill Information Services, using different data sources, reached the same conclusion as the Econometric Forecasting Service.

#### Table VIII

#### New Privately-Owned Housing Units Started - Selected Characteristics: 1988 to 1992

YEAR	REGION (HOMES 1,000)					
	North-East	Mid-West	South	West		
1988	235	274	575	404		
1989 - San	179	266	536	396		
1990	131	253	479	329		
1991	113	233	414	254		
1992	127	288	497	288		

Source: U.S. Bureau of the Census, Construction Reports, series C20, monthly.

Mica: February, 1995

africt.

## Table IX

antigene päärivasteen tii <b>ITEM</b> tiiteksevaneen van saar v	1990	1991	1992	1993*	1994
Value of new construction put in place (bil.\$)	442.1	403.4	436.0	460.0 -	-
Value of new construction put in place (bil. 1987\$)	397.5	360.7	386.9	398.4	405.9
Number of private housing units (000)	1,193	1,014	1,200	1,250	1,300
Shipments of mobile homes (000 units)	188.2	170.7	210.8	265.0	290.0
Producer price index for all construction materials (1982=100)	119.6	120.4	122.5	127.8	
Producer price index for all gypsum products (1982=100)	105.2	99.3	100.3	-	-

#### Construction: Trends and Projections, 1990-94

Source: U.S. Department of Commerce: Bureau of the Census; International Trade Administration (ITA); U.S. Department of Labor, Bureau of Labor Statistics. Estimates and forecasts by ITA.

estimate

forecast

One can look at the forecast for gypsum wallboard products also. In 1993 sales rose to 20.5 billion square feet, an increase of 2 percent over the previous year. Gypsum sales are expected to increase to 21 billion square feet, an increase of 1.5 percent for 1994. Gypsum sales are on a modest recovery path after the recession in 1991 and a boom year in 1992 (15 per cent adjusted value growth).<sup>22</sup> What may be hampering the overall gypsum industry is the poor prices gypsum receives. The Producer Price Indexes, a publication of the U.S. Bureau of Labor Statistics, reports that the average Price Index (using 1982 as a base) in 1992 for the average construction material was 122.5. However gypsum products only had a price index of 100.3, one of the lowest and well below its 1986 value 137.0.(9).

Despite the current situation, it is important to look at the long range forecast of construction. If we look at gypsum products, solely, modest recovery is expected until 1998 while non-residential construction will not appreciate until 1995. The remodelling sector is expected to lift total gypsum products sales to an annual 1.6 per cent growth rate through

<sup>22</sup>Manufacturing USA, 1994

1998. Construction estimates are relatively similar with only modest growth (2 per cent annually). If interest rates remain static or rise slightly the remodelling sector should remain strong while the commercial real estate slump is likely to persist through the middle of the decade.<sup>23</sup>

To look at the Canadian construction industry, Canada Mortgage and Housing Corporation was contacted by phone. They reported that Canada's housing starts have increased from 156,197 in 1992 to 156,900 in 1994. However, in B.C., housing starts increased from 31,875 (10) to 38,800 in 1994 - an increase of 22 per cent. The 1995 forecast by CMHC, however, indicates B.C. house starts will decrease to 36,100,<sup>24</sup> an 8 percent decrease. Vancouver accounts for over half the housing starts in the province.

#### Table X

 1997 - 1997 - 1997 - 1997 - 1997 - 1997 - 1997 - 1997 - 1997 - 1997 - 1997 - 1997 - 1997 - 1997 - 1997 - 1997 -	a the same has she	<u>, 이상 (</u> ), 2011년 - 21		
YEAR	CANADA	% OF INCREASE	B.C.	% OF INCREASE
1992	156,197		31,875	
1993	155,443	.5	42,807	+32
1994	156,900	+1	38,800	-10

#### Housing Starts in Canada

Source: Interview with CMHC (Canada Mortgage and Housing Corporation), December, 1994.

#### <sup>23</sup> U.S. Industrial Outlook

<sup>24</sup> Real Estate Weekly, January 1994

#### 5.4.1 <u>Consumers</u>

The Synkoloid Company of Canada - Synkoloid has major joint cement plants in Surrey, B.C., Edmonton, Alberta, and Auburn, Washington. All three plants use formulations established at the Surrey plant and labs. This company is the largest joint cement producer in Western Canada and the Pacific Northwest and it is owned by C.S.R. (Australia). They operate in the U.S. under the name of "Beadex". They once had two plants in California, but have since closed them down and negotiated a joint marketing agreement with Hamilton Industries Inc. of Orange, California, a dominant U.S. west coast joint cement manufacturer. Synkoloid does not use mica in their products any more, having re-formulated around a fibrous cellulose product and other mineral fillers. Ten years ago, they consumed 80-100 tonnes of mica per month at their Surrey location. The mica cost \$310 (Can) per tonne delivered and was a relatively coarse grade from KMG Minerals (N.C.). They expressed disinterest in sericite during an interview, but might be interested in a white muscovite mica if it were priced under 20 cents per kg. It is noted that large market leaders like Synkoloid are generally very reluctant to change their formulations for fear of a negative reaction from applicators to even a minor variation in product characteristics, such as spreadability or stiffness. The principal "If it ain't broke, don't fix it," is very prevalent.

<u>Westroc Industries Ltd.</u> - this company (previously "Marvelite Industries"), the other substantive western Canadian producer, manufactures joint cement in Calgary, Alberta. They specify white muscovite mica (Suzorite mica is unacceptable) and consume approximately 200 tonnes per year. Asheville Mica (North Carolina) supplies the mica at about 45 cents per kg delivered, according to company officials, in truckload shipments of 25 kg bags. it is interesting to note that years ago, Marvelite used asbestos "shorts" instead of mica.

<u>U.S. Gypsum Co.</u> - this company is the U.S. sales leader in gypsum products with U.S.\$1.4 billion in 1993 sales. "U.S.G." is the Pacific Northwest's largest consumer of mica. At their Tacoma plant, they consume 500 tonnes of mica per year. Some 250 tonnes per year of high grade white mica is purchased from Franklin Industrial Mineral's plant in New Mexico. Another 250 tonnes per year of a lower grade sericite product is purchased from a small California supplier. Their California plant in Torrence purchases from these two sources also. The other 8 nationwide plants and Canadian Gypsum Corp. (a subsidiary plant) use mica from U.S.G.'s own mica mining operations in North Carolina. U.S.G. has reduced their total mica consumption by 8 to 10,000 t.p.a. over the last 5-7 years. They currently consume 24,000 to 25,000 t.p.a., 23,000 of which comes from their own mines (including shipments to Canadian Gypsum Corporation (CGC) in Canada).

<u>Hamilton Industries</u> - this California company is the largest producer of joint cement in the far west with production of over 320 tonnes a day. In 1986, they consumed over 6,000 tonnes of mica per year but this volume has been significantly reduced to only 1,000 tonnes per year currently, as a result of reformulations to reduce overall costs. Most of the mica is from the Franklin Industrial Mineral plant in New Mexico. The growing trend towards light-weight products using coated perlite filler is doubtless a factor.

<u>Magnum Products</u> - this company, formerly called RUCO, is another major U.S. joint cement producer based in Kansas City, Mo, operating 8 plants throughout the U.S. They maintain a small plant in Kent, Washington, and are estimated to have perhaps 5 per cent of the Pacific Northwest joint cement market. All plants use mica in their formulations; their Washington operation only consumes approximately 75 tonnes per year while other bigger plants such at Kansas City use as much as 300 tonnes per year. Currently, they are buying a standard 200 mesh grade of mica, bought on the open market from the closest (cheapest) source. Like U.S.G., they do not require a high brightness white mica for their standard "mud" product. The only truly white mica they require is for spray-on ceiling textures. Some 98 per cent of their mud products are sold in the wet form. They reported that mica from Pacer in North Dakota was unsatisfactory because of its particle size distribution.

<u>Supro Corporation</u> - Supro is a regional joint cement producer located in Pomona, California. They consume about 500 tonnes of 80 mesh mica per year, purchased from a low-grade sericite mine in Bishop, California.

<u>National Gypsum Company (previously Gold Bond Building Products)</u>- this company is a major U.S. joint cement producer based in Charlotte, North Carolina, recently returned to financial viability after several years of near-bankruptcy. They operate eight joint cement plants throughout the country and consume a total of 9,500 tonnes per year of mica, which they buy on the open market, some of it through long-term purchase contracts. They specify a high degree of brightness since much of their "reddi-mix" (dry) product is used for unpainted ceiling textures. They prefer to purchase only <u>one</u> grade of mica to simplify formulations and keep inventories down. Their consumption of mica is steady over time, nor do they envisage any trend away from this.

Their biggest plants are in the eastern and mid-west States. Their Baltimore plant, for example, consumes 2,000 tonnes of mica per year; another uses 3,000. Their west coast plant is located in Long Beach, California; it purchases approximately 600 tonnes per year on a steady basis.

#### 5.4.2 Conclusions

According to Roskill, the U.S. market for gypsum plasterboard is mature and will only grow if housing starts increases. This is further evidenced by the U.S. Industrial Outlook forecasts. However, there are other markets which are poised for growth. These include Western Europe, Eastern Europe, and Japan. The conditions that vaulted plasterboard sales after WWII in America are present in Eastern Europe right now. Japanese sales of wallboard are already experiencing strong gains due to its fire- resistant properties.

Mica consumption in the Western Canadian Provinces and Western States is declining with two major joint cement producers discontinuing or significantly reducing mica consumption. North Carolina mica is located closer to the stronger housing markets of the Southeast and the Midwest (8) than western sources. From the market survey it was discovered that the main reason for declining mica consumption by western joint cement producers was mica's relatively high delivered price. The high price of mica becomes even more critical when one considers that the price of gypsum products has not increased since 1982(9). But, mica use could still remain strong in this industry. For instance, the plant manager at U.S.G.'s Tacoma plant felt that mica usage would increase back to its former levels at his plant, as there is no full substitute for mica in formulations. Its properties are unique, particularly in combination with other ingredients.<sup>25</sup> Finally, a weak Canadian dollar and shorter transportation routes could enable B.C. mica to successfully compete in the West against North Carolina mica and partial substitutes such as treated perlite.

#### 5.5 Oil Well Drilling Muds - Lost Circulation Materials (LCM's)

Drilling muds (or fluids) are used in oil and gas-well drilling operations to influence the drilling rate, cost, safety and efficiency of operations. The drilling mud composition may be varied to suit changing conditions and requirements throughout the depth of the well. Drilling muds are used for several reasons including the following: to lubricate the drilling bit, to carry rock cuttings to the surface, to seal the walls of the hole to prevent loss in low pressure or fractured formations and to provide a hydrostatic head of pressure. The drilling mud should be non-corrosive to the equipment, should not damage production formations, and should be disposable in a manner causing no harm to the environment.

Drilling fluids have a natural tendency to flow into permeable formations and fracture zones, since the pressure of the drill hole is normally higher than the surrounding formation. If the drilling mud escapes, there is a loss of hydrostatic pressure. In those

<sup>&</sup>lt;sup>25</sup> Based on interview with Tacoma USG plant manager

circumstances, mica is the added as a "contingency product" to the drilling mud to seal off the lost circulation zones. The platy structure of mica facilitates the overlapping of particles to form a layered wall, thereby reducing fluid loss. Mica also helps keep solids in suspension.

Various products compete with mica in lost circulation formulations including bagasse, cottonseed, and bentonite. Bagasse and cottonseed have a large advantage in that they are much cheaper than mica. Bentonite can account for 2 to 12 per cent of the drilling mud volume.<sup>26</sup> Bentonite also has such desirable characteristics as increased viscosity and prevention of hole caving. It is also competitively priced. Barytes are the main component used in drilling mud formulations, but they are not a substitute for mica. Other ingredients include asbestos, caustic soda, lime soda ash and sodium sulphate.

U.S. consumption of mica in oil well LCM's (lost circulation materials) in 1989 was 6,000 tonnes (about 5.0 per cent of total U.S. mica consumption).<sup>27</sup> Davis reports the tonnage dropped to 2,000 tonnes in 1992 but climbed up to 4,000 tonnes in 1993. North American use of mica in drilling muds accounts for two-thirds of total world usage in drilling muds. In 1983, 3,800 tonnes of mica was used in LCM's.<sup>28</sup> The decrease was due to the low level of drilling activity throughout North America in the late 80's, caused in turn by low world oil prices. In 1991, the Gulf War increased oil prices and drilling activity picked up again. Since then drilling activity has slowly been increasing.

There are two forms of mica used in drilling muds: coarse flakes with a mesh size of 6 and coarse powder passing 30 mesh. Low quality mica is consumed in oil wells as purity and colour are not important. The price of mica for LCM's ranges from U.S.\$50-\$100 per tonne.

Most of the North American oil well drilling mud is manufactured either in Texas or Oklahoma City, where most of the oil drilling activity takes place. There is some drilling mud being manufactured in Calgary, Alberta. This drilling mud is used by the oil industry in B.C., Alberta, Montana and Wyoming. It is expected that this is the same market region which B.C. mica could serve, if available, since the high transportation cost to ship low value mica to Texas and Oklahoma decreases the feasibility of such action.

5.5.1 Consumers

<sup>26</sup> Roskill, 1991

<sup>27</sup> Roskill, 1991

<sup>28</sup> Roskill, 1991

<u>Halliburton Energy Systems</u> - based in Calgary, this company currently uses only very small amounts of mica in their formulations.

<u>M.I. Drilling Fluids</u> - based in Calgary, this company uses 5 - 10 tonnes per year of mica from a Calgary distributor.

<u>Renaissance</u> - based in Calgary, this company currently uses only small amounts of mica in their formulations.

<u>Canamara United Supply Ltd.</u> - also based in Calgary, Alberta, this distributor probably supplies 50-80 per cent of the Alberta market, if not more. Canamara stock three different gradations: coarse, medium, and fine (1/4" to 10 mesh, 10-20 mesh, and 20-100 mesh, respectively). They purchase in 25 kg bags from Suzorite in Quebec. In 1993, they sold about 110 tonnes of mica.

<u>Brine-Add Drilling Fluids</u> - this company only uses small amounts of mica for custom formulations for other manufacturers.

5.5.2 Suppliers

<u>Suzorite</u> (Zemex)- this product's yellow colour is not a problem in drilling fluids and dominates the Alberta market, through Canamara.

<u>Pacer</u> - this company produces a low quality mica in South Dakota. Some of the drilling fluid companies interviewed in Alberta were unaware of Pacer's presence in the LCM market. Canamara is aware of Pacer's presence but commented that Pacer did not produce a full size range of mica products, making the Pacer mica unacceptable for their customers.

#### 5.5.3 Conclusions

From the market survey it was determined that mica is not required in normal drilling formulations. It is only used as a contingency product when other LCM's fail to seal the drill hole wall and for custom work. Many drilling operators purchase mica from a distributor and formulate the lost circulation fluid on-site themselves, to deal quickly with unexpected fluid losses.

Because of the low price paid for mica for LCM's, most mica suppliers look at this market only as an outlet of surplus or inferior mica that can't be sold to higher paying industries such as plastics and construction. To accurately forecast the consumption of mica in drilling fluids is difficult. Consumption is proportional to drilling rig count, not oil

production.<sup>29</sup> And this rig count is entirely dependent on oil prices which are impossible to predict. Despite a huge consumption decline since the early 1980's, drilling activity is steadily increasing in the Western Canadian market area. Furthermore, re-activation of old reserves with horizontal drilling may increase the need for LCM's and custom LCM's which can result in the additional use of mica. Davis' estimate of 4,000 tonnes consumed in drilling fluids in the U.S. would suggest that Canadian consumption probably would only amount to a few hundred tonnes annually as noted in the survey.

#### 5.6 Other Industries That Use Mica

#### 5.6.1 <u>Refractory Bricks</u>

Mica is used as a filler in refractory bricks where its heat resistance properties are useful. it is also used as a colouring agent. Lower quality mica (sericite) is sometimes used in brick manufacture. However, wollastonite has dominated the mineral filler market for bricks in the past. Upon correspondence with 13 firms in the Lower Mainland and the U.S., it has been determined that none of these firms currently incorporates mica in their bricks.

#### 5.6.2 Amphiboles Replacement

Mica, due to its similarities to asbestos and the amphibole minerals, can be used as a partial replacement. Partial replacement indicates that mica must be used in conjunction with other materials to impart the same qualities as asbestos. Mica's high tensile strength and high temperature resistance properties can be substituted for asbestos in the following products: brake linings, clutch facings, caulking compounds, vinyl sheet backings and some cement products. In the 1980's this use for mica was expected to have huge growth potential. However, a literature search found no indication of any large demand. The only company reported to be doing business in this industry is Quebec's Suzorite Mica Products. In 1987, they claimed that 25 per cent of their products were sold to replace asbestos (roughly 4,000 tonnes per year).<sup>30</sup> In 1991, 30 per cent of their mica output was sold for this use. The reasons for such modest increases include:

1) EPA regulations on asbestos have been relaxed. In 1989 the Environmental Protection Agency(U.S.A.) banned asbestos use. However, in 1991 this ruling was overturned by the Supreme Court. As recently as January 1994, "Industrial Minerals" reported that cement sheets, shingles for cladding, roofing, felt, millboard,

<sup>&</sup>lt;sup>29</sup> Roskill, 1991

<sup>&</sup>lt;sup>30</sup> Reprint from the Canadian Mining Journal, September, 1986

pipeline wrap, and vinyl asbestos have all been added to the list of asbestos-based products already authorized for use in the U.S.A.<sup>31</sup>

2) There are also other substitutes for asbestos such as crysophosphate. Crysophosphate was developed in Quebec and involves phosphating chrysotile asbestos, reducing biological activity.

#### 5.6.3 Cosmetics/Decoration

Treated mica used in cosmetics sells for approximately U.S.\$6000 per tonne. However, very small amounts are used by the cosmetics industry. Easily the largest consumer is the Mearl Corporation (New York) which acquires its mica from its subsidiary Franklin Mineral Products (not Franklin Industrial Minerals). Mica is also used in very small amounts in decorative wallpaper. A recent heritage restoration project in Kyoto, Japan (to rebuild an Imperial Summer Palace) used mica in interior wall shoji screens to impart a glittering effect.

#### 5.6.4 Sealant

Mica's platy structure allows it to be useful in the same way mica is useful in oil drilling muds. The mica is an impermeable barrier to fluids and chemicals wishing to enter soil, and eventually a groundwater supply. Although mica sealants are inappropriate for waste dump linings (illitic clays are the best), a Sodium-4-Mica clay has been developed<sup>32</sup> as a research project. This clay, with natural mica, captures strontium from nuclear waste and prevents it from seeping into the groundwater. With higher environmental standards, there could be an increased role for mica in some environmental applications where its sealant properties are desired.

<sup>32</sup> Wall Street Journal, June 18, 1992

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<sup>&</sup>lt;sup>31</sup> Industrial Minerals, January, 1994

#### 5.7 Summary of Market Demand

#### 5.7.1 Paints and Coatings

The market survey revealed about 2,500 tonnes of mica being consumed by the paint and coatings firms interviewed in North America. This represents about 12 per cent of the total mica reportedly being used in the industry. The survey did include all paint manufacturers of over 200 employees. It is suspected that the smaller paint manufacturers who produce customized and specialized paints are the principal users of mica in their formulations. The Pacific Northwest paint manufacturers use only a small volume of mica. Only KMG (Franklin Industrial Minerals) supply mica to the local paint market and they indicate from the survey that slightly over 200 tonnes a year are used in the region. The larger Californian paint manufacturers use about 2,550 tonnes per year. The Japanese and Korean pearlescent paint manufactures could be a potential market for BC mica if the quality and specifications are acceptable.

#### 5.7.2 Plastic/Resins

The survey contacted most of the major plastics/resin firms in North America. It did not, however, contact plastic compounders. Like the paint contractors, the plastic compounders could be adding mica to the resin ingredients. Some 1,000 tonnes of mica was identified as currently being used by the plastics and resin manufacturers. This represents about 15 per cent of the total likely consumed by the industry. Davis, however, indicates the total U.S. mica consumption in plastics at 4,000 tonnes. The automobile industry is the largest user of mica filled plastics but the automobile manufactures rely on the plastic compounders for plastic parts. Mica used in plastics is a specialty mica and commands a high price if it meets the specifications of the plastic compounders. The market survey did not reveal any plastics/resin companies in the Pacific Northwest who use mica in their formulations.

#### 5.7.3 Oil Well Drilling Muds

The market survey contacted oil well drilling mud manufacturers and drilling contractors in Alberta which serve the oil and gas industry throughout Western Canada. Oil drilling activity is currently increasing after years of depressed conditions and low mica consumption; this is expected to slowly increase as oil drilling activity resumes. The survey revealed less than 200 tonnes of mica currently being used as an ingredient in drilling muds, primarily provided by one company.

#### 5.7.4 <u>Rubber</u>

The major tire manufacturers were contacted. It would appear that the use of mica as a filler and dusting agent has been substantially reduced in the last few years. Substitute products and changes in manufacturing procedures have reduced the demand for mica. Foreign tire competition has also reduced the demand for rubber in domestic automobile tires. None of the tire manufacturers included in the survey currently use mica. About 5,000 tonnes annually were used by the rubber industry in the late 1980s.

#### 5.7.5 Joint Cement

The survey revealed that approximately 3,800 tonnes of mica are used annually by manufacturers of joint cement in Western Canada, Washington, Oregon, and California. The high delivered cost of mica in the west has driven some major western joint cement producers to reformulate to reduce overall cost. In a competitive environment other substitute products are used in combination to replace mica. It is noteworthy that the U.S. national majors, namely U.S.G. and National Gypsum, with most of their capacity in the east, closer to the sources of mica and therefore less affected by transportation costs, maintain very stable levels of mica usage. Their formulations are typically identical from one plant to another (ie: minimal regional flexibility).

#### **Table XI**

#### Joint Cement Consumption Estimate

AREA	TONNES
Western Canada	200 - 190 - 190 - 190 - 190 - 190 - 190 - 190 - 190 - 190 - 190 - 190 - 190 - 190 - 190 - 190 - 190 - 190 - 190
Pacific North West U.S.	575
California	3,000

Source: Market Survey

#### 5.7.6 Other End Users

The survey did not reveal any other significant users of mica in the market area under study.

#### 5.7.7 Summary of Mica Demand

The U.S. Bureau of Mines' annual report on mica by Lawrence L. Davis is the most up-to-date estimate of mica consumption. For 1993, Davis estimated some 92,000 tonnes of mica were consumed in the U.S., of which 49,000 (53 percent) was used in joint cement. 12 shows Davis's estimate by major end-user groups.

#### Table XII

	1993
Paints and Coatings	16,000 tonnes
Plastic/Resins	4,000 "
Oil Well Drilling Muds	4,000 "
Rubber	-
Joint Cement	49,000 "
Other (asbestos substitute, roofing, cosmetics, etc.)	19,000 "
Tota	1 92,000 "

#### Summary Of Mica Demand In The U.S.

Source: Davis 1993

Based on the market survey conducted by the consultants, an estimate of the current demand for mica has been developed for the Pacific Northwest region. The summary results in 13 show the volume of mica consumed by each of the major end user groups based on responses from all the chemical and dry mineral filler distributors in the region, all of whom were most cooperative. Demand is shown for B.C., Alberta, and Washington/Oregon.

It should be recognized that the mica demand identified, despite an extensive market survey, may not represent the total demand. It is possible that there are some firms or distributors which were not contacted, who purchase mica, albeit in small amounts. It is clear nonetheless from 13 that mica consumption is minimal in the Pacific Northwest region, likely in the range of only 1,200 tonnes per year.

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#### Table XIII

Pacific Northwest Mica Consumption tonnes 1994

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	WASHINGTON/ OREGON	ALBERTA	B.C.	eligi - an derenget son an der Marin der der Schreden für
775	575	200	-	Joint Cement
200	i guantennati	200	and ref farms	Oil Well Drilling Mud
190/260	150-200		40-60	Paints/Coatings/Plastics
1,165-1,235	725-775	400	40-60	Total:
	150-200		40-60	Paints/Coatings/Plastics

Source: Market Survey

#### 6.0 FACTORS AFFECTING MARKET PENETRATION

The purpose of this chapter is to identify those factors which will affect the expected market share should a producer start the mining and production of mica in B.C. These factors will have an influence on the possible sales of B.C. mica to the end user groups identified in the survey.

#### 6.1 <u>Competition</u>

The mica market is currently very competitive. There are a large number of mica mines and processors in the world despite recent mergers and consolidation in the industry. None of the many North American producers, however, are located in the Pacific Northwest. The closest competitive facilities are Franklin Industrial Mineral's operation in Velarde, N.M., and Pacer Corporation's plant at Custer, S.D. Most of the other processors are located in North Carolina, except for Suzorite, located in Quebec. A number of firms have been supplying mica for years and have established strong ties with their customers. Most of the mica processors are producing well below plant capacity and are anxious to protect their existing market shares.

#### 6.2 <u>Production Costs</u>

A number of companies mine mica as a by-product of kaolin, feldspar, silica or other minerals and therefore the marginal cost of producing mica is minimal. There are other small low-cost producers who only enter the market when demand and prices are high, diluting the revenues of those producers which have long-term commitments to the mica industry. The mica content of the ore also has a great effect on production costs as those mines with high mica content of good quality will have lower production costs than other mica mines. Other factors affecting production costs are the types and grades of mica to be produced; for example, a producer of dry and wet-ground mica in several mesh sizes will have greater production costs than a producer with a single grade and one or two mesh sizes. There are some producers with up to 20 different mica products, each for a different market sub-group. The costs to produce high value- added mica for specialized use in plastics and pearlescent paints can be substantial, particularly coated mica. In addition to higher production costs, specialized mica applications require a large investment in research and development as well as on-going technical sales support.

#### 6.3 Transportation Costs

Transportation costs can be a significant issue in marketing mica. Low-value mica used in oil drilling muds, for example, can not justify high transportation costs and the market region, therefore, is limited. The transportation costs could equal the f.o.b. plant value of the product if several handling transfers are involved as well as line-haul charges. The volume of mica and regularity of shipments also have a bearing on the transportation costs as well as the type of transport. Large volume water-borne shipments, for example, are cheaper on a unit basis than smaller shipments by truck. Back-haul opportunities can also affect transportation costs; for example, one major California joint cement manufacturer regularly serves the Seattle market with a subsidiary trucking fleet which currently returns to California empty. These trucks could be used to ship B.C. mica to California at very low marginal costs. There could also be opportunities to joint-load mica with other products in order to obtain lower transportation costs to certain geographic destinations. Mica prices quoted to customers do not normally include transportation costs.

#### 6.4 Packing Costs

Mica packaging costs can be significant. Mica shipped in 50-lb (25 kg) bags and loaded on shrink wrap pallets to protect the mica from the elements will have higher packaging costs than bulk truck or shipload containers. However, since most of the volumes purchased are low, individually sealed bags shipped on pallets in 24 tonne truckloads is the most common form of shipment. Most mica processors indicate packaging as a separate cost item left up to the customer to decide the means of packaging. The packaging method will also have an impact on the transportation costs.

#### 6.5 Financial Resources

Some of the mica companies are controlled by financially strong corporations. USG Corporation and Zemex Corp (Suzorite Minerals and Feldspar), have the financial resources to remain competitive and promote the use of their products. Financial resources must be available in order to make long-term commitments to remain in the mica industry. Financial resources are also needed for the research required to develop the specialty micas used in plastics and paints.

#### 6.6 Quality Assurance

The market survey revealed that the quality of mica purchased was very important. Mica buyers have their own specifications for use in their individual products. They will not tolerate quality variations which could alter their product performance or colour. Mica processors must therefore provide the necessary quality control to establish buyer confidence.

#### 6.7 <u>Research and Development</u>

During the market survey, it became apparent that in order to obtain and retain a significant share of the higher value-added mica market, a producer must also have a strong research and development program. Technical information on how to use mica in various products is needed, particularly when selling to the plastics/resins and paint market group. Users want to know how to correctly use mica in order to achieve its full benefits. There are market opportunities which will require research and development in order to lead the market (e.g. asbestos substitute). Suzorite is an example of a company which does devote considerable resources to its research and development in order to assist the plastics/resins industry in understanding the properties of mica in their products. One major U.S. producer underlined that the "ramp-up" time to develop and successfully market up-scale treated products to the automotive industry is considerable.

#### 6.8 Marketing Program

A well-developed marketing program will affect market penetration. The marketing program must consider the type of marketing personnel, dealer or agent network requirements, potential customer follow-up, on-going customer liaison and technical support. It should be noted that effective marketing to a large number of widely distributed user-groups is expensive and will significantly affect overhead costs. Dealers and sales agents are less expensive, but these dealers and sales agents work for a number of firms and may not devote the attention needed to a mica product to effectively market it to a new industry group or a new sale territory.

#### 6.9 Price

The price of mica is one of the most important factors. It must be competitive for the type and size of mica offered by the mica processor. The price will also have to be flexible when entering new market areas. Volume discounts may be appropriate. It should be noted that the price must be directly related to costs in the long run in order to remain financially viable with an adequate return on the investment. 14 shows price ranges for various types of processed mica.

#### **Table XIV**

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#### **Mica Price List**

MESH SIZES	PRICE BASIS	PRICE PER TONNE USD
Dry ground: 20-100 mesh	FOB Plant, USA	<b>\$220 - 440</b>
Wet ground: 80-325 mesh	FOB Plant, USA	\$561 - 1,210
Micronised: 625-3000 mesh	FOB Plant, USA	\$572 - 836
Flake: 14-20 mesh	FOB Plant, USA	\$341 - 400
Dry ground: 20-60 mesh	FOB Durban	\$325 - 355

Source: Industrial Mineral Journal, Nov. 1994 and Roskill

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#### 7.0 CONCLUSIONS

Several conclusions can be drawn from the mica market study. The key findings are as follows:

- 1) The International and North American production and consumption of all types of mica have been steadily declining over the past 5 years and are not expected to return to former tonnage levels. Ground mica (wet and dry), however, has experienced a recent increase in demand, particularly wet-ground mica.
- 2) In general, production capacity exceeds the total demand for mica, both worldwide and in North America.
- 3) In recent years, the industry has undergone considerable structural change and contraction with a number of mergers, acquisitions and rationalization of production and plant locations.
- 4) There appears to be a growing niche market for mica used in value-added specialty products such as pearlescent fillers for automotive paints and formed plastics used in automobiles.

The volume of mica used in these special applications is relatively low but it is increasing. The unit value, however, is very high since these end products are typically wet-ground and subsequently surface coated, a very costly process. Considerable research and development is required to achieve the properties demanded for these applications; on-going technical support must also be provided.

- 5) The demand for mica in the Pacific Northwest is primarily centred on its use by joint cement compounders in Seattle and Calgary, and by drilling fluid companies in Alberta. The volume of mica used in joint cement has decreased in the region since the 1970's. It appears to be also decreasing in California through reformulation by the major producers in an effort to reduce overall product costs. The use of mica by western paint manufacturers is minimal.
- 6) In B.C., there appear to be several primary mica deposits or base-metal operations where mica is a by-product which might be suitable for development based on their ore quality and location. It would seem, however, that there is insufficient regional demand at this time to justify production. There could be a viable market in the future for specialty treated micas used in paints and plastics. The principal market areas would likely be Japan, Korea and California, and perhaps others related to automotive parts production. In order to meet the quality requirements of these

niche markets, however, B.C. mica deposits would have to be subjected to intensive technical testing and applied market research to ensure customer acceptance.

7) All the mica requirements of the Pacific Northwest are presently supplied by producers in Quebec, North Carolina, and New Mexico (a small amount from California). Clearly if demand was to increase to a viable level, a B.C. mica producer would have a substantial transportation cost advantage throughout Alberta, B.C., the Pacific Northwest States and northern California (Figure 3). A B.C. producer of wet-ground and coated mica could supply mica for specialty paints and plastics used in more distant markets.

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# Acknowledgement

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The guidance and assistance of Mr. Z.D. Hora of Ministry of Energy, Mines and Petroleum Resources, Government of British Columbia in Victoria and Mr. Peter Coolen of Natural Resources Canada in Saskatoon is gratefully acknowledged.

# APPENDIX I

# B.C. MEMPR Mica "Minfile" Data

# MINFILE / pc **MINFILE NUMBER INDEX** GEOLOGICAL SURVEY BRANCH - MINERAL RESOURCES DIVISION MINISTRY OF ENERGY, MINES AND PETROLEUM RESOURCES

PAGE: 1 **REPORT: RGEN0600** 

MINFILE     NTS       Number     Name     Commodities     Status     Map     Latitude/Longitude     UTM/Nort       082ESW127     SHUTTLEWORTH CREEK     AB     MI     VM     PAPR     082E06W     49 19 06     119 29 24     11     54656	559677
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TOTAL NUMBER OF OCCURRENCE(S): 38

\* Contains 8 or more commodities

#### MINFILE / pc

PAGE: 1 REPORT: RGEN0100

#### MASTER REPORT GEOLOGICAL SURVEY BRANCH - MINERAL RESOURCES DIVISION MINISTRY OF ENERGY, MINES AND PETROLEUM RESOURCES

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degrees, and usually dip hear vertical. The anthophyllite is light greenish grey to pale green to white in colour and occurs in three forms; as hard woody chunks with fibres 20 to 25 centimetres long, as randomly orientated sheaf like clumps, 0.63 to 1.8 centimetres in length, and as powdery aggregates of tiny needle-like fibres. All fibre is easily reduced to a talc-like powder by rubbing between fingers or by pounding on a flat surface. The second and third types of anthophyllite described above are

#### MINFILE / pc MASTER REPORT GEOLOGICAL SURVEY BRANCH - MINERAL RESOURCES DIVISION MINISTRY OF ENERGY, MINES AND PETROLEUM RESOURCES

PAGE : 2 REPORT: RGEN0100

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#### CAPSULE GEOLOGY

commonly intermixed with varying amounts of silvery green to black biotite and brown vermiculite. A few lenses are comprised almost completely of fine grained biotite. The vermiculite, an alteration product of the biotite, is brittle, soft, slippery and exfoliates quite well when heated. A sample of long fibre anthophyllite analyzed as follows in per cent (Minister of Mines Annual Report 1948, page 182):

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This occurrence has been explored intermittently since its discovery in 1898. One lens of fine grained biotite was mined to produce material for use in roof manufacturing some time prior to 1948. The deposit was trenched by W.J. Asseltine and associates in 1948 and trenched and drilled by Western Asbestos and Development Ltd in 1953. In 1988, the deposit was investigated as a source for the platinum reported to be found in Shuttleworth Creek. No production 2.072 ter e grade e figures are available. andra a statistica. Maria a statistica e statistica e statistica.

#### BTRLTOGRAPHY

EMPR AR 1920, p. 164; \*1948, p. 182; \*1953, pp. 181-184; 1960, p. 132 EMPR ASS RPT 17354 GSC SUM RPT 1910, pp. 117, 118 GSC MAP 15-1961; 538A; 1736A

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DIMENSION:	4000 x 1500	Metres	STRIKE/DIP:	TRENI	)/PLUNGE:
COMMENTS:	Pegmatite stock.				
		<ul> <li>Association of the second secon</li></ul>			and a second
IOST ROCK	지수는 승규는 것 모르기	and the second	1. 1. 1. 1. 1. 1. 1. 1. 1. 1. 1. 1. 1. 1	나라에 가지 않는 것 않는 것이다.	
DOMINANT HOST ROCK:	Plutonic			이 가지가 이 가지 않아 않아?	<u>6</u>
				las - presente de Marcha	
STRATIGRAPHIC AGE	GROUP		ATION	IGNEQUS/METAN	ORPHIC/OTHER
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<b>Helikian</b>	Purcell		ton	and the second secon	
Proterozoic	Shaped the strend of the	이 이 지수가 아니는 아이는	유사회사 (1998) - 이 이 이 가슴이 가슴이 가슴 가슴 가슴다. 전체	Moyie Intrusi	ons
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T TTUOT OCY -	Medium Grained Pegn			19 & C +	
HITHOROGI:	Granodiorite Sill	actic			
	Granodiorite Dike				
	Contraction and the second				
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· · · · · · · · · · · · · · · · · · ·	Quartzite				
· · · · ·	Mica Schist				
	ومراجع فيستجد ومستشفية	م فحج من م الله ال	Wallenandar Graak -		
HOST ROCK COMMENTS:	Pegmatite of the Mi	dale Procerozoic	Hellroaring Creek s	LOCK.	
SEOLOGICAL SETTING					
TECTONIC BELT:			PHY	SIOGRAPHIC AREA: Pur	cell Mountains
	Ancestral North Ame	gen en de la companya		· · · · · · · · · · · · · · · · · · ·	
METAMORPHIC TYPE:	Regional	RELA	TIONSHIP: Post-miner	alization GRADE:	
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ويحاج فالعرف المراجع					
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	Beryllium	a construction of the second	0.1000 Per cent		
COMMENTS :		ryllium oxide.	ng tin the second states and the		
REFERENCE :	Assessment Report :		an a		
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CAPSULE GEOLOGY	in prene din practice	and the second secon		n an	
	The Hellroari	og Creek pegmatit	e stock is about 20	kilometres	
			etres west-northwest		
			dspar, quartz, mica		
	1960's, beryllium.			A second se	
		derlain by mart	zite and argillite o	f the Creston	
			and mica schist of t		
			cell Supergroup. The and dykes of granod		
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	Formation metasedi	ments to the sout	h. The Aldridge For		
	folded into an open	n northwest plung	ing anticline with t	the Hellroaring	
	folded into an open Creek stock emplace	n northwest plung ed in the core.	ing anticline with t	he Hellroaring	

The pegmatite stock trends north-northwest for 4 kilometres within the Aldrige Formation and is up to 1.5 kilometres wide. The stock appears to be a series of large dyke swarms. Most of the sampling and diamond drilling is concentrated in an area at the north end of the stock, where drilling encountered thicknesses of up to 150 metres.

The stock is comprised of medium to coarse grained white to light grey pegmatite typically containing 60 to 70 per cent feldspar, 20 to 30 per cent quartz, 0 to 10 per cent muscovite and 0 to 10 per cent tourmaline. Beryl, garnet, pyrite, pyrrhotite, galena and arsenopyrite occur in minor to trace amounts. The feldspar occurs in distinct microcline and albite rich zones. Quartz occurs in massive lenses several metres thick that are free of feldspar. Muscovite forms fine flakes along fractures and books, up to 13 centimetres across, in irregular patches. Thin needle-like tourmaline crystals (3 by 10 millimetres) and blades up to 3 centimetres long occur in patches. Beryl forms erratically scattered very pale bluish green and white crystals and irregular masses up to 7.5 centimetres in diameter and 15 centimetres in length that tend to be associated with plagicclase, quartz and muscovite. Garnet is present as pink to red grains 1 to 2 millimetres across in addition to occasional veinlets of pyrite, pyrrhotite, galena and arsenopyrite. Iron and manganese staining is common on outcrops and in drill core.

Work in 1965, by Richfield Oil Corporation, indicated the north end of the stock contains 450,000 tonnes of 0.1 per cent beryllium oxide (Assessment Report 13415, p. 21). Diamond drilling in 1985 and 1986 by Lumberton Mines Ltd. encountered zones containing in excess of 1 per cent tourmaline (Assessment Report 15760, p. 12). Nineteen samples of feldspathic pegmatite analyzed as follows in per cent -(Exploration in B.C. 1987, p. B111):

SiO2	64.86	tò	76.72
A1203	12.61	to	19.00
K20	0.45	to	12.45
Na20	1.95	to	6.44
CaO	0.05	to	0.64
Fe203	0.05	to	4.24

Tests carried out by CANMET indicate that the pegmatite can be processed to produce feldspar and mica concentrates that meet industry standards with full liberation at 50 mesh.

This stock was first staked in 1958 as a beryllium prospect. Subsequent exploration, by various operators in the 1960's and by Lumberton Mines Ltd., in 1984 and 1985 failed to discover beryllium reserves of sufficient grade to warrant further development as a beryllium prospect. However, this work combined with further sampling and diamond drilling by Lumberton Mines in 1986 indicates that the stock contains a considerable amount of glass and ceramic grade feldspar.

### BIBLIOGRAPHY

EMPR AR 1960-135, 1961-141, 1965-259 EMPR EXPL \*1987, pp. B109-B116 EMPR ASS RPT \*13415; \*15760 EMPR IND MIN FILE (Bearcat Explorations Ltd., Annual Report 1984). EMPR OF 1988-14, 1991-10 EMPR PRELIM MAP 16 EMPR Mineral Market Update, July 1991 GSC MEM 228 GSC EC GEOL 23, p. 62; 29, p. 71 GSC P 60-21, p. 12 GSC MAP 603A; 12-1957 EMR MP CORPFILE (International Beryllium Corp.; Canuck Beryllium Corp.) GCNL #25, #70, #166, 1984 N MINER Aug. 30, 1984 CJES \*Vol. 8, 1971, pp. 85-95 (Ryan, B.D. and Blenkinsop, J. (1971): Geology and Geochronology of the Hellroaring Creek Stock, British Columbia)

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MINFILE NUMBER: 082LNW068

MINFILE NUMBER: 082LSE006 NATIONAL MINERAL INVENTORY: 082L7 Au1 NAME(S): LUMBY (CHAPUT), BS 2, B.S. 2, LUMBY, CHAPUT, CHAPUT MINE, LUM, P.S., B.S., M.M., QUIN, TEACHER, MINE STATUS: Past Producer Underground MINING DIVISION: Vernon NTS MAP: 082L07W UTM ZONE: 11 LATITUDE: 50 15 53 NORTHING: 5569645 LONGITUDE: 118 56 24 EASTING: 361731 ELEVATION: 0722 Metres LOCATION ACCURACY: Within 500M COMMENTS: Plateau zone is 2.25 kilometres north-northeast of the community of Lumby, east of Bessette Creek, 4.25 kilometres west of Rawlings Lake (Assessment Report 14469). COMMODITIES: Gold Graphite Mica Silver Lead Zinc Copper MINERALS. SIGNIFICANT: Pyrite Graphite Galena Sphalerite Tetrahedrite Chalcopyrite Argentite Pyrrhotite ASSOCIATED: Ouartz ALTERATION: Graphite Muscovite Sericite Chlorite Clav Biotite COMMENTS: Biotite hornfels. ALTERATION TYPE: Argillic Propylitic MINERALIZATION AGE: Unknown DEPOSIT CHARACTER: Vein Shear Breccia CLASSIFICATION: Hydrothermal Mesothermal Epigenetic Industrial Min. TYPE: Polymetallic veins Ag-Pb-Zn Gold-quartz veins SHAPE: Bladed MODIFIER: Fractured Sheared DIMENSION: 150 x 46 Metres STRIKE/DIP: 110/40 TREND/PLUNGE: COMMENTS: Plateau zone mineralization. HOST ROCK DOMINANT HOST ROCK: Sedimentary FORMATION IGNEOUS/METAMORPHIC/OTHER STRATIGRAPHIC AGE GROUP Undefined Formation Triassic-Jurassic Nicola Jurassic Nelson Intrusions 5 11 Bet LITHOLOGY: Argillite Lapilli Ash Tuff Feldspar Crystal Tuff Phyllite Siltstone Granodiorite GEOLOGICAL SETTING TECTONIC BELT: Omineca PHYSIOGRAPHIC AREA: Shuswap Highland TERRANE: Quesnel INVENTORY ORE ZONE: PLATEAU CATEGORY: Indicated YEAR: 1993 500000 Tonnes OUANTITY: GRADE COMMODITY \_ 4,5000 Grams per tonne Gold COMMENTS: Estimated reserves. REFERENCE: Information Circular 1993-13, page 11. ORE ZONE: PLATEAU YEAR: 1994 CATEGORY: Unclassified 27000000 Tonnes QUANTITY: GRADE COMMODITY 100.0000 Per cent Graphite 100.0000 Per cent Mica COMMENTS: Grades of graphite and mica are unknown. REFERENCE: Information Circular 1994-19, page 16.

CAPSULE GEOLOGY

The Lumby (Chaput) deposit is located immediately to the north

CAPSULE GEOLOGY

of Lumby.

Mineralization was noted and prospected in the early 1900s by a local teacher (called the Teacher showing). Mineralized veins were exposed in the 1960s by a logging company (the Mine showing). In 1968, underground development began and a mill was constructed. In 1971, Alberta Gypsum acquired the property and mill and undertook underground and surface exploration in an attempt to establish mineable reserves. Coast Interior Ventures acquired the property in 1974 and worked it sporadically until 1979. The mill was expanded to 150 tons capacity in 1980, but the plant was closed in 1981. In 1983, Quinto Mining Corporation purchased the property and increased the size. Geochemical and geophysical surveys were conducted and a trenching program exposed the Plateau shear zone which was sampled. In 1985, 10 reverse circulation holes were drilled and 13 holes were diamond drilled. In 1986, the Saddle Mountain portion of the property was mapped and geophysical surveys were conducted; 2700 metres of diamond drilling was completed on the Plateau shear zone, In 1987, 32 reverse circulation and 7 diamond drillholes were completed along with additional geophysical and geochemical surveys. An initial metallurgical test was completed. In 1988, a computer model was generated of the Plateau shear zone and 2 crosscuts and an exploratory drift were completed in the hangingwall. A preliminary feasibility study was conducted. In 1990, the Plateau shear zone workings were mapped and sampled. In 1992, the underground workings were re-sampled, assayed and mineralogical and metallurgical tests were done. In 1993, metallurgical testing was completed.

The area is underlain by sedimentary and volcanic rocks of the Upper Triassic to Lower Jurassic Nicola Group. At the Lumby occurrence, the rocks include argillite, siltstone, sericitic lapilli ash tuff, chloritic feldspar crystal tuff and minor phyllite. This sequence is well-bedded, gently folded about a west-northwest trending antiformal axis and crosscut by minor high-angle normal faults. A small granodiorite stock of Jurassic age intrudes the package and biotite hornfels is weakly developed in the wallrocks. The Plateau shear zone is a major west trending fault which dips about 48 degrees to the south and transects the central part of the property. A narrow north trending shear is also evident containing barren to weakly pyritic bull quartz.

Mineralization is known in two areas, the Chaput mine and the Plateau zone. Both are spatially related to the same structure, the Plateau shear zone.

The Chaput mine, at the western end of the Plateau shear zone, contains silver-lead-zinc mineralization associated with a system of quartz-sulphide veins arranged in a step-like pattern. The quartz veins occur in z-shaped dragfolds on the south limb of the west-northwest trending anticline. The veins are hosted in argillites that are bounded by felsic to intermediate lapilli and ash tuff. The veins, 0.3 to 1.5 metres wide, occur in a zone which strikes 110 to 120 degrees and dips south. The veins pinch and swell along strike and downdip. The best grades occur near the flat portions of the flexures. The sulphides are fine to medium grained and are intergrown with milky white and grey quartz. Sulphides comprise galena, sphalerite, pyrite, tetrahedrite, pyrrhotite, chalcopyrite and argentite. Chlorite, sericite and clay minerals are typical wallrock alteration minerals. Most mineralization in the Chaput mine is reported to occur below 600 metres (ASL) elevation. diamond-drill hole intersection across a 1.0 metre (true width) quartz vein assayed 2296.76 grams per tonne silver and 2.33 grams per tonne gold (George Cross Newsletter 15, 1987). Between 1968 and 1976, 1991 tonnes of ore was mined producing 1,697,290 grams of silver, 1214 grams of gold, 654 kilograms of copper, 72,217 kilograms of lead and 50,847 kilograms of zinc.

The Plateau shear zone is located 600 metres to the east above 700 metres (ASL) elevation and is apparently along strike with the Chaput mine. The Plateau shear zone is 5 to 31 metres in width, averaging 24 metres, and occurs in argillite on the footwall contact with felsic to intermediate lapilli and ash tuffs. The zone strikes 110 to 120 degrees, dips 40 to 80 degrees south and has been traced for about 1000 metres east-west.

The mineralization has been confirmed downdip in excess of 150 metres. The enclosed quartz veins are up to 5 metres in aggregate width. In most areas within the zone, quartz veins are intensely sheared and brecciated. Gold is associated with fine to coarse-grained disseminated to locally massive pyrite, minor pyrrhotite and chalcopyrite. Sphalerite and galena are generally rare, but carry sporadic silver values. In many parts of the zone the breccia matrix contains a significant amount of carbonaceous (graphitic) material, where many of the highest gold values have been reported. Two mineralized sub-zones (Hangingwall, Footwall) within the Plateau zone have been outlined.

REPORT: RGEN0100

PAGE

### MINFILE / pc MASTER REPORT

GEOLOGICAL SURVEY BRANCH - MINERAL RESOURCES DIVISION MINISTRY OF ENERGY, MINES AND PETROLEUM RESOURCES

### CAPSULE GEOLOGY

Estimated reserves of the Plateau shear zone are 500,000 tonnes grading 4.5 grams per tonne gold (Information Circular 1993-13, page 11).

The deposit is currently receiving attention as a graphite/ sericite/gold project by Quinto Mining Corporation. Four crosscuts have been completed across the mineralized zone which has widths up to 46 metres. The main drift, which follows the hangingwall, is now over 304 metres long, 3.6 metres wide and 3 metres high. In stope No. 3, a 22-metre high cave stope is being extracted over a 18-metre width in preparation for milling. Quinto bought a mechanical laboratory from Bacon Donaldson which is being reassembled in Lumby. A special flotation system was designed to handle the unique sericite/graphite/silica mineralization (George Cross Newsletter No.115 (June 15), 1994).

Metallurgical testing indicates that the graphite is too fine grained and too tightly bound to the muscovite to be a viable byproduct. The graphite occurs as ultra-fine grains interleaved in very fine grained muscovite/sericite. The graphite enables the muscovite/sericite to be readily floatable which may have value as a byproduct (Assessment Report 22837).

Metallurgical testing in 1993 concluded that 3 products could be extracted from the Plateau shear zone material. These are a very fine grained muscovite-graphite mix which has been termed "Schillerite No. 1", a pyrite-gold concentrate from which gold can be recovered and a very fine-grained muscovite product termed "Schillerite No. 2" (Assessment Report 23029). Unclassified reserves are 27 million tonnes of graphite (Information Circular 1994-19, page 16).

### BIBLIOGRAPHY

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MINFILE NUMBER:	082LSE048	N	ATIONAL MINERAL I	NVENTORY :	1.9-9991 - 19-55-615 1
NAME(S):	CHERRYVILLE	Alexandri yelareka ku	a y ana an ang an		and the States
e Maria de Carlos de				ja de la companya de	and a second sec
STATUS :	Showing		MINING	DIVISION · Ver	non
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LONGITUDE:	118 37 42		Standard (1997) - Standard (1997) Standard (1997) - Standard (1997) Standard (1997) - Standard (1997)	EASTING: 383	950
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LOCATION ACCURACY:	Within 5 KM	· 영국 · 영국 가격 이 문제가 이 가격을 즐기는 것이 있다.	in the second second second		
COMMENTS :	Approximate location of an "in Mines Annual Report 1932, page	A144).	se na Paris de la composición de la com		
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PAGE 11 REPORT: RGEN0100

MINFILE NUMBER: 082LSW064 NATIONAL MINERAL INVENTORY: NAME(S): BRETT-BIRD, BIRD, BRETT, ARMSTRONG MICA STATUS: Prospect MINING DIVISION: Vernon NTS MAP: 082L06E UTM ZONE: 11 LATITUDE: 50 28 45 NORTHING: 5593800 LONGITUDE: 119 06 19 EASTING: 350630 ELEVATION: 490 Metres LOCATION ACCURACY: Within 500M COMMENTS: Adit (Minister of Mines Annual Report 1950, page 226). COMMODITIES: Mica Uranium MINERALS SIGNIFICANT: Muscovite Uraninite COMMENTS: Radioactive mineral is possibly uraninite. A "few grains" present. ASSOCIATED: Oligoclase Orthoclase Quartz MINERALIZATION AGE: Mesozoic-Cenozoic DEPOSIT CHARACTER: Disseminated CLASSIFICATION: Pegmatite Industrial Min. TYPE: Muscovite pegmatite SHAPE: Irregular HOST ROCK DOMINANT HOST ROCK: Plutonic FORMATION IGNEOUS/METAMORPHIC/OTHER GROUP STRATIGRAPHIC AGE Unnamed/Unknown Group Proterozoic Silver Creek Mesozoic-Cenozoic Unnamed/Unknown Informal LITHOLOGY: Peqmatite Quartz Biotite Schist HOST ROCK COMMENTS: The pegmatite host rock intrudes the Proterozoic Silver Creek Formation. GEOLOGICAL SETTING TECTONIC BELT: Omineca PHYSIOGRAPHIC AREA: Shuswap Highland TERRANE: Plutonic Rocks Kootenay METAMORPHIC TYPE: Regional RELATIONSHIP: Pre-mineralization GRADE: Greenschist COMMENTS: The Silver Creek Formation is regionally metamorphosed. CAPSULE GEOLOGY The Brett-Bird showing is located 7 kilometres east-northeast of Armstrong, near Sneesby Creek. This area, east of the Okanagan Valley fault, is underlain by metamorphic rocks of unknown age, metasedimentary rocks of the Proterozoic Silver Creek Formation and volcanic and sedimentary rocks of the Cambro-Ordovician Tsalkom Formation. All these units are probably in low-angle fault contact with each other. Intruding these rocks are Middle Jurassic granitic plutons. Pegmatite bodies of Mesozoic or Cenozoic age intrude the Silver Creek. Eocene Kamloops Group volcanic rocks occur to the north. Quartz biotite schist of the Silver Creek is intruded by irregular, sheet-like bodies of oligoclase, orthoclase, quartz and muscovite pegmatite. Fresh greenish-tinged muscovite occurs disseminated and in patches throughout the pegmatite, with the grain size of the mica varying with the grain size of the other minerals. Muscovite plates range in size from 1 millimetre to 15 by 25 centimetres in size. In a coarse-grained section of the pegmatite, patches of muscovite, 30 by 60 centimetres in size, cover up to 5 or 10 per cent of the exposure. A few grains of radioactive mineral, possibly uraninite, occur in the pegmatite. The first record of exploration is from 1927 when an open cut exposed muscovite plates. By 1950, a 10-metre adit and the three main open cuts had been completed. Approximately 100 tonnes of mica were shipped between 1932 and 1950. BIBLIOGRAPHY EMPR AR 1927-photo(following p. 192),\*213; 1932-144; \*1950-226,227; 1958-66 EMPR ASS RPT 49 EMPR OF 1989-5, 1990-30, 1990-32 EMPR MAP 7216G, 8513G EMPR RGS 1976 EMPR FIELDWORK 1987, pp. B15-22, 55-58; 1988, pp. 355-363 EMPR PF (In 082LSW General - Claim Map, 1966)

RUN DATE: 09/11/95 RUN TIME: 10:39:30

### MINFILE / pc MASTER REPORT GEOLOGICAL SURVEY BRANCH - MINERAL RESOURCES DIVISION MINISTRY OF ENERGY, MINES AND PETROLEUM RESOURCES

BIBLIOGRAPHY

GSC OF 637 (Map C), 736, 2167 GSC MEM \*296, p. 157 GSC EC GEOL 16(1952) p. 44; \*16(2nd Ed.) p. 229 GSC P 89-1E pp. 51-60

DATE CODED: 850724 DATE REVISED: 930331 CODED BY: GSB REVISED BY: DISC REPORT: RGEN0100

FIELD CHECK: N

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PAGE :

RUN DATE: 09/11/95 RUN TIME: 10:37:16

MINFILE / pc PRODUCTION REPORT GEOLOGICAL SURVEY BRANCH - MINERAL RESOURCES DIVISION MINISTRY OF ENERGY, MINES AND PETROLEUM RESOURCES

PAGE : 2 REPORT: RGEN0200

MINFILE NUMBER:	082LSW064		NAME :	BRETT-BIRD			STATUS: Pro:	spect
Production <u>Year</u>		Tonnes <u>Mined</u>	Tonnes <u>Milled</u>		Commodity		Grams Recovered	Kilograms <u>Recovered</u>
1950		1			Mica			1,000
SUMMARY TOTALS:	082LSW064		NAME :	BRETT-BIRD				
			Metric		Imperial			
	Mined: Milled:		9 (j. <b>1</b>	tonnes	1	tons		
Recovery:	Mica:		1,000	kilograms	2,205	pounds		
Comments:	1050	<b>D</b>		nistan of Mit	 al Rememb 10	-	•.	

For period 1932-1950. Minister of Mines Annual Report 1950. 1950:

RUN DATE: 09/11/95 RUN TIME: 10:39:30

### MINFILE / pc Master Report

GEOLOGICAL SURVEY BRANCH - MINERAL RESOURCES DIVISION MINISTRY OF ENERGY, MINES AND PETROLEUM RESOURCES

and the second							
MINFILE NUMBER:	<u>082M 080</u>		a sa	ange <b>1</b>	NATIONAL MINE	RAL INVENTORY:	en antigation e trac
	STANMACK, OLE BULL			$e^{\frac{1}{2}(1-\sum_{i=1}^{n-1} e^{\frac{1}{2}})}$			
	영향 것이 좋아? 영화 중에			212129		1	
	Showing				MI	NING DIVISION:	Revelstoke
	082M09W					UTM ZONE:	11
LATITUDE :	51 42 20					NORTHING:	5729044
LONGITUDE :	118 26 00					EASTING:	400955
ELEVATION:	1900 Metres			al dat	14 g		المرجوع والمراجع المرجعة
LOCATION ACCURACY:	Within 500M						en e
COMMENTS :	Location of Ole Bul	l shaft, Fig.	6 (Assess	aent Re	eport 11860).		
COMMODITIES:	Gold			ngsten	M	lica	
						- 1. State - 1. State- 1. State- 1. State- 1. State- 1. State 1. State 1. State 1.	
MINERALS							
SIGNIFICANT:	Pyrite	Pyrrhotite			S	cheelite	Chalcopyrite
	Galena	Tetrahedrite	Mic	a			
COMMENTS:	Green chromium mica	. (Fuchsite).					
ASSOCIATED:	Quartz	Ankerite	a da serara			· · · · · · · · · · · · · · · · · · ·	
ALTERATION:	Ankerite						
ALTERATION TYPE:	Carbonate						
MINERALIZATION AGE:	-						
ISOTOPIC AGE:		DATING METHOD	). Unknown		MATED	IAL DATED:	
1SOTOPIC AGE:		DATING METHOL	: Ulknown		MALER	TAL DAILD:	
DEPOSIT	•						
CHARACTER :	Vein	Discordant					
CLASSIFICATION:	Epigenetic	Industrial Mi	in.				
TYPE:	Gold-quartz veins						
SHAPE :	Irregular						
HOST ROCK							
DOMINANT HOST ROCK:	Metasedimentary						
STRATIGRAPHIC AGE	CROTIR	PC	RMATION			IGNEOUS/METAM	OP DUTC /OTUEP
Upper Proterozoic	Horsethief Creek		ndefined Fo		~~~~~	IGNEOUS/MEIAM	ORPHIC/OIHER
opper Procerozore	HOISECHIEI CIEEK	01.	idelined ro	JI MALIC	11		
LITHOLOGY:							
	Quartzite						
	Schist						
	Greenstone			· •			
GEOLOGICAL SETTING							
TECTONIC BELT:	Omineca				PHYSIOGRA	PHIC AREA: Sel	kirk Mountains
TERRANE :	Kootenay						
METAMORPHIC TYPE:	Regional	RE	LATIONSHI	2:		GRADE :	
	•						
INVENTORY							
	•						
ORE ZONE:	SAMPLE						
OKE ZONE:							
	CATEGORY: Assay/ana	lveie		,	YEAR: 1942		
	SAMPLE TYPE: Rock	-79-9			1742 ·		
		-					
	COMMODITY	<u> </u>	SRADE				
	Tungsten	· · · · · · · · ·	9.1000		ent		
COMMENTS :	May not have been a	ssayed for oth	her metals.	•			
REFERENCE :	Property File (Newm	arch, C.B., 19	942)				
CAPSULE GEOLOGY							
	Underlying roc	k types consis	st of metas	sedimer	ntary rocks i	.nter-	
	layered with mafic						
	quartzites, schists						
	The metavolcanics a						
	to greenstone and c						
	ated to Hoy's (Bull			-			
	Quartzite Schist Di						
	and Upper Proterozo	ic Horsethief	Creek Grou	ıp (As:	sessment Repo	ort	
	11860).					· .	
	Phase 2 and ph	ase 3 folds an	re develope	ed in a	an inverted s	trati-	
	graphic panel. Pre						
	dips commonly at 20						
	Two sets of qu			area	The common l	v	
	mineralized discord	ant veine etvi	ike $10 \pm 0$	20 dem	rees and din	70 to	
	85 degrees west. T	hev renne A 10		ree in	width Barr	en veine	
	ob degrees west. T	mey range u.I:			"Tuch. Dall		

85 degrees west. They range 0.15 to 4 metres in width. Barren veins, concordant with bedding, although with steeper dips, are up to 3 metres thick.

The mineralized veins are composed essentially of milky quartz and often contain minor pyrite and green chrome mica and lesser pyrrhotite. Scheelite occurs in some of the gold-bearing veins. The gold occurs both in the quartz veins and in the country rock immediately adjacent to the auriferous veins.

Quartz veins in the Ole Bull shaft area lie within calcareous

PAGE: 14 REPORT: RGEN0100

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CAPSULE GEOLOGY	and a set of the set o			
	phyllices. A grab sample assay tungsten assay by Newmarch (194			
· 化酸素酸医 - 化乙酸酸		t gave 371.0 grams per tonne		
BLIOGRAPHY			- 小田市 1983年1月1日 - 1993年1月1日 - 1993年1月11日 - 1993年1月11日 - 1993年1月11日 - 1993年1月11日 - 1993年110月110月110月110月110月110月110月110月110月110	
	GSC SUM RFT *1928, Part A, pp.		27 X 48 1 1 1	
	EMPR AR 1886-202; 1895-691; 189 214-215; 1959-105-106	6-536; 1898-1059,1192; 1922-		ante de la compañía d
**************************************	EMPR MAP 25 EMPR PF (*Newmarch, C.B. (1942)	: Ole Bull Tungsten)		an an thairte an thairt Thairte an thairte an th
	EMPR ASS RPT *10393, *11101, *1 W MINER April, 1984	1860, *13235		an an the second se
	N MINER April 26, 1984	empound a contra contract		Response
	IPDM March/April 1984, p. 11 GCNL Oct 25, 1982			
	EMPR EXPL 1982-121; 1983-164-16 GSC OF 637	5; 1984-128-129		
	GSC MAP 12-1964; 237A		ter include en s	
	EMPR OF 1991-17			
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		n parte y 1224 an		
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### MINFILE / pc MASTER REPORT GEOLOGICAL SURVEY BRANCH - MINERAL RESOURCES DIVISION MINISTRY OF ENERGY, MINES AND PETROLEUM RESOURCES

MINFILE NUMBER: 082M 168 NATIONAL MINERAL INVENTORY: NAME (S): YELLOW CREEK, COLUMBIA STATUS: Showing NTS MAP: 082M16W UTM ZONE: 11 LATITUDE: 51 59 20 LONGITUDE: 118 22 00 NORTHING: 5760466 EASTING: 406153 ELEVATION: 2100 Metres LOCATION ACCURACY: Within 1 KM Beryllium COMMODITIES: Mica MINERALS represente prove 344 market bold back SIGNIFICANT: Mica Beryl Garnet Muscovite Biotite ASSOCIATED: Quartz MINERALIZATION AGE: Unknown ISOTOPIC AGE: DATING METHOD: Unknown MATERIAL DATED: DEPOSIT CHARACTER: Unknown CLASSIFICATION: Pegmatite Industrial Min. Kyanite family TYPE: Rare element pegmatite - LCT family Kyanite family Charles and a star HOST ROCK DOMINANT HOST ROCK: Metamorphic STRATIGRAPHIC AGE GROUP FORMATION IGNEOUS/METAMORPHIC/OTHER Paleozoic Lardeau Undefined Formation LITHOLOGY: Mica Schist Pegmatite GEOLOGICAL SETTING TECTONIC BELT: Omineca PHYSIOGRAPHIC AREA: Selkirk Mountains TERRANE: Kootenay METAMORPHIC TYPE: Regional RELATIONSHIP CPADE . CAPSULE GEOLOGY The area is underlain by probable Lardeau Group consisting of mica-schist cut by quartz veins and pegmatites. Mica is associated with the quartz veins and kyanite occurs in pegmatite dykes and the schists. Beryllium occurs in muscovite and biotite of pegmatites and in kyanite and garnet of schist. BIBLIOGRAPHY Watson, K de P. (1947): American Mineralogist, v. 32, p. 94 EMPR AR 1912-K143; 1952-A258 CANMET IR 285, pp. 42-49 GSC EC GEOL 23, p. 60 GSC P 66-1, p. 51 GSC MAP 12-1964 GSC OF 637 DATE CODED: 850724 FIELD CHECK: N CODED BY: GSB REVISED BY: LDJ DATE REVISED: 860313 FIELD CHECK: N Construction and the construction of the construction an Startenard

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METAMORPHIC TYPE:	Regional	RELATIONSHIP:	GRADE: Amp	libolite
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MINFILE NUMBER:	083D 007		NATIO	NAL MINERAL INVENTORY:	
NAME(S):	YELLOW CREEK, MICA MICA QUEEN, BIG BEN	Distriction of the second			
STATUS :	Showing			MINING DIVISION:	Golden
	083D01W	and the second second		UTM ZONE :	11
LATITUDE :	52 00 05		and the second second second	NORTHING:	5761800
LONGITUDE :	118 18 40			EASTING:	
ELEVATION:	1950 Metres		a de la companya de		
LOCATION ACCURACY:	Within 1 KM			والمتحدث أتعطى التحاد التحاد والمحا	
COMMENTS :	flowing forks (at the Minerals File: Wat	he headwaters) of son, K.deP (1944):	Yellow Creek (In Draft report of	l northwestward dustrial n the Mica	
	Deposits on Yell	ow Creek).	ta até da	and a start of the	
COMMODITIES:			Beryllium		
CON110011110.	Nyumee		ocrystaum.		
INERALS					
	Kyanite	Muscovite	Bervl		
ASSOCIATED:	Biotite	Quartz	Feldspar	Tourmaline	Garnet
MINERALIZATION AGE:	Cretaceous	•			ULLIUU
BPOSIT					
CHARACTER :	Layered	Stratiform	Vein	Podiform	
CLASSIFICATION:	Pegmatite	Metamorphic	Industrial Min	<b>a.</b> Tanga sa tahar sa nge	
TYPE:	Muscovite pegmatite	-	R	are element pegmatite	- LCT family
SHAPE :	Tabular				-
MODIFIER:				de la companya de la	
DIMENSION:			STRIKE/DIP: 2	94/66 TRENI	/PLUNGE :
COMMENTS :	The pegmatite sill :	ranges in thicknes	s from 1.5 to 6 1	netres.	
	Upper amphibolite fa	acies metamorphic	conditions were :	reached in the	
	northern Monashee M	ountains at circa	100 Ma (Geology )	<i>V</i> ol. 18, 1990).	
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OST ROCK				el defensione de la strategia esta	
DOMINANT HOST ROCK:	Metasedimentary	이 가장 지수는 것이 같이 있어?		1990 - Star Barris (1990)	
TRATIGRAPHIC AGE	GROUP Horsethief Creek	FORMAT	d/Unknown Format.	IGNEOUS/METAN	ORPHIC/UIHER
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LITHOLOGY :	Pelitic Kyanite Sch	ist			
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of the Semipelite-Amphibolite unit (Geological Society of America Memoir 153) or equivalent Aluminous Pelite unit, both of the Horsethief Creek Group (Open File 1988-26). A recent regional compilation, however, shows these lithologies as belonging to the underlying Lower Pelite unit of the Horsethief Creek Group (Geological Survey of Canada Open File 2324). Kyanite is found mainly in schists and coarse gneisses with

#### CAPSULE GEOLOGY

muscovite, biotite, quartz, feldspar and garnet. Greyish-blue flat kyanite crystals vary in size from place to place, ranging from 0.6 to 7.0 centimetres long. Kyanite comprises up to 10 to 15 per cent by volume of the rock in the area.

A micaceous pegmatite sill is exposed at about 1524 metres elevation over approximately 45 metres. Muscovite comprises 15 per cent per rock volume in isolated patches, generally averaging much less. A second pegmatite sill, 1.5 to 6.0 metres thick is exposed at 1951 metres and intrudes schist and gneiss. Muscovite averages approximately 10 per cent rock volume, reaching as high as 20 per cent over 3 square metres. Individual muscovite booklets reach a maximum of 20 centimetres diameter and 5 centimetres thick, the average being much smaller. Most of the muscovite is twinned, badly cracked and iron stained. Nearby exposures of pegmatite contain minor amounts of tourmaline (Watson, 1944).

A beryl crystal was observed at the locality of the pegmatite mentioned above (ibid.). Beryl was reported seen in pegmatites at the Head of Yellow Creek. Spectrographic analyses recorded trace beryllium in muscovite and biotite from pegmatite and in kyanite and garnet from the wall rock schist (American Mineralogist, Vol. 18, p. 94, 1947).

### BIBLIOGRAPHY

EMPR AR 1898-39; 1913-42; 1920-N95; 1928-C188; 1931-148; \*1952-258 EMPR OF \*1988-26 EMPR IND MIN FILE (\*Watson, K.DeP (1944): Draft Report on Mica Deposits on Yellow Creek by) GSC OF 2324 GSC P 66-1; \*77-1C GSC EC GEOL No. \*23, pp. 58, 60. GSA MEM 153, pp. 445-461 Geology \*Vol 18, pp. 103-106, 1990 Mitchell, W.J. (1976): Structure and stratigraphy of the Warsaw Mountain area, British Columbia; unpublished M.Sc. thesis, University of Calgary, Alberta. Perkins, M.J. (1983): Structural geology and stratigraphy, Big Bend of the Columbia River, Selkirk Mountains, British Columbia; unpublished Ph.D. thesis, Carleton University, Ottawa, Ontario. \*Watson, K de P. (1947): American Mineralogist, v. 18, p. 94.

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#### INVENTORY

ORE ZONE: QUARRY

	CATEGORY: Measured	YEAR: 1980
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11月1日4月1日	Mica 60.5000	
REFERENCE :	Canadian Mining Journal, May 1982, page 1	13. 4 20 20 20 20 20 20 20 20 20 20 20 20 20

CAPSULE GROLOGY

The Canoe North Mica property is situated on the north side of the Canoe River about 5 kilometres southwest of Cedarside.

The showing is underlain by folded Hadrynian Lower Kaza Group kyanite-staurolite-garnet-biotite and/or muscovite-quartz-feldspar pelitic schist. Other lithologies of the lower Kaza Group include psammite, amphibolite, marble, calc-silicate, conglomerate, coarse grained grit and diamictite. The foliation of layers within the showing strike 240 degrees and dip 10 degrees northwest. A more detailed description of the regional structure and metamorphism is given in the Canoe South Mica (083D 017) and Albreda (083D 018) occurrences.

In the quarry, schist consists predominantly of muscovite and quartz with lesser garnet, biotite and feldspar, in layers striking 240 degrees and dipping 10 degrees to the northwest. A sample from the main quarry was sent to the Department of Mines, Ottawa where garnet, rutile and ilmenite were identified by x-ray diffraction. The main quarry is about 61 metres in diameter and 3.0 to 4.5 metres deep.

In 1961, a drill program, consisting of 18 short holes covering an area of 152 square metres, indicated approximately 200,000 tonnes of reserves grading 85 to 90 per cent mica to depth of 3.65 metres (Northern Miner March 15, 1962). Some holes were drilled to a depth of 12 metres without reaching the lower limit of the mica-rich layer. A processing plant was built in Cedarside in 1960 and 100 tonnes of mica product was produced for market (Minister of Mines Annual Report 1960). During 1961, a further 125 tonnes of mica were produced (Minister of Mines Annual Report 1961). In 1962 remodelling of the plant was completed and testing begun. Several shipments of mica were made to dry-wall joint cement consumers (Minister of Mines Annual Report 1962).

Mits Development Company Ltd. drilled a 91.5 metre hole on the Canoe 1 claim in 1978. In 1979, a further 16 holes were drilled totalling 641.3 metres. Forty five samples were submitted for froth flotation for mica recovery. Results ranged from 51.6 to 68.5 per cent muscovite (Assessment Report 7687).

Outland Resources Corp. outlined 2,290,000 tonnes of reserves after acquiring the property in 1980. The grade was 60.5 per cent muscovite. Another 1,000,000 tonnes of reserves was fairly assured (Canadian Mining Journal, May 1982).

Property work in 1986 and 1987 included a pre-feasibility study. Conclusions of the study were that present markets were inadequate to justify production at that time.

### BIBLIOGRAPHY

EMPR AR 1902-1083-1084; \*1960-148; \*1961-151; \*1962-158 EMPR EXPL 1978-E289; 1979-333; 1986-A79 EMPR ASS RPT \*7687 EMPR IND MIN FILE (\*Report for Mits Development Company Ltd, June 1978) GSC OF 2324 GSC P \*89-1E, pp. 101-107, \*90-1E, pp. 71-80 GSC M 15-1967; 1339A GSC EC GEOL No. 19, pp. 83,84 CMJ \*May 1982, p. 13 N MINER \*March 15, 1962; March 11, 1982; Sept 1, 1983 GCNL No. 62, 155, 1981; No. 45, 1982; No. 107, 112, 1987 EMR MIN BULL MR 223 B.C. 86

DATE CODED: 850724 DATE REVISED: 911208 CODED BY: GSB REVISED BY: KJM FIELD CHECK: N FIELD CHECK: N

# MINNILE / pc FRIDUCTION REPORT GEOLOGICAL SURVEY BRANCH MINNERS RESCURCES DIVISION MINISTRY OF ENERGY MINES AND PETROLSUM RESOURCES

MINFILE NUMBER:	083D (012 78	CONTRACT NAME : CANO	e Norte MICA		TATUS: Past Prod	ucer
Production Year	Tonnes Mined		la an the state of 🙆	xwedity R	ecovered	Kilograms Recovered
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Recovery:	Mica:		grams	496,040 pounds		
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MINFILE NUMBER:	083D 017 NATIONAL MINERAL INVENTOR	<b>₩</b> £% <u>, sin sin sin</u> tre
NAME (S):	CANOE SOUTH MICA, ALBREDA/CAMP CREEK, CANOE GRID	
and the second	Past Producer Underground MINING DIVISIO	M. Camibae
	083D11W UTM ZON	
· · · · · · · · · · · · · · · · ·		NG: 5844700
		NG: 345500
ELEVATION:	0968 Metres	
LOCATION ACCURACY:		
COMMENTS:	Center of Canoe Grid (Industrial Minerals File, mineral property map	and the strength of the
	83D11/W). The state gravity of a state of the state of the state state of the state of the state of the state of the state	· · · · · · · · · · · · · · · · · · ·
COMMODITIES:	Mica Mica State Control of the second of the state of the State State State of the	
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MINERALS	이는 책임 가슴 이 것 같아. 이는 것 같아. 가슴 것을 것을 것 같아.	
SIGNIFICANT:	Mica and a first Muscovite and a state of the	. A
ASSOCIATED:		Quartz
	Plagioclase	
COMMENTS :	The associated mineral assembage will vary depending whether the	
	showing is hosted by pelitic schist/pelite or within pegmatite bodies	
1	hosted in the former. Refer to capsule geology for explanation.	
MINERALIZATION AGE:		
ISOTOPIC AGE:	135+/-4 Ma DATING METHOD: MATERIAL DATED:	
	en de la construcción de la constru La construcción de la construcción d	
DEPOSIT	n de la construcción de la constru La construcción de la construcción d	
	Concordant Stratiform Vein Disseminated	
CLASSIFICATION:		
	Tabular	
MODIFIER:		
DIMENSION:		ND/PLUNGE: 135/04
COMMENTS :	Trend and plunge are for a fold axis approximately one kilometer south	
	of the occurrence (GSC Paper 89-1E, pp. 101-107). Age of metamorphism	
	is for the main metamorphic event (GSC Paper 90-1E, pp. 71-80).	
	n en	
HOST ROCK		
DOMINANT HOST ROCK:	Metasedimentary	
STRATIGRAPHIC AGE	GROUP FORMATION IGNEOUS/MET	AMORPHIC/OTHER
Upper Proterozoic	Kaza Undefined Formation	AMORFHIC/ UTHER
Proterozoic-Paleoz.		amorphic Complex
LITHOLOGY:	Pelitic Schist	
	Pegmatite	
	Sub Feldspathic Psammite	
	Sub Feldspathic Grit	
	Amphibolite	
	Diamictite Andrew States and States	
	Marble	
	Calc-silicate the state of the	
	Quartzite	
	Conglomerate	
HOST ROCK COMMENTS:	Host rocks are interpreted to be lower Kaza Group (Geological Survey	
	of Canada Open File 2324).	
	والمراجع أراجع المناصب والمراجع والمناصر والمراجع والمراجع والمراجع والمراجع والمراجع والمراجع والمراجع والمراجع	
GEOLOGICAL SETTING		landhas Novebadaa
TECTONIC BELT:		artooo moundains
	Kootenay Ancestral North America Regional RELATIONSHIP: GRADE: A	mphibolite
METAMORPHIC TYPE:		Amphibolite
COMMENTS:	Relationship of metamorphism varies with age of the host rock.	
ADDOWN R. GROT OCT		
CAPSULE GEOLOGY	A showing of white muscovite has been exposed on the west side	
	of Highway 5, approximately 9 kilometers south of Valemount.	
	An open cut at the showing exposed quality white muscovite. It is not	
	known whether this showing occurs in pelitic schist or pegmatite. A	
	tunnel of unknown length was started at the west end of the pit.	
	Mutiphase deformation has affected stratigraphy of the lower	
and a second state	Kaza Group and underlying Hadrynian Horsethief Creek Group strata,	
	resulting in large antiform-synform pairs trending northwest. At	
	least three phases of deformation have been recognized. The later	
	two phases have produced coaxial, generally northwest-plunging fold	
	axes, superimposed on the limbs of large-scale, phase one structures	
	(Geological Survey of Canada Paper 89-1E). The trend and plunge of a	
	major fold axis 1 kilometre south of the Canoe South Mica occurrence	
	are 135 and 04 degrees respectively.	
	Metamorphic grade is dominantly within the kyanite stability	
	field of amphibolite grade, with local development of migmatite which	
	increases from east to west. Pressures and temperatures of	
	metamorphism range from 620 to 780 megapascals and 565 to 682	
		INFILE NUMBER: 083D

MINFILE NUMBER: 083D 017

Sec. 1			182 - 1828 - 1
CAPSULE GEOLOGY			
<ul> <li>Apple Apple 1</li> </ul>	degrees celsius respectively (Geological Survey of Canada Paper	State of the second	s de la Ser
	89-1E). The age of the main metamorphic event in this area is Ear.	ly	1. 1. 1. 1. 1. 1. 1. 1. 1. 1. 1. 1. 1. 1
	Cretaceous (135+/-4 Ma) (Geological Survey of Canada Paper 90-1E).	• • • • • • • • • • • • • • • • • • •	
	The showing occurs in Hadrynian lower Kaza Group pelitic schi		
a	(locally kyanite, staurolite, garnet, muscovite and biotite bearing		
	of the lower Kaza Group. Other lithologies of the lower Kaza Group		
	the vicinity include subfeldspathic psammite and grit, ortho-	-	and granter
	amphibolite, marble, calc-silicate, quartzite, diamictite and		
	conglomerate (Geological Survey of Canada Open File 2324). Pegmat.	:ite	
	bodies, ranging in thickness from 3 centimetres to 3 metres, are		
	present throughout the area. They consist of coarse grained		
	plagioclase, quartz and muscovite with minor garnet. Some bodies	are	
	transposed and deformed with host lithologies, whereas others		
	crosscut foliation and folds of host lithologies, therefore		
	representing different generations (Geological Survey of Canada Pa	iper	
	89-1E).	· · · · ·	
	Approximately 4 tonnes were mined with 4000 lbs (1915 kilogram	ums)	
	being packed out (Minister of Mines Annual Report 1915).		
	Mica schist from the Albreda vicinity was ground by L.T. Farl	lev	
	and Co. and by G.W. Richmond of Vancouver for use by roofing		
	manufacturers in Vancouver and Victoria (Ministry of Mines Annual		
	Report 1947).		
BIBLIOGRAPHY			
	EMPR AR *1914-K54-K55; 1947-A216		
	EMPR IND MINFILE (*Report for Mits Development Co. Ltd., June 1978	3)	
	GSC OF 2324	•	
	GSC P *89-1E, pp. 101-107; *90-1E, pp. 71-80		
	GSC MAP 15-1967; 1339A		
	GSC EC GEOL No. 19, pp. 83-84		
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### MINFILE / pc PRODUCTION REPORT GEOLOGICAL SURVEY BRANCH - MINERAL RESOURCES DIVISION

PAGE: 4 REPORT: RGEN0200

MINFILE NUMBER:	083D 017	181) 		NAME :	CANOB SOUTH	MICA				STATUS :	Past	Producer	
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The Canoe River map area is predominantly underlain by a folded sequence of Hadrynian metasedimentary strata, belonging to the Horsethief Creek and Kaza groups and their basement gneisses.

### MINFILE / pc MASTER REPORT

25 PAGE REPORT: RGEN0100

### GEOLOGICAL SURVEY BRANCH - MINERAL RESOURCES DIVISION MINISTRY OF ENERGY, MINES AND PETROLEUM RESOURCES

#### CAPSULE GEOLOGY

Horsethief Creek Group strata in the Canoe River area are locally sufficiently pelitic to produce abundant aluminosilicate minerals (kyanite) when subject to high grade regional metamorphism (Open File stability field of amphibolite grade is dominantly within the kyanite stability field of amphibolite grade. The age of the main metamorphic event in the area is Early Cretaceous (135+/-4 Ma) (Geological Survey of Canada Paper 90-1E, pp 71-80). Further information on temperatures and pressures are given in the Canoe South Mica occurrence (083D and pressures are given in the Canoe South Mica occurrence (083D 300 and 500 a 017).

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Recent geologic mapping of the area by Walker (1989) suggests this region consists of an overturned north-facing metasedimentary package. Host rocks of the showing are interpreted as Hadrynian lower Kaza Group, consisting predominantly of biotite-muscovite-rich pelites, with lesser coarse grits and psammites and minor amphibolite and semipelite (Geological Survey of Canada Paper 89-1E, pp. 101-107). Alternatively, Murphy (1990) interprets these rocks as belonging

to the Semipelite-Amphibolite division of the Hadrynian Horsethief Creek Group, which he has subdivided into six regional mappable units. The lower two of these units host the Albreda mica occurrence. The basal unit consists of thin to medium bedded, flaggy, quartz-biotite- plagioclase psammite, stratiform amphibolite schist, massive conformable garnet amphibolite and kyanite-staurolite -garnet-muscovite-biotite-quartz-plagioclass schist (locally with quartzofeldspathic knots and laminae). The overlying unit consists of pelitic schists with minor psammite laced with quartzofeldspathic stringers lending the appearance of migmatite (Geological Survey of the second Canada Paper 90-1E, pp 71-80). Refer to the Canoe South Mica showing

(083D 017) for additional comments on the regional structure. Pegmatite bodies, ranging in thickness from 3 centimetres to 3 metres are present throughout the area. These consist of coarse grained plagioclase, quartz and muscovite with minor garnet. Some bodies are transposed and deformed with host lithologies, whereas others crosscut foliation and folds of host lithologies, therefore representing different generations (Geological Survey of Canada Paper 89-1E). It is not known whether any of these pegmatites host mica of Some was a set of the start of the commercial quality.

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MINFILE NUMBER:	083D 019	NATIONAL MINERAL INVENT	ORY:
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	DREADNOT, ADVENTURE, BOULDER, MAMMOTH, MICA, TETE JAUNE,		
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	Showing 083D13E	MINING DIVIS UTM Z	ION: Cariboo
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ELEVATION: LOCATION ACCURACY:		en en en de la service de la company de la service de la company de la service de la company de la service de l	
		e of the Barron claim group (Assessment	
	Report 276).	the second s	
COMMODITIES:		an an a <b>Beryllium</b> and the second second	
CONHODITIES.	and the second	and the second state of th	1
MINERALS		1. A strategy of the second s second second seco	
SIGNIFICANT:	Mica Muscovite	Kyanite Beryl mation (D3) pegmatites is 125+/-7 Ma and	
CONTRACTO :	pre-phase 3 deformation (D3) r	eqmatites 154+/-6 Ma (Geological Survey	
1 · ·	of Canada Paper 90-1E, pp. 71-	80).	
ASSOCIATED:	Quartz Feldspar Lower Cretaceous	Garnet	Apatite
		HOD: Unknown MATERIAL DATED:	Unknown
		and the second	
DEPOSIT CHARACTER.	Vein Concordant	Discondant - Discondant	
CLASSIFICATION:	Pegmatite Industrial	Discordant Disseminate	
TYPE:	Muscovite pegmatite	Kyanite family	
SHAPE: DIMENSION	Irregular 152 x 23 Metres		REND/PLUNGE:
COMMENTS :	Orientation of pegmatite on th	e Reliance claim group is 135/30-40SW	
		e for pegmatite on the Bonanza claim	i.
	(EMPR IND MIN FILE; Report by	J.M. Cummings, 1941).	
HOST ROCK			
DOMINANT HOST ROCK:	Metaplutonic		
CTDATTCDADUTC ACE	ADOLD .		
STRATIGRAPHIC AGE	GROUP		ETAMORPHIC/OTHER
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### CAPSULE GEOLOGY

folds) on a meso and megascopic scale. These later pegmatites have small apophyses into host lithologies, which show no evidence of strain. Pegmatites are hosted in pelitic schists of the Hadrynian lower Kaza Group. Schists are largely mica-garnet, quartz-mica, quartz-feldspar-mica in composition. Other lithologies of the lower Kaza Group include psammite, amphibolite, marble and calc-silicate. The Canoe South Mica showing (083D 017) contains a more detailed description of the regional deformation and conditions of metamorphism in the area.

The age of pegmatites has been determined as being 154+/-6 Ma and 125+/-7 Ma for pre and post phase three deformation pegmatites, respectively.

Quartz, feldspar and muscovite comprise the main constituents of the pegmatites. Accessories include garnet, tourmaline, kyanite, or beryl and apatite. Pegmatites are commonly irregular and lens-like bodies, most frequently oriented 135 degrees and dipping 30 to 40 degrees to the southwest. Textures within these bodies vary greatly with only certain mica bands large enough to be of commercial value (Minister of Mines Annual Report 1920). Where muscovite is of good quality, it is light brown to light greenish and occurs in well formed booklets ranging from 10 by 10 by 1.25 centimetres to 45 by 30 by 5 centimetres; however, the quantities in any one pegmatite is not unusually high (Geological Survey of Canada Economic Geology Report No. 19). In certain pegmatites, muscovite was noted to be the best quality and of the greatest abundance in small pockets near the hanging wall (Minister of Mines Annual Reports 1899, 1913). Elsewhere, quality muscovite was observed concentrated in bands up to 1.5 metres wide on either side of the hanging or foot walls (Assessment Report 276).

Beryl was reported in pegmatite on the Bonanza property on Mica Mountain by McEvoy (Minister of Mines Annual Report 1898) and deScmid (Minister of Mines Annual Report 1913). Lay (Minister of Mines Annual Report 1928) found no trace of beryl or any other unusual accessory mineral. But a composite sample was reported (GSC spetrographic analyses) to contain less than 0.01 per cent beryllium (Geological Survey of Canada, Economic Geology Report No. 23).

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EMPR ASS RPT \*276 EMPR OF 1988-26 EMPR PF (\*Report on the Bonanza Mica Property, Mica Mtn., Tete Jaune, B.C., J.M. Cummings, 1941) EMPR IND MIN FILE (Report for Mits Development Co. Ltd., June 1978) GSC OF 2324 GSC OF 2324 GSC F \*60-21, p. 9; 89-1E, pp. 101-107; 90-1E, pp. 71-80 GSC MAP 15-1967, 1339A GSC EC GEOL \*No. 19, pp. 83-84,90; \*No. 23, pp. 58, 60

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FIELD CHECK: N FIELD CHECK: N

### MINFILE / pc MASTER REPORT

GEOLOGICAL SURVEY BRANCH - MINERAL RESOURCES DIVISION MINISTRY OF ENERGY, MINES AND PETROLEUM RESOURCES

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MINFILE NUMBER:	083D 020		NATIONAL	MINERAL INVENTORY:	
NDME (C)	TOWNY NEDOCTE TO	TO OWNER IT OTHER	DEDOGTA UDDED OVO		
NAME (3):	HIGHWAY DEPOSIT LOW	COLUMBIA GROUP, MIC	DEPUSIT UPPER SHOW	IING, MICA CREEK,	
	MICA CREEK SECOND I	FORK, POTLATCH CREEK	. FRED LAING RIDGE	en président de la companya de la c Recepción de la companya de la compa	
	Showing			MINING DIVISION: Rev	velstoke
	083D02E 083D01W		1 <u>5</u>	UTM ZONE: 11	
	52 01 34		Contraction and Article March	NORTHING: 57	64900
	118 34 16	the difference of the first of	<ul> <li>A state of the state</li> </ul>	EASTING: 39	2200
ELEVATION:	725 Metres	a sha waxa ka shekara ka			
LOCATION ACCURACY:	Within 500M		Second	gydd y de ser e seredd e r	
COMMENTS:	Mica-bearing pegmat	lite dyke at the Hig	nway Deposit Lower	Showing	
	(Newmarch, 1942).	anan geografia di sala di sala sala Internet sala di terdena sala sala sa	<ul> <li>A statistical statist Statistical statistical statisteps statistical statistical statistical statistical statisti</li></ul>	· 建酸盐合物的 《史书》中《书书》。 	
COMMODITIES:	Mica	Kyanite			
		a na internet da a cara		an an an Array and Ar	
MINERALS					
SIGNIFICANT:		Kyanite			28 J
ASSOCIATED:		Tourmaline	Quartz	Feldspar	Garnet
MINERALIZATION AGE:	Unknown			the second states and the second	
DEPOSTT		중 이 나는 가지 나가도 가지 않는다. 이 사	· · · · · · · · · · · · · · · · · · ·	· · · · · · · · · · · · · · · · · · ·	
	Voia	Disservent	Charles + 6		
CHARACTER: CLASSIFICATION: TYDE	VCIII Decimatite	Discordant Metamorphic	Stratiform Industrial Min.	Layered	
TYPE.	Kyanite family	Mecanorphic		write meanative	
	Tabular		muSCC	wite pegmatite	
MODIFIER:		exection to set and		ang	
DIMENSION:		Metres	STRIKE/DIP 065/9	0 TREND/PLU	INCE
COMMENTS :	Strike and dip are	for mica-bearing pe	qmatite dyke at the	Highway	51102.
	Deposit Lower Showi	ng (Newmarch, 1942)	. Mica booklets oc	cur over a	
	1.2 metre square ar	ea in a 1.2 metre w	ide pegmatitie dyke	te de la companya de	
HOST ROCK	Mahan Jack and a				
DOMINANT HOST ROCK:	Metaplutonic			i da se	
STRATIGRAPHIC AGE	GROUP	FORMATI	ON	IGNEOUS/METAMORPH	
Hadrynian	Horsethief Creek		/Unknown Formation		11C/OINBR
		United to the second se			
LITHOLOGY:	Kyanite Garnet Mica	Schist	na hairean sin a		
	Micaceous Pegmatite	Dike	-		
	Micaceous Pegmatite	e Sill			
	Pelite				
	Semi Pelite				
and the second	Marble Gneiss				
HOST ROCK COMMENTS	Mica is found in mi	caceous pegmatite d	wkes and sills and	with kyanite	
		he Lower Pelite uni			
	1997 - P				
GEOLOGICAL SETTING					
TECTONIC BELT:			PHYSI	OGRAPHIC AREA: Selkir	k Mountains
	Kootenay				<b>.</b> .
METAMORPHIC TYPE:	Regional	RELATIO		ization GRADE: Amphibo	olite
			Syn-minerali	zation	
				and the second second	
CAPSULE GEOLOGY					
	The Highway De	posit Lower Showing	is one of many mic	aceous	
		sill occurrences in	-		
		including the nort			
	Potlatch Creek, the	e southerly flowing	tributaries of Mica	Creek and	
	portions of the val	ley bottom of the m	ain Mica Creek (New	march,	
		as large semi-conc			
		etween the Semipeli			
	-	of Creek Group. Dis			
		sporadic. A common			
	-	theast trending rid	ge 3 kilometres sou	icn-southwest	
	of Warsaw Mountain.			3703	
		penerations of pegma pegmatites are conc			
		e units. Younger g			
		cosity. Pegmatite d			
		9.0 metres in width			
··		ations are also hig		en e	
		are plagioclase-ri		sting of 70	
		se, 20 per cent muso			
		en strained and well			
		lykes and sills rang			
		from 0.32 to 8.9 ce			
		Mica booklets ofte			
		associated with mica ch, 1942). For a de			
a sur an	CONTHETTIC (NEMUGIC	, 1972). FOI a de	correct description		NUMBER: 083D
<ul> <li>A second sec second second sec</li></ul>				PLAT THE	

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### MINFILE / pc MASTER REPORT

PAGE 29 REPORT: RGEN0100

GEOLOGICAL SURVEY BRANCH - MINERAL RESOURCES DIVISION MINISTRY OF ENERGY, MINES AND PETROLEUM RESOURCES

### 网络人名英格兰人姓氏德斯 计分类编辑的 化硫酸 CAPSULE GROLOGY regional geology refer to the Warsaw Mountain showing (083D 041). At the Highway Deposit Lower Showing, mica booklets 7.62 by 7.62 centimetres, appear to be concentrated in an area of about 120 square centimetres in a 1.22-metre wide pegmatite dyke. This zone consists of 20 per cent muscovite by rock volume. This mica-bearing pegmatite Nelson (\* 1923 e. dyke strikes 065 degrees and dips vertically. A 0.635-centimetre band of kyanite is found in the enclosing A 0.635-centimetre band of kyanite is found in the enclosing schists. In the lower reaches of Mica Creek kyanite forms bands within schists. At the headwaters of the first and second within schists. At the headwaters of the first and second tributaries of Mica Creek kyanite is present in localized pelitic horizons near the base of the Semipelite-Amphibolite division (Geological Society of America Memoir 153), the Aluminous Pelite unit (Open File 1988-26) or Lower Pelite unit (Geological Survey of Canada Open File 2324) of the Horsethief Creek Group. Kvanite porphyroblasts in these horizons are up to 5 centimetres in length. Def G.S. Bit in the second state of the control of the control of the second state BIBLIOGRAPHY EMPR OF 1988-26 EMPR IND MIN FILE (\*Newmarch, C.B. (1942): Preliminary Report on mica deposits on the Mica Creek area) mica deposits on the Mica Cleek alea, GSC OF 2324 GSC P 77-1C GSC BC GEOL NO 19-90 GSA Memoir 153, pp. 445-461 Mitchell, W.J. (1976): \*Structure and stratigraphy of the Warsaw Distribution of the Structure and stratigraphy of the Structur tchell, W.J. (1976): \*Structure and stratyraphy of the second stratyra Perkins, M.J. (1983): Structural geology and stratigraphy, Big Bend of the Columbia River, Selkirk Mountains, British Columbia unpublished Ph.D. thesis, Carleton University, Ottawa, Ontario. TE CODED: 850724 REVISED: 911209 REVISED BY. KJM DATE CODED: 850724 FIELD CHECK: N FIELD CHECK: N DATE REVISED: 911209 الإيماني المسافرة ويتعادي المؤلفية من معتهم. المأسب المهادية المؤفولاتين المسأكية في المسافرة المعادية وموقولات المسافرة المالية. المسافر المهادين والأرادي المشتقلاتين المياني (لملائي المعادية والمهادين المسافر المسافر المسافر المسافر المساف المسافرة الم

PAGE: 30 REPORT: RGEN0100

	MINIST	RY OF ENERGY, MINI	es and petroleum re	SOURCES	
MINFILE NUMBER:	<u>083D 030</u>		NATIONAL	MINERAL INVENTORY:	
NAME (S) :	NORTH BLUE RIVER, BL	UE RIVER, WHITERI	VER	a aan oo oo oo ahaa	n a shekara ya
		化化学学校 化化学学	and the second	and the second second second	
	Showing	and the second second	e de la construction de la const	MINING DIVISION:	Kamloops
	083D03W	<ul> <li>A state of the state of the state</li> </ul>		UTM ZONE : NORTHING :	11
	52 07 00	and the second second	网络美国人名英格兰人名英格兰人	NORTHING:	5776475
LONGITUDE :	119 23 00		terta a generativa d	EASTING:	336814
ELEVATION:	0915 Metres	A fight of the second		and the second second second	
LOCATION ACCURACY:	Within 5 KM	The second states	and the second second		
COMMENTS :	Center of a large pe	qmatite body immed	liately northwest o	f Blue River	
	(Geological Survey o	f Canada, Paper 84	1-1A, p. 92).	*	
COMMODITIES:	Mica				1. 1. 1. 1. 1. 1. 1. 1. 1. 1. 1. 1. 1. 1. 1
			and the second second second	and the second second second	
IINERALS		و و الاستان و العبد	Martin Andreas I.		
SIGNIFICANT:		Muscovite		지수는 소리가 가지 않는 것	
ASSOCIATED:		Albite	Oligoclase	Garnet	Tourmaline
		Beryl	Apatite	general second second	
COMMENTS :	Pegmatite is compose	d principally of a	albite and oligocla	se feldspar	
	and a vitreous quart	z. Accessories in	nclude garnet, kyan	ite, tourmaline	
	beryl and apatite (M				
MINERALIZATION AGE:				-	
		DATING METHOD: Unl	nown	MATERIAL DATED: Unkn	OWD.
LUGIOLIC AGE:	, , , , , , , , , , , , , , , , ,				A411
EPOSIT					
	Main	Concordant	Diservice	<b>D</b>	
CHARACTER :			Discordant	Disseminated	
		Industrial Min.			
TYPE :	Muscovite pegmatite			and the second	
SHAPE :	Tabular				
DIMENSION:	60 x 30	Metres	STRIKE/DIP:	TREND/	PLUNGE :
COMMENTS :	Some of these pegmat	ite bands are over	30 metres wide an	d 60 metres	
	long (AR 1902). The				
	is 125+/-7 and 154+/				
	15 125+/ / und 154+/	o na, respective.	ly (doe raper so in	· ·	
OST ROCK					
	Main an Distance of the Contest				
DOMINANT HOST ROCK:	Mecapiuconic				
<u>ter de la fitse set el terres el c</u>					1997 - 1997 - 1997 - 1997 - 1997 - 1997 - 1997 - 1997 - 1997 - 1997 - 1997 - 1997 - 1997 - 1997 - 1997 - 1997 -
TRATIGRAPHIC AGE	GROUP	FORMAT		IGNEOUS/METAMO	RPHIC/OTHER
adrynian	Horsethief Creek	Undefin	ned Formation		
roterozoic-Paleoz.				Shuswap Metamo	rphic Complex
			· ·		
LITHOLOGY:	Pegmatite				
	Pelitic Schist				
	Micaceous Schist				
	Semi Pelite				
	Psammite				
	Grit				
	Marble				
	Calc-silicate				
and a second second second					
EOLOGICAL SETTING					
TECTONIC BELT:	Omineca		PHYS	IOGRAPHIC AREA: Cari	boo Mountains
	Kootenay				
METAMORPHIC TYPE:		RELATIO	ONSHIP: Pre-mineral	ization GRADE: Amph	ibolite
			Post-minera		
COMMENT'S .	Relationship of meta	mornhism varies w			
COPE-ERITO :	Rezactionship of meed	morphion varies w.	ten age or pegaatere		
	الأرجار المراجع المراجع أرجاك				
APSULE GEOLOGY					
			nowing hosted in pe	gmatite, 5	
	kilometres northwest				
	The Canoe River	map area is pred	ominantly underlain	by a	
•	sequence of Hadrynia	n metasedimentary	strata, belonging	to the	
	Windermere Supergrou				
	their basement gneis				
	semipelite, psammite				
	· · · · ·			ich was first	
			for this showing wh		
	mentioned as one of				
	of mica hosted in pe		anoe River area (Mi	nister of	
	Mines Annual Report	1902).			
			d in 1983 as part o	f a field	
	study of the structu				
	area (Geological Sur				
	description of pegma				
	assumed to be part of	L CHIS DOUY OF AN	apopnyses of it. hree deformation pe	amatikaa k	
	TTRE ARES OF DYE	ADD DOST DDASE T	usee deformation De	undLites has	
	been determined to h pegmatites in the Ca	be 154+/-6 Ma and	125+/-7 Ma respecti	vely from	

pegmatites in the Cariboo Mountains west of Valemount (Geological Survey of Canada Paper 90-1E, pp. 71-80). Large masses of pegmatite were observed interbanded with

PAGE: 31 REPORT: RGEN0100

		ere de la Atra
CAPSULE GEOLOGY	micaceous schists of the Hadrynian Horsethief Creek Group. Albite or	
an saile an	oligoclase feldspar and a vitreous quartz comprise the major	
	pegmatites in the Canoe River area contain garnet, tourmaline,	CARLES &
AGSTED.	kyanite, beryl and apatite as accessories (Minister of Mines Annual Report 1920). Some pegmatite bands and masses are over 30 metres	San Tari Canada Para
- 「」、「」、「」、「」、「」、「」、「」、「」、「」、「」、「」、「」、「」、「	Report 1920). Some pegmatite bands and masses are over 30 metres wide and 60 metres long. It is these pegmatites in which large	
	crystals of commercial sheet mica are found, geological and	in anticia notra rai -
	geochemical conditions permitting (Minister of Mines Annual Report 1902).	
	An index which the heart of the presence is a first second second second second second second second second sec	
BIBLIOGRAPHY	EMPR AR 1888-313; 1893-80A-81A; 1898-39; *1902-1083; 1912-K52-K53;	
	1017 VED 4014 VEC VET 1000 NOE NOE 1001 NOE NOC. 1004 150.	
an a	GSC OF 2324	
HERE GREATLY	GSC P *84-1A, pp. 91-94; 90-1E, pp. 71-80 GSC MAP 15-1967, 1339A	
	GSC: ROYCEROTENO S. 1.9 COMORE 83-84 CONTRACTOR STOLEN STOLEN STOLEN STOLEN STOLEN STOLEN STOLEN STOLEN STOLEN	
	"这话说,你们,还能让你了,这个问题就是是这些问题,你能是我的过去式和过去分词道。"他的事故是我们是我的问题,我们们不是不是我的。	
DATE CODED: DATE REVISED:	850724 911209 REVISED BY: KJM	FIELD CHECK: N
	· "我们在"你们的",我们的你们的你们的你们,你们们的你们,你们们们们们的你们,你们们们们们们们不是你们的你们,你们们们们们们们们们们们们们们们们们们们们们们	and the second
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いた。 「「「「」」 「「」」	"你们还是一些你?"我来来说道:"你们还是你的你的事?""你们,你们们们们,我们们们不是你的?""你们,我是 <b>我</b> 我们	
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	김 사람이 많은 것이 같은 것은 것이 같은 것이 없는 것이 같을 것을 수 없다.	
an cair a sha waya T		"你说这些,这些感觉得能不能。" "这些话,你们的你们
17. L.	nigra, slavit, stanta stanta va stantaria. Sa na vitar	
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1991、戴颜、微柔动下。	MINP	ILE NUMBER: 0830 030

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STATUS: Prospect INFING DIVISION: Kenloops UNEXPORT 52 310 LENATION: 113 53 00 LENATION: 110 53 00 LENATION: 110 500 Mattes LENATION: 110 500 Mattes SIGUITION: Mices Mascovice ASSOCIATED: Quart: Mice SIGUITION: Mices Mascovice ASSOCIATED: Quart: File SIGUITION: Mices Mascovice ASSOCIATED: Quart: File SIGUITION: Mices Mascovice COMMONITIES: Statiform Concerdent ISOTOFIC AGE: 135 +/ 4 Ma DATING METHOD: Unknown MATERIAL DATED: Unknown CLASSIFICATION: Meteomorphic Industrial Min. SMARE: Tabular DIMENSIG: 1350 x 65 Mattes STRIKE/DIP: 115/ TERED/PLINGE: CLASSIFICATION: Meteomorphic Industrial Min. SMARE: Tabular DIMENSIG: 1350 x 65 Mattes STRIKE/DIP: 115/ TERED/PLINGE: CLASSIFICATION: Meteomorphic Industrial Min. SMARE: Tabular DIMENSIG: 350 x 65 Mattes STRIKE/DIP: 115/ TERED/PLINGE: CLASSIFICATION: Meteomorphic Industrial Min. SMARE: Tabular DIMENSIG: 350 x 65 Mattes CLASSIFICATION: Meteomorphic Industrial Min. SMARE: Tabular DIMENSIG: 350 x 65 Mattes CLASSIFICATION: Meteomorphic Industrial Min. SMARE: Tabular DIMENSIG: 350 x 65 Mattes CLASSIFICATION: Meteomorphic Complex STRIKE/DIP: 115/ TERED/PLINGE: CLASSIFICATION: Meteomorphic Complex. DUART: Monolende Biolite Schist Quart: Mice Schist Micescoir PLINGE MARE: Cariboo Mountains METAMORFHIC ANEA: Cariboo Mountains METAMORFHIC ANEA: Cariboo Mountains METAMORFHIC ANEA: Cariboo Mountains METAMORFHIC TYPE: Regional RELATIONSHIP: Syn-mineralization GRADE: Amphibolite VERICH ONE ZONE: SMARE: Maced Metamorphic Complex. METAMORFHIC TYPE: Regional RELATIONSHIP: Syn-mineralization GRADE: Amphibolite VERICH ONE ZONE: SMARE: Maced Metamorphic Complex. METAMORFHIC TYPE: Regional RELATIONSHIP: Syn-mineralization GRADE: Amphibolite VERICH ONE ZONE: MARESHIP: Syn-mine	MINFILE NUMBER:	083D 032	1	IATIONAL MINERAL INVENTORY:
STATUS: Prospect MINING DIVISION Kallops MINING STATUS: Prospect MINING STATUS: Network (Maillow) LUMATING: 4010 MUNING Status) LUMATING: 1000 Metree LUMATING: 1000 Metree LUCATING: 1000 Metree LUCATING: 1000 Metree COMMONTIES: Muca Margine Status (Margine Status) MUNING MARGENER Margine Status) SUBJECT (MARGENER Margine Status) SUBJECTIONT: Mica ASSOCIATES: Duarts Musacovite ASSOCIATES: Duarts Feldspar SUBJECTIONT: Mica Musacovite ASSOCIATES: Duarts Feldspar SUBJECTIONT: Mica Musacovite Musacovite SUBJECTIONT: Mica Musacovite Musacovite SUBJECTION: Margine Musacovite MUNING STATUS SUBJECTIONT: Mica Musacovite SUBJECTION: Margine Musacovite MUNING Status SUBJECTION: Margine Musacovite MUNING STATUS SUBJECTION: Margine Musacovite MUNING STATUS MUNING STATUS MUNING STATUS MUNING STATUS MUSACOVICE: Musacovite MUNING STATUS MUNING STATUS MUNING STATUS MUNING MUSACOVICE: Musacovite MUNING MUSACOVICE: Musacovite MUNING MUSACOVICE: Musacovite MUNING MUSACOVICE: MUNING MUNING MUNING MUSACOVICE: MUNING MUNING MUNING MUSACOVICE: MUNING MUNING MUNING MUNING MUNING MUNING MUNING MUNING MUNING MUN	NAME(S):	RAFFERTY, M-10	a on the state of the state of the state State of the state of	<sup>1</sup> Tan 1997 Anter 1997 and http://www.sci.org/ ten-stationary.org/1997 (New York, 1997).
NES NAGE (BEDINE LAITTON: 13 00 00 ELEVATION: 1000 Motree LAINTING: 53 00 ELEVATION: 1000 Motree LAINTING: 53 00 ELEVATION: 1000 Motree LAINTING: 53 00 ELEVATION: 1000 Motree LAINTING: 5000 Motree	STATUS :	Prospect	ダント センション かいしん たいしん しょうしょう	MINING DIVISION . Kamloops
LATITORS: 52 21 00 LUMETTORS: 52 21 00 LUMETTORS: 112 25 00 en LUMETTORS: 52 21 00 LUMETTORS: 112 25 00 en LOCATION ACCENCY: Within 5000 COMMENT: Approximate centre of the claim group on the north side of the Sorth Thompson River, 40 kilometres northwest of Blue River (Assessment Report 13844). COMMENT: State Lower of the claim group on the north side of the Sorth Thompson River, 40 kilometres northwest of Blue River (Assessment Report 13844). COMMENT: State Lower Cretaceous ISGOTOFIC AGE: LOSE AGE: LOSE Cretaceous ISGOTOFIC AGE: Monothis IS degrees for 1300 metres and Los atempts COMMENT: HORE TO AGE: Manual Sector AGE: Agented to be the age of the main metamorphic event (Geological Survey of Canada Paper 90-18, pp. 71-60). FRIGUES/METHOFIC AGE GAUET MUSC AGE: Machined Biotic Schist Quartz Mico Schilt Quartz Mico Schilt Quartz Mico Schilt Quartz Mico Schilt Quartz Mico Schilt Quartz Mico Schilt CretEGONT: Bosted in the Lower Fasa Group on the northwestern margin of the Shuewap Metamorphic Complex. COMMENTS: Bosted In the Lower Fasa Group on the northwestern margin of the Shuewap Metamorphic Complex. COMMENTS: Bosted Monothed Biotic Schist Quartz Mico Schilt Quartz Mico Schilt Mico Schilt Mico Schilt Mico Schilt Mico Schilt Mico Schilt Mico Schilt Mico	NTS MAP:	083D11W	计计划 法公共的法律 法保留条件的 化化学分析 化分子	TTEM VOND 11
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ELEVATION : 1000 Metree LEVATION : COMMENTS : Approximate centre of the claim group on the north wide of the Horth Report 180401. COMMONTES: Mice SIGNITIONT: Mice Mascowite Siture (Linear Contents of Siture River (Linear Section Graphite Graphite Graphite INSERLIZATION AGE Lower Createous INSERLIZATION AGE LOWER CONCOMING MATERIAL DATED: Unknown DOINT CIMBACTER: Stratiform Concordant CLASSIFICATION Metamonylic Industrial Min. DESERVICE The Main zone trends 115 degrees for 1300 metres and dips steeply contensor, Mineralization age is assumed to be the age of the main metamorphic event (Geological Survey of Canada Paper 90-12, pp. 71-60). FF MORE CMINNT HOST ROCK. Metamontary MATGBARKIC AGE GROUP DEF FORCECON CANADA AGE DATE AGE AND DATE AND AGE INTERNATION INTERDARY CONCOMING AGE AND DATE AND AGE INTERNATION NUMBER CONCOMING Complex LITHOLOGY: Quart Muscovite Biotite Schist Quarts Mica Schist Cuarts Korbale Complex. COMMENTS: Ended in the Lower Kaze Group on the northwestern margin of the Shuwap Metamorphic Complex. COMMENTS: Lower Main AGE AGE AND	LONGITUDE :	119 25 00	Real and the second second second second	EASTING: 336018
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DMINANT HOST ROCK: Metasedimentary         RATIGRAPHIC AGE       GROUP       FORMATION       IGNEOUS/METAMORPHIC/OTHER         Stars       Undefined Formation       Shuswap Metamorphic Complex         Discourse       Quarts Muscovite Biotite Schist       Shuswap Metamorphic Complex         Quarts Microsovite Biotite Schist       Quarts Microsovite Biotite Schist       Shuswap Metamorphic Complex         DIST ROCK COMMENTS: Hosted in the Lower Kaza Group on the northwestern margin of the Shuswap Metamorphic Complex.       Phyllite         DIST ROCK COMMENTS: Hosted in the Lower Kaza Group on the northwestern margin of the Shuswap Metamorphic Complex.       PhysiogRAPHIC AREA: Cariboo Mountains TRANCE Cariboo Mountains TRANCE Cariboo         METAMORPHIC TYPE: Regional       RELATIONSHIP: Syn-mineralization GRADE: Amphibolite         VENTORY       ORE ZONE: SAMPLE       GRADE         COMMENTS: Schist samples containing muscovite. 01 the 44.4700 Per cent       COMMENTS: Schist samples containing muscovite. 01 the 44.470 per cent muscovite.         REFERENCE:       Reafferty prospect is located on the north side of the North Thompson River at Adolf Creek. 48 kilometres northwest of the community of Blue River. The deposit was trenched and sampled by Pacific Mica Lin 1984 and 1985.         PSULE GROLOSY       The Referty prospect is located on the north side of the North Thompson River at Adolf Creek. 48 kilometres northwest of the community of Blue River. The deposit was trenched and sampled by Pacific Mica Lin 1984 (Geological Survey of Canada Paper 90-1				
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Quartzite Sandstone Phyllite OST ROCK COMMENTS: Hosted in the Lower Kaza Group on the northwestern margin of the Shuswap Metamorphic Complex. OLOGICAL SETTING TECTONIC BELT: Omineca TERRANE: Cariboo METAMORPHIC TYPE: Cariboo METAMORPHIC TYPE: Regional RELATIONSHIP: Syn-mineralization GRADE: Amphibolite VENTORY ORE ZONE: SAMPLE CATEGORY: Assay/analysis SAMPLE TYPE: Grab COMMENTS: Schist samples containing muscovite. Of the 44.47 per cent Mica COMMENTS: Schist samples containing muscovite. Of the 44.47 per cent muscovite, 15 per cent was contaminated with graphite. REFERENCE: Assessment Report 13844. PSULE GROLOGY The Rafferty prospect is located on the north side of the North Thompson River at Adolf Creek, 48 kilometres northwest of the community of Blue River. The deposit was trenched and sampled by Pacific Mica Ltd. in 1984 and 1985. The area is underlain by quartz mica schist, quartzite and phyllite of the Upper Proterozoic lower Kaza Group from overturned strata of the Hadrynian Horsethief Creek Group to the northeast. The main metamorphic event has been dated to have occurred at 135 +/- 4 Ma (Geological Survey of Canada Paper 90-1E, pp. 71-80). Refer to the Canne South Mica showing (083D 017) for a detailed description of the regional deformation and metamorphism. The deposit is comprised of two distinct zones of muscovite rich schist. A zone of quartz-muscovite-biotite schist, 65 muscovite rich		Quartz Mica Schist		
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		schist. A zone of	quartz-muscovite-biotite schi:	

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### MINFILE / pc MASTER REPORT GEOLOGICAL SURVEY BRANCH - MINERAL RESOURCES DIVISION MINISTRY OF ENERGY, MINES AND PETROLEUM RESOURCES

### インドレーマン 「シンマン」を示えたうない 記念 記録 日本語 きるいしゅう CAPSULE GEOLOGY trends 115 degrees for at least 250 metres, possibly up to 1350 metres, and dips steeply southwest. Minor garnet and locally intense iron staining due to pyrrhotite are present. The zone grades schist and quartzite. The zone is in sharp contact to the southwest with quartzite and micaceous quartzite. A second less well defined zone (the M-10 zone) occurs southwest of the previous zone them zone (the M-10 zone) occurs southwest of the previous zone, where large blocks of guartz mica schist are exposed on the steep north material, only slightly removed from bedrock. Schist samples from the main zone are reported to contain 44.47 per cent muscovite, of which 15 per cent was contaminated with graphite (Assessment Report 13844). Muscovite from the M-10 zone was found to be free of graphite. Grinding and beneficiation tests, performed at the University of Toronto, indicate that a concentrate, 2 - Part States containing at least 95 per cent muscovite, can be produced. Good liberation and separation occur in the 0.15 to 0.6 millimetre size range (Assessment Report 12679). An and a second s n an thair sin air air a Traiteann BIBLIOGRAPHY EMPR ASS RPT \*12679; \*13844 EMPR INF CIRC 1986-1, p. 70 GSC OF 2324 EMPER INF CIRC 1986-1, p. 70 Contract of the second s 1.2680.000 GSC # 0/11A, pp. /15/16, 0/11, pp. 101 20, pp. 100, FIELD CHECK: N FIELD CHECK: N REVISED BY: KJM DATE REVISED: 911119 The management and the second s , addina ann an thairte ann an tair Allacha à tharraichte ann an tairte een on the same an the stand and it where a second second stands the second standard as a special of second 2 definition and the second condi-AND THE CONTRACTOR - Andrewski i Standard Andrewski - Standard II. Andrewski - Standard II. Andrewski - Standard II. - and a data water of the second s

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		SI, MINES AND FRIC	DEUM RESOURCES		
MINFILE NUMBER:	<u>0928 - 028</u> .	N	ATIONAL MINERAL I	NVENTORY :	entry and the co
NAME (S) :	ROSE	4 - P		al de	$\mathbf{x} \in \mathcal{X}^{(n)}(\mathcal{A})$
NTS MAP: LATITUDE: LONGITUDE:	48 53 02 123 48 47 0500 Metres			DIVISION: UTM ZONE: NORTHING: EASTING:	10 5414650
LOCATION ACCURACY: COMMENTS:		the creek's mouth i			n an
COMMODITIES:	Mica Sericite				
IINERALS		e provenské slovenské			and the second
SIGNIFICANT: ASSOCIATED: MINERALIZATION AGE:	Graphite				n de Rezervente de la constante de la constante La constante de la constante de La constante de la constante de
DEPOSIT				an a	n an Chasain Tha Astain Astain
CHARACTER: CLASSIFICATION:					
					$(1,2^{\frac{1}{2}},1)^{\frac{1}{2}}$
DOMINANT HOST ROCK:	Metasedimentary				
STRATIGRAPHIC AGE	GROUP	FORMATION	IGNE	OUS/METAMO	RPHIC/OTHER
Apper Devonian	Sicker	McLaughlin Ridge			
Carboniferous	Buttle Lake	Fourth Lake	an an an an Arightin. An an an Arighting		
LITHOLOGY:	Sericite Schist Graphitic Schist				
HOST ROCK COMMENTS:	Probably McLaughlin Ridge Form			n de la companya. Na companya de la com	
BOLOGICAL SETTING	an an Araba an an ann an Araba an an Araba an Araba. An Araba		ng filo to nodetako en terreze Terreze		a da fa ta cardina. Alta
TECTONIC BELT:			PHYSIOGRAPHIC	AREA: Vanc	ouver Island Ranges
METAMORPHIC TYPE:	Wrangell Regional	RELATIONSHIP:	G	RADE: Gree	nschist
			ала 1		. @7 <sup>1</sup> .
CAPSULE GEOLOGY					
	The Rose occurrence is lo volcanic rocks of the Late Dev (Sicker Group) and by sediment Fourth Lake Formation (Buttle disrupted by folding, faulting Tertiary) and the intrusions of (informally called the Mount H Upper Triassic Karmutsen Forma Most of the original rock	onian McLaughlin Ri s of the Mississipp Lake Group). The l (, (pre-Triassic as f gabbro and diabas all Gabbro) that ar tion.	dge Formation ian to Pennsylvan ocal stratigraphy well as Late a sills and dykes a coeval with the		
	obliterated by extensive fault			e traditione	
	deformation, resulting in the About 70 metres of sericite an non-schistose argillite have h road. In the rocks a strongly	d graphitic schists een exposed along t developed schistos	, as well as he north side of ity strikes 065	1. 1. 1. 1. 1. 1. 1. 1. 1. 1. 1. 1. 1. 1	
	degrees and dips 79 degrees no 1965, page 268).		nes Annual Report	tera gordino di Gordiane de com	
BIBLIOGRAPHY				11 - A I	edika anta ku
na series de la constance de la constance de la constance	EMPR FIELDWORK 1979, pp. 49-51 GSC P 72-44; 75-1A, p. 23; 79- GSC MEM 13; 36; 96	-30			
	GSC MAP 42A; 1386A; 1553A GSC OF 463; 701	· · · ·			
DATE CODED: DATE REVISED:	901003	CODED BY: REVISED BY:	GSB GJP		FIELD CHECK: N FIELD CHECK: N
	an a	an film general General Den States (1997)			
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	a da servicio de la companya de la c Porta de la companya d				
			and the second second		

	<b></b>	<u> </u>	<u>na nakén nanang sérén</u> kan	<del>dag berten 1996 bin das statu</del> nses, segun est.	<u>, 593 </u>	an the second second second second
MINFILE NUMBER:	092HNW067		NATIO	NAL MINERAL INVE	NTORY :	
NAME(S):	COQUIHALLA					
STATUS :	Showing			MINING DI	TSTON . I	New Westminster
	092111E			1777	ZONE	10
	49 36 27			NOF	THING:	5496600
LONGITUDE :	121 02 42			E/	STING: (	541250
	1000 Metres		and the state of the	and the second straight		
	Within 5 KM			a - Constantino de la		
	Location for railway h Romeo and Coquihalla.					and the second second
	Romeo and coquinaita.	an a				
COMMODITIES:	Feldspar Si	ilica	Mica			
	an mara Roman an Anna Anna				1.2.37	
INERALS				and a second		
		Jartz	Muscovite	an gala an taobh an an guile. Tagailte		in a status Angeleria de la companya
MINERALIZATION AGE:						
POSIT						n an the state of the
	Stratabound					and the second
CLASSIFICATION:		ngenetic	Industrial Mi	n.		
	Ceramic pegmatite	-				
	and the second second				$(p_{1},\beta_{1},\beta_{2},\beta_{3})$	
IOST ROCK						
DOMINANT HOST ROCK:	Plutonic	an am a thair				
						A Stage Alexandre
STRATIGRAPHIC AGE	GROUP	FORMAT	ION			RPHIC/OTHER
and and the set of the set of the set of the	102.8 +/- 1.5 Ma	الأيون المحمول المراجع (1934). الأحد المحمول	an a	Lagre i	Juconic	
DATING METHOD.	Potassium/Argon					
MATERIAL DATED:	Muscovite					
						and the second second
LITHOLOGY:	Pegmatite			and the second		
	Granodiorite					
	-		an an teachtra an teachtra.		tal contra	
HOST ROCK COMMENTS:	Isotopic age by Monger Sheet 3).	: (Geological Su	rvey of Canada M	ap 41-1989,		the second s
	SHEEL S).					
BOLOGICAL SETTING					1.64.33	
TECTONIC BELT:	Intermontane		li versi in 🖓 🕺 🛛 🖻	HYSIOGRAPHIC ARE	A: Casca	ade Mountains
TERRANE :	Plutonic Rocks					
CAPSULE GEOLOGY		NATES AND			1999 1997 - 1997 - 1997	
	Pegmatites are a Late Jurassic and Earl					
	occur as irregular int					
	metres wide and are be					
	Coguihalla and along					
	The pegmatites co					
	quartz and muscovite i	in crystals up to	o five centimetr	es wide.	le strange de la composition	
	Locally, they exhibit					
	intruded at a late sta					
		An tao ing balan ing t				
BIBLIOGRAPHY	EMPR OF 1991-10	<sup>1</sup> A. S.	an gular shirt an an Shirt an shirt	n an Arran Arra an Arra. An Arra an Arra an Arra		
	EMPR OF 1991-10 GSC MEM 139, p. 94, 10	n <b>a</b>	and a second second Second second	an an an trainn an that an	No Carlos No Anglia	
	GSC P 69-47; 88-E1, pr	o. 177-183			1997 - 1997 - 1997 - 1997 - 1997 - 1997 - 1997 - 1997 - 1997 - 1997 - 1997 - 1997 - 1997 - 1997 - 1997 - 1997 -	
	GSC MAP 737A; 12-1969;					
DATE CODED:	850724		CODED BY: GSB			FIELD CHECK: 1
DATE REVISED:	920316	3	REVISED BY: DMN		1. N. 1. N. 1.	FIELD CHECK: 1
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				<ul> <li>A second sec second second sec</li></ul>		

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<del>The state of the second states and the second states and the second states and the second states and the second</del>		
MINFILE NUMBER:	0921 277 NATIONAL MINERAL INVENTORY: 09213 Sia1	
NAME (S):	MICA, FAIR HARBOUR, MARK, SST. ST. ST. ST. ST. ST. ST. ST. ST. ST	
	MICA, FAIR HARBOUR, MARK, sent state	
STATUS :	Prospect MINING DIVISION: Alberni	
NTS MAP:	092L03E UTM ZONE: 09	
LATITUDE:	50 03 30 NORTHING: 5546620	
LONGITUDE:	127 06 12 EASTING: 635764	
ELEVATION:	0010 Metres to a construction of the construct	
LOCATION ACCURACY	Within 500M and the lower of the second state of the second state of the second state of the second state of the	
COMMENTS	Location of sericite showing on Mica One claim is on the south shore	
00.1111110.	at the head of Fair Harbour off Tahsish Inlet:	
COMMODITIES:	Sericite Mica Mica Silica	
and Maria		
MINERALS		
SIGNIFICANT:	Sericite Quartz Pyrite Dumortierite Magnetite	
ASSOCIATED:	Pyrite Dumortierite Magnetite	
ALTERATION:	Quartz Sericite 45 15 15 15 16 16 16 16 16 16 16 16 16 16 16 16 16	
ALTERATION TYPE:	Silicific'n Sericitic was say the actual at a start of the	
MINERALIZATION AGE:		
	DATING METHOD: Unknown MATERIAL DATED:	
	and a second	
PEPOSIT		
CHARACTER :	Maggive	
CLASSIFICATION:		
	Irregular	
MODIFIER:	Sheared     Faulted       0091 x 0003     Metres     STRIKE/DIP: 100/50S     TREND/PLUNGE:	
DIMENSION:	0091 x 0003 Metres STRIKE/DIP: 100/50S TREND/PLUNGE: Attitude of local stratigraphy is west striking, dipping 40 to 60	
COMMENTS:		
	degrees south.	
IOST ROCK	· "你们你们的你们,你们们你们的你们,你们们你们的你们,我们们你们的你们,你们你能能是你们的你们,你们你们不知道你?"	
DOMINANT HOST ROCK:	Metavolcanic, per ladies in des l'hard service propertie de Maria avec de l'Arte and en la tra	
TO ATTON ADDITO ACE	GROUP FORMATION IGNEOUS/METAMORPHIC/OTHER	
TRATIGRAPHIC AGE		•
ower Jurassic		
ISOTOPIC AGE:		
DATING METHOD:		
MATERIAL DATED:	MOLIUSKS	
Jurassic	Island Plutonic Suite	
ISOTOPIC AGE:		
	Potassium/Argon	
MATERIAL DATED:	Philogophice	
T TIMIOT OOV	Siliceous Tuff	
LITHOLOGI:	Siliceous furi	
	Chlorite Andesite	
	Quartz Porphyry Dike	
	Massive Sericite Rock	
NOCE DOCK COMPANY	Bonanza mollusks from Quatsino Sound. Intrusive phlogopite from	
HOST ROCK COMMENTS:	Zeballos stock (Geological Survey of Canada, Paper 74-8).	
	Zeballos Stock (Geological Bulley of Canada, Faper 14-0).	
SEOLOGICAL SETTING		
TECTONIC BELT:	Insular PHYSIOGRAPHIC AREA: Vancouver Island Ran	iae
	Wrangell Plutonic Rocks	.90
a internetio .		
INVENTORY	and the second secon	
ORE ZONE:		
ORE ZONE:		
	CATEGORY: Assay/analysis YEAR: 1971	
	SAMPLE TYPE: Channel	
	· 프로프로토 · · · · · · · · · · · · · · · · · · ·	
	Along 3.4 metres in shallow trench, commodity is SiO2.	
KEPEKENCE:	Geology, Exploration and Mining 1971, page 481	
APSULE GEOLOGY	The veries of the Migo aggregation is underlaid by used striking	
	The region of the Mica occurrence is underlain by west striking,	
	040 to 060 degree south dipping rhyodacitic to basaltic-andesitic	
	flows, tuffs and pyroclastics of the Lower Jurassic Bonanza Group.	
	The volcanic rocks are intruded by granodiorites and related rocks of	
	the Amai and Zeballos intrusions, located several kilometres to the	
	south and east respectively. The intrusions are related to the	
	Jurassic Island Plutonic Suite.	
	The occurrence is within an assemblage of chloritic andesite and	
	fine to medium-grained tuff, intruded by a quartz-porphyry dyke.	
	Mineralization occurs in an alteration zone along a fault	
	striking west and consists of quartz and massive sericite with pyrite,	
	Stituid acor and consists of daries and mapping serveres with blanch	
	MINFILE NUMBER: 092L	2

CAPSULE GROLOGY

magnetite and minor dumortierite. In the visible exposures north of the base of the slope, the rocks have been highly altered, along the steep fault zone. The visible exposures indicated that the alteration is zoned but not Encough can be seen to allow accurate measurements of zone widths. From the unaltered tuff northward, there is an intensely silicified band ranging up to 2 metres wide. Next is a band consisting of a mixture of fine-grained silica, sericite, and magnetite, and finally, an undetermined width of silicified and pyritized material

Rock from the silicifed zone is pale, creamy white, often brown weathering, hard and fine-grained. A streaky foliation visible in some outcrops probably represents original bedding. In thin sections the rock is seen to consist of recrystallized quartz in grains with diameters of 0.01 to 0.12 millimetres, occasionally reaching 0.20

diameters of 0.01 to 0.12 millimetres, occasionally reaching 0.20 millimetres. Sericite and pyrite are present in minor quantities. One channel sample cut along 3.4 metres in a shallow trench across the silica-sericite-magnetite zone contained: SiO2 = 64.52, T 21 N=20-0 22 Fe(total) = 4.50, H2O(+105 degrees C) = 4.20, SO3 = 1.54 (Geology, Exploration and Mining 1971, page 481).

The property is adjacent to a copper showing on the east (Laura Lee-Mark - 092L 277).

#### BIBLIOGRAPHY

EMPR ASS RPT \*8931 EMPR GEM \*1971-479,481 EMPR OF 1987-15 GSC OF 9; 170; 463 GSC SUM RPT-1913; 1920A GSC SUM RPT-1913; 1920A GSC P 69-1A; 70-1A; 72-44; 74-8 GSC ANN RPT 1886 GSC MAP 4-1974; 255A Carson, D.J.T., (1968): Metallogenic Study of Vancouver Island with emphasis on the Relationship of Plutonic Rocks to Mineral Deposits, Ph D Thesis, Carleton University Ottawa

DATE CODED: 850724 DATE REVISED: 890125

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MINFILE NUMBER: 093A 083 NATIONAL MINERAL INVENTORY: NAME (S) : MICA MOUNTAIN, CLEARWATER MICA da se se se STATUS: Prospect MINING DIVISION: Cariboo NTS MAP: 093A01W UTM ZONE: 10 LATITUDE: 52 08 03 NORTHING: 5778829 LONGITUDE: 120 26 31 EASTING: 675078 **ELEVATION: 1920 Metres** LOCATION ACCURACY: Within 1 KM COMMENTS: Located 65 kilometres north-northwest of Clearwater, 3 kilometres west of Wells Grey Provinial Park. COMMODITIES: Mica MINERALS SIGNIFICANT: Muscovite ASSOCIATED: Quartz Feldspar MINERALIZATION AGE: Unknown DEPOSIT CHARACTER: Concordant Podiform CLASSIFICATION: Pegmatite Magmatic Industrial Min. TYPE: Muscovite pegmatite SHAPE: Irregular DIMENSION: 60 Metres STRIKE/DIP: TREND/PLUNGE: COMMENTS: A 60-metre wide north-trending zone of pegmatite pods and dikes 1.5 to Here 9 metres wide. HOST ROCK DOMINANT HOST ROCK: Metasedimentary STRATIGRAPHIC AGE GROUP Proterozoic-Paleoz. Snowshoe FORMATION IGNEOUS/METAMORPHIC/OTHER Undefined Formation LITHOLOGY: Quartz Mica Schist Quartz Pegmatite Dike HOST ROCK COMMENTS: The Snowshoe Group is (?) Hadrynian to Paleozoic in age. GEOLOGICAL SETTING PHYSIOGRAPHIC AREA: Quesnel Highland TECTONIC BELT: Omineca TERRANE: Barkerville METAMORPHIC TYPE: Regional RELATIONSHIP: GRADE : TNURNTORY ORE ZONE: SAMPLE CATEGORY: Assay/analysis YEAR: 1931 SAMPLE TYPE: Grab COMMODITY GRADE Mica 30.0000 Per cent COMMENTS: Early work indicated 25 to 30 per cent mica. REFERENCE: Minister of Mines Annual Report 1931, page 109. CAPSIER GROLOGY The Mica Mountain prospect is located about 65 kilometres north-northwest of Clearwater, 3 kilometres west of Wells Gray Provincial Park. A 60-metre wide zone of irregular pods and dikes of pegmatite in guartz mica schist of the Snowshoe Group has been traced northward across the summit of Mica Mountain. Individual pods and dikes range from 1.5 to 9 metres in width. The pegmatite varies considerably in composition, with quartz and feldspar predominating, accompanied by subordinate muscovite mica. The muscovite occurs as irregularly distributed, well-developed "books", up to 15 centimetres in length. The mica tends to be more abundant near surface. Early work (1931) indicated that the mica grades up to 25 to 30 per cent. BIBLIOGRAPHY EMPR AR \*1931-109 EMPR PF (Mellin, R.C. 1930, Report on the Clearwater Mica Mine; Calquhoun, M.E. circa 1930, excerpt from Report on Clearwater Mica Mine; Claim Map of Area, date unkown) GSC P 70-1A GSC MAP 42-1961; 1-1963; 1424A

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APSOLA GEOLOGI	Jurassic Francois L	ite dikes occur in ake Intrusive Suite	a batholith of the	Upper e is 9 metres	
	northeast of Casey	Lake. The pegmatit nor plagioclase and	ike approximately 1 te consists of quar	.2 kilometres tz, perthitic size ranges	
ibliography	northeast of Casey orthoclase, and min up to about 2.5 cen	Lake. The pegmatit nor plagioclase and	ike approximately 1 te consists of quar	.2 kilometres tz, perthitic size ranges	e BBB and the cost
도 1 (국가), <sub>11</sub> , 4명의 -	northeast of Casey orthoclase, and min up to about 2.5 cen EMPR AR 1965-126 EMPR PF (See 093K G	Lake. The pegmatit nor plagioclase and ntimetres. Seneral file. Endako	Lke approximately 1 ce consists of quar biotite. Crystal	.2 kilometres tz, perthitic size ranges	e BHO-callMatters
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MINFILE NUMBER:						
NAME(S):	WOLVERINE RANGE		a tana ang sa			
STATUS:	Showing			MINING DIVIS	SION: Omineca	
NTS MAP:			12 July 10 Jul		20 <b>NE :</b> 10	
	55 43 53			NORTH	HING: 6176750	
LONGITUDE :				EAST	NING: 416950	
- 10 GOD T C	1860 Metres				and the second second	
LOCATION ACCURACY:						
COMMENTS :	The occurrence is lo kilometres northeast				n en ante en la sectión de la companya de la compa La companya de la comp	
COMMODITIES:	Mica	Feldspar				
INERALS			Apple 1 and the second second second			- 22
SIGNIFICANT:	Feldspar	Muscovite			and the second second	
ASSOCIATED:	Quartz	Plagioclase	Biotite	Garnet	Sector and the Sector	$\{1,2,3,\dots,k\}$
MINERALIZATION AGE:	Unknown					
and the second sec						
SPOSIT						
CHARACTER :	Massive				n Alexandra a construction and	
CLASSIFICATION:	Pegmatite	Syngenetic	Industrial Min	🕻 kan berger berger 🕆 ander	Martin Line Arthres	
TYPE:	Ceramic pegmatite					
DST ROCK					entage of the second of the second of the	1.11.11
DOMINANT HOST ROCK:	Plutonic					
the second second states where			and the second	and the second second		
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oterozoic				Wolverine	2 Complex	
ertiary				Unnamed/U	Inknown Informal	
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LITHOLOGY:				izago de la composición de la	naan Monadoo Doolas II. Talaha Santa Santa Santa	· .
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19 <u>1</u> 93		otite Granodiorit ta from zircon an	e alysis indicate ar	n early Tertiary	na a chuir agus chruin an s San San Agus an s San San San San San San San San San San	· .
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## MINFILE / pc MASTER REPORT GEOLOGICAL SURVEY BRANCH - MINERAL RESOURCES DIVISION MINISTRY OF ENERGY, MINES AND PETROLEUM RESOURCES

STATUS: Showing MINING NTS MAP: 093011W LATITUDE: 55 40 53 LONGITUDE: 123 26 29 ELEVATION: 915 Metres LOCATION ACCURACY: Within 5 KM COMMENTS: The Falls claims are situated on the north fork of Six Mile Creek (Minister of Mines Annual Report 1904, page G112). COMMODITIES: Mica INERALS SIGNIFICANT: Mica MINERALIZATION AGE: Unknown EPOSIT CHARACTER: Unknown CLASSIFICATION: Industrial Min. COMMENTS: A detailed description for this occurrence is not available.	S.
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CHARACTER: Unknown         CLASSIFICATION: Industrial Min.         COMMENTS: A detailed description for this occurrence is not available.         ST ROCK         MINANT HOST ROCK: Metasedimentary         MATIGRAPHIC AGE       GROUP         FORMATION       IGN         Der Proterozoic       Misinchinka         Unnamed/Unknown Formation       LITHOLOGY: Unknown         NST ROCK COMMENTS: The Falls claims may be underlain by Misinchinka Group sediments         NOGICAL SETTING       TECTONIC BELT: Foreland	<u>GNEOUS/METAMORPHIC/OTHER</u>
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ST ROCK       MINANT HOST ROCK: Metasedimentary         MINANT HOST ROCK: Metasedimentary       FORMATION         MATIGRAPHIC AGE       GROUP       FORMATION         Misinchinka       Unnamed/Unknown Formation         LITHOLOGY: Unknown       Distriction         DST ROCK COMMENTS: The Falls claims may be underlain by Misinchinka Group sediments         DIOGICAL SETTING         TECTONIC BELT: Foreland	<u>GNEOUS/METAMORPHIC/OTHER</u>
ST ROCK         MINANT HOST ROCK: Metasedimentary         MATIGRAPHIC AGE       GROUP       FORMATION       IGN         Der Proterozoic       Misinchinka       Unnamed/Unknown Formation         LITHOLOGY: Unknown       Distriction       Distriction         DST ROCK COMMENTS: The Falls claims may be underlain by Misinchinka Group sediments       Distriction         DIGICAL SETTING       TECTONIC BELT: Foreland       PHYSIOGRAPHIC	<u>GNEOUS/METAMORPHIC/OTHER</u>
MINANT HOST ROCK: Metasedimentary       FORMATION       IGH         MINANT HOST ROCK: Metasedimentary       FORMATION       IGH         Der Proterozoic       Misinchinka       Unnamed/Unknown Formation         LITHOLOGY: Unknown       Distriction       Distriction         DST ROCK COMMENTS: The Falls claims may be underlain by Misinchinka Group sediments       Distriction         DIGICAL SETTING       TECTONIC BELT: Foreland       PHYSIOGRAPHIC	<ul> <li>S.</li> <li>S. Antipage of the state of</li></ul>
LATIGRAPHIC AGE       GROUP       FORMATION       IGH         Der Proterozoic       Misinchinka       Unnamed/Unknown Formation       IGH         LITHOLOGY:       Unknown       Unknown       ST         DST ROCK COMMENTS:       The Falls claims may be underlain by Misinchinka Group sediments         DIOGICAL SETTING       TECTONIC BELT:       Foreland	<ul> <li>S.</li> <li>S. Antipage of the state of</li></ul>
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States and the second secon PSULE GEOLOGY # Second secon	
The Falls occurrence is situated on the north fork of Six M	
Creek, approximately 44 kilometres northwest of the town of Macke	
in the Omineca Mining Division.	
The Falls occurrence lies within Ancestral North America ter	errane de la companya
sediments, possibly within the Upper Proterozoic Misinchinka Grou	
As recorded in the 1904 Department of Mines Annual Report "the m	
appears to be very good grade and the surface showing is said to	
very encouraging . A more detailed description is not available	
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IBLIOGRAPHY - Revised and the second s	
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MINFILE NUMBER:				NAL MINERAL INVENTORY	(: 094C10 Mic1
NAME(S):	FAMILY FARM, GENERAL EAST MICA MOUNTAIN	L HOLDING CO., MI	CA MOUNTAIN,		
STATUS :	Past Producer	at a sign and at	Underground	MINING DIVISION	: Omineca
NTS MAP:	094C10E	an england service p	an a	UTM ZONE	3: 10
LATITUDE:	56 33 19			NORTHING	5: 6269000
LONGITUDE:	124 43 57			EASTING	3: 393500
ELEVATION:	1750 Metres				
LOCATION ACCURACY:				And the second second second second	
COMMENTS :	Area of main working the north end of East	st Mica Mountain	(Mica Mountain),	about 9 kilo-	
	metres southwest of				
	Williston Lake) (Min Geological Survey of		Report 1927A, pag		
COMMODITIES:	Mica	Gemstones	n ninger (norder sonder sonder sonder Sonder sonder	이 방법에 이 이 가격을 가격해 이 있는 것 같은 것 같은 것	
		and the second			
INERALS					
SIGNIFICANT:	Beryl	•	Quartz	Tourmaline	Garnet
COMMENTS: ASSOCIATED:	Beryl was reported f from this occurrence		the district, but	not necessarily	
MINERALIZATION AGE:					
EPOSIT					
CHARACTER :	Vein	Disseminated	Concordant		
CLASSIFICATION: TYPE:	Pegmatite Muscovite pegmatite	Industrial Min.			
	Bladed				
DIMENSION :		Metres		50/70W TREN	D/PLUNGE: 150/1
COMMENTS:	The pegmatite dike is in length and an int parallel to schistos	ermediate axis 1	shape with a lon 2 metres in lengt	g axis 100 metres n oriented	
OST ROCK DOMINANT HOST ROCK:	-	20210	TTON		
TRATIGRAPHIC AGE	<u>GROUP</u> Ingenika	FORMA Unnam	ed/Unknown Format		MORPHIC/OTHER
LITHOLOGY:	Schist				
	Quartzite				
	Pegmatite Dike				
	Pegmatite Dike				
	Pegmatite Dike				
TECTONIC BELT:	Omineca		P	HYSIOGRAPHIC AREA: Om	nineca Mountains
TECTONIC BELT: TERRANE:	Omineca Cassiar				nineca Mountains
TECTONIC BELT:	Omineca Cassiar	RELAT		HYSIOGRAPHIC AREA: Om ralization GRADE:	nineca Mountains
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TECTONIC BELT: TERRANE: METAMORPHIC TYPE:	Omineca Cassiar Regional		IONSHIP: Pre-mine	ralization GRADE:	nineca Mountains
TECTONIC BELT: TERRANE: METAMORPHIC TYPE:	Omineca Cassiar Regional The Family Farm	n occurrence is s	TONSHIP: Pre-mine	ralization GRADE:	nineca Mountains
TECTONIC BELT: TERRANE: METAMORPHIC TYPE:	Omineca Cassiar Regional The Family Farm Peak (East Mica Mour	n occurrence is s htain) 6.5 kilome	TONSHIP: Pre-mine situated on the no	ralization GRADE: rth side of Mica Williston Lake.	nineca Mountains
TECTONIC BELT: TERRANE: METAMORPHIC TYPE:	Omineca Cassiar Regional The Family Farm Peak (East Mica Mour The area is underlai	n occurrence is s htain) 6.5 kilome in by regionally	TONSHIP: Pre-mine situated on the no tres southwest of metamorphosed mio	ralization GRADE: rth side of Mica Williston Lake. geoclinal rocks	nineca Mountains
TECTONIC BELT: TERRANE: METAMORPHIC TYPE:	Omineca Cassiar Regional The Family Farm Peak (East Mica Moun The area is underlai of the Hadrynian Inc	n occurrence is s ntain) 6.5 kilome in by regionally genika Group. Ir	TONSHIP: Pre-mine dituated on the no stres southwest of metamorphosed mio a the vicinity, th	ralization GRADE: rth side of Mica Williston Lake. geoclinal rocks ese	nineca Mountains
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despite some surface weathering. The smaller parallel pegmatite dike of similar shape occurs about a hundred metres northeast of the larger one. Although pyrite, tourmaline and garnet are more abundant, only minor amounts of

PAGE: 45 REPORT: RGEN0100

MINFILE / pc : MASTER REPORT GEOLOGICAL SURVEY BRANCH - MINERAL RESOURCES DIVISION MINISTRY OF ENERGY, MINES AND PETROLEUM RESOURCES

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MINFILE / pc PRODUCTION REPORT GEOLOGICAL SURVEY BRANCH - MINERAL RESOURCES DIVISION-MINISTRY OF ENERGY, MINES AND PETROLEUM RESOURCES

PAGE : 5 REPORT: RGEN0200

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MINFILE NUMBER:	094C 034	1 YZ 1 (11)	NAME :	FAMILY FARM	na nu n		STATUS: Past 1	Producer
Production Year	Tonne <u>Mine</u>		Tonnes Milled			Commodity	Grams <u>Recovered</u>	Kilograms <u>Recovered</u>
1927	and Arrest	2				Mica		2,300
SUMMARY TOTALS:	094C 034		NAME :	FAMILY FARM				
			Metric	Martin Martine Martine		Imperial	en an ann an Arrainn an Arrainn An Arrainn an Arrainn an Arrainn an Arrainn An Arrainn an Arrainn	
	Mined: Milled:		2	tonnes tonnes		2	tons tons tons	
Recovery:	Mica:		2,300	kilograms	ar e	5,071	pounds	i i sur
Comments:	· • • • • •	1					and and a gate of the second	

1927: In 1927, 2.3 tonnes of mica were mined (Annual Report 1927)

MINFILE NUMBER:	094C 035		na <b>na</b>	TIONAL MINERAL	INVENTORY:	094C10 Mic1	
NAME (S):	WEST MICA MOUNTAIN	e de la companya de l	an a		Sec.		
	물 이 이 이 영국의 말했	en de la companya de		1997 - 1997 - 1997 - 1997 - 1997 - 1997 - 1997 - 1997 - 1997 - 1997 - 1997 - 1997 - 1997 - 1997 - 1997 - 1997 -			
STATUS :	Prospect	and the second			DIVISION:		
	094C10W		hadi da kata kata sa k Kata sa kata sa		UTM ZONE:		
	56 31 52		nationale a contention d		NORTHING:		
LONGITUDE :					EASTING:	390600	
	2000 Metres	1 (A+ )				이 집에 가지 않는 것이 같다.	11
LOCATION ACCURACY:							
COMMENTS :	Located on West Mica A154).	a Mountain (Mini	ster of Mines A	nnual Report, p	age		
			september 2000 g		1997 - 1997 - 1997 - 1997 - 1997 - 1997 - 1997 - 1997 - 1997 - 1997 - 1997 - 1997 - 1997 - 1997 - 1997 - 1997 -		
COMMODITIES:	Mica	Gemstones					
NERALS	and the second second		nsi ili statu i		100		
SIGNIFICANT:	Muscovite	Quartz	Feldspar	Tourm	aline	Garnet	
ASSOCIATED:	Pyrite						
INERALIZATION AGE:	Unknown		ing Ngalan San Ang	and the second second			
POSIT							
CHARACTER :							
CLASSIFICATION:		Industrial Min.					
TYPE:	Muscovite pegmatite						
ST ROCK							
OMINANT HOST ROCK:	Metasedimentary						
RATIGRAPHIC AGE	GROUP	FORM	ATION	TCN	FOILS /METAM	ORPHIC/OTHER	
drynian	Ingenika		fined Formation		2000/102111		
•	0.0						
LITHOLOGY :	Pegmatite						
	Mica Schist						
	Gneiss						
	Quartzite						
METAMORPHIC TYPE:	Regional	RELA	TIONSHIP:		GRADE: Ampl	nibolite	
COMMENTS :	Kyanite zone (Paper	75-33, Map 2-19	75).				
COMMENTS :		75-33, Map 2-19	75).				
COMMENTS : PSULE GEOLOGY	Kyanite zone (Paper						
	Kyanite zone (Paper The West Mica M	Mountain míca oc	Currence is loc				
	Kyanite zone (Paper The West Mica M side of West Mica Mc	Mountain mica oc Duntain, 84 kilo	currence is loc metres north of	Germansen Land	ing.		
	Kyanite zone (Paper The West Mica M side of West Mica Mc Hostrocks are p	Mountain mica oc ountain, 84 kilo pegmatites withi	currence is loc metres north of n mica schists	Germansen Land and gneisses an	ing.		
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MINFILE NUMBER:	094C 036	NATIONAL MINERAL INVENTORY: 094C10	Micl
NAME(S):	RAVENAL, LOST PIPE	and the second	
STATUS :	Showing	MINING DIVISION: Omineca	1
NTS MAP:		UTM ZONE: 10	- 
	56 29 49	NORTHING: 6262500	).
LONGITUDE :		EASTING: 393900	
	2100 Metres		
LOCATION ACCURACY:			
		owing claims (Minister of Mines Annual Report	
COMMODITIES:	Mica	Gemstones	
INBRALS			Sec. 1
	Muscovite	Feldspar Quartz Tourmaline Gar	met
ASSOCIATED:		-	
INERALIZATION AGE:			
· · ·			7
POSIT			
CHARACTER :			14.00
CLASSIFICATION:	-	Industrial Min.	
TYPE:	Muscovite pegmatite		
0 000			
ST ROCK	Motomorphic		
OMINANT HOST ROCK:	Mecamorphic		
RATIGRAPHIC AGE	GROUP	FORMATION IGNEOUS/METAMORPHIC/C	ידעדס
drynian	Ingenika	Undefined Formation	/1/15/
ar ymran	THACHTYC		
LITHOLOGY:	Permatite		
2111020011	Mica Schist		
	Quartzite		
	Gneiss	1 Sector 1 S	
	Glieiss		
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TECTONIC BELT:		PHYSIOGRAPHIC AREA: Cassiar Mou	Intains
	Cassiar	a standard a the standard and a standard a s	2. B. C.
			<ul> <li>Automotion</li> </ul>
METAMORPHIC TYPE:		RELATIONSHIP: GRADE; Amphibolite	•
	Regional Kyanite zone (Paper		•
COMMENTS:		75-33, Map 2-1975).	•
	Kyanite zone (Paper	- 75-33, Map 2-1975).	
COMMENTS:	Kyanite zone (Paper The Ravenal mic	75-33, Map 2-1975). ca occurrence is located on the south side of	
COMMENTS:	Kyanite zone (Paper The Ravenal mic Mount Henri, 80 kild	75-33, Map 2-1975). ca occurrence is located on the south side of ometres north of Germansen Landing.	
COMMENTS:	Kyanite zone (Paper The Ravenal mid Mount Henri, 80 kild Hostrocks are p	75-33, Map 2-1975). ca occurrence is located on the south side of ometres morth of Germansen Landing. pegmatites within mica schists and gneisses and	
COMMENTS:	The Ravenal mic Mount Henri, 80 kild Hostrocks are j quartzites of the Ha	75-33, Map 2-1975). ca occurrence is located on the south side of ometres north of Germansen Landing. pegmatites within mica schists and gneisses and adrymian Ingenika Group which have been	
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	an a			
MINFILE NUMBER:	094Cade037	NATIONAL M	INERAL INVENTORY:	094C7 Au1
NAME (S) :	RUBY CREEK, RUBY, LORIMER CREEK	٢	ar ta ta ta ta ta ta ta	
STATUS .	Showing		MINING DIVISION:	Omineca
			UTM ZONE :	
	094C07E			
	56 26 01			6255400
LONGITUDE :	124 40 48		EASTING:	396400
ELEVATION:	1350 Metres		1 Mar	<ul> <li>All All All All All All All</li> </ul>
LOCATION ACCURACY:	Within 1 KM			Real and the second second
	Location is the "gold" occurren	re on Geological Survey of	Canada Man	and the second
COLUMNO.	2-1975 (Paper 75-33, page 17).	Ne on declogical bury of		
COMMODITIES:	Mica	「絵葉」「花山」	1 A	an a
NERALS	Mica Pyrrhotite	Charter and a second	Foldenar	n Maria. An Ingeneration
INERALIZATION AGE:		QUALLY	- 	
			1997 - 1997 - 1997 - 1997 - 1997 - 1997 - 1997 - 1997 - 1997 - 1997 - 1997 - 1997 - 1997 - 1997 - 1997 - 1997 -	
Posit				
CHARACTER :	Vein			
CLASSIFICATION .	Pegmatite Industrial	Min.	- 11 g	
TYDE.	Muscovite pegmatite			
11FB.	THE PERMETER		an an an Anna an Anna an Anna. An an Anna an A	
ST ROCK				
DMINANT HOST ROCK:	metasedimentary			
1484 (1997) - CORE	<u>a se a se</u>		1997 - 1997 - 1997 - 1997 - 1997 - 1997 - 1997 - 1997 - 1997 - 1997 - 1997 - 1997 - 1997 - 1997 - 1997 - 1997 -	
ATIGRAPHIC AGE	GROUP	FORMATION	IGNEOUS/METAMO	RPHIC/OTHER
rynian	Ingenika	Undefined Formation	and a start of the second s Second second	an an an an an an Arbeir an Arbeir. An an Arbeir
and the second		and the second		e de la companya de l
LITHOLOGY :	Peqmatite			
	Mafic Gneiss		2.1.1.21	the set of
	Mica Schist			
	Quartzite		and the second	
METAMORPHIC TYPE: COMMENTS:	Kyanite zone (Geological Survey			
			and a second second second	
PSULE GEOLOGY				
	The Ruby Creek mica occur:	cence is located on Ruby (Lo	primer (?))	and the second
	Creek (Minister of Mines Annual			
	approximately 74 kilometres non	th of Germansen Landing		. 1
	approximately 14 kirometres nor	consisting of primarily feld		
	Mica-Dearing pegmacices, c	onsisting of primarily ferd	ispar and	
	quartz, occur in an area underl			
	and quartzites of the Hadrynian			
	been regionally metamorphosed t	the kyanite zone of the a	mphibolite	
	facies.	and the second states of the	ina général de la company	
	The mode of occurrence is	described as similar to the	Mica	
	Mountain occurrence (094C 035)			
	(Minister of Mines Annual Report			
	metamorphic grade is higher, th			
	pyrrhotite is abundant in the r			
	bands are up to 6 metres in this			
	pyrrhotite assayed trace gold a	and silver and nil nickel ar	ld copper.	3
	and the second second second second		$-\partial_{t} x - \partial_{t} \partial^{2} \sigma_{t} f^{-1} = -i \Delta \phi_{t}^{-1}$	
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	(Geological Survey of Canada Me	emoir 274).	
COMMODITIES:	Mica Silica	Feldspar	
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SIGNIFICANT: ASSOCIATED:	Muscovite Quartz Plagioclase	Feldspar	
MINERALIZATION AGE:			
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CLASSIFICATION:		Industrial Min.	
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HOST ROCK			
DOMINANT HOST ROCK:	Plutonic		
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STRATIGRAPHIC AGE	GROUP	FORMATION	IGNEOUS/METAMORPHIC/OTHER
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Mesozoic-cenozoic			Wolverine Complex
LITHOLOGY:	Granodiorite Migmatite		
	Gneiss		
	Schist		
	Granite		
HOST ROCK COMMENTS:	The Wolverine complex consists Cretaceous to Tertiary intrusio	of metamorphosed Ingenika rock ns.	s and
GEOLOGICAL SETTING			
TECTONIC BELT:	Omineca	DIRACTOOD	DUIC APPA Oning on Mountains
TERRANE:		PHYSIOGRA	PHIC AREA: Omineca Mountains
METAMORPHIC TYPE:	<b>kegional</b>	RELATIONSHIP:	GRADE: Granulite

#### CAPSULE GEOLOGY

The Blackpine Lake pegmatite occurrences are located to the northeast of Blackpine Lake, approximately 80 kilometres northeast of Germansen Landing.

The pegmatites are found near the margins of several intrusive bodies which are part of the Wolverine Complex. The Wolverine Complex consists of an assemblage of migmatites, gneisses and schists, with intimately associated granitic rocks and pegmatites of Cretaceous to Tertiary age (Geological Survey of Canada Memoir 274, page 91). The Wolverine rocks are metamorphic equivalents of the Hadrynian Ingenika Group, metamorphism occurring in the Jurassic. The largest granodiorite body is located on the mountain immediately northeast of Blackpine Lake, and outcrops over an area of approximately 13 square kilometres (Geological Survey of Canada Memoir 274, page 98). Several smaller bodies of granodiorite have been mapped for an additional 15 kilometres to the north-northeast.

Small bodies of pegmatite are abundant above and around the granodiorite stocks, and swarms of dikes are also found at intervals along the ridges between the granodiorite stocks and Chase Mountain, 25 kilometres north-northeast of Blackpine Lake. The pegmatites are generally in the form of dykes or sills, usually less than 3 metres thick and 150 metres long. In places the pegmatites form a reticulate network, which may occupy nearly 50 per cent of the rock volume over a 1.25 kilometres square area. The pegmatites are of simple composition, and are composed principally of quartz, microcline microperthite and muscovite and minor sodic plagioclase, biotite, actinolite, garnet, magnetite, sphene, sillimanite and zircon. Muscovite commonly forms euhedral pseudo-hexagonal books as much as 12.5 centimetres in diameter and 7.5 centimetres thick, in some cases forming pockets in the dikes up to 3 metres across, composed of 50 per cent muscovite. Numerous quartz veins are associated with the pegmatites.

In addition to the pegmatites, cream-coloured, coarse-grained,

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CAPSULE GEOLOGY	active fight and a		,————————————————————————————————————		in states have a
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# MINFILE / pc MASTER REPORT GEOLOGICAL SURVEY BRANCH - MINERAL RESOURCES DIVISION

53 PAGE : REPORT: RGEN0100

MINISTRY OF ENERGY, MINES AND PETROLEUM RESOURCES

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MINFILE NUMBER:	103H 043	an <sub>a</sub> lan ti <del>n</del> t	NATIONAL	MINERAL INVENTORY :	· · · · ·
NAME (S) :	CAMPANIA IS. MICA				
STATUS :	Showing			MINING DIVISION:	Skeena
	103H03W			UTM ZONE :	
	53 03 42	-		NORTHING :	
	129 27 18				469500
	0010 Metres			mpitto:	100000
LOCATION ACCURACY:				-*	
	Description. Pre	1986 103H-G043.	· .		
COMMODITIES:	Mica			. *	,
MINERALS					
SIGNIFICANT:	Mica				
MINERALIZATION AGE:					
ISOTOPIC AGE:		DATING METHOD: Unkno	wn M	ATERIAL DATED:	
DEPOSIT					
CHARACTER :					
CLASSIFICATION:		Industrial Min.	The second second	· · · · · ·	and the many states and the
TYPE :	Muscovite pegmatite	e		1	
SHAPE :	Irregular				
DIMENSION:	0020	Metres	STRIKE/DIP:		PLUNGE :
COMMENTS :	Average length of ]	pegmatite bands.			
HOST ROCK DOMINANT HOST ROCK:	Plutonic				
STRATIGRAPHIC AGE	GROUP	FORMATION		IGNEOUS/METAM	
Lower Cretaceous				Coast Plutonic	: Complex
ISOTOPIC AGE:				- 14 A	
	Potassium/Argon			**	
MATERIAL DATED:	Biotite				
T TOUCH OCY	Biotite Quartz Mon				· · · · · · · · · · · · · · · · · · ·
	Granodiorite				
	Granodiorice				
	Pegmatite	: •			. · · · · · · · · · · · · · · · · · · ·
	1.4.4				
HOST ROCK COMMENTS:	1. 1. 1. 1. 1. 1. 1. 1. 1. 1. 1. 1. 1. 1				
HOST ROCK COMMENTS: GEOLOGICAL SETTING					
HOST ROCK COMMENTS: GEOLOGICAL SETTING TECTONIC BELT:	Coast Crystalline		PHYS	OGRAPHIC AREA: Fio:	rd Ranges (Northern)
HOST ROCK COMMENTS: GEOLOGICAL SETTING TECTONIC BELT:	Coast Crystalline	na tina dia mina am	$(1,2,\ldots,2^{n-1}) \in \mathbb{R}^{n-1}$	Charles and Solar	-
HOST ROCK COMMENTS: GEOLOGICAL SETTING TECTONIC BELT:	Coast Crystalline Plutonic Rocks Regional	RELATIONS	HIP:	GRADE: Ampl	-
HOST ROCK COMMENTS: GEOLOGICAL SETTING TECTONIC BELT: TERRANE:	Coast Crystalline Plutonic Rocks Regional	RELATIONS	n on one of the second se	GRADE: Amp	-
HOST ROCK COMMENTS: GEOLOGICAL SETTING TECTONIC BELT: TERRANE:	Coast Crystalline Plutonic Rocks Regional	RELATIONS	1997 - 1997 - 1997 - 1997 - 1997 HIP: 1997 - 1997 - 1997 - 1997 1997 - 1997 - 1997 - 1997 - 1997 - 1997 - 1997 - 1997 - 1997 - 1997 - 1997 - 1997 - 1997 - 1997 - 1997 - 1997 -	GRADE: Amp	-
HOST ROCK COMMENTS: GEOLOGICAL SETTING TECTONIC BELT: TERRANE:	Coast Crystalline Plutonic Rocks Regional	RELATIONS	internet de la composition de la compos de la composition de la de la composition de la de la composition de la composition de la composition de la composit	GRADE: Ampl	_
HOST ROCK COMMENTS: GEOLOGICAL SETTING TECTONIC BELT: TERRANE: METAMORPHIC TYPE:	Coast Crystalline Plutonic Rocks Regional The core of C	RELATIONS ampania Island consist	HIP: s of clean, mass:	GRADE: Ampl	_
HOST ROCK COMMENTS: GEOLOGICAL SETTING TECTONIC BELT: TERRANE: METAMORPHIC TYPE:	Coast Crystalline Plutonic Rocks Regional The core of C to coarse-grained	RELATIONS ampania Island consist biotite quartz monzon:	HIP: s of clean, mass: te of the Coast 1	GRADE: Ampl ive medium Plutonic	_
HOST ROCK COMMENTS: GEOLOGICAL SETTING TECTONIC BELT: TERRANE: METAMORPHIC TYPE:	Coast Crystalline Flutonic Rocks Regional The core of C to coarse-grained Complex. To the w	RELATIONS ampania Island consist biotite quartz monzon est of a northwest tra	HIP: s of clean, mass: te of the Coast 1 mding fault is gr	GRADE: Ampl ive medium Plutonic ranodiorite.	-
HOST ROCK COMMENTS: GEOLOGICAL SETTING TECTONIC BELT: TERRANE: METAMORPHIC TYPE:	Coast Crystalline Plutonic Rocks Regional The core of C to coarse-grained Complex. To the w Mica, resembl	RELATIONS ampania Island consist biotite quartz monzon est of a northwest tr ing coarse muscovite (	HIP: s of clean, mass; te of the Coast 1 mding fault is g rystals, occurs:	GRADE: Ampl ive medium Plutonic ranodiorite. in 15 to 60	-
HOST ROCK COMMENTS: GEOLOGICAL SETTING TECTONIC BELT: TERRANE: METAMORPHIC TYPE:	Coast Crystalline Plutonic Rocks Regional The core of C to coarse-grained Complex. To the w Mica, resembl	RELATIONS ampania Island consist biotite quartz monzon est of a northwest tra	HIP: s of clean, mass; te of the Coast 1 mding fault is g rystals, occurs:	GRADE: Ampl ive medium Plutonic ranodiorite. in 15 to 60	-
HOST ROCK COMMENTS: GEOLOGICAL SETTING TECTONIC BELT: TERRANE: METAMORPHIC TYPE:	Coast Crystalline Plutonic Rocks Regional The core of C to coarse-grained Complex. To the w Mica, resembl centimetre wide ba	RELATIONS ampania Island consist biotite quartz monzon est of a northwest tr ing coarse muscovite (	HIP: s of clean, mass: te of the Coast 1 mding fault is gr rystals, occurs : e within the quar	GRADE: Ampl ive medium Plutonic ranodiorite. in 15 to 60 rtz monzo-	-
HOST ROCK COMMENTS: GEOLOGICAL SETTING TECTONIC BELT: TERRANE: METAMORPHIC TYPE:	Coast Crystalline Plutonic Rocks Regional The core of C to coarse-grained Complex. To the w Mica, resembl centimetre wide ba nite. These bands metres in extent.	RELATIONS ampania Island consist biotite quartz monzon: est of a northwest tro ing coarse muscovite of nds of coarse pegmatit are irregular and di Belts and streaky zon	HIP: s of clean, mass: te of the Coast H mding fault is g rystals, occurs : e within the quan continuous and an tes of fine crysta	GRADE: Ampl ive medium Plutonic ranodiorite. in 15 to 60 ctz monzo- ce 7 to 30 alline mica,	-
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HOST ROCK COMMENTS: GEOLOGICAL SETTING TECTONIC BELT: TERRANE: METAMORPHIC TYPE:	Coast Crystalline Plutonic Rocks Regional The core of C to coarse-grained Complex. To the w Mica, resembl centimetre wide ba nite. These bands metres in extent. up to 100 metres 1 pegmatites.	RELATIONS ampania Island consist biotite quartz monzon est of a northwest tra ing coarse muscovite of nds of coarse pegmatif are irregular and di Belts and streaky zon ength, are widely dist	HIP: s of clean, mass; te of the Coast i inding fault is gr rrystals, occurs : within the quar continuous and ar wes of fine crysta ributed in finer	GRADE: Ampl ive medium Plutonic ranodiorite. in 15 to 60 rtz monzo- re 7 to 30 alline mica, -textured	-
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NATIONAL MINERAL INVENTORY: MINFILE NUMBER: 103H 044 NAME (S) : BAKER INLET, MICA MAID, MICA BOY, SERICITE, BAKER MICA MINING DIVISION: Skeena Open Pit STATUS: Past Producer UTM ZONE: 09 NTS MAP: 103H13W NORTHING: 5963901 LATITUDE: 53 49 20 LONGITUDE: 129 54 00 EASTING: 440752 ELEVATION: 0120 Metres LOCATION ACCURACY: Within 500M COMMENTS: Located on north side of Baker Inlet, 60 kilometres south-southeast of Prince Rupert (Minister of Mines Annual Report 1934). COMMODITIES: Mica MINERALS SIGNIFICANT: Mica Sericite MINERALIZATION AGE: Unknown DEPOSIT CHARACTER: Unknown CLASSIFICATION: Pegmatite Industrial Min. TYPE: Muscovite pegmatite TYPE: Musee SHAPE: Irregular 2 x 1 STRIKE/DIP: 360/17W TREND/PLUNGE: Metres DIMENSION: COMMENTS: Pockets and lenses of good grade mica in pegmatitc zone. HOST ROCK DOMINANT HOST ROCK: Metasedimentary FORMATION IGNEOUS/METAMORPHIC/OTHER STRATIGRAPHIC AGE GROUP Coast Plutonic Complex Paleozoic LITHOLOGY: Mica Schist Peqmatite Quartz Monzonite GEOLOGICAL SETTING PHYSIOGRAPHIC AREA: Fiord Ranges (Northern) TECTONIC BELT: Coast Crystalline TERRANE: Alexander RELATIONSHIP: GRADE: Greenschist METAMORPHIC TYPE: Regional CAPSULE GEOLOGY A small amount of mica was mined from the north shore of Baker Inlet, east of Grenville Channel, 60 kilometres south-southeast of Prince Rupert. A belt of metasediments of the Alexander Terrane, up to 1 kilometre wide, extends southeast from Telegraph Passage along the east side of Grenville Channel for 60 kilometres. The belt is locally intruded and bounded to the northeast by quartz monzonites of the Coast Plutonic Complex. A pegmatitic zone outcrops along a bluff at 88 metres elevation, 300 metres north of Baker Inlet, within northwest trending mica schists. The zone strikes north, dips 17 degrees west and has been traced along strike for 60 metres. Trenching has uncovered pockets and lenses of good grade mica within the pegmatite up to 3 metres long and 1.5 metres wide. Pulverizing tests carried out by ore testing labs in Ottawa are as follows (Minister of Mines Annual Report 1934, page Bl0): -Per cent of Mica grade Size raw feed (per cent) fraction 99 77 +100 mesh 99 -100 to +200 88 -200 mesh 68 80 \_\_\_\_\_ A second deposit of mica outcrops in the vicinity, at 120 metres elevation, 180 metres from Baker Inlet. A micaceous zone in altered mica schists has been traced for 200 metres and contains 10 to 90 per cent sericite across widths of 0.6 to 2.1 metres (Minister of Mines Annual Report 1940, page 99). In 1940, 73 tonnes of crude sericite mica were shipped from this deposit to Vancouver. An unknown amount was also shipped in 1941. BIBLIOGRAPHY EMPR AR 1932-50; 1933-45; \*1934-B10; \*1940-99; 1941-93,94 GSC P 70-41 GSC MAP 23-1970; 1385A

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# APPENDIX II

Japanese Importers of Mica

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## POTENTIAL IMPORTERS

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DATA NUMBER	COMPANY NAME	INTERESTED ITEM	CONTACTS	
P1D-1115580000 1994.03.15	NIPPON RIKA KOGYOSHO CO., LTD,	Mics Paper Mics Screp	Att: Masao Toyoshima Department Of Foreign Operation	TEL 03-3771-0174 FAX 03-3777-1319
	Annual Sales(M. Yen): 3,406 Staff: 170	Polyester Film	1-20-6, Ooi, Shinagawa-ku, Takyo 140, Japan	
PID-1123470000	MATSUSHITA TRADING CO.,	Mica	All: Haruyoshi Macsushita	TEL 03-3737-1441
1994.03.15	LTD. Annual Sales(M. Yen): 89 Staff: 5	Cosmetic	1-1-7, Kamata, Ohta-ku, Tokyo 144, Japan	FAX 03-3731-1019
PID-1131600000 1994.03.15	M. WATANABE CO., LTD.	Mica (Crude)	Au: Noritaka Miyake Salea Department	TEL 03-3241-5231
1994.03.13	Annual Sales(M. Yen): 12,000 Staff: 100	Quartz Mineral Substances	4-2-16, Nihonbashi Muro-machi, Chuo-ku, Tokyo, 103 Japan	FAX 03-3241-9165
PID-1137930000	TAMAKI MICA CO., LTD.	Mica	An: Toshiro Watanabe Tradu Dep.	TEL 03-3563-0373 FAX 03-3563-0148
	Annual Sales(M. Yeo): 200 Staff: 9		1-20-5, Ginza, Chuo-ku, Tokyo 104, Japan	Det 10, 200 (0, 10)
PID-1157040000	SHIOZAKI & CO., LTD.	Міся	An: Ichiro Nemoto Trade Department	TEL 03-3586-7711
1994.03.15	Azmual Sales(M, Yen); N/A Stalf: N/A		3-10-2, Akasaka, Minato-ku, Tokyo 107, Japan	FAX 03-3585-6806

# APPENDIX III

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## APPENDIX IV

Suzorite Mica Specifications Sheet

SUZORITE.

DESCRIPTION 40-2	Concentrated phiogopite n application where these pro			d or purified for
USES	Drilling fluid additive - Use fluid formulations.	· · · · · · · · · · · · · · · · · · ·		-
	Asphalt-based compound and reinforcements.			
	Asphalt-based roll-foofing	g and shingles - Us	ed as an anti-stic	ck agent.
	Insulating heat shields.		نور <u>ور می می می می می می می می می</u>	
SPECIFICATION	Screen Analysis U.S. Sieve +20 mesh -20 +40 mesh -40 +70 mesh -70 mesh	<1% 25-50% 25-40% 10-45%	-850	M +850 )+425 5+212 -212
· ·	Bulk Density - 30-55 lb/ft Molsture Content - <0.49		Scott Volumeter	method.
PARTICLE SIZE DISTRIBUTION				
		Size In Mesh (US Si	eve) and Microns	

Average Particle Size 48 Mesh - 320 µM

ومنسور والتسمير والتكافر والتك		
PACKAGING	Suzorite mica is non-hazardous, chemically inert, contains no asbestos and less than 0.1% free silica. See Technical Bulletin T-1 for additional data and MSDS, including chemical analysis.	
SAFETY	Shipped in 50-lb (25-kg), multi-ply paper bags in one ton lots on pallets (included as standard). Stretch wrap, supersaks, bulk and other options available at extra cost.	
SHEET, S PRODUC	Pure Suzorite micaOutput <td co<="" td=""></td>	
	CANADA & INTERNATIONAL	

ANDA & INTERNATIONAL 1475 Gratem Bell Street Bouchewille, Ouebec J4B 841 (514) 855-2450 FAX: (514) 855-9942 TWX: SUZORITE MTL 05-257841



DESCRIPTION	Special phiogopite mica, medium-fine grade, treated to control defoilation of the mica crystals where this property is desirable. 25-Z is 80 percent or more mica; gangué mineral content is usually 10 to 20%, primarily feldspar and pyroxene.
USES	<ul> <li>Drilling fluid additive - Used to prevent lost circulation in high performance drilling fluid formulations. "Medium" grade (corresponds approximately to Baroid/Dresser "coarse" grades, and to N.A.M. "fine" grade).</li> <li>Insulating and heat shields - in steel manufacture.</li> <li>Decoration - For artificial marble or stone simulation products. These mica grades impart an attractive glimmering effect.</li> </ul>
SPECIFICATION	Screen Analysis         μM           +10 mesh         20-40%         +2mm           -10 +20 mesh         45-65%         -2mm +850           -20 mesh         5-25%         -850           Bulk Density - 40-60 lb/ft³ (560-960 kg/m³) by Scott Volumeter method.           Molature Content -         <0.4%
PARTICLE SIZE DISTRIBUTION	Particle Size in Mesh (US Sieve) and Microns Zverage Particle Size 15 Mesh - 1300 µM

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PACKAGING	Shipped in 50-lb (25-kg), multi-ply paper bags in one ton lots on pallets (included as standard). Stretch wrap, supersaks, bulk and other options available at extra cost.
SAFETY	Suzorite mica is non-hazardous, chemically inert, contains no asbestos and less than 0.1% free silica. See Technical Bulletin T-1 for additional data and MSDS, including chemical analysis.
FLAKE APPEARANCE SELLER	Fure Suzorite mica         Fure Suzorite markets for Childrane Superson Substance with Respect to This         Suller markets for Childrane Suzorite Suzerites Superson

- CANADA & INTERNATIONAL 1475 Graham Bell Street Boucherville, Quebec J4B 6A1 (314) 655-2450 FAX: (514) 655-9942 TWX: SUZORITE MTL 05-267641

# Suzorite mica

	이 이 사람들은 가 많은 것 같아요. 이 사람은 것이 같아요. 이 것이 있는 것은 것을 것을 것을 못했다.
DESCRIPTION	Special phiogopite mica, coarse grade, treated to control defoliation of the mica crystals where desirable. 15-Z is 80 percent or more mice; gangue mineral content is usually 10 to 20%, primarily feldspar and pyroxene.
USES	Drilling fluid additive – Used to prevent lost circulation in high performance drilling fluid formulations. "Coarse" grade (corresponds approximately to N.A.M. "coarse" grade). Reconstituted mice – Raw material for high operating temperature electrical insulation.
NOMINAL SCREEN ANALYSIS	$\begin{array}{c} U.S. Sieve \\ - \frac{1}{4} & 0 - 5\% \\ -\frac{1}{4} & - 4 \text{ mesh } 20 - 35\% \\ -4 & +10 \text{ mesh } 50 - 75\% \\ -10 \text{ mesh } 0 - 10\% \end{array}$
BULK DENSITY	45 - 65 lb/ft³ (720 - 1,040 kg/m³)
PACKAGING	Multi-ply paper bags, palletized and stretch wrapped, are standard (25 kg or 50 lb each). Special containers or packaging, or polyethylene-lined jute bags, available at extra cost.
HANDLING SAFETY	Suzorite <sup>s</sup> mica is non-hazardous, chemically inert, contains no asbestos, and contains less than 0.1% free silica.

## SELLER WARRANTS THAT THIS PRODUCT MEETS THE SPECIFICATIONS LISTED ON THE PRODUCT DATA SHEET. SELLER MAKES NO OTHER WARRANTIES EX-PRESS OR IMPLIED WITH RESPECT TO THIS PRODUCT OR ITS USE.

SUZORITE MICA PRODUCTS INC.

NE: (301)584-1355

Suzorite<sup>4</sup> Mica Products, Inc. 1478 Graham Bell St., Boucherville (Quebec) J4B 6A1 Phone: (514) 655-2450, FAX: (514) 655-9942

one (\$14) 655-2450.

Effective October 1, 1983

# APPENDIX V

# KMG Mica Specifications

CASCADE MARKETING LTD

#210 - 3540 W. 41st AVENUE VANCOUVER B.C.

KMG...worldwide

MICRO-MICA<sup>™</sup>

The property of the property of

MICRO-MICA is an ultra-fine air micronized functional pigment consisting of pure muscovite mica. Unique functional, morphological and mineralogical properties allow MICRO-MICA to provide lubrication, physical reinforcement, chemical durability and temperature stability in a wide variety of applications.

## Description

Muscovite mica has a laminar crystal structure that allows it to be split into thin films that are flexible, elastic, waterproof and have outstanding dielectric and insulating characteristics. This combination of properties is not duplicated in any other known mineral.

in a specialized high presure air jet milling process, muscovite mica is reduced and delaminated into thy pigment partioles while maintaining an excellent diameter to thickness ratio. These deiaminated, pulverized plates retain the characteristics of the pure Muscovite mineral and exhibit the desired physical properties obtained by air jet milling.

The result is a unique functional pigment consisting of tough, chemically inert flakes with high hydrophyllic properties, a low index of refraction and a variety of physical properties beneticial in a number of end uses.

Muscovite mica should not be confused with various other micaceous minerals which do not have the same basal cleavage and laminar particle shape.

## Applications

The physical and chemical properties of the mioa particles together with the tendency to orient in parallel laminae, ability to distort to 90° without fracture, and resistance to chemical change, allow MICRO-MICA to be used extensively as a dry powder in various operations and as a constituent in a variety of end uses.

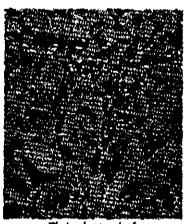
#### Paint/Costings

YAN 2

Dispersed in liquid/solid coating systems MiCRO-MICA mica mechanically reinforces paint film and imparts greater resistance to electricity, heat, light moisture and chemicals. Mica fortified paints tend to have a longer service life and better color rentention.

• The overlapping layer of mica plates form a tough shield that improves paint integrity and durability.

• The mica flakes serve as a tool for relieving stress caused by progressive oxidation, polymerization and expansion of the substrate.



Photombrograph of MICRO-MICA C-3000

MICRO-MICA improves the brushing and application characteristics of coatings and promotes improved adhesion to the substrate.

MICRO-MICA increases the opacity of white opaque pigments such as TiOz, and intensifies colored pigments.

• MICRO-MICA stays uniformly dispersed and is a hydrophylic pigment suitable for formulation in aqueous and oleoresinous systems.

## Rubber

The platey nature of the pigment and its unique thermal properties allow mica to be effectively utilized as a production aid and as an inert additive in the manufacture of a variety of rubber products. The mica flakes, in dry form and aqueous dispersions, help prevent sticking and mold adhesion. Additionally, mica can be compounded into many rubber goods to reduce gas permeation and help orsate a uniform pore structure that leads to improved resiliency and reduced shrinkage.

## Plastics

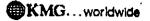
MICRO-MICA, due to its highly delaminated flake structure, is used to reinforce thermoplastic and thermoset composites. As a rigid flake reinforcement, mica provides mechanical reinforcement along a plane; rather than a single axis, as is the case with glass fiber.

 Addition of MICRO-MICA results in improved dimensional stability, flexural strength, heat distortion temperature, chemical resistance, and reduced warpage. These properties can be further improved with the addition of a surface treatment that improves the mica-polymer bond.

 MICRO-MICA is a white mica that can be compounded in color sensitive applications and appearance products.

## Other Applications

The inert chemical and laminar physical characteristics make MICRO-MICA suitable for use as an asbestos replacement and in many industrial products including: wallpaper, adhesives, caulking compounds, sealants, welding rods, spray mastics, lubricants, anti-seize compounds, cutting oils, wallboard joint cement, dry powder fire extinguishers, and grinding wheels.



# MICRO-MICA

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## Typical Properties

## Soreen Analvale

## Micro-Mica C-1000\*

100.0% passing 100 mesh 97.5% min. passing 325 mesh \*Ave, particle also 1 millions or last thick, by 10-20 microra damatar

## Micro-Mica C-3000\*

100.0% passing 100 mesh 99.0% min. passing 325 mesh 'Avg. particle day 1/2 micron or less thick by 5-10 microst in diamater

## Micro-Mica C-4000\*

100.0% passing 100 mesh 99.9% min. passing 325 mesh We particle also \$/2 micronian last thick by 1 -8 microne in dia-meter

## **Physical Properties**

Specific Gravity	2.82
Refractive index	1.58
Apparent Density	12.00-
lba./cu.ft.	14.00
Wet Buiking Value	
gal./ib.	0.04257
Surface Area C-1000	4.48
m.º/g.(BET) C-3000	5.07
C-4000	6.11
Oil Absorption	42.00
Hardness (Moh)	2.5
pH	8
Moisture @100° C	<0.20%

Chemical Properties	
Loss on ignition	4.80%
Silica (SiOz)	48.40%
Alumina (Al-O-)	33.15%
Potesh (K2O)	9.30%
Iron Oxide (Fe2Os)	2.10%
Calcium Oxide (CaO)	0.48%
Magnesia (MgO)	0.68%
Titanium Dioxide (TIO2)	0.85%
Manganese (MnOz)	0.02%
Sodium (NazO)	0.45%
Phosphorous (P)	<0.01%
Sulfur (S)	<0.01%

Sec. Sec. 29

## Service and Support

KMG Minerals, Inc., is an integrated supplier that mines and produces the most complete range of mica products available, Including Wet Ground, Dry Ground, and Micro-Mica orades.

KMG is prepared to provide technical support for all products. The research and development lab and staff are 82 available for questions regarding specific applications and formulations.

0-Various grades and custom biended products can be developed to meet specific customer needs. 57

48 KMG Minerals, inc. and its affiliates

- 07 have mined and processed mice and
- 11 other industrial minerals since 1908.
- 00 Additional available products include
- 2.5 potash feldspar. silica, and brick, ĝ

KMG is represented by stocking distributors in most major U.S. olties. Canada, Western Europe, South America, Japan and Korea.

Call for the name of the distributor in YOU' BIDE

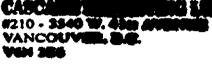
## Packaging and Handling

KMG Mica products are packaged in 50 lb, multiwall paper bags patietized on cardboard slip sheets. Wood pallets, stretch-wrapping and special packing ere available.

KMG Mica products are inert, stable, and uncontaminated materials that are low in free silica and heavy metal. Impurities.

When handling ground mion it is recommended that a NIOSH/OSHA approved dust mask be worn wherever alroome particulates exceed the recommended TLV-PEL exposure limits listed in the current ACGIH guidelines,

Additional health and safety ouldelines are contained in the Material Safety Data Sheet, which is available udon request.





KMG MINERALS, INC. P.O. Box 729, 1433 Grover Road. Kings Mountain, North Carolina 28086. Telephone: (704) 739-1321. Telex: 703063. Fax: (704) 739-7888. Call for the name of your local distributor.

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# MICAS FOR PAINT

Product	<u>Mesh Size</u>
C-4000	99.9% - 325
C-3000	99.6% - 325
WG 325	93.0% - 325
C-500	93.0% <b>-</b> 325
2300	93.0% - 325

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# WG 325<sup>™</sup>

## (1) 我们的问题,我们就能够了这些问题,我们就是我们就能够完整了。

WG S25 is a finely ground high aspect ratio functional pigment conzisting of wet ground pure muscovite mice. Unique functional, morphological, and mineralogical properties make WG S25 an important mineral additive that improves the chemical and physical durability of 'coatings, adds strength to plastics and provides benefits in such diverse applications as asbestos 'replecement, adhesives and cosmetics.

## Description

Muscovite mice has a laminar orystal structure that allows it to be split into thin films that are flexible, elastic, waterproof and have outstanding dielectric and insulating obsracteristics. This combination of properties is not duplicated in any other known mineral.

In a specialized frictional wet milling process, muscovite mica is detaminated into pigment particles with a very high diameter to thickness ratio. Particle edges and surfaces are much smoother and oleaner than mica products produced in dry grinding or other wet processes.

These highly delaminated, polished plates retain the characteristics of the pure Muscovite mineral and exhibit the desirable physical properties obtained through wet grinding.

The result is a unique functional pigment consisting of tough, chemically inert flakes with high hydrophyllio properties, a low index of refraction and a variety of physical properties beneficial in a number of end uses.

Wet ground mica should not be confused with various other micaceous minerals which do not have the same basal cleavage and iaminar particle shape.

## Applications

The physical and chemical properties of the mica particles together with the tendency to orient in parallel laminae, ability to distort to 90° without fracture, and resistance to chemical change, make WG 325 a highly functional mineral pigment beneficial

#### Paint/Coatings

Dispersed in liquid/solid coating systems wet ground mice mechanically reinforces the paint film and imparts greater resistance to electricity, heat, light, molsture and chemicals. Mice fortified paints tend to have a longer service life and better color retention.

 The overlapping layers of mica form a tough shield that improves paint film integrity and durability.

• WG 325 provides physical reinforcement that helps resist oracking and checking.



Photomicrograph of WG 325 Wet Ground While Muscovite Mice

 The mica flakes serve as fool for relieving stress caused by progressive oxidation, polymerization and expansion of the substrate.

• WG 325 decreases bilatering and reduces staining from the substrate in industrial primers.

 WG 325 improves the brushing and application obstracteristics of coatings and promotes improved adhesion to the substrate.

 WG 325 increases the opacity of white opaque pigments such as TiO<sub>2</sub>, and intensifies colored pigments.

• WG 325 stays uniformly dispersed and is a hydrophyllic pigment suitable for formulation in aqueous and oleoresinous systems.

#### Plastics

Wet ground mica, due to its highly delaminated flake structure, is used to reinforce thermoplastic and thermoset composites. As a rigid flake reinforcement, mica provides mechanical reinforcement along a plane; rather than a single axis, as is the case with glass fiber.

 Addition of WG 325 results in improved dimensional stability, flexural strength, heat distortion temperature, ohemical resistance, and reduced warpage. These properties can be further improved with the addition of a surface treatment that improves the mica-polymer bond.

• WG 325 is a white mica that can be compounded in color sensitive applications and appearance products.

Surface treated grades are available upon request.

#### Rubber

The platey nature of the pigment and its unique thermai properties allow mice to be effectively utilized as a production aid and as an inert additive in the manufacture of a variety of rubber products. The mice flakes, in dry form and in aqueous dispersions, help prevent sticking and mold adhesion. Additionally, mice can be compounded in rubber to reduce gas permeation and improve resiliency.

## Foundry

Wet ground mical is used in the manufacture of various foundry core and mold release compounds, mold washes, and facing agents. Mical adds excellent parting and surfacing properties to the finished casting.

# WG 325 <sup>"</sup>

#### 是这个人们的""我们",这些你们,我们就是你们的你,你不知道你们的你们,你们就是你们的你们,你们就是你们的你们。""你们,你们不是你们的你们,你们不能能能能能能。 第二章

## **Other Applications**

The inert-chemical and laminarphysical characteristics make mica suitable for use as an asbestos replacement and as a functional additive in many products including: printing inks, adhesives, caulking compounds, wall paper, sealants, weiding rods, spray mastics, lubricants, anti-seize compounds, cutting oils, wallboard joint cements, dry powder fire extinguishers, and grinding wheels.

## Typical Properties

## Screen Analysia

100%	passing 100 mesh
99% min.	passing 200 mesh
90% min.	passing 325 mesh

## Physical Properties

Specific Gravity	2.82
Refractive Index	1.58
Apparent Density	
lbs./cu.ft.	<12.00 ·
Wet Bulking Value	
gal./ib.	0.04257
Surface Area	
m. /g. (BET)	3.80
Oil Absorption	40.00
spatula method	42.00 2.5
Hardness (Moh)	£.⊃ 8
pH Moleture @100* C	<0.20%
MORPHILLE COLOUR C	<b>LU.ZU76</b>

## **Chemical Properties**

Loss on Ignition	4.80%
Strica (SIO2)	48.40%
Alumina (AizOs)	33.15%
Potash (K2O)	9.30%
Iron Oxide (FeeOs)	2.10%
Calcium Oxide (CaO)	0.48%
Magnesia (MgO)	0.68%
Titanium Dioxide (TiO <sub>2</sub> )	0.85%
Manganesė (MriOz)	0.02%
Sodium (Na:O)	0.45%
Phosphorous (P)	<0.01%
Sulfur (S)	<0.01%

## Service and Support

KMG Minerals, Inc. is an integrated supplier that mines and produces the most complete range of mica products available, including Wet Ground, Dry Ground, and Micro-Mica grades.

KMG is prepared to provide technical support for all products. The research and development lab and staff are available for questions regarding specitic applications and formulations.

Various grades and custom blended products can be developed to meet specific customer needs.

KMG Minerals, Inc. and its affiliates have mined and processed mica and other industrial minerals since 1908. Additional available products include potash feldspar, silica, & white brick. KMG is represented by stocking distributors in most major U.S. cities, Canada, Western Europe, South America, Japan and Korea.

Call for the name of the distributor in your area.

## Packaging and Handling

KMG Mica products are packaged in 50 lb. multiwall paper bags palletized on cardboard slip sheets. Wood pallets, stretch-wrapping and special packing are available.

KMG Mice products are inert, stable, and uncontaminated materials that are low in free silica and heavy metal impurities.

When handling ground mica it is recommended that a NIOSH/OSHA approved dust mask be worn wherever airborne particulates exceed the recommended TLV-PEL exposure limits listed in the current ACGIH guidelines.

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