MARKET STUDY FOR
BRITISH COLUMBIA MICA

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

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405, 101 22nd Street East
Saskatoon, Saskatchewan
S7K 0E1

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Prepared by: McNeal & Associates Consultants Ltd.
5301 Airport Road South
Richmond, B.C.
V7B 1B5
and
Donald F. Gunning, P.Eng.
Consultant
154 Woodland Dr.
Delta, B.C.
V4L 2C1

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1.0 INTRODUCTION

1.1 Background

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 value-added nature of these specialized products.
1.4 Mica Definition

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 [$\text{KAl}_2(\text{AlSi}_3\text{O}_{10})(\text{OH})_2$] 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 [$\text{KMg}_3(\text{AlSi}_3\text{O}_{10})(\text{OH})_2$] 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.
### Table I

**Chemistry and Selected Properties of Various Micas**

<table>
<thead>
<tr>
<th>CHEMICAL CONSTITUENTS</th>
<th>MUSCOVITE</th>
<th>PHLOGOPITE</th>
<th>Biotite</th>
</tr>
</thead>
<tbody>
<tr>
<td>SiO₂</td>
<td>46.5</td>
<td>40.0</td>
<td>37.0</td>
</tr>
<tr>
<td>Al₂O₃</td>
<td>34.0</td>
<td>17.0</td>
<td>18.0</td>
</tr>
<tr>
<td>K₂O</td>
<td>10.0</td>
<td>10.0</td>
<td>9.0</td>
</tr>
<tr>
<td>Na₂O</td>
<td>0.8</td>
<td>0.5</td>
<td>1.0</td>
</tr>
<tr>
<td>MgO</td>
<td>0.5</td>
<td>26.0</td>
<td>8.0</td>
</tr>
<tr>
<td>CaO</td>
<td>0.3</td>
<td>--</td>
<td>--</td>
</tr>
<tr>
<td>Fe₂O₃</td>
<td>2.5</td>
<td>0.2</td>
<td>2.0</td>
</tr>
<tr>
<td>FeO</td>
<td>1.0</td>
<td>2.8</td>
<td>21.0</td>
</tr>
<tr>
<td>Minor Elements</td>
<td>--</td>
<td>0.5</td>
<td>1.0</td>
</tr>
<tr>
<td>H₂O</td>
<td>4.5</td>
<td>3.0</td>
<td>3.0</td>
</tr>
<tr>
<td>% BY WEIGHT</td>
<td>100.0</td>
<td>100.0</td>
<td>100.0</td>
</tr>
</tbody>
</table>

**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**: 58-79, 79-97
- **Specific heat (at 25°C)**: $2 \times 10^{10}$, $1 \times 10^{17}$, less
- **Volume resistivity (ohms/cm³)**: $0.207$, $0.207$
- **Modulus of elasticity (Pa)**: $172 \times 10^9$, $172 \times 10^9$
- **Compression strength (Pa)**: $221 \times 10^6$, $221 \times 10^6$
- **Volume resistivity in ohms/cm³ @ 25°C**: $5 \times 10^9$, --
- **Optical axial angle (2V)**: $38°-47°$, 0-10°, 0-25°
- **Temperature of decomposition**: 400-500°C, 850-1000°C, 0.25°
- **Dielectric constant**: 6.5-9.0, 5.0-6.0
- **Linear coefficient of expansion x 10⁻⁶ cms/°C, range 20°C-600°C**: 58-79, 79-97
- **Coefficient of expansion per °C perpendicular to cleavage 20°C-100°C (10⁻⁶)**: 15-25, 1-1 x 10⁻⁳
- **Coefficient of expansion per °C parallel to cleavage 0°C-200°C (10⁻⁶)**: 8-9, 13-14.5
- **Tensile strength Pa x 10⁶**: 225-297, 255-297
- **Modulus of elasticity Pa x 10⁶**: 172, 172
- **Dielectric strength (0.025-0.030 mm thick) volts/cm x 10⁶**: 2.4-11.2, 1.7-0.8
- **Resistivity ohms-cm**: $10^{12}-10^{15}$
- **Thermal conductivity perpendicular to cleavage @ 100°C (K cal/m²/hr/°C)**: 0.57, 0.57

Source: Tanner, P. 694
2.0 B.C. MICA DEPOSITS

2.1 History

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-to-date in fact) is reported in the 1970 B.C. Minister 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.
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 The Economics of Mica, 1991 and supplemented by Lawrence L. Davis's later paper (US Bureau of Mines, 1994). James T. Tanner's 1994 paper Industrial Minerals and Rocks, 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. 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 Finland

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.

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1 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 Glimmermahleleverk 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 India

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. Japan Mica Industrial Co. Ltd. is the largest mica processor, using blocks, splittings

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2 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. Ltd., 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 Norway

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 Russia

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 Canada

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. 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.

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3 Industrial Minerals, May 1994

4 industrial Specialities News, December 26, 1994
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 II

End Use For Suzorite Mica (1991)

<table>
<thead>
<tr>
<th>TONNES</th>
<th>USE</th>
</tr>
</thead>
<tbody>
<tr>
<td>8,400</td>
<td>Plastics</td>
</tr>
<tr>
<td>7,200</td>
<td>Asbestos Replacement</td>
</tr>
<tr>
<td>4,800</td>
<td>Joint Cement</td>
</tr>
<tr>
<td>3,600</td>
<td>Other</td>
</tr>
<tr>
<td>24,000</td>
<td>TOTAL</td>
</tr>
</tbody>
</table>

Source: Canadian Mining Journal
Table III
Canadian Mica (1991)

<table>
<thead>
<tr>
<th>TONNES</th>
<th>DESTINATION</th>
</tr>
</thead>
<tbody>
<tr>
<td>13,920</td>
<td>U.S.</td>
</tr>
<tr>
<td>4,560</td>
<td>Canada</td>
</tr>
<tr>
<td>4,320</td>
<td>Asia</td>
</tr>
<tr>
<td>1,200</td>
<td>Europe</td>
</tr>
<tr>
<td>24,000</td>
<td>TOTAL</td>
</tr>
</tbody>
</table>

Source: Canadian Mining Journal

3.1.15 U.S.A.

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

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

<table>
<thead>
<tr>
<th></th>
<th>SCRAP AND FLAKE MICA</th>
<th>SHEET MICA</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Powder</td>
<td>Waste</td>
</tr>
<tr>
<td>Exports</td>
<td>metric tons (US$000)</td>
<td>metric tons (US$000)</td>
</tr>
<tr>
<td>1989</td>
<td>3,628 $1,634</td>
<td>1,224 555</td>
</tr>
<tr>
<td>1990</td>
<td>4,319 2,050</td>
<td>580 646</td>
</tr>
<tr>
<td>1991</td>
<td>3,420 1,717</td>
<td>874 331</td>
</tr>
<tr>
<td>1992</td>
<td>3,954 2,054</td>
<td>475 204</td>
</tr>
<tr>
<td>1993</td>
<td>4,614 2,504</td>
<td>335 99</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Imports for consumption:</th>
<th>SCRAP AND FLAKE MICA</th>
<th>SHEET MICA</th>
</tr>
</thead>
<tbody>
<tr>
<td>Powder</td>
<td>metric tons (US$000)</td>
<td>metric tons (US$000)</td>
</tr>
<tr>
<td>1989</td>
<td>8,902 4,971</td>
<td>4,183 1,256</td>
</tr>
<tr>
<td>1990</td>
<td>9,142 5,133</td>
<td>4,034 987</td>
</tr>
<tr>
<td>1991</td>
<td>9,725 5,219</td>
<td>3,630 996</td>
</tr>
<tr>
<td>1992</td>
<td>11,568 7,479</td>
<td>3,786 974</td>
</tr>
<tr>
<td>1993</td>
<td>13,098 8,080</td>
<td>4,765 1,307</td>
</tr>
</tbody>
</table>

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\(^1\)

(Thousand metric tons and thousand dollars)

<table>
<thead>
<tr>
<th>End use:</th>
<th>1992</th>
<th>1993</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Quantity</td>
<td>Value</td>
</tr>
<tr>
<td>Joint cement</td>
<td>43</td>
<td>6,819</td>
</tr>
<tr>
<td>Paint</td>
<td>16</td>
<td>5,227</td>
</tr>
<tr>
<td>Plastics</td>
<td>4</td>
<td>1,347</td>
</tr>
<tr>
<td>Well-drilling mud</td>
<td>2</td>
<td>281</td>
</tr>
<tr>
<td>Other(^3)</td>
<td>19</td>
<td>8,082</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>84</strong></td>
<td><strong>421,755</strong></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Method of grinding:</th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Dry</td>
<td>W</td>
<td>W</td>
<td>168</td>
</tr>
<tr>
<td>Wet</td>
<td>W</td>
<td>W</td>
<td>745</td>
</tr>
</tbody>
</table>

W: Withheld to avoid disclosing company proprietary data.

\(^1\)Domestic and some imported scrap. Low-quality sericite is not included.

\(^2\)Based on unrounded dollars and thousand metric tons.

\(^3\)Includes mica used for molded electrical insulation, roofing, rubber, textile and decorative coatings, welding rods, and miscellaneous.

\(^4\)Data 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:

**Asheville Mica Corporation** - 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.

**Aspect Mining Co.** - 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.
Concord Mica - 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.

Deneen Mica Co, Inc. - 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.

Feldspar Corporation - 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.

Foote Mineral Co. - 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.

Franklin Industrial Minerals Co. (of Nashville, Tenn.)- operates a muscovite mica mine and mill at Velarde, New Mexico, 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 (see also KMG description later in this section).

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5 Industrial Specialities News, Dec. 26, 1994
6 Industrial Minerals, Nov. 1994
Franklin Mineral Products - 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.

FMC Corporation - 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.

Gross Mineral Corporation - 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.

Indusmin Inc. - 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.

KMG Minerals - 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.

Mineral Mining Co. Inc. - 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.

Pacer Corporation - 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.
Unimin Corp - 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.

USG (United States Gypsum) Corporation - 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.
### Table VI

#### Mica Statistics

<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>World Production (tonnes)</td>
<td>228,000</td>
<td>214,000</td>
<td>207,000</td>
<td>200,000</td>
<td>180,000</td>
<td>190,000</td>
</tr>
<tr>
<td>U.S. Production of Scrap &amp; Flake Mica (tonnes)</td>
<td>119,000</td>
<td>109,000</td>
<td>103,000</td>
<td>85,000</td>
<td>88,000</td>
<td>96,000</td>
</tr>
<tr>
<td>As Mined Production Value: (million dollars)</td>
<td>6.27</td>
<td>5.84</td>
<td>5.54</td>
<td>4.64</td>
<td>4.45</td>
<td>4.90</td>
</tr>
</tbody>
</table>

#### Highlights From U.S. Mineral Commodity Summaries 1994

- **Tonnes mined**: 96,000 (58% North Carolina)
- **Tonnes ground**: 95,000
- **Tonnes imported**: 22,000 (71% from Canada)
- **Tonnes exported**: 6,000
- **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**: 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, capacitors, direct current motors and generators, electric heating appliances, electric lamps, diaphragms and transformer coils. Wet- and dry-ground 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 30-mesh 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:

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

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 Rubber

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 anti-friction and anti-sticking agent in moulds and in vulcanizing 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.

**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. 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. 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 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. Paint is mainly consumed by the construction

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7 Roskill
8 Ibid
9 Ibid
10 Ibid
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.11

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.12 This corporation sells pearlescent pigments

11 US Industrial Outlook 1994

12 Based on interview with Donna McGee of EM Industries
under the trade name "Afflair". Kemira Oy is one of the main suppliers to the Japanese automotive paint manufacturers.

5.1.1 Consumers

Other paint manufacturers which use mica include:

The Mearl Corporation - 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.

The Glidden Company - 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.

E.I. Du Pont - 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.

Cloverdale Paint Inc. - 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.

Acheson Colloids - 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.

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

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

Bonder International - 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. 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 Resins

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13 Roskill
POLYPROPYLENE (PP) 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 (PE) Polyethylene's main application is in blow-moulded 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.14

POLYURETHANE (PU) 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.

POLYETHYLENE (PET) As already stated earlier polyethylene fibres are and POLYBUTYLENE mixed with mica to improve impact strength in low loadings (5-10%).15 However, mica can also fill combined PET and PBT fibres (60% PET load) to impart very desirable electrical properties.

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14 Roskill
15 Roskill
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).

**NYLON (PA)**

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.
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.\(^\text{16}\) 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.\(^\text{17}\) 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.\(^\text{18}\) 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.\(^\text{19}\) 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).

\(^{16}\) Hawley

\(^{17}\) Hawley

\(^{18}\) Canadian Minerals Yearbook, 1987

\(^{19}\) 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.

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

Eagle Quality Products Co. - 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.S. Gypsum Co. - markets treated (with Hercules silanes) and untreated delaminated mica grades.

MICA (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.

Franklin Mineral Products - produces surface treated grades suitable for PP and PE.

PQ Corp. - 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.

Plascoat Corp. - 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.

Tec-Air - produce mica filled PP fan blades.

General Motors - 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.

Mitsubishi Ltd. - developed a mica filled HDPE fuel tank.

Hercules - sells silanes which couple mica.

DuPont - markets mineral filled plastic food containers.

General Electric - produces mica-filled PBTs marketed under the name "Valox".

Celanese Corporation - produces mica-filled PBTs.

GAF Corp. - produces mica-filled PBTs.

Dow Chemical Co. - developed mica filled PU polymers suitable for exterior auto parts.

5.3 Rubber

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. 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. 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.

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20 Roskill
Table VII
Tire Production Statistics

<table>
<thead>
<tr>
<th>YEAR</th>
<th>REPLACEMENT UNITS (millions)</th>
<th>ORIGINAL EQUIPMENT (millions)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1991</td>
<td>155.4</td>
<td>--</td>
</tr>
<tr>
<td>1992</td>
<td>161.5</td>
<td>46</td>
</tr>
<tr>
<td>1994</td>
<td>163.5</td>
<td>--</td>
</tr>
</tbody>
</table>

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. 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.

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21 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

<table>
<thead>
<tr>
<th>YEAR</th>
<th>REGION (HOMES 1,000)</th>
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<tbody>
<tr>
<td></td>
<td>North-East</td>
</tr>
<tr>
<td>1988</td>
<td>235</td>
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<tr>
<td>1989</td>
<td>179</td>
</tr>
<tr>
<td>1990</td>
<td>131</td>
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<td>1991</td>
<td>113</td>
</tr>
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<td>1992</td>
<td>127</td>
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Source: U.S. Bureau of the Census, Construction Reports, series C20, monthly.
Table IX

Construction: Trends and Projections, 1990-94

<table>
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</thead>
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<tr>
<td>Value of new construction put in place</td>
<td>442.1</td>
<td>403.4</td>
<td>436.0</td>
<td>460.0</td>
<td>-</td>
</tr>
<tr>
<td>(bil.$)</td>
<td></td>
<td></td>
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<td></td>
<td></td>
</tr>
<tr>
<td>Value of new construction put in place</td>
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<td>360.7</td>
<td>386.9</td>
<td>398.4</td>
<td>405.9</td>
</tr>
<tr>
<td>(bil. 1987$)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Number of private housing units (000)</td>
<td>1,193</td>
<td>1,014</td>
<td>1,200</td>
<td>1,250</td>
<td>1,300</td>
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<tr>
<td>Shipments of mobile homes (000 units)</td>
<td>188.2</td>
<td>170.7</td>
<td>210.8</td>
<td>265.0</td>
<td>290.0</td>
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<tr>
<td>Producer price index for all construction</td>
<td>119.6</td>
<td>120.4</td>
<td>122.5</td>
<td>127.8</td>
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<td>materials (1982=100)</td>
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<tr>
<td>Producer price index for all gypsum</td>
<td>105.2</td>
<td>99.3</td>
<td>100.3</td>
<td>-</td>
<td>-</td>
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<td>products (1982=100)</td>
<td></td>
<td></td>
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</tr>
</tbody>
</table>


* 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). 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

---

22Manufacturing 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.23

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 36,100,24 an 8 percent decrease. Vancouver accounts for over half the housing starts in the province.

Table X

<table>
<thead>
<tr>
<th>YEAR</th>
<th>CANADA</th>
<th>% OF INCREASE</th>
<th>B.C.</th>
<th>% OF INCREASE</th>
</tr>
</thead>
<tbody>
<tr>
<td>1992</td>
<td>156,197</td>
<td>-</td>
<td>31,875</td>
<td></td>
</tr>
<tr>
<td>1993</td>
<td>155,443</td>
<td>.5</td>
<td>42,807</td>
<td>+32</td>
</tr>
<tr>
<td>1994</td>
<td>156,900</td>
<td>+1</td>
<td>38,800</td>
<td>-10</td>
</tr>
</tbody>
</table>

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

23 U.S. Industrial Outlook
24 Real Estate Weekly, January 1994
5.4.1 Consumers

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.

Westroc Industries Ltd. - 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.S. Gypsum Co. - 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).

Hamilton Industries - 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.

Magnum Products - 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.

Supro Corporation - 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.

National Gypsum Company (previously Gold Bond Building Products)- 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 one 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. 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

25 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. 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). 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. 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

26 Roskill, 1991
27 Roskill, 1991
28 Roskill, 1991
Halliburton Energy Systems - based in Calgary, this company currently uses only very small amounts of mica in their formulations.

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

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

Canamara United Supply Ltd. - 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.

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

5.5.2 Suppliers

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

Pacer - 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.\textsuperscript{29} 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 Refractory Bricks

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).\textsuperscript{30} 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,

\textsuperscript{29} Roskill, 1991

\textsuperscript{30} 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.\textsuperscript{31}

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\textsuperscript{32} 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.

\textsuperscript{31} Industrial Minerals, January, 1994

\textsuperscript{32} Wall Street Journal, June 18, 1992
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 manufacturers 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 Rubber

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 (i.e.: minimal regional flexibility).

Table XI

<table>
<thead>
<tr>
<th>AREA</th>
<th>TONNES</th>
</tr>
</thead>
<tbody>
<tr>
<td>Western Canada</td>
<td>200</td>
</tr>
<tr>
<td>Pacific North West U.S.</td>
<td>575</td>
</tr>
<tr>
<td>California</td>
<td>3,000</td>
</tr>
</tbody>
</table>

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. Table XII shows Davis's estimate by major end-user groups.

### Table XII

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

<table>
<thead>
<tr>
<th>Category</th>
<th>1993</th>
</tr>
</thead>
<tbody>
<tr>
<td>Paints and Coatings</td>
<td>16,000 tonnes</td>
</tr>
<tr>
<td>Plastic/Resins</td>
<td>4,000 &quot;</td>
</tr>
<tr>
<td>Oil Well Drilling Muds</td>
<td>4,000 &quot;</td>
</tr>
<tr>
<td>Rubber</td>
<td>-</td>
</tr>
<tr>
<td>Joint Cement</td>
<td>49,000 &quot;</td>
</tr>
<tr>
<td>Other (asbestos substitute, roofing, cosmetics, etc.)</td>
<td>19,000 &quot;</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td>92,000 &quot;</td>
</tr>
</tbody>
</table>

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 Table XIII 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 Table XIII that mica consumption is minimal in the Pacific Northwest region, likely in the range of only 1,200 tonnes per year.
Table XIII

Pacific Northwest Mica Consumption
tonnes 1994

<table>
<thead>
<tr>
<th></th>
<th>B.C.</th>
<th>ALBERTA</th>
<th>WASHINGTON/OREGON</th>
<th>TOTAL</th>
</tr>
</thead>
<tbody>
<tr>
<td>Joint Cement</td>
<td>-</td>
<td>200</td>
<td>575</td>
<td>775</td>
</tr>
<tr>
<td>Oil Well Drilling Mud</td>
<td>-</td>
<td>200</td>
<td>-</td>
<td>200</td>
</tr>
<tr>
<td>Paints/Coatings/Plastics</td>
<td>40-60</td>
<td>-</td>
<td>150-200</td>
<td>190/260</td>
</tr>
<tr>
<td>Total</td>
<td>40-60</td>
<td>400</td>
<td>725-775</td>
<td>1,165-1,235</td>
</tr>
</tbody>
</table>

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 Competition

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 Production Costs

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 Research and Development

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

**Mica Price List**

<table>
<thead>
<tr>
<th>MESH SIZES</th>
<th>PRICE BASIS</th>
<th>PRICE PER TONNE USD</th>
</tr>
</thead>
<tbody>
<tr>
<td>Dry ground: 20-100 mesh</td>
<td>FOB Plant, USA</td>
<td>$220 - 440</td>
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Source: Industrial Mineral Journal, Nov. 1994 and Roskill
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.
Acknowledgement

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
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TOTAL NUMBER OF OCCURRENCE(S): 38

* Contains 8 or more commodities
MINFILE NUMBER: 082BSW127

NAME(S): SHUTTLEWORTH CREEK, PEDRO, SUNSHINE, SHUT

STATUS: Past Producer

NTS MAP: 082E06N

LATITUDE: 49 19 06

LONGITUDE: 119 29 24

ELEVATION: 884 Metres

LOCATION ACCURACY: Within 500M

COMMENTS: Located 0.8 to 1.2 kilometres south of Shuttleworth Creek, 6.5 kilometres southeast of Okanagan Falls (Minister of Mines Annual Report 1953).

COMMODITIES: Asbestos, Mica, Vermiculite

MINERALS

SIGNIFICANT: Anthophyllite

ASSOCIATED: Biotite, Amphibole, Serpentinite, Magnetite, Talc

ALTERATION: Amphibole, Serpentinite, Talc

ALTERATION TYPE: Serpentinite

MINERALIZATION AGE: Unknown

DEPOSIT

CHARACTER: Stockwork

CLASSIFICATION: Metamorphic

TYPE: Asbestos

SHAPE: Bladed

DIMENSION: 800 x 200 x 30 Metres

COMMENTS: Dimensions for dunite mass.

HOST ROCK

DOMINANT HOST ROCK: Plutonic

STRATIGRAPHIC AGE

Eocene

LITHOLOGY: Fine Grained Dunite

Granitic Gneiss

Granodiorite Gneiss

Felsic Dike

Pegmatite

HOST ROCK COMMENTS: Dunite body intrudes Okanagan Gneiss (Unit Egn, Geological Survey of Canada Map 1736A).

GEOLOGICAL SETTING

TECTONIC BELT: Omineca

TERRANE: Undivided Metamorphic Assembl.

METAMORPHIC TYPE: Regional

PHYSIOGRAPHIC AREA: Okanagan Highland

GRADE:

CAPSULE GEOLOGY

The Shuttleworth Creek occurrence lies on a hillside between 790 and 980 metres elevation, 0.8 kilometres south of Shuttleworth Creek and 6.5 kilometres southeast of Okanagan Falls. The deposit is hosted in a mass of fine grained, dark green to black (unweathered) dunite that intrudes light to medium grey granitic and granodioritic gneiss of the Eocene Okanagan Gneiss. The dunite body is 800 metres long, up to 200 metres in exposed width and approximately 30 metres thick. The rock is composed mostly of olivine with up to 10 per cent altered to amphibole and minor serpentinite and magnetite. The amphibole is in turn partly altered to talc. A few patches and irregular veinlets of estatite are also present. The dunite is intruded by felsic dykes and irregular pegmatitic masses 0.13 to 2.1 metres thick.

Asbestos mineralization consists of anthophyllite, occurring in irregular lenses and cross fibre veinlets scattered throughout the dunite. The lenses are 0.3 to 3 metres wide and up to 3.7 metres in length. Individual veinlets are 0.63 to 68 centimetres thick, with most varying from 5 to 15 centimetres. They strike in various directions, most commonly between 050 and 080 degrees and 135 and 150 degrees, and usually dip near 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
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):

\[
\begin{align*}
\text{SiO}_2 & : 57.50 \\
\text{Al}_2\text{O}_3 & : 0.36 \\
\text{Cr}_2\text{O}_3 & : 0.03 \\
\text{Fe}_2\text{O}_3 & : 1.10 \\
\text{FeO} & : 5.69 \\
\text{MnO} & : 0.25 \\
\text{MgO} & : 29.21 \\
\text{CaO} & : 2.24 \\
\text{H}_2\text{O}^+ & : 3.60 \\
\text{H}_2\text{O}^- & : 0.22
\end{align*}
\]

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 figures are available.

BIBLIOGRAPHY

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
GSC OP 481; 1969

DATE CODED: 850724  CODED BY: GSB  FIELD CHECK: N
DATE REVISED: 910528  REVISIED BY: PSF  FIELD CHECK: N
MINFILE NUMBER: 082FRE110  
NATIONAL MINERAL INVENTORY: 082F9 Gem1  

NAME(S): HELLOORING CREEK, LINDA, LINDA 1  

STATUS: Developed Prospect  
MTS MAP: 082F00E  
LATITUDE: 49 34 00  
LONGITUDE: 116 10 29  
ELEVATION: 1615 Metres  
LOCATION ACCURACY: Within 500M  
COMMENTS: Centre of drill hole 86-13 on the east side of Hellroaring Creek, 18 kilometres southwest of Kimberley (Exploration in B.C. 1987, Figure B32).

COMMODITIES: Feldspar Mica Beryllium Gemstones  
MINERALS  
SIGNIFICANT: Feldspar Microcline Albite Muscovite Beryl  
ASSOCIATED: Quartz Pyrite Pyrrhotite Galena Arsenopyrite  
COMMENTS: Trace pyrite, pyrrhotite, galena and arsennopyrite.

DEPOSIT  
CHARACTER: Massive Disseminated  
CLASSIFICATION: Pegmatite Magmatic Syngenetic Industrial Min.

DIMENSION: 4000 x 1500 Metres  
COMMENTS: Pegmatite stock.

HOST ROCK  
DOMINANT HOST ROCK: Plutonic  

STRATIGRAPHIC AGE GROUP: Heliikian  
FORMATION: Purcell  
LITHOLOGY: Medium Grained Pegmatite  
HOST ROCK COMMENTS: Pegmatite of the Middle Proterozoic Hellroaring Creek stock.

GEOLOGICAL SETTING  
TECTONIC BELT: Omineca  
TERRANE: Ancestral North America  
METAMORPHIC TYPE: Regional  
RELATIONSHIP: Post-mineralization GRADE:

INVENTORY  
ORE ZONE: NORTH  
CATEGORY: Indicated  
YEAR: 1965  
QUANTITY: 450000 Tonnes  
COMMODITY: Beryllium  
GRADE: 0.1000 Per cent  
COMMENTS: Grade given for beryllium oxide.  

CAPSULE GEOLOGY  
The Hellroaring Creek pegmatite stock is about 20 kilometres southwest of Kimberley and 31 kilometres west-northwest of Cranbrook. The stock has been explored for feldspar, quartz, mica and, in the 1960’s, beryllium.  
The area is underlain by quartzite and argillite of the Creston Formation and argillite, quartzite and mica schist of the Aldridge Formation, both of the Helikian Purcell Supergroup. These metasediments are intruded by sills and dykes of granodiorite of the Proterozoic Moyie Intrusions, which are in turn intruded by pegmatite of the Middle Proterozoic Hellroaring Creek stock. The east trending St. Mary fault separates this area from the area underlain by Creston Formation metasediments to the south. The Aldridge Formation is folded into an open northwest plunging anticline with the Hellroaring Creek stock emplaced in the core.  
The pegmatite stock trends north-northeast for 4 kilometres within the Aldridge Formation and is up to 1.5 kilometres wide. The stock appears to be a series of large dyke swarms. Most of the
CAPSULE GEOLOGY

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, pyroxene, 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 3 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 plagioclase, quartz and muscovite. Garnet is present as pink to red grains 1 to 2 millimetres across in addition to occasional veinlets of pyrite, pyroxene, galena and arsenopyrite. Iron and manganese staining is common on outcrops and in drill core.


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<td>Fe₂O₃</td>
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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.

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EMPR IND MIN FILE (Bearcat Explorations Ltd., Annual Report 1984)
EMPR OF 1988-34, 1991-10
EMPR PRELIM MAP 16
EMPR Mineral Market Update, July 1991
GSC MEM 228
GSC BC GEOG 23, p. 62; 29, p. 71
GSC P 60-21, p. 12
GSC MAP 603A; 12-1957
EMPR MP CORP FILE (International Beryllium Corp.; Canuck Beryllium Corp.)
GCNL #25, #70, #166, 1984
N MINER Aug. 30, 1984
MINFILE NUMBER: 082YJG002

NAME(S): MOUNT GRIFFIN

STATUS: Showing

MTS MAP: 0821555

LATITUDE: 50 55 55

LONGITUDE: 118 33 40

ELEVATION: 2133 Metres

LOCATION ACCURACY: Within 1 KM

COMMENTS: Summit of Mount Griffin, about 26 kilometres west of Revelstoke.

(Geological Survey of Canada Memoir 296, page 157).

COMMODITIES: Mica

MINERALS

SIGNIFICANT: Mica

MINERALIZATION AGE: Unknown

DEPOSIT

CHARACTER: Disseminated

CLASSIFICATION: Pegmatite

TYPE: Muscovite pegmatite

HOST ROCK

DOMINANT HOST ROCK: Plutonic

STRATIGRAPHIC AGE: Proterozoic-Paleoz.

LITHOLOGY:

Granitic Gneiss

Para Gneiss

Ortho Gneiss

Garnet Sillimanite Schist

Amphibolite

Marble

Quartzite

GEOLOGICAL SETTING

TECTONIC BELT: Omineca

TERRANE: Kootenay

METAMORPHIC TYPE: Regional

PHYSIOGRAPHIC AREA: Shuswap Highland

GRADE: Amphibolite

CAPSULE GEOLOGY

Small amounts of books of amber sheet-mica, up to 20 centimetres across, have been observed in pegmatites on Mount Griffin, located about 26 kilometres west of Revelstoke. The mica is fractured and twinned and contains inclusions. Surrounding rocks comprise Precambrian-Paleozoic (?) Shuswap Metamorphic Complex granitic gneiss, paragneiss, garnet sillimanite schist, amphibolite, marble, orthogneiss and quartzite.

BIBLIOGRAPHY

GSC MEM *296, p. 157
GSC MAP 1059A
GSC OF 481
EMFP FIELDWORK 1987, pp. 54-58; 1988, pp. 49-54
EMFP OF 1990-30

DATE CODED: 940110

CODED BY: GO

FIELD CHECK: N

DATE REVISED: 940110

REVISED BY: GO

FIELD CHECK: N
**MINFILE NUMBER:** 082MAP068

**NATIONAL MINERAL INVENTORY:**

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<td>Located south of Gardom Lake, about 6 kilometres north-northwest of the community of Enderby (GSC Open File 637 (Occurrence 213)).</td>
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**COMMODITIES:** Mica

**MINERALS**

| SIGNIFICANT | Mica |

**MINERALIZATION AGE:**

**DEPOSIT**

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**HOST ROCK**

| DOMINANT HOST ROCK | Metamorphic |

**STRATIGRAPHIC AGE**

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<tr>
<td>Proterozoic-Paleoz.</td>
<td>Mount Ida</td>
<td>Silver Creek</td>
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</table>

**LITHOLOGY:**

- Micaceous Schist
- Pelitic Schist
- Quartzite
- Micaceous Quartzite
- Calcareous Quartzite

**GEOLOGICAL SETTING**

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<th>TECTONIC BELT</th>
<th>Omineca</th>
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<td>TERRANE</td>
<td>Kootenay</td>
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<tr>
<td>METAMORPHIC TYPE</td>
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**CAPSULE GEOLOGY**

The Elmer mica occurrence is located from GSC Open File 637 and is situated northwest of the community of Enderby. Jones (GSC Memoir 286) describes that some of the more highly metamorphosed parts of the Silver Creek Formation contain highly micaceous schists. Current geology maps indicate the area of the showing is underlain by pelitic schist, quartzite, micaceous quartzite and calcareous quartzite of the Hadrynian and/or Paleozoic Silver Creek Formation (Mount Ida Group).

**BIBLIOGRAPHY**

- EMPF PF (General File - Dawson, G.M. (1898): Geology map of Shuswap Sheet)
- GSC 286, p. 157
- GSC OF 637 (Occurrence 213)
- GSC P 48-4; 74-1A, pp. 25-30; 86-1A, pp. 81-88; 89-1E, pp. 51-60
- GSC MAP 1993

**DATE CODED:** 850724
**CODED BY:** GSB
**FIELD CHECK:** N

**DATE REVISED:** 950511
**REVISED BY:** GO
**FIELD CHECK:** N
MINFILE NUMBER: 082L6006

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

NTS Map: 082L07W

Latitude: 50° 15' 53"

Longitude: 118° 56' 24"

Elevation: 702.2 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 14465).

Commodities:
- Gold
- Graphite
- Mica
- Silver
- Lead
- Zinc
- Copper

Minerals:
- Pyrite
- Chalcopyrite
- Galena
- Pyrrhotite
- Sphalerite
- Tetrahedrite
- Graphite
- Agente
- Muscovite
- Sericite
- Chlorite
- Clay

Alteration:
- Propylitic
- Alteration Type: Argillic
- Mineralization Age: Unknown

Deposit:
- Character: Vein
- Classification: Hydrothermal
- Type: Polymetallic veins Ag-Pb-Zn
- Shape: Bladed
- Modifier: Fractured
- Dimension: 150 x 46 Metres
- Comments: Plateau zone mineralization.

Host Rock:
- Dominant Host Rock: Sedimentary

Stratigraphic Age:
- Triassic-Jurassic
- Jurassic

Lithology:
- Argillite
- Lapilli Ash Tuff
- Feldspar Crystal Tuff
- Phyllite
- Siltstone
- Granodiorite

Geological Setting:
- Tectonic Belt: Omineca
- Terrane: Quesnel
- Physiographic Area: Shuswap Highland

Inventory:
- Ore Zone: Plateau
  - Category: Indicated
  - Year: 1993
  - Quantity: 500000 Tonnes
  - Commodity: Gold
  - Grade: 4.5000 Grams per tonne
  - Comments: Estimated reserves.

Capule 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 explored in the 1940s 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 and mill and undertook 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 tuffs. 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 associated 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. A 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 gold that was in-situ 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.
Estimated reserves of the Plateau shear zone are 500,000 tonnes grading 4.6 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. 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 22637).

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).

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EMPR EXPL 1975-B53; 1978-B96; 1986-C97; *1987-B23-B27
EMPR ASS RPT #6954, *14469, 15340, 16429, 17816, 19506, 20339, 20385, 20363, 20727, 21953, 21561, 21954, 22637, *23029
EMPR MAP 65 (1989)
EMPR OF 1990-30; 1992-1; 1994-1
EMPR INF CIRC 1993-13; 1994-16, p. 16
EMPR PP (*Property Summary Report, March 25, 1987 by R.E. Meyers, District Geologist (Kamloops))
EMPR BCMETAL MM00428
GSC SUM RPT 1898 (Map 604)
GSC GSM 296
GSC OF 637 (#286)
GSC MAP 1059A; 7216G; 8502G
EMR MP CORPFILE (Alberta Gypsum Ltd.)
CANMET IR 72-5
GCNCL #140, July 18, 1977; #72, #115, 1984; #1, #15, #177, #187, 1985; #33, #57, 1986; #3, #15, 1987; #115, #193, #201, 1994
N MINER Mar. 10, 1986; Feb. 1, 1988
WIN May, 1987
IPDM November, 1985

DATE CODED: 850724 Coded BY: GSB
DATE REVISED: 9412214 REVISED BY: DEJ
FIELD CHECK: N

MINFILE NUMBER: 082167006
**MINFILE NUMBER:** 082162006  
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**SUMMARY TOTALS:**  
**NAME:** LIMBY (CHAPUT)

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**Comments:**

MINFILE NUMBER: 082LSE048

NAME(S): CHERRYVILLE

STATUS: Showing

LATITUDE: 50 16 10

LONGITUDE: 118 37 42

ELEVATION: 0800 Metres

LOCATION ACURACY: Within 5 KM

COMMENTS: Approximate location of an "interesting" mica showing (Minister of Mines Annual Report 1932, page A144).

COMMODITIES: Mica

MINERALS

SIGNIFICANT: Mica

MINERALIZATION AGE: Unknown

DEPOSIT

CHARACTER: Unknown

CLASSIFICATION: Industrial Min.

HOST ROCK

DOMINANT HOST ROCK: Metamorphic

STRATIGRAPHIC AGE/GROUP: Proterozoic-Paleoz. Gneiss

LITHOLOGY: Gneiss

TECTONIC BELT: Omineca

TERRANE: Kootenay

PHYSIOGRAPHIC AREA: Shuswap Highland

CAPSULE GEOLOGY

The Cherryville occurrence is located about 2 kilometres northwest of Cherryville, west of the Shuswap River. The area is underlain by metamorphic rocks of the Proterozoic to Paleozoic Kootenay Assemblage. "Interesting occurrences" of mica occur in gneissic rocks near Cherryville. No other information is available.

BIBLIOGRAPHY

EMPR AR *1932-A144
EMPR PF (082LSE General - Geology Maps of the Trinity Lake Area, C.E. Cairns, 1929-1930)
EMPR OF 1990-30
GSC MAP 7216G; 8502G
GSC OP 637
GSC MMB 296

DATE CODED: 850724
DATE REVISED: 941220
CODED BY: GSB
REVISED BY: DJE

FIELD CHECK: N
FIELD CHECK: N

MINFILE NUMBER: 082LSE048
MINFILE NUMBER: 082LSW064

NAME(S): Brett-Bird, Bird, Brett, Armstrong Mica

STATUS: Prospect

LATITUDE: 50 28 45
LONGITUDE: 119 06 19
ELEVATION: 490 Metres

LOCATION ACCURACY: Within 500M


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

TYPE: Muscovite pegmatite

SHAPE: Irregular

HOST ROCK

DOMINANT HOST ROCK: Plutonic

STRATIGRAPHIC AGE

Proterozoic

Mesozoic-Cenozoic

GROUP: Unnamed/Unknown Group

FORMATION: Silver Creek

LITHOLOGY: Pegmatite

Quartz Biotite Schist

HOST ROCK COMMENTS: The pegmatite host rock intrudes the Proterozoic Silver Creek Formation.

GEOLOGICAL SETTING

TECTONIC BELT: Omineca

TERRAINS: Plutonic Rocks

METAMORPHIC TYPE: Regional

PHYSIOGRAPHIC AREA: Shuswap Highland

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 Sneesy 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 plutonic granites. 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.

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EMPR ASS RPT 49
EMPR MAP 7216G, 8513G
EMPR RGS 1976
EMPR PF (In 082LSW General - Claim Map, 1966)
BIBLIOGRAPHY

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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  CODED BY: GSB  FIELD CHECK: N
DATE REVISED: 930331  REVISED BY: DISC  FIELD CHECK: N
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**SUMMARY TOTALS: 082LSW064**

- **Mined:** 1 tonnes
- ** Recovered:** 1,000 kilograms

**Recovery:**
- **Mica:** 1,000 kilograms to 2,205 pounds

**Comments:**
MINFILE NUMBER: 082M 080

NAME(S): STANMAC, OLE BULL

STATUS: Showing

NTS MAP: 082M09W

LATITUDE: 51 42 20

LONGITUDE: 118 26 00

ELEVATION: 1900 Metres

LOCATION ACCURACY: Within 500M

COMMENTS: Location of Ole Bull shaft, Fig. 6 (Assessment Report 11860).

COMMODITIES: Gold Silver Tungsten Mica

MINERALS

SIGNIFICANT: Pyrite Pyrrhotite Gold Scheelite Chalcopryte

Galena Tetrahedrite Mica

COMMENTS: Green chromium mica. (Fuchsite).

ASSOCIATED: Quartz Ankerite

ALTERATION: Ankerite

ALTERATION TYPE: Carbonate

MINERALIZATION AGE: Unknown

ISOTOPIC AGE: DATING METHOD: Unknown

DEPOSIT

CHARACTER: Vein Discordant

CLASSIFICATION: Epigenetic Industrial Min.

TYPE: Gold-quartz veins

SHAPE: Irregular

HOST ROCK

DOMINANT HOST ROCK: Metasedimentary

STRATIGRAPHIC AGE GROUP: Upper Proterozoic Horsethief Creek

FORMATION: Undefined Formation

LITHOLOGY: Phyllite Quartzite Schist Greenstone

GEOLOGICAL SETTING

TECTONIC BELT: Omineca

TERRANE: Kootenay

METAMORPHIC TYPE: Regional

PHYSIOGRAPHIC AREA: Selkirk Mountains

GRADE:

INVENTORY

ORE ZONE: SAMPLE

CATEGORY: Assay/analysis

YEAR: 1942

SAMPLE TYPE: Rock

COMMODITY

Tungsten 9.1000 Per cent

GRADE:

COMMENTS: May not have been assayed for other metals.

REFERENCE: Property File (Newmarch, C.B., 1942)

CAPSULE GEOLOGY

Underlying rock types consist of metasedimentary rocks interlayered with mafic volcanic rocks. The metasediments consist of quartzites, schists, phyllites, calcareous schists and carbonates. The metavolcanics are tholeiitic flows and mafic tuffs metamorphosed to greenstone and chloritic phyllite. The rocks exposed are correlated to Hoy's (Bulletin 71) Metavolcanic-Phyllite Division and Quartzite Schist Division of probable Lower Paleozoic Hamill Group and Upper Proterozoic Horsethief Creek Group (Assessment Report 11860).

Phase 2 and phase 3 folds are developed in an inverted stratigraphic panel. Predominant schistosity is east to southeast with dips commonly at 20 degrees east.

Two sets of quartz veins occur in the area. The commonly mineralized discordant veins strike 10 to 20 degrees and dip 70 to 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
CAPSULE GEOLOGY

Phyllites. A grab sample assayed 44.6 grams per tonne gold. A tungsten assay by Newmarch (1942) gave 9.1 per cent tungsten. A grab sample in the Ole Bull adit gave 371.0 grams per tonne silver (Assessment Report 11860).

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EMPR BULL 1, p. 119; 20, Part 12, p. 17, 71
GSC P 64-32, p. 33
EMPR AR 1886-202; 1895-691; 1896-536; 1898-1059; 1192; 1922-214-215; 1959-105-106
EMPR MAP 25
EMPR PP (*Newmarch, C.B. (1942): Ole Bull Tungsten)
EMPR ASS RPT *10391, *11101,*11860, *13235
W MINER April, 1984
N MINER April 26, 1984
IPDM March/April 1984, p. 11
GCNL Oct 25, 1982
EMPR EXPL 1982-121; 1983-164-165; 1984-128-129
GSC OF 637
GSC MAP 12-1964; 237A
EMPR OF 1991-17

DATE CODED: 850724
CODED BY: GSB
DATE REVISED: 860312
REVISED BY: LDJ
FIELD CHECK: N
MINFILE NUMBER: 082M 168

NAME(S): YELLOW CREEK, COLUMBIA

STATUS: Showing

LATITUDE: 51°59'20" N
LONGITUDE: 118°22'00" W
ELEVATION: 2100 Metres

LOCATION ACCURACY: Within 1 km

MINERALS

SIGNIFICANT: Mica
ASSOCIATED: Quartz, Beryl, Garnet, Muscovite, Kyanite, Biotite

COMMODITIES: Mica, Beryl, Garnet, Muscovite, Kyanite, Biotite

MINING DIVISION: Golden

LATIN NAME: Muscovite, Kyanite, Biotite

DATING METHOD: Unknown

MATERIAL DATED: Unknown

HISTORY

CHARACTER: Unknown
CLASSIFICATION: Pegmatite - LCT family
TYPE: Industrial Min.

SIGNIFICANT: Mica
ASSOCIATED: Quartz, Beryl, Garnet, Muscovite, Kyanite

SIGNIFICANT: Mica
ASSOCIATED: Quartz, Beryl, Garnet, Muscovite, Kyanite

CLASSIFICATION: Pegmatite - LCT family

SIGNIFICANT: Mica
ASSOCIATED: Quartz, Beryl, Garnet, Muscovite, Kyanite

SIGNIFICANT: Mica
ASSOCIATED: Quartz, Beryl, Garnet, Muscovite, Kyanite

CLASSIFICATION: Industrial Min.

SIGNIFICANT: Mica
ASSOCIATED: Quartz, Beryl, Garnet, Muscovite, Kyanite

SIGNIFICANT: Mica
ASSOCIATED: Quartz, Beryl, Garnet, Muscovite, Kyanite

CLASSIFICATION: Pegmatite - LCT family

SIGNIFICANT: Mica
ASSOCIATED: Quartz, Beryl, Garnet, Muscovite, Kyanite

SIGNIFICANT: Mica
ASSOCIATED: Quartz, Beryl, Garnet, Muscovite, Kyanite

MINERALIZATION AGE: Unknown

ISOTOPIC AGE: Unknown

DATING METHOD: Unknown

MATERIAL DATED: Unknown

HOST ROCK

DOMINANT HOST ROCK: Metamorphic

STRATIGRAPHIC AGE: Paleozoic

GROUP: Lardeau
FORMATION: Undefined Formation

LITHOLOGY: Mica Schist

GEOLOGICAL SETTING

TECTONIC BELT: Omineca
TERRANE: Kootenay
METAMORPHIC TYPE: Regional

PHYSIOGRAPHIC AREA: Selkirk Mountains

GRADE:

RELATIONSHIP:

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

EMPR AR 1912-K143; 1952-A258
CANMET IR 285, pp. 42-49
GSC RC GEOG 23, p. 60
GSC P 66-1, p. 51
GSC MAP 12-1964
GSC OF 637

DATE CODED: 850724
CODED BY: GSB
FIELD CHECK: N

DATE REVISED: 860313
REVISED BY: LDJ
FIELD CHECK: N
MINFILE NUMBER: 082M 175

NAME(S): KINBAKET LAKE

STATUS: Showing
NTS MAP: 082M162B
LATITUDE: 51 57 20
LONGITUDE: 118 01 00
ELEVATION: 0760 Metres
LOCATION ACCURACY: Within 1 KM
COMMENTS: Area 1, Figure 4 (Open File 1988-26).

COMMODITIES: Garnet Kyanite Mica

MINERALS
SIGNIFICANT: Garnet Kyanite Mica
ASSOCIATED: Quartz
MINERALIZATION AGE: Lower Cambrian

DEPOSIT
CHARACTER: Vein Layered Stratobound Disseminated
CLASSIFICATION: Metamorphic Pegmatite Industrial Min.
TYPE: Kyanite family
SHAPE: Tabular Folded

HOST ROCK
DOMINANT HOST ROCK: Metasedimentary

STRATIGRAPHIC AGE GROUP FORMATION IGNeous/METAMORPHIC/OThER
Hadrynian Horsethief Creek Unnamed/Unknown Formation Unnamed/Unknown Informal
Lower Cambrian

LITHOLOGY:
Garnet Schist
Quartz Schist Pegmatite
Quartz Kyanite Vein

GEOLOGICAL SETTING
TECTONIC BELT: Omineca
TERRANE: Kootenay
METAMORPHIC TYPE: Regional
RELATIONSHIP: Syn-mineralization GRADE: Amphibolite

CAPSULE GEOLOGY
The Big Band (Mica Creek) - McNaughton Lake area, located approximately 100 kilometres to the north and northeast of Revelstoke, is underlain by Hadrynian Horsethief Creek Group and Lower Cambrian strata. In the Kinbasket Mountain - Sullivan River area schists of probable Lower Cambrian age contain up to 50 per cent garnet and locally, abundant kyanite associated with large quartz veins and pegmatites (Eichelberger, 1953). Mica is also present.

BIBLIOGRAPHY
EMPR OF 1988-26, p. 11
EMPR AR 1921-G164
GSC MAP 12-1964
GSC OF 637

DATE CODED: 850724
DATE REVISED: 900104

CODED BY: GSB
REVISED BY: LDJ

FIELD CHECK: N
FIELD CHECK: N
**MINFILE NUMBER:** 082M 180

**NAME(S):** BIG BEND

**STATUS:** Showing

**NTS MAP:** 082M15E

**LATITUDE:** 51° 49' 30" N

**LONGITUDE:** 118° 30' 30" W

**ELEVATION:** 8600 Metres

**LOCATION ACCURACY:** Within 1 KM

**COMMENTS:** Description, Annual Report 1901, p. 1012.

**COMMODITIES:** Mica

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<tr>
<td>ISOTOPIC AGE</td>
<td>DATING METHOD</td>
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</table>

**DEPOSIT**

| CHARACTER | Unknown |
| CLASSIFICATION | Industrial Min. |

**HOST ROCK**

| DOMINANT HOST ROCK | Metamorphic |

**STRATIGRAPHIC AGE**

<table>
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<th>FORMATION</th>
<th>ISOGENIC/METAMORPHIC/OTHER</th>
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<tbody>
<tr>
<td>Paleozoic</td>
<td>Lardeau</td>
<td>Undefined Formation</td>
</tr>
</tbody>
</table>

**LITHOLOGY:** Quartz Mica Schist

**GEOLOGICAL SETTING**

| TECTONIC BELT | Omineca |
| TERRANE | Kootenay |
| METAMORPHIC TYPE | Regional |

**PHYSIOGRAPHIC AREA:** Selkirk Mountains

**GRADE:** Amphibolite

**CAPSULE GEOLOGY**

The area is underlain by probable Lower Paleozoic Lardeau Group metasediments consisting of quartz-mica schist.

**BIBLIOGRAPHY**

- EMF AR 1901-1012; 1910-K94
- GSC P 64-32
- GSC MAP 12-1964
- GSC OP 637

**DATE CODED:** 850724

**CODED BY:** GSB

**DATE REVISED:** 860314

**REVISED BY:** LDJ
MINFILE NUMBER: 083D 007

NAME(S): YELLOW CREEK, MICA KING, CLEAR WHITE, MICA QUEEN, BIG BEND

STATUS: Showing

NS RO: 083D007

LATITUDE: 52 00 05

LONGITUDE: 118 18 40

ELEVATION: 1950 Metres

LOCATION ACCURACY: Within 1 KM

COMMENTS: Old workings at 6400 feet between westward flowing and northwestward flowing forks (at the headwaters) of Yellow Creek (Industrial Minerals File: Watson, K.deP (1944): Draft report on the Mica Deposits on Yellow Creek).

HOST ROCK: Metasedimentary

STRAIGHTGRAPHIC AGE GROUP FORMATION

Hadrynian Horsethief Creek Unnamed/Unknown Formation

LITHOLOGY: Pelitic Kyanite Schist

IGNEOUS/METAMORPHIC/OTHER

Mica Schist

Sileceous Gneiss

Micaceous Pegmatite Sill

Micaceous Quartzite

Amphibolite

Semi Pelite

Pegmatite Dike

HOST ROCK COMMENTS: Occurrence is found in Semipelite-Amphibolite unit of the Horsethief Creek Group (Mitchell, 1976). See capsule geology for details.

GEOLOGICAL SETTING

TECTONIC BELT: Omineca

PHYSIOGRAPHIC AREA: Selkirk Mountains

TERRANE: Kootenay

RELATIONSHIP: Syn-mineralization

METAMORPHIC TYPE: Regional

GRADE: Amphibolite

POST-mineralization

CAPSULE GEOLOGY

The Yellow Creek occurrence is located at the head waters of Yellow Creek on the west side of McNaughton Lake, approximately 13 kilometres south-southeast of Boat Encampment. Warsaw Mountain is located approximately 3.25 kilometres to the northwest.

Mineralization at the Yellow Creek occurrence consists of two types: kyanite and mica hosted in schists and gneiss, and mica and beryl hosted in pegmatite sills and dykes.

The area is underlain primarily by folded metasedimentary rocks of the Hadrynian Horsethief Creek Group. The regional foliation in the area strikes 294 degrees and dips 66 degrees. Upper amphibolite facies metamorphic conditions were reached in the northern Monashee Mountains at circa 100 Ma (Geology Vol. 18, 1990).

Upper amphibolite facies metamorphic conditions were reached in the northern Monashee Mountains at circa 100 Ma (Geology Vol. 18, pp. 103-106). An expanded description of the regional geology is given in the Warsaw Mountain showing (083D 041).

At the Yellow Creek occurrence, kyanite is present near the base 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
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

EMP AR 1898-39; 1913-42; 1920-N95; 1928-C188; 1931-148; *1952-258
EMP OF *1988-26
Deposits on Yellow Creek by)
GSC OP 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
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;
MINFILE NUMBER: 083D 012

NAME(S): CANOE NORTH MICA, CANOE, CANOE 1, VTS GRID, VALEMOUNT, CANOE RIVER, VALEMOUNT, JOHN 1-11

STATUS: Past Producer

tns MAP: 083D14W
LATITUDE: 52 45 35
LONGITUDE: 119 17 36
ELEVATION: 0993 Metres

LOCATION ACCURACY: Within 500M

MINING DIVISION: Cariboo

COMMENTS: Location of drillhole GM-12 on the Canoe North Mica occurrence (Assessment Report 7687).

COMMODITIES: Mica

MINERALS

SIGNIFICANT: Mica

ASSOCIATED: Kyanite, Staurolite, Garnet, Biotite, Pyrite, Pyrrhotite

COMMENTS: Garnet, rutile and ilmenite were identified by X-ray diffraction on a schist sample by the Department of Mines, Ottawa (Industrial Minerals File: Report for Mits Development Co. Ltd., June 1978).

MINERALIZATION AGE: Lower Cretaceous

ISOTOPIC AGE: 135 +/- 4 Ma.

DISPOT

CHARACTER: Disseminated

CLASSIFICATION: Metamorphic Industrial Min.

TYPE: Unknown

SHAPE: Tabular

MODIFIER: Folded

DIMENSION: 18 Metres STRIKE/DIP: 240/10 TREND/PLUNGE: 

COMMENTS: Hole 78-1 collared in 18.3 metres of schist (Assessment Report 7687). The foliation of layers within the showing strike 240 degrees and dip 10 degrees northwest (Minister of Mines Annual Report 1961).

HOST ROCK

DOMINANT HOST ROCK: Metasedimentary

STRATIGRAPHIC AGE GROUP FORMATION IGNeous/METAMORPHIC/OTHER

Hadrynian Kaza Undefined Formation Shuswap Metamorphic Complex

Proterozoic-Paleoz.

LITHOLOGY: Pelitic Schist Muscovite Quartz Schist Biotite Muscovite Pelite Psammitite Amphibolite Marble Calc-silicate Conglomerate Coarse Grained Grit Diamictite

HOST ROCK COMMENTS: The Canoe North Mica occurrence is located on the northwestern margin of the Shuswap Metamorphic Complex.

GEOLoGICAL SETTING

TECTONIC BELT: Omineca PHYSIOGRAPHIC AREA: Cariboo Mountains

TERRANE: Kootenay Ancestral North America

METAMORPHIC TYPE: Regional RELATIONSHIP: Syn-mineralization GRADE: Amphibolite

COMMENTS: Showing is immediately west of the southern Rocky Mountain Trench.

INVENTORY

ORE ZONE: QUARRY

CATEGORY: Inferred YEAR: 1980

QUANTITY: 1000000 Tonnes

COMMODITY GRADE

Mica 60.500 Per cent

COMMENTS: Fairly assured reserves.


MINFILE NUMBER: 083D 012
ORE ZONE: QUARRY

CATEGORY: Measured
YEAR: 1980
QUANTITY: 2290000 Tonnes
COMMODITY: Mica
GRADE: 60.5000 Per cent


CAPSULE GEOLOGY

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 psammitie, amphibolite, marble, calc-silicate, conglomerate, coarse grained grit and diamicite. 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 89-12, pp. 101-107, *90-1E, pp. 71-80
GSC M 15-1967; 1335A
GSC EC GEOL No. 19, pp. 83, 84
CMJ *May 1982, p. 13
N MINER *March 15, 1962; March 11, 1982; Sept 1, 1983
GCNR No. 62, 155, 1981; No. 45, 1982; No. 107, 112, 1987
EMR MIN BULL MR 223 B.C. 86

DATE CODED: 850724
CODED BY: GSB
DATE REVISED: 911208
REVISED BY: KJM

FIELD CHECK: N
**MINFILE NUMBER:** 083D-012  **NAME:** CANOE NORTH MICA  **STATUS:** Past Producer

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<th>Commodity</th>
<th>Grams Recovered</th>
<th>Kilograms Recovered</th>
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<tr>
<td>1965</td>
<td>100</td>
<td></td>
<td>Mica</td>
<td>100,000</td>
<td></td>
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</tbody>
</table>

**SUMMARY TOTALS:**
- **Metric:**
  - Mined: 225 tonnes
  - Milled: 248 tonnes
- **Imperial:**
  - Mica: 225,000 kilograms (496,040 pounds)

**Recovery:**
- 1961: 125 tonnes of mica product were produced for market (BMNR AR 1961)
- 1965: 100 tonnes of mica product were produced for market (BMNR AR 1960)

**Comments:**
- The data includes information on mica production and recovery from a previous mining operation at Canoe North Mica.
MINFILE NUMBER: 083D 017

NAME(S): CANOB SOUTH MICA, ALBREDA/CAMP CREEK, CANOE GRID

STATUS: Past Producer

MINING DIVISION: Underground

NTS MAP: 083D11W

LATITUDE: 52 43 55

LONGITUDE: 119 17 17

ELEVATION: 0968 Metres

LOCATION ACCURACY: Within 500M

COMMENTS: Center of Canoe Grid (Industrial Minerals File, mineral property map 83D11/W).

COMMODITIES: Mica

MINERALS

SIGNIFICANT: Mica

ASSOCIATED: Muscovite Staurolite Garnet Biotite Quartz

COMMENTS: The associated mineral assemblage will vary depending whether the showing is hosted by pelitic schist/pelite or within pegmatite bodies hosted in the former. Refer to capsule geology for explanation.

MINERALIZATION AGE: Lower Cretaceous

ISOTOPIC AGE: 135 +/-4 Ma

DATING METHOD: Discordant

MATERIAL DATED: Vein Disseminated Industrial Min.

DEPOSIT

CHARACTER: Concordant Stratafim Metamorphic

CLASSIFICATION: Pegmatite Tabular

SHAPE: Folded Faulted

DIMENSION: STRIKE/DIP: 135/04

TREND/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).

HOST ROCK

DOMINANT HOST ROCK: Metasedimentary

LITHOLOGY: Pelitic Schist Pegmatite Sub Feldspathic Psammite Sub Feldspathic Grit Amphibolite Diamictite Marble Calc-silicate Quartzite Conglomerate

HOST ROCK COMMENTS: Host rocks are interpreted to be lower Kaza Group (Geological Survey of Canada Open File 2324).

GEOLoGICAL SETTING

TECTONIC BELT: Omineca Kootenay

TERRANE: Ancestral North America Regional

METAMORPHIC TYPE: Amphibolite

RELATIONSHIP: GRADE: Amphibolite

COMMENTS: Relationship of metamorphism varies with age of the host rock.

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 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
degrees celsius respectively (Geological Survey of Canada Paper 89-1E). The age of the main metamorphic event in this area is Early Cretaceous (135+/-4 Ma) (Geological Survey of Canada Paper 90-1E).

The showing occurs in Hadrynian lower Kaza Group pelitic schist (locally kyanite, staurolite, garnet, muscovite and biotite bearing) of the lower Kaza Group. Other lithologies of the lower Kaza Group in the vicinity include subfeldspathic psammite and grit, ortho-amphibolite, marble, calc-silicate, quartzite, diamictite and conglomerate (Geological Survey of Canada Open File 2324). Pegmatite 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 Paper 89-1E).

Approximately 4 tonnes were mined with 4000 lbs (1815 kilograms) being packed out (Minister of Mines Annual Report 1915).

Mica schist from the Albreda vicinity was ground by L.T. Farley 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)
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
**MINFILE NUMBER:** 083D 017  
**NAME:** CANOE SOUTH MICA  
**STATUS:** Past Producer

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<th>Commodity</th>
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**SUMMARY TOTALS:** 083D 017  
**NAME:** CANOE SOUTH MICA

<table>
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<th>Imperial</th>
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<tr>
<td>4 tonnes</td>
<td>4 tons</td>
</tr>
<tr>
<td>1,815 kilograms</td>
<td>4,001 pounds</td>
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</tbody>
</table>

**Comments:** 1914: 1,815 kilograms were packed out and used in Vancouver for roofing.
MINFILE NUMBER: 083D 018

NATIONAL MINERAL INVENTORY:

NAME(S): ALBREDA, DEC GRID

STATUS: Showing

NYS MAP: 083D11E

LATITUDE: 52 40 16

LONGITUDE: 119 13 25

ELEVATION: 1067 Metres

LOCATION ACCURACY: Within 500M


COMMODITIES: Mica Kyanite

MINERALS

SIGNIFICANT: Mica Muscovite Kyanite

COMMENTS: Refer to capsule geology for explanation.

ASSOCIATED: Biotite Plagioclase Quartz Garnet Staurolite

Sillimanite

COMMENTS: The associated mineral assemblage will vary depending whether the mica/kyanite is hosted in pelitic schist/pelite or within pegmatite dykes hosted in the former. Refer to capsule geology for explanation.

MINERALIZATION AGE: Lower Cretaceous

ISOTOPIC AGE: 135+/-4 Ma.

DATING METHOD: MATERIAL DATED:

DEPOSIT

CHARACTER: Concordant Stratiform Disseminated

CLASSIFICATION: Metamorphic Industrial Min.

TYPE: Kyanite family Industrial Min.

SHAPES: Tabular Muscovite pegmatite

MODIFIER: Folded

DIMENSION: Strike/dip are for regional foliation and trend/plunge are for fold axis near showing (GSC Paper 89-lE, pp. 101-107). Age of mineralization is for the main metamorphic event (GSC Paper 90-lE, pp. 71-80).

HOST ROCK

DOMINANT HOST ROCK: Metasedimentary

STRATIGRAPHIC AGE GROUP FORMATION IGNEOUS/METAMORPHIC/OTHER

Hadrynian Kaza Undefined Formation Shuswap Metamorphic Complex

Hadrynian Horsethief Creek Undefined Formation


HOST ROCK COMMENTS: Pelitic schists are locally kyanite, sillimanite, staurolite, garnet, quartz, biotite and/or muscovite bearing (GSC Open File 2324).

GEOLOGICAL SETTING

TEC'TONIC BELT: Omineca

TERRANE: Kootenay

METAMORPHIC TYPE: Regional

COMMENTS: Showing is immediately west of the southern Rocky Mountain Trench.

CAPSULE GEOLOGY

The Alberda showing is located about 6.5 kilometres north-northwest of the Alberda Station on the Canadian National Railway from Kamloops to Tete Jaune Cache and Jasper. Little information is available for this occurrence except boulders of mica-garnet schist containing a fairly high proportion of bladed kyanite are exposed in railway cuttings for about half a mile in the vicinity of Alberda (Minister of Mines Annual Report 1947). It is not known whether there are nearby exposures hosted in within pelite/schist units of the metasediments themselves or in pegmatite dykes within enclosing metasediments. A claim group of four claims, the Dec Grid, was reported by the Mits Development Co. Ltd. in June 1978 and is assumed to cover the previously described kyanite bearing boulders. 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.
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 1988-26). The metamorphic 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 017).

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 psammitite, stratiform amphibolite schist, massive conformable garnet amphibolite and kyanite-staurolite-garnet-muscovite-biotite-quartz-plagioclase schist (locally with quartzofeldspathic knots and laminae). The overlying unit consists of pelitic schists with minor psammitic laced with quartzofeldspathic stringers lending the appearance of migmatite (Geological Survey of 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 commercial quality.

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EMPR IND MIN FILE *(Report for Mits Development Co. Ltd., June 1978)
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

DATE CODED: 850724  CODED BY: GSB
DATE REVISED: 911209  REVISED BY: KJM
FIELD CHECK: N

MINFILE NUMBER: 083D 018
MINFILE NUMBER: 083D 019

NATIONAL MINERAL INVENTORY:

NAME(S): MICA MOUNTAIN, BARRON 1-4, BONANZA GROUP, BONANZA, PREMIER, MINNIE SMITH, DREADNUT, ADVENTURE, BOULDER, MAMMOTH, MICA, TYTE VAUGH, RELIANCE CLAIM GRP.

STATUS: Showing

NTS MAP: 083D13E
LATITUDE: 52 53 56
LONGITUDE: 119 32 43
ELEVATION: 2316 Metres

LOCATION ACCURACY: Within 500M

COMMENTS: Main sill located at the centre of the Barron claim group (Assessment Report 276).

COMMODITIES: Mica Kyanite Beryl

MINERALS

SIGNIFICANT: Mica Muscovite Kyanite Beryl

COMMENTS: The age of post-phase 3 deformation (D3) pegmatites is 125+/-7 Ma and pre-phase 3 deformation (D3) pegmatites 154+/-6 Ma (Geological Survey of Canada Paper 90-11, pp. 71-80).

ASSOCIATED: Quartz Feldspar Garnet Tourmaline Apatite

MINERALIZATION AGE: Lower Cretaceous

ISOTOPIC AGE: 125+/-7 Ma.

DATING METHOD: Unknown

MATERIAL DATED: Unknown

DEPOSIT

CHARACTER: Vein Concordant Discordant Disseminated

CLASSIFICATION: Pegmatite Industrial Min.

TYPE: Muscovite pegmatite Kyanite family

SHAPE: Irregular

DIMENSION: 152 x 23 Metres

STRIKE/DIP: 135/35S

TREND/PLUNGE: 

COMMENTS: Orientation of pegmatite on the Reliance claim group is 135/30-40SW (EMPR AR 1920). Dimensions are for pegmatite on the Bonanza claim (EMPR IND MIN FILE; Report by J.M. Cummings, 1941).

HOST ROCK

DOMINANT HOST ROCK: Metaplutonic

STRATIGRAPHIC AGE GROUP: Hadrynian Kaza

Proterozoic-Paleozoic

LITHOLOGY: Pegmatite Dike Pegmatite Sill Garnet Mica Schist Quartz Mica Schist Quartz Feldspar Mica Schist Pelitic Schist

HOST ROCK COMMENTS: Mica Mountain occurrence is located on the northeastern margin of the Shuswap Metamorphic Complex.

GEOLOGICAL SETTING

TECTONIC BELT: Omineca

PHYSIOGRAPHIC AREA: Cariboo Mountains

TERRANE: Kootenay

Ancestral North America

METAMORPHIC TYPE: Regional

RELATIONSHIP: Pre-mineralization GRADE: Amphibolite

Post-mineralization

COMMENTS: Showing is immediately west of southern Rocky Mountain Trench.

CAPSULE GEOLOGY

The Mica Mountain showing is located on the northern and eastern flanks of Mica Mountain between 2072 and 2487 metres, Tete Jaune Cache is approximately 10 kilometres to the northeast. Mica Mountain has a long history of mica and lesser kyanite prospecting and exploration recorded as far back as 1898. At various times a number of attempts have been made to develop properties on Mica Mountain, but the showings to date contain too low a proportion of sheet mica of marketable grade to permit profitable operation (Minister of Mines Annual Report 1947). Work on these claims consisted primarily of short adits, winces and trenches along and into pegmatite bodies.

Mica at these old showings is hosted in pegmatite dykes and sills. Sills are transposed and deformed with host lithologies, whereas dykes crosscut foliation and folds of host rocks. Based on crosscutting relations, pegmatite bodies were intruded prior to and after phase three deformation. Phase three deformation consists of variable developed crenulation cleavages on a micro and mesoscopic scale and open to tight, isoclinal folds (coaxial with phase two
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, 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 spectrographic analyses) to contain less than 0.01 per cent beryllium (Geological Survey of Canada, Economic Geology Report No. 23).

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EMPR AR 1888-313; 1893-80A-81A; *1898-39; 1912-K52-K53; *1913-K59; 1914-K56-K57; 1915-K54-K55; *1920-N95-N96; 1921-N95,N96; 1924-152; *1928-C188-C189; 1931-A148-A149; *1947-A215-A216,A220
EMPR ABS RPT *276
EMPR OF 1988-26
EMPS IND MIN FILE (Report for Mits Development Co. Ltd., June 1978)
GSC OF 2324
GSC P *60-21, p. 9; 89-1E, pp. 101-107; 90-1E, pp. 71-80
GSC MAP 15-1967, 1339A
GSC EC GEBL *No. 19, pp. 83-84,90; *No. 23, pp. 58, 60

DATE CODED: 850724  CODED BY: GSB
DATE REVISED: 911209  REVISED BY: KJM
FIELD CHECK: N
MINFILE NUMBER: 083D 020

NATIONAL MINERAL INVENTORY:

NAME(S): HIGHWAY DEPOSIT LOWER SHOWING, HIGHWAY DEPOSIT UPPER SHOWING, MICA CREEK,
MICA WONDER GROUP, COLUMBIA GROUP, MICA CREEK FIRST FORK,
MICA CREEK SECOND FORK, POTLATCH CREEK, FRED LAING RIDGE

STATUS: Showing

MINING DIVISION: Revelstoke

NTS MAP: 083D02E 083D01W

UTM ZONE: 11

LATITUDE: 52 01 34

NORTHING: 5764900

LONGITUDE: 118 34 16

EASTING: 392200

ELEVATION: 725 Metres

LOCATION ACCURACY: Within 500M

COMMENTS: Mica-bearing pegmatite dyke at the Highway Deposit Lower Showing (Newmarch, 1942).

COMMODITIES: Mica

Yanite

MINERALS

SIGNIFICANT: Muscovite

ASSOCIATED: Biotite

MINERALIZATION AGE: Unknown

DEPOSIT

CHARACTER: Vein

CLASSIFICATION: Pegmatite

TYPE: Yanite family

SHAPE: Tabular

MODIFIER: Faulted

DIMENSION: 1 x 1 Metres

STRIKE/DIP: 065/90

TREND/PLUNGE:

COMMENTS: Strike and dip are for mica-bearing pegmatite dyke at the Highway Deposit Lower Showing (Newmarch, 1942). Mica booklets occur over a 1.2 metre square area in a 1.2 metre wide pegmatite dyke.

HOST ROCK

DOMINANT HOST ROCK: Metaplutonic

STRATIGRAPHIC AGE

GROUP: Hadrynian

FORMATION: Horsethief Creek

IGNEOUS/METAMORPHIC/OTHER

LITHOLOGY:

Yanite

Kyanite Garnet

Mica Schist

Micaceous Pegmatite Dike

Micaceous Pegmatite Sill

Pelite

Semi Pelite

Marble Gneiss

HOST ROCK COMMENTS: Mica is found in micaceous pegmatite dykes and sills and with kyanite and garnet within the Lower Pelite unit (GSC OF 2324).

GEOLOGICAL SETTING

TECTONIC BELT: Omineca

TERRANE: Kootenay

METAMORPHIC TYPE: Regional

RELATIONSHIP: Post-mineralization

GRADE: Amphibolite

Syn-mineralization

CAPSULE GEOLOGY

The Highway Deposit Lower Showing is one of many micaceous pegmatite dyke and sill occurrences in an area covering both slopes of Fred Laing Ridge including the northerly flowing tributaries of Potlatch Creek, the southerly flowing tributaries of Mica Creek and portions of the valley bottom of the main Mica Creek (Newmarch, 1942). Pegmatites, as large semi-concordant bodies, are abundant along the contact between the Semi-pelite and Pelite units of the Hadrynian Horsethief Creek Group. Distribution within the northern Semi-pelite unit is sporadic. A common association with marble was noticed along a southeast trending ridge 3 kilometres south-southwest of Warsaw Mountain.

At least two generations of pegmatites occur in this area. Earlier generation pegmatites are concordant and boudinaged within enclosing Semi-pelite units. Younger generation pegmatites crosscut layering and schistosity. Pegmatite dykes and sills in the area range from 0.90 to 9.0 metres in width, with thick pegmatites usually discordant. Orientations are also highly variable.

All pegmatites are plagioclase-rich, typically consisting of 70 per cent plagioclase, 20 per cent muscovite and 10 per cent quartz. Plagioclase is often strained and well twinned (Mitchell, 1976).

Mica within these dykes and sills range from 5 to 20 per cent by rock volume and in size from 0.32 to 8.9 centimetres diameter and 5.0 centimetres thick. Mica booklets often show evidence of internal strain. Minerals associated with mica are almandine garnet and black tourmaline (Newmarch, 1942). For a detailed description of the
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 dyke strikes 065 degrees and dips vertically.

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 tributaries of Mica Creek kyanite is present in localized pelitic horizons near the base of the Semipelitic-Anfibolite 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. Kyanite porphyroblasts in these horizons are up to 5 centimetres in length.
MINFILE NUMBER: 083D 030

NATIONAL MINERAL INVENTORY:

NAME(S): NORTH BLUE RIVER, BLUE RIVER, WHITERIVER

STATUS: Showing
NTS MAP: 083D03W
LATITUDE: 52 07 00
LONGITUDE: 119 23 00
ELEVATION: 0915 Metres
LOCATION ACCURACY: Within 5 KM
COMMENTS: Center of a large pegmatite body immediately northwest of Blue River (Geological Survey of Canada, Paper 84-1A, p. 92).

COMMODITIES: Mica

SIGNIFICANT: Mica
ASSOCIATED: Quartz Albite Oligoclase Garnet Tourmaline Kyanite Beryl Apatite Quartz Albite Oligoclase Garnet Tourmaline Kyanite Beryl Apatite COMMENTS: Pegmatite is composed principally of albite and oligoclase feldspar and a vitreous quartz. Accessories include garnet, kyanite, tourmaline, beryl and apatite (Minister of Mines Annual Report 1902).

MINERALIZATION AGE: Lower Cretaceous
ISOTOPIC AGE: 125 +/- 7 Ma DATING METHOD: Unknown MATERIAL DATED: Unknown

DEPOSIT CHARACTER: Vein Concordant Discordant Disseminated
CLASSIFICATION: Pegmatite Industrial Min.
SHAPE: Tabular
DIMENSION: 60 x 30 Metres STRIKE/DIP: TREND/PLUNGE:
COMMENTS: Some of these pegmatite bands are over 30 metres wide and 60 metres long (AR 1902). The age of post/pre phase 3 deformation pegmatites is 125 +/- 7 and 154 +/- 6 Ma, respectively (GSC Paper 90-1E).

HOST ROCK DOMINANT HOST ROCK: Meta-plutonic

STRATIGRAPHIC AGE GROUP: Hadrynian Proterozoic-Paleoz.
FORMATION: Horsethief Creek Undefined Formation
IGNEOUS/METAMORPHIC/OTHER: Shuswap Metamorphic Complex

LITHOLOGY: Pegmatite Pelitic Schist Micaceous Schist Semi Pelite Grit Marble Calc-silicate


CAPSULE GEOLOGY

The North Blue River is a mica showing hosted in pegmatite, 5 kilometres northwest of Blue River. The Canoe River map area is predominantly underlain by a sequence of Hadrynian metasedimentary strata, belonging to the Windermere Supergroup (Miette, Horsethief Creek and Kaza groups) and their basement gneisses. Lithologies common to the area include semipelite, psammitic, grit, marble and calc-silicate. Little information is available for this showing which was first mentioned as one of several occurrences of large books and crystals of mica hosted in pegmatites in the Canoe River area (Minister of Mines Annual Report 1902). A large pegmatite body was mapped in 1983 as part of a field study of the structural evolution and metamorphism in the Blue River area (Geological Survey of Canada Paper 84-1A, pp. 91-94). The description of pegmatite in the Blue River area given in 1902 is assumed to be part of this body or an apophyses of it.

The ages of pre and post phase three deformation pegmatites has been determined to be 154 +/- 6 Ma and 125 +/- 7 Ma respectively 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...
CAPSULE GEOLOGY

Micaceous schists of the Hedrymian Horsefly Creek Group. Albite or oligoclase feldspar and a vitreous quartz comprise the major principal constituents (Minister of Mines Annual Report 1902). Other pegmatites in the Canoe River area contain garnet, tourmaline, kyanite, beryl and apatite as accessories (Minister of Mines Annual 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 geochemical conditions permitting (Minister of Mines Annual Report 1902).

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GSC OP 2324
GSC P *84-1A, pp. 91-94; 90-1E/ pp. 71-80
GSC MAP 15-1967, 1339A
GSC BC GeoL No. 19, pp. 83-84

DATE CODED: 850724
DATE REVISED: 911303
CODED BY: GSB
REVISED BY: KJM
FIELD CHECK: N
FIELD CHECK: N
CAPSULE GEOLOGY

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. A northwest trending thrust fault is interpreted to separate the 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 Canoe 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 metres wide,
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 northeastward into interbedded quartz-hornblende-biotite-garnet 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, where large blocks of quartz mica schist are exposed on the steep north bank of the North Thompson River. The blocks are likely slumped 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, 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).

BIBLIOGRAPHY

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EMPR ASS RPT 12679; *13844
EMPS INF CIRC 1986-1, p. 70
GSC OF 2324
GSC P 87-1A, pp. 713-718; 89-1E, pp. 101-107; 90-1E, pp. 71-80
GSC MAP 15-1967; 1339A
GSC EC GEOL No. 19, pp. 83-84
The Rose occurrence is located in an area underlain mainly by volcanic rocks of the Late Devonian McLaughlin Ridge Formation (Sicker Group) and by sediments of the Mississippian to Pennsylvania Fourth Lake Formation (Buttle Lake Group). The local stratigraphy is disrupted by folding, faulting, (pre-Triassic as well as Late Tertiary) and the intrusions of gabbro and diabase sills and dykes (informally called the Mount Hall Gabbro) that are coeval with the Upper Triassic Kwalumet Formation. Most of the original rock textures and structures have been obliterated by extensive faulting, shearing and polyphase deformation, resulting in the formation of cataclastic schists. About 70 metres of sericite and graphitic schists, as well as non-schistose argillite have been exposed along the north side of a road. In the rocks a strongly developed schistosity strikes 065 degrees and dips 79 degrees north (Minister of Mines Annual Report 1965, page 268).
MINFILE NUMBER: 092BNW067

NAME(S): Coquihalla

STATUS: Showing
LATITUDE: 49° 36' 27"
LONGITUDE: 121° 02' 42"
ELEVATION: 1000 Metres
LOCATION ACCURACY: Within 5 KM
COMMENTS: Location for railway bridge over Fallslake Creek, midway between Romeo and Coquihalla.

COMMODITIES: Feldspar, Silica, Mica

MINERALS

SIGNIFICANT: Orthoclase, Quartz, Muscovite

DEPOSIT

CHARACTER: Stratabound
CLASSIFICATION: Pegmatite, Syngenetic, Industrial Min.

HOST ROCK

DOMINANT HOST ROCK: Plutonic

STRATIGRAPHIC AGE GROUP FORMATION IGNeous/MeTAMORPHIC/OthER
Jurassic-Cretaceous

ISOtopIC AGE: 102.8 +/- 1.5 Ma
DATING METHOD: Potassium/Argon
MATERIAL DATED: Muscovite

LITHOLOGY: Pegmatite, Granodiorite

HOST ROCK COMMENTS: Isotopic age by Monger (Geological Survey of Canada Map 41-1989, Sheet 3).

GEOLOGICAL SETTING

TECTONIC BELT: Intermontane
TERRANE: Plutonic Rocks

CAPSULE GEOLOGY

Pegmatites are a common occurrence within granodiorite of the Late Jurassic and Early Cretaceous Eagle Plutonic Complex. They occur as irregular intrusions from a few centimetres to several metres wide and are best exposed along railway cuts between Romeo and Coquihalla and along either side of the Coquihalla River.

The pegmatites comprise pink orthoclase, milky white, massive quartz and muscovite in crystals up to five centimetres wide. Locally, they exhibit a gradation into the granodiorite and probably intruded at a late stage of consolidation of the pluton.

BIBLIOGRAPHY

EMPR OF 1991-10
GSC MEM 139, p. 94, 109
GSC P 69-47; 88-El, pp. 177-183
GSC MAP 737A; 12-1969; 41-1989
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.
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 enough 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 silicified 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 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: SiO$_2$ = 64.52, Al$_2$O$_3$ = 22.11, K$_2$O = 1.21, Na$_2$O = 0.22, Fe(total) = 4.50, H$_2$O(+105 degrees C) = 4.20, S$_3$O$_3$ = 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).

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GSC OF 9; 170; 463
GSC SUM RPT 1913; 1920A
GSC P 69-1A; 70-1A; 72-4; 74-8
GSC ANN RPT 1886
GSC MAP 4-1974; 255A
MINFILE NUMBER: 093A 083

NATIONAL MINERAL INVENTORY:

NAME(S): MICA MOUNTAIN, CLEARWATER MICA

STATUS: Prospect

LATITUDE: 52 08 03

LONGITUDE: 120 26 31

ELEVATION: 1920 Metres

LOCATION ACCURACY: Within 1 KM

COMMENTS: Located 65 kilometres north-northwest of Clearwater, 3 kilometres west of Wells Gray Provincial Park.

COMMODITIES: Mica

MINERALS

SIGNIFICANT: Muscovite

ASSOCIATED: Feldspar

MINERALIZATION AGE: Unknown

DEPOSIT

CHARACTER: Concordant

CLASSIFICATION: Pegmatite

TYPE: Muscovite pegmatite

SHAPE: Irregular

DIMENSION: 60 Metres

COMMENTS: A 60-metre wide north-trending zone of pegmatite pods and dikes 1.5 to 9 metres wide.

HOST ROCK

DOMINANT HOST ROCK: Metasedimentary

STRATIGRAPHIC AGE GROUP: Proterozoic-Paleozoic

FORMATION: Snowshoe

LITHOLOGY: Quartz Mica Schist

HOST ROCK COMMENTS: The Snowshoe Group is (?)Hadrynian to Paleozoic in age.

GEOLOGICAL SETTING

TECTONIC BELT: Omineca

TERRANE: Barkerville

METAMORPHIC TYPE: Regional

PHYSIOGRAPHIC AREA: Quesnel Highland

INVENTORY

ORE ZONE: SAMPLE

CATEGORY: Assay/analysis

SAMPLE TYPE: Grab

COMMODITY: Mica

GRADE: 30.0000 Per cent

COMMENTS: Early work indicated 25 to 30 per cent mica.


CAPSULE GEOLOGY

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 quartz 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

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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 unknown)
GSC P 70-1A
GSC MAP 42-1961; 1-1963; 1424A

DATE CODED: 850724
CODED BY: GSB
DATE REVISED: 910612
REVISED BY: PSF

FIELD CHECK: N

MINFILE NUMBER: 093A 083
MINFILE NUMBER: 093G 047

NAME(S): HIXON MICA

STATUS: Showing

LATITUDE: 53 26 37

LONGITUDE: 122 29 26

ELEVATION: 0808 Metres

LOCATION ACCURACY: Within 1 KM

COMMENTS: Approximate centre of Placer Lease 2118.

COMMODITIES: Mica

MINERALS

SIGNIFICANT: Mica

MINERALIZATION AGE: Unknown

DEPOSIT

CHARACTER: Stratabound

CLASSIFICATION: Replacement

HOST ROCK

DOMINANT HOST ROCK: Metasedimentary

STRATIGRAPHIC AGE GROUP FORMATION IGNEOUS/METAMORPHIC/OTHER

Proterozoic-Paleoz. Snowshoe Undefined Formation

LITHOLOGY: Mica Schist Gneiss Meta Sediment/Sedimentary

HOST ROCK COMMENTS: Snowshoe Group is (?)Hadrynian to Paleozoic in age.

GEOLOGICAL SETTING

TECTONIC BELT: Omineca

TERRAINS: Barkerville

PHYSIOGRAPHIC AREA: Cariboo Plateau

CAPSULE GEOLOGY

The Hixon mica showing occurs within the (?)Hadrynian to Paleozoic Snowshoe Group of the Barkerville Terrane, adjacent to the western contact with the Quesnellia Terrane. The dominant rock types are metasedimentary which range from paragneiss to various schist types and marbles depending on the degree of metamorphism and deformation. The Snowshoe Group also contains some metamorphosed igneous units. The area of the showing is underlain by gneiss which grades into a mica schist. No other information is available.

BIBLIOGRAPHY

EMPR AR 1926-A166
EMPR PP (See 93G General File - NW Area and Quesnel Area)
GSC MAP 1424A

DATE CODED: 850724

CODED BY: GSB

DATE REVISED: 890220

REVISED BY: DGB

FIELD CHECK: N

FIELD CHECK: N
MINFILE NUMBER: 093J 022

NAME(S): CARP LAKE

STATUS: Showing
NTS MAP: 093J14E
LATITUDE: 54 47 53
LONGITUDE: 123 11 41
LOCATION ACCURACY: Within 1 KM

COMMENTS: Four mica occurrences are shown on the northern part of Geological Survey of Canada Map 979A.

COMMODITIES: Mica

MINERALS
SIGNIFICANT: Muscovite
MINERALIZATION AGE: Unknown

DEPOSIT
CHARACTER: Disseminated
CLASSIFICATION: Syngentic Pegmatite
   Industrial Min.
   Type: Muscovite pegmatite

HOST ROCK
DOMINANT HOST ROCK: Plutonic

STRATIGRAPHIC AGE GROUP FORMATION IGNEOUS/METAMORPHIC/OTHER
Upper Triassic Takla Undefined Formation Wolverine Complex
Unknown

LITHOLOGY: Pegmatite
Ortho Gneiss
Felsic Intrusive

HOST ROCK COMMENTS: Pegmatites intrude Wolverine Complex.

GEOLOGICAL SETTING
TECTONIC BELT: Intermontane
TERRANE: Kootenay
PHYSIOGRAPHIC AREA: Nechako Lowland

CAPSULE GEOLOGY
The Carp Lake showing is underlain by orthogneiss and felsic intrusive rocks of the Wolverine Complex and fault bounded blocks of Upper Triassic Takla Group rocks. The Carp Lake showing consists of muscovite "books" within Wolverine Complex pegmatitic bodies. The muscovite "books" are up to 7.6 centimetres square.

BIBLIOGRAPHY
GSC MAP 979A; 1424A
GSC EC GROL 19, p. 83

DATE CODED: 860908 CODED BY: GRF FIELD CHECK: N
DATE REVISED: 890222 REVISED BY: DGB
**MINFILE NUMBER:** 093E 094  
**NATIONAL MINERAL INVENTORY:**

**NAME(S):** CASEY PEGMATITE  
**STATUS:** Showing  
**NTS MAP:** 093K03E  
**LONGITUDE:** 125° 02' 10"  
**LOCATION ACCURACY:** Within 1 KM  
**COMMENTS:** Largest body of pegmatite in the area, approximately 1.2 kilometres northeast of Casey Lake.

**COMMODITIES:** Feldspar  
Mica  
Silica

**MINERALS**

**SIGNIFICANT:** Orthoclase  
Plagioclase  
Biotite  
Quartz

**ASSOCIATED:** Perthite

**MINERALIZATION AGE:** Unknown

**DEPOSIT**

**CHARACTER:** Discordant  
**CLASSIFICATION:** Pegmatite  
**SHAPE:** Tabular  
**DIMENSION:** 0009 Metres  
**COMMENTS:** Largest dike is 9 metres wide.

**HOST ROCK**

**DOMINANT HOST ROCK:** Plutonic

**STRATIGRAPHIC AGE**

**GROUP:** Upper Jurassic

**FORMATION:** Francois Lake Intrinsic Suite

**LITHOLOGY:** Pegmatite Dike  
Aplitic Dike

**GEOLOGICAL SETTING**

**TECTONIC BELT:** Intermontane  
**TERRANE:** Cache Creek

**PHYSIOGRAPHIC AREA:** Nechako Plateau

**CAPSULE GEOLOGY**

Several pegmatite dikes occur in a batholith of the Upper Jurassic Francois Lake Intrusive Suite. The largest dike is 9 metres wide and occurs alongside an aplitic dike approximately 1.2 kilometres northeast of Casey Lake. The pegmatite consists of quartz, perthitic orthoclase, and minor plagioclase and biotite. Crystal size ranges up to about 2.5 centimetres.

**BIBLIOGRAPHY**

EMPR AR 1965-126  
EMPR PF (See 093K General file, Endako Area Maps)  
EMPR OF 1991-10  
EMPR EXPL 1992-69-106  
EMPR FIELDWORK 1992, pp. 475-482  
GSC OF 2593  
GSC P 90-1F, pp. 115-120; 91-1A, pp. 7-13  
GSC MEM 252  
GSC MAP 631A; 907A; 1424A

**DATE CODED:** 850724  
**DATE REVISED:** 950314
MINFILE NUMBER: 093N 189

NAME(S): Wolverine Range

STATUS: Showing

NTS MAP: 093N09W

LATITUDE: 55 43 53

LONGITUDE: 124 19 21

ELEVATION: 1860 Metres

LOCATION ACCURACY: Within 1 KM

COMMENTS: The occurrence is located within the Wolverine Range approximately 12 kilometres northeast from the settlement of Manson Creek.

COMMODITIES: Mica, Feldspar

MINERALS

SIGNIFICANT: Feldspar, Muscovite, Biotite, Garnet

ASSOCIATED: Quartz, Plagioclase, Industrial

MINERALIZATION AGE: Unknown

DEPOSIT

CHARACTER: Massive, Syngenetic

CLASSIFICATION: Pegmatite, Industrial Min.

TYPE: Ceramic pegmatite

HOST ROCK

DOMINANT HOST ROCK: Plutonic

STRATIGRAPHIC AGE

GROUP: Proterozoic, Tertiary

FORMATION: Wolverine Complex, Unnamed/Unknown Informal

LITHOLOGY: Pegmatite, Garnet, Muscovite, Biotite, Granodiorite

HOST ROCK COMMENTS: Preliminary U-Pb data from zircon analysis indicate an early Tertiary age for the granodiorites within the Wolverine Complex.

GEOLOGICAL SETTING

Tectonic Belt: Omineca

Terrane: Cassiar

Physiographic Area: Omineca Mountains

CAPSULE GEOLOGY

The Wolverine Range occurrence is located within the Wolverine Range, approximately 12 kilometres northeast from the settlement of Manson Creek. Pegmatites at the showing are coarse grained and consist of quartz, plagioclase, orthoclase, muscovite, biotite and garnet. These pegmatites are dike shaped and are found within garnet-muscovite-biotite granodiorites of the Proterozoic Wolverine Complex. Preliminary U-Pb data from zircon analysis indicate an early Tertiary age for the granodiorites within the complex (Bulletin-in preparation).

BIBLIOGRAPHY

EMPR OF 1991-10

EMPR BULL Perri, P. and Melville, D.M., in preparation, Geology of the Germansen landing - Manson Creek Area, North Central British Columbia

EMPR FIELDWORK 1988, pp. 169-180

GSC P 41-5, 42-2, 45-9, 75-33

GSC MAP 876A; 907A; 1424A; 5249G

GSC MEM *252, p. 28

DATE CODED: 880724

CODED BY: GSB

FIELD CHECK: N

DATE REVISED: 921129

REVISED BY: DMM

FIELD CHECK: N
The Falls occurrence is situated on the north fork of Six Mile Creek, approximately 44 kilometres northwest of the town of Mackenzie, in the Omineca Mining Division. As recorded in the 1904 Department of Mines Annual Report, "the mica appears to be very good grade and the surface showing is said to be very encouraging." A more detailed description is not available.
The Family Farm occurrence is situated on the north side of Mica Peak (East Mica Mountain) 6.5 kilometres southwest of Williston Lake. The area is underlain by regionally metamorphosed miogeoclinal rocks of the Hadrynian Ingenika Group. In the vicinity, these metasediments largely comprise quartzites and schists.

According to Geological Survey of Canada Summary Report 1927, all mica-bearing pegmatites in this area consist of feldspar and quartz, and small amounts tourmaline, garnet, and pyrite. The tourmaline occurs as small well-formed, jet black crystals frequently arranged in rosettes, and commonly found in the country rocks adjoining the pegmatites. The garnets are bright ruby-red in colour. One pegmatite dikes in the area is also reported to have contained a well-developed crystal of pale bluish green beryl.

The Family Farm occurrence comprises two concordant dikes of white pegmatite, intruding schist and consisting of mostly muscovite, quartz and feldspar.

The larger dikes forms an elongate ellipsoidal that strikes 150 degrees, dips 70 degrees west and plunges to 12 degrees towards 150 degrees, with long and intermediate axes of 100 metres and 12 metres respectively. This dikes varies up to 10 metres wide. Muscovite crystals, up to 4.5 centimetres in diameter, occur in the pegmatite, with the larger grains generally within 1 metre of the wallrocks. The muscovite is reported to be of excellent quality despite some surface weathering.

The smaller parallel pegmatite dikes 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...
muscovite mica are present in this dike. The larger dike was explored by a shaft and several drifts, while the smaller one was trenched by General Holdings Company Ltd. between 1925 and 1927. The company extracted up to 2.3 tonnes of mica from the workings in 1927 (Minister of Mines Annual Report 1927, page 161).
**MINFILE NUMBER:** 094C 034  
**NAME:** FAMILY FARM  
**STATUS:** Past Producer

<table>
<thead>
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<th>Production Year</th>
<th>Tonnes Mined</th>
<th>Tonnes Milled</th>
<th>Commodity</th>
<th>Grams Recovered</th>
<th>Kilograms Recovered</th>
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<td>1927</td>
<td>2</td>
<td></td>
<td>Mica</td>
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**SUMMARY TOTALS:** 094C 034  
**NAME:** FAMILY FARM

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<td>Mined:</td>
<td>2 tonnes</td>
</tr>
<tr>
<td>Milled:</td>
<td>tonnes</td>
</tr>
<tr>
<td>Recovery: Mica:</td>
<td>2,300 kilograms</td>
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</tbody>
</table>

**Comments:** 1927: In 1927, 2.3 tonnes of mica were mined (Annual Report 1927).
NAME(S): WEST MICA MOUNTAIN

STATUS: Prospect

NTS MAP: 094C1OW

LATITUDE: 56 31 52
LONGITUDE: 124 46 43

ELEVATION: 2000 Metres

LOCATIONS ACCURACY: Within 1 KM

COMMENTS: Located on West Mica Mountain (Minister of Mines Annual Report, page A154).

MINING DIVISION: Omineca

UTM ZONE: 10
NORTHING: 6266400
EASTING: 3906000

LOCATION: Within 1 KM

COMMENTS: Located on West Mica Mountain (Minister of Mines Annual Report, page A154).

COMMODITIES: Mica, Gemstones

MINERALS

SIGNIFICANT: Muscovite, Quartz, Feldspar, Tourmaline, Garnet

ASSOCIATED: Pyrite

MINERALIZATION AGE: Unknown

DEPOSIT

CHARACTER: Vein

CLASSIFICATION: Pegmatite, Industrial Min.

TYPE: Muscovite pegmatite

HOST ROCK

DOMINANT HOST ROCK: Metasedimentary

STRATIGRAPHIC AGE: Hadrynian

FORMATION: Ingenika

LITHOLOGY: Pegmatite, Mica Schist, Gneiss, Quartzite

GEOLOGICAL SETTING

TECTONIC BELT: Omineca

TERRANE: Cassiar

METAMORPHIC TYPE: Regional

RELATIONSHIP: Kyanite zone

PHYSIOGRAPHIC AREA: Omineca Mountains

GRADE: Amphibolite

The West Mica Mountain mica occurrence is located on the north side of West Mica Mountain, 84 kilometres north of Germansen Landing. Hostrocks are pegmatites within mica schists and gneisses and quartzites of the Hadrynian Ingenika Group which have been metamorphosed to the kyanite zone of the amphibolite facies of regional metamorphism. The occurrence is described (1927 Summary Report, Part A, page 33A) as the richest pegmatite dike in the Mica Mountain mica district; apparently, large muscovite crystals (possibly up to 33 centimetres across) have been extracted from the deposit and a small shipment made. The mode of occurrence is described as similar to the Mica Mountain occurrence (094C 034) located 5 kilometres to the northeast.

All mica-bearing pegmatites in the area are reported to be formed of feldspar and quartz with small amounts of pyrite, tourmaline and garnets. The tourmaline occurs as small well-formed, jet black crystals frequently arranged in rosettes, and commonly found in the country rocks adjoining the pegmatites. The garnets are bright ruby-red in colour.

BIBLIOGRAPHY

EMPR AR *1926-153, 1927-C161
GSC P 75-33, p. 17
GSC SUM RPT *1927, Part A, pp. 31A-35A
GSC EC GEOL No. 19, pp. 83, 90
EMR MP CORPFILE (General Holding Company Limited)
CANMET RPT No. 701, pp. 78-80
### MINFILE NUMBER: 094C 036
### NATIONAL MINERAL INVENTORY: 094C10 Mic1

**NAME(S):** RAVENAL, LOST PIPE

**STATUS:** Showing

**NTS MAP:** 094C07E

**LATITUDE:** 56 29 49

**LONGITUDE:** 124 43 24

**ELEVATION:** 2100 Metres

**LOCATION ACCURACY:** Within 1 KM

**COMMENTS:** Located from map showing claims (Minister of Mines Annual Report 1926, page A154).

**COMMODITIES:** Mica, Gemstones

**MINERALS**

<table>
<thead>
<tr>
<th>SIGNIFICANT</th>
<th>ASSOCIATED</th>
<th>MINERALIZATION AGE</th>
<th>DEPOSIT</th>
<th>CLASSIFICATION</th>
<th>TYPE</th>
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<td>Pyrite</td>
<td>Unknown</td>
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<td>Pegmatite</td>
<td>Muscovite pegmatite</td>
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</table>

**HOST ROCK**

**DOMINANT HOST ROCK:** Metamorphic

**STRATIGRAPHIC AGE GROUP:** Ingenika

**FORMATION:** Undefined Formation

**LITHOLOGY:** Pegmatite, Mica Schist, Quartzite, Gneiss

**GEOLOGICAL SETTING**

**TECTONIC BELT:** Omineca

**TERRANE:** Cassiar

**METAMORPHIC TYPE:** Regional

**PHYSIOGRAPHIC AREA:** Cassiar Mountains

**RELATIONSHIP:** Grade: Amphibolite

**COMMENTS:** Kyanite zone (Paper 75-33, Map 2-1975).

### CAPSULE GEOLOGY

The Ravel mica occurrence is located on the south side of Mount Henri, 80 kilometres north of Germanen Landing. Hostrocks are pegmatites within mica schists and gneisses and quartzites of the Hadrynian Ingenika Group which have been metamorphosed to the kyanite zone of the amphibolite facies of regional metamorphism. Two small pegmatite veins, 1 metre and 50 centimetres wide respectively, are exposed on a vertical cliff. The veins are mainly quartz, with mica of "good grade" (Geological Survey of Canada Summary Report, 1927, Part A, page 33). All mica-bearing pegmatites in the area are reported to be formed of feldspar and quartz with small amounts of pyrite, tourmaline and garnet. The tourmaline occurs as small well-formed, jet black crystals frequently arranged in rosettes, and commonly found in the country rocks adjoining the pegmatites. The garnets are bright ruby-red in colour.

### BIBLIOGRAPHY

- EMPAR AR 1926-155
- GSC SUM RPT *1927, Part A, p. 33A
- GSC P 75-33, p. 17

**DATE CODED:** 850724 **CODED BY:** GSB **FIELD CHECK:** N

**DATE REVISED:** 920309 **REVISED BY:** RHM **FIELD CHECK:** N
MINFILE NUMBER: 094C 037

NAME(S): RUBY CREEK, RUBY, LORIMER CREEK

STATUS: Showing

LATITUDE: 56 26 01
LONGITUDE: 124 40 48
ELEVATION: 1350 Metres

LOCATION ACCURACY: Within 1 km

COMMENTS: Location is the "gold" occurrence on Geological Survey of Canada Map 2-1975 (Paper 75-33, page 17).

COMMODITIES: Mica

MINERALS

SIGNIFICANT: Mica
MINERALIZATION AGE: Unknown

DEPOSIT

CHARACTER: Vein
CLASSIFICATION: Pegmatite
TYPE: Muscovite pegmatite

HOST ROCK

DOMINANT HOST ROCK: Metasedimentary

STRATIGRAPHIC AGE GROUP: Ingenika
LITHOLOGY: Pegmatite
Mafic Gneiss
Mica Schist
Quartzite

GEOLOGICAL SETTING

TECTONIC BELT: Omineca
TERRANE: Cassiar
METAMORPHIC TYPE: Regional

RELATIONSHIP: GRADE: Amphibolite
PHYSIOGRAPHIC AREA: Omineca Mountains

CAPSULE GEOLOGY

The Ruby Creek mica occurrence is located on Ruby (Lorimer (?)) Creek (Minister of Mines Annual Report 1930, page 152), approximately 74 kilometres north of Germansen Landing.

Mica-bearing pegmatites, consisting of primarily feldspar and quartz, occur in an area underlain by mica schists, mafic gneisses and quartzites of the Hadrynian Ingenika Group. These rocks have been regionally metamorphosed to the kyanite zone of the amphibolite facies.

The mode of occurrence is described as similar to the Mica Mountain occurrence (094C 035) located 11 kilometres to the north (Minister of Mines Annual Report 1926, page 153) except that the metamorphic grade is higher, the rocks are more gneissic and pyrrhotite is abundant in the mafic layers. The pyrrhotite-rich bands are up to 6 metres in thickness. A selected sample of pyrrhotite assayed trace gold and silver and nil nickel and copper.

BIBLIOGRAPHY

EMPR AR *1926-153, 1927-CL61, *1930-152
GSC P 75-33, p. 17
GSC SUM RPT *1927, Part A, pp. 31A-35A
GSC EC GEOL No. 19, pp. 81, 90
GSC MAP 2-1975

DATE CODED: 850724
DATE REVISED: 920310

CODED BY: GSB
REVISED BY: RHM
MINFILE NUMBER: 094C 092

NATIONAL MINERAL INVENTORY:

NAME(S): JACKPINE, BLACKPINE LAKE

STATUS: Showing
NTS MAP: 094CO6W
LATITUDE: 56 21 22
LONGITUDE: 125 21 46
ELEVATION: 1500 Metres
LOCATION ACCURACY: Within 5 KM
COMMENTS: Location of the main granodiorite body, northeast of Blackpine Lake (Geological Survey of Canada Memoir 274).

COMMODITIES: Mica

MINERALS
SIGNIFICANT: Muscovite
ASSOCIATED: Plagioclase
MINERALIZATION AGE: Unknown

DEPOSIT
CHARACTER: Massive
CLASSIFICATION: Pegmatitic
TYPE: Muscovite pegmatite
SHAPE: Tabular

HOST ROCK
DOMINANT HOST ROCK: Plutonic

STRATIGRAPHIC AGE
Hadrynian
Mesozoic-Cenozoic

LITHOLOGY: Pegmatite
Granodiorite
Migmatite
Gneiss
Schist
Granite

HOST ROCK COMMENTS: The Wolverine complex consists of metamorphosed Ingenika rocks and Cretaceous to Tertiary intrusions.

TECTONIC BELT: Omineca
TERRANE: Cassiar
METAMORPHIC TYPE: Regional

PHYSIOGRAPHIC AREA: Omineca Mountains

CLASSIFICATION: Pegmatite

TYPE: Muscovite pegmatite

SHAPE: Tabular

IGNeous/METAMORPHIC/OThER

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 margin of several intrusive bodies which are part of the Wolverine Complex. The Wolverine Complex consists of an assemblage of migmatic, 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, sphenite, 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,
graphic granite occurs in irregular bodies up to 30 metres in diameter in the gneiss-migmatite roof rocks above the granodiorite body, northeast of Blackpine Lake. Feldspar (probably microperthite) in the graphic granite constitutes up to 70 per cent of the bodies (Geological Survey of Canada Memoir 274, page 101), the remainder of the rock being quartz (25 per cent) and twinned sodic plagioclase (5 per cent).

CAPSULE GEOLOGY

BIBLIOGRAPHY

GSC MEM 274, pp. 91-102
GSC MAP 1030A
MINFILE NUMBER: 094C 124

NAME(S): BIRTHDAY

STATUS: Showing
MTS MAP: 094C07W 094C07E
LATITUDE: 56 28 52
LONGITUDE: 124 45 30
ELEVATION: 1850 Metres
LOCATION ACCURACY: Within 1 KM
COMMENTS: Located from map showing claims (Minister of Mines Annual Report 1926, page A154).

COMMODITIES: Mica

MINERALS
SIGNIFICANT: Muscovite
MINERALIZATION AGE: Unknown

DEPOSIT
CHARACTER: Massive
CLASSIFICATION: Pegmatite
TYPE: Muscovite pegmatite

HOST ROCK
DOMINANT HOST ROCK: Metamorphic

STRATIGRAPHIC AGE
GROUP: Hadrynian
LITHOLOGY: Pegmatite
Mica Schist
Gneiss
Quartzite

GEOLOGICAL SETTING
TECTONIC BELT: Omineca
TERRANE: Cassiar
METAMORPHIC TYPE: Regional

PHYSIOGRAPHIC AREA: Omineca Mountains
RELATIONSHIP: GRADE: Amphibolite

The Birthday mica occurrence is located southwest of Pyramid Peak (Minister of Mines Annual Report 1926, page A154), 76 kilometres north of Germansen Landing. A mica-bearing pegmatite dike is hosted in an area of mica schists, gneisses and quartzites of the Hadrynian Ingenika Group which have been regionally metamorphosed to the kyanite zone of the amphibolite facies.

The pegmatite dike is described (Geological Survey of Canada Summary Report 1927, Part A, page 33A) as being 15 to 60 metres in width, and more than 450 metres long. Although no mica of "commercial" grade was seen in outcrop, "two or three valuable crystals of muscovite" were observed in float.

Refer to the Family Farm occurrence (094C 034) for further details of these regional pegmatite occurrences.

BIBLIOGRAPHY
EMPR AR *1926-153; 1927-C161
GSC P 75-33, p. 17
GSC SGD RPT *1927, Part A, pp. 31A-35A
GSC EC GROU No. 12, pp. 83, 90
EMR MP CORFILE (General Holding Company Limited)
CAMLIT RPT No. 701, pp. 78-80

DATE CODED: 920310
CODED BY: RHM
DATE REVISED: 920310
REVISED BY: RHM

FIELD CHECK: N
MINFILE NUMBER: 094C 125

NAME(S): CARIBOU

STATUS: Showing

NTS MAP: 094C10E

LATITUDE: 56 30 34

LONGITUDE: 124 39 15

ELEVATION: 1750 Metres

LOCATION ACCURACY: Within 1 KM

COMMENTS: Located from map showing claims (Minister of Mines Annual Report 1926, page Al54).

COMMODITIES: Mica

MINERALS

SIGNIFICANT: Muscovite Quartz Feldspar

MINERALIZATION AGE: Unknown

DEPOSIT

CHARACTER: Vein Massive Industrial Min.

CLASSIFICATION: Pegmatite Magmatic Industrial Min.

TYPE: Muscovite pegmatite

HOST ROCK

DOMINANT HOST ROCK: Metamorphic

STRATIGRAPHIC AGE GROUP: Ingenika

FORMATION: Undefined Formation

LITHOLOGY: Pegmatite Mica Schist Gneiss Quartzite

GEOLOGICAL SETTING

TECTONIC BELT: Omineca

TERRANE: Cassiar

METAMORPHIC TYPE: Regional

RELATIONSHIP: GRADE: Amphibolite


CAPSULE GEOLOGY

The Caribou mica occurrence is located on the east side of Mount Henri, 82 kilometres north of Germansen Landing.

Hostrocks are pegmatites within mica schists, gneisses and quartzites of the Hadrynian Ingenika Group which have been regionally metamorphosed to the kyanite zone of the amphibolite facies.

The occurrence is described (Geological Survey of Canada Summary Report, Part A, page 33A) as consisting of "small veins" composed largely of quartz and muscovite, but no "marketable" mica was observed in place on the property.

Refer to the Family Farm occurrence (094C 034) for further details of these regionally occurring mica-bearing pegmatites.

BIBLIOGRAPHY

EMPR AR *1926-1531; 1927-C161
GSC P 75-33, p. 17
GSC MAP 2-1975
GSC SUM RPT *1927, Part A, pp. 31A-35A
GSC EC GEO1 No. 19, pp. 83-90
EME MP CORPFILE (General Holding Company Limited)
CARMET RPT No. 701, pp. 78-80

DATE CODED: 920310

CODED BY: RHM

DATE REVISED: 920310

REVISED BY: RHM
MINFILE NUMBER: 094C 126

NAME(S): SUNSET

STATUS: Showing

MINING DIVISION: Omineca

MTS MAP: 094C07E

UTM ZONE: 10

LATITUDE: 56 29 25

NORTHING: 6261700

LONGITUDE: 124 40 51

EASTING: 396500

ELEVATION: 1800 Metres

LOCATION ACCURACY: Within 1 KM

COMMENTS: Located from map showing claims (Minister of Mines Annual Report 1926, page A154).

COMMODITIES: Mica

MINERALS

SIGNIFICANT: Muscovite

QUARTZ

Feldspar

MINERALIZATION AGE: Unknown

DEPOSIT

CHARACTER: Vein

CLASSIFICATION: Industrial Min.

TYPE: Muscovite pegmatite

HOST ROCK

DOMINANT HOST ROCK: Metamorphic

STRATIGRAPHIC AGE

GROUP: Ingenika

FORMATION: Undefined Formation

LITHOLOGY: Pegmatite

Mica Schist

Gneiss

Quartzite

GEOLOGICAL SETTING

TECTONIC BELT: Omineca

PHYSIOGRAPHIC AREA: Omineca Mountains

TERRANE: Cassiar

METAMORPHIC TYPE: Regional

RELATIONSHIP: GRADE: Amphibolite

COMMENTS: Kyanite zone (Geological Survey of Canada Paper 75-33, Map 2-1975)

CAPSULE GEOLOGY

The Sunset mica occurrence is located on the southeast side of
Mount Henri, 80 kilometres north of Germansen Landing.
Hostrocks are pegmatites within mica schists, gneisses and
quartzites of the Hadrynian Ingenika Group which have been regionally
metamorphosed to the kyanite zone of the amphibolite facies. The
occurrence is described (Geological Survey of Canada Summary Report
1927, Part A, page 33A) as consisting of "small veins" composed
largely of quartz and muscovite, but no "marketable" mica was
observed in place on the property.
Refer to the Family Farm occurrence (094C 034) for further
details of these regionally occurring mica-bearing pegmatite
occurrences.

BIBLIOGRAPHY

EMPR AR *1926-153, 1927-C161
GSC P 75-33, p. 17
GSC MAP 2-1975
GSC SDM RPT *1927, Part A, pp. 31A-35A
GSC SC GEOL No. 19, pp. 83-90
EMR MP CORFILE "General Holding Company Limited"
CARMET RPT No. 701, pp. 78-80

DATE CODED: 920310
CODED BY: RHM
FIELD CHECK: N

DATE REVISED: 920310
REVISED BY: RHM
FIELD CHECK: N
MINFILE NUMBER: 103H 043

NAME(S): CAMPAIGN IS. MICA

STATUS: Showing
NTS MAP: 103H03W
LATITUDE: 53 03 42
LONGITUDE: 129 27 18
ELEVATION: 0010 Metres
LOCATION ACCURACY: Within 1 KM
COMMENTS: Description. Pre 1986 103H-G043.

COMMODITIES: Mica

MINERALS
SIGNIFICANT: Mica
MINERALIZATION AGE: Unknown
ISOTOPIC AGE: Unknown
DATING METHOD: Unknown
MATERIAL DATED: Unknown

DEPOSIT
CHARACTER: Vein
CLASSIFICATION: Pegmatite, Industrial Mica
TYPE: Muscovite pegmatite
SHAPE: Irregular
DIMENSION: 0020 Metres
COMMENTS: Average length of pegmatite bands.

HOST ROCK
DOMINANT HOST ROCK: Plutonic

STRATIGRAPHIC AGE
GROUP: Lower Cretaceous
FORMATION: 115 +/- 6 Ma
DATING METHOD: Potassium/Argon
MATERIAL DATED: Biotite
LITHOLOGY: Biotite Quartz Monzonite, Granodiorite

HOST ROCK COMMENTS:

GEOLGICAL SETTING
TECTONIC BELT: Coast Crystalline
TERRANE: Plutonic Rocks
METAMORPHIC TYPE: Regional
PHYSIOGRAPHIC AREA: Fiord Ranges (Northern)
GRADE: Amphibolite

CAPSULE GEOLOGY

The core of Campania Island consists of clean, massive medium to coarse-grained biotite quartz monzonite of the Coast Plutonic Complex. To the west of a northwest trending fault is granodiorite. Mica, resembling coarse muscovite crystals, occurs in 15 to 60 centimetre wide bands of coarse pegmatite within the quartz monzonite. These bands are irregular and discontinuous and are 7 to 30 metres in extent. Belts and streaky zones of fine crystalline mica, up to 100 metres length, are widely distributed in finer-textured pegmatites.

The coarser-grained mica constitutes about 10 to 25 per cent of the bands and the finer mica composes 25 to 50 per cent of the zones.

BIBLIOGRAPHY
EMPR AR *1930-67,68
GSC P *70-41, p. 40
GSC MAP 23-1970; 1385A

DATE CODED: 860801
DATE REVISED: 890803
CODED BY: LDJ
REVISED BY: LDJ

FIELD CHECK: N
FIELD CHECK: N
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 B10):

<table>
<thead>
<tr>
<th>Size</th>
<th>Per cent of Mica grade fraction raw feed (per cent)</th>
</tr>
</thead>
<tbody>
<tr>
<td>+100 mesh</td>
<td>77</td>
</tr>
<tr>
<td>-100 to +200</td>
<td>88</td>
</tr>
<tr>
<td>-200 mesh</td>
<td>68</td>
</tr>
</tbody>
</table>

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.
APPENDIX II

Japanese Importers of Mica
<table>
<thead>
<tr>
<th>DATA NUMBER</th>
<th>COMPANY NAME</th>
<th>INTERESTED ITEM</th>
<th>CONTACTS</th>
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</thead>
<tbody>
<tr>
<td>PID-1115580000</td>
<td>NIPPON RIIA KOGYOSHO CO., LTD.</td>
<td>Mica Paper, Mica Scrap</td>
<td>Att: Masao Toyoshima</td>
</tr>
<tr>
<td>1994.03.15</td>
<td></td>
<td>Polyester Film</td>
<td>Department Of Foreign Operation</td>
</tr>
<tr>
<td></td>
<td>Annual Sales(M. Yen): 3,406</td>
<td></td>
<td>1-20-6, Ooi, Shinagawa-ku, Tokyo 140, Japan</td>
</tr>
<tr>
<td></td>
<td>Staff: 170</td>
<td></td>
<td>FAX 03-3777-1319</td>
</tr>
<tr>
<td>PID-1123470000</td>
<td>MATSUSHITA TRADING CO., LTD.</td>
<td>Mica Cosmetic</td>
<td>Att: Haruyoshi Matsushita</td>
</tr>
<tr>
<td>1994.03.15</td>
<td></td>
<td></td>
<td>1-1-7, Kamata, Ohta-ku, Tokyo 144, Japan</td>
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<tr>
<td></td>
<td>Annual Sales(M. Yen): 89</td>
<td></td>
<td>FAX 03-3731-1019</td>
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<td></td>
<td>Staff: 5</td>
<td></td>
<td></td>
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<tr>
<td>PID-1131600000</td>
<td>M. WATANABE CO., LTD.</td>
<td>Mica (Crude) Quartz</td>
<td>Att: Noritaka Miyake</td>
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<td>1994.03.15</td>
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<td>Mineral Substances</td>
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<tr>
<td></td>
<td>Annual Sales(M. Yen): 12,000</td>
<td></td>
<td>4-2-16, Nihombashi Mum-onachi, Chuo-ku, Tokyo 103 Japan</td>
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<tr>
<td></td>
<td>Staff: 100</td>
<td></td>
<td>FAX 03-3241-9165</td>
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<tr>
<td>PID-1137930000</td>
<td>TAMAKI MICA CO., LTD.</td>
<td>Mica</td>
<td>Att: Toshiro Watanabe</td>
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<tr>
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<td>Annual Sales(M. Yen): 200</td>
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<td>1-20-5, Ginza, Chuo-ku, Tokyo 104, Japan</td>
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<td></td>
<td>Staff: 9</td>
<td></td>
<td>FAX 03-3563-0148</td>
</tr>
<tr>
<td>PID-1157040000</td>
<td>SHIOZAKI &amp; CO., LTD.</td>
<td>Mica</td>
<td>Att: Ichiro Nemoto</td>
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<td>1994.03.15</td>
<td></td>
<td></td>
<td>Trade Department</td>
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<tr>
<td></td>
<td>Annual Sales(M. Yen): N/A</td>
<td></td>
<td>3-10-2, Akasaka, Minato-ku, Tokyo 107, Japan</td>
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<td></td>
<td>Staff: N/A</td>
<td></td>
<td>FAX 03-3585-6806</td>
</tr>
</tbody>
</table>
APPENDIX III

Bibliography
BIBLIOGRAPHY

anon., 1993, "Imports of commodity by country," a publication of JETRO, December 1993, pp.176-177.
Ludwig, Saul, 1994, "Demand is strong, price hikes should stick," Modern Tire Dealer, April 1994, p.56.
APPENDIX IV

Suzorite Mica Specifications Sheet
Concentrated phlogopite mica, purposely not fully delaminated or purified for application where these properties are desirable.

**USES**

Drilling fluid additive - Used to prevent lost circulation in high performance drilling fluid formulations.

Asbestos substitutes - Used in friction products (e.g. brake linings, clutch plates).

Filtration aids.

Asphalt-based compounds and coatings - Used as moisture and oxygen barriers and reinforcements.

Asphalt-based roll-roofing and shingles - Used as an anti-stick agent.

Insulating heat shields.

**SPECIFICATION**

Screen Analysis

<table>
<thead>
<tr>
<th>U.S. Sieve</th>
<th>µM</th>
</tr>
</thead>
<tbody>
<tr>
<td>+20 mesh</td>
<td>&lt;1%</td>
</tr>
<tr>
<td>-20 +&lt;40 mesh</td>
<td>25-50%</td>
</tr>
<tr>
<td>-40 +70 mesh</td>
<td>25-40%</td>
</tr>
<tr>
<td>-70 mesh</td>
<td>10-45%</td>
</tr>
</tbody>
</table>

Bulk Density - 30-55 lb/ft³ (480-880 kg/m³) by Scott Volumeter method.

Moisture Content - <0.4%

**PARTICLE SIZE DISTRIBUTION**

Average Particle Size 48 Mesh - 320 µM
| **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. |

**FLAKE APPEARANCE**

![Pure Suzorite mica](image)

Electron Photo Micrography x500

**WARRANTY**

Seller warrants that this product meets the specifications listed on the product data sheet. Seller makes no other warranties express or implied with respect to this product or its use.

Produced by: SUZORITE MICA PRODUCTS INC.
Subsidiary of Corone Corporation

**CANADA & INTERNATIONAL**

1475 Graham Bell Street
Boucherville, Quebec J4B 8A1
(514) 655-2450
FAX: (514) 655-6842
TWX: SUZORITE MTL 05-267841
**DESCRIPTION**

Special phlogopite mica, medium-fine grade, treated to control defoliation of the mica crystals where this property is desirable. 25-Z Is 80 percent or more mica; 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. "Medium" grade (corresponds approximately to Baroid/Dresser "coarse" grades, and to N.A.M. "fine" grade).

Insulating and heat shields - In steel manufacture.

Decoration - For artificial marble or stone simulation products. These mica grades impart an attractive glimmering effect.

**SPECIFICATION**

Screen Analysis

<table>
<thead>
<tr>
<th>U.S. Sieve</th>
<th>%</th>
<th>μM</th>
</tr>
</thead>
<tbody>
<tr>
<td>+10 mesh</td>
<td>20-40%</td>
<td>+2mm</td>
</tr>
<tr>
<td>-10 +20 mesh</td>
<td>45-65%</td>
<td>-2mm +850</td>
</tr>
<tr>
<td>-20 mesh</td>
<td>5-25%</td>
<td>-850</td>
</tr>
</tbody>
</table>

Bulk Density - 40-60 lb/ft³ (560-960 kg/m³) by Scott Volumeter method.

Moisture Content - <0.4%

**PARTICLE SIZE DISTRIBUTION**

*Particle Size in Mesh (US Sieve) and Microns
Average Particle Size 15 Mesh - 1300 μM*
<table>
<thead>
<tr>
<th>PACKAGING</th>
<th>Shipped in 50-lb (25-kg), multi-ply paper bags in one ton lots on pallets (included as standard). Stretch wrap, supersacks, bulk and other options available at extra cost.</th>
</tr>
</thead>
<tbody>
<tr>
<td>SAFETY</td>
<td>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.</td>
</tr>
</tbody>
</table>

**FLAKE APPEARANCE**

![Pure Suzorite mica](image)

Electron Photo Micrography X500

**WARRANTY**

Sellers warrants that this product meets the specifications listed on the product data sheet. Seller makes no other warranties express or implied with respect to this product or its use.

Produced by: SUZORITE MICA PRODUCTS INC.
Subsidiary of Corona Corporation

CANADA & INTERNATIONAL
1475 Graham Bell Street
Boucherville, Quebec J4B 6A1
(314) 635-2450
FAX: (514) 655-8942
TWX: SUZORITE MTL 05-287641
DESCRIPTION
Special phlogopite mica, coarse grade, treated to control defoliation of the mica crystals where desirable. 15-Z is 80 percent or more mica; 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 mica - Raw material for high operating temperature electrical insulation.

U.S. SIEVE

<table>
<thead>
<tr>
<th>Screen Size</th>
<th>Percent</th>
</tr>
</thead>
<tbody>
<tr>
<td>¼&quot; 4 mesh</td>
<td>0 - 5%</td>
</tr>
<tr>
<td>¼&quot; 10 mesh</td>
<td>20 - 35%</td>
</tr>
<tr>
<td>50 - 75%</td>
<td></td>
</tr>
<tr>
<td>0 - 10%</td>
<td></td>
</tr>
</tbody>
</table>

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™ 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 EXPRESS OR IMPLIED WITH RESPECT TO THIS PRODUCT OR ITS USE.

Suzorite™ Mica Products, Inc.
1475 Graham Bell St., Boucherville (Quebec) J4B 6A1
Phone: (514) 655-2450, FAX: (514) 655-9942

Effective October 1, 1983
APPENDIX V

KMG Mica Specifications
MICRO-MICA

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, water proof and have outstanding dielectric and insulating characteristics. This combination of properties is not duplicated in any other known mineral. In a specialized high pressure air jet milling process, muscovite mica is reduced and delaminated into tiny pigment particles while maintaining an excellent diameter to thickness ratio. These delaminated, 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 hydrophylic properties, a low index of refraction and a variety of physical properties beneficial in a number of end uses.

Muscovite mica should not be confused with various other micaeous minerals which do not have the same basal cleavage and laminar 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, 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/Coatings

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 retention.

- 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.
- 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 TiO₂ and intensifies colored pigments.
- MICRO-MICA stays uniformly dispersed and is a hydrophyllic pigment suitable for formulation in aqueous and oleaginous 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 create 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.
Typical Properties

Screen Analysis

Micro-Mica C-1000
100.0% passing 100 mesh
97.5% min. passing 325 mesh
Avg. particle size 1 micron or less thick by 10-20
microns diameter

Micro-Mica C-3000
100.0% passing 100 mesh
97.0% min. passing 325 mesh
Avg. particle size 0.5 micron or less thick by 5-10
microns in diameter

Micro-Mica C-4000
100.0% passing 100 mesh
97.5% min. passing 325 mesh
Avg. particle size 0.5 micron or less thick by 1-5
microns in diameter

Physical Properties

Specific Gravity 2.62
Refractive Index 1.58
Apparent Density 12.00-
lbs./cu.ft.
Wet Bulking Value 14.00
gal./lb.
Surface Area - C-1000 4.48 m²/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 (SiO₂) 49.40%
Alumina (Al₂O₃) 33.15%
Potash (K₂O) 9.30%
Iron Oxide (Fe₂O₃) 2.10%
Calcium Oxide (CaO) 0.48%
Magnesia (MgO) 0.68%
Titanium Dioxide (TiO₂) 0.85%
Manganese (MnO) 0.02%
Sodium (Na₂O) 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 specific 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, and brick.

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 Mica 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-FEL exposure limits listed in the current
ACGIH guidelines.

Additional health and safety guidelines are contained in the Material
Safety Data Sheet, which is available upon request.
<table>
<thead>
<tr>
<th>Product</th>
<th>Mesh Size</th>
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<tbody>
<tr>
<td>C-4000</td>
<td>99.9% - 325</td>
</tr>
<tr>
<td>C-3000</td>
<td>99.6% - 325</td>
</tr>
<tr>
<td>WG 325</td>
<td>93.0% - 325</td>
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<tr>
<td>C-500</td>
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<tr>
<td>2300</td>
<td>93.0% - 325</td>
</tr>
</tbody>
</table>
WG 325

WG 325 is a finely ground high aspect ratio functional pigment consisting of wet ground pure muscovite mica. Unique functional, morphological, and mineralogical properties make WG 325 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 replacement, adhesives and cosmetics.

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 frictional wet milling process, muscovite mica is delaminated into pigment particles with a very high diameter to thickness ratio. Particle edges and surfaces are much smoother and cleaner than mica products produced by 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 hydrophobic 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 micaeous minerals which do not have the same basal cleavage and laminar 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 mica mechanically reinforces the 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 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 cracking and checking.
- The mica flakes serve as tool for relieving stress caused by progressive oxidation, polymerization and expansion of the substrate.
- WG 325 decreases blistering and reduces staining from the substrate in industrial primers.
- WG 325 improves the brushing and application characteristics of coatings and promotes improved adhesion to the substrate.
- WG 325 increases the opacity of white opaque pigments such as TiO₂ and intensifies colored pigments.
- WG 325 stays uniformly dispersed and is a hydrophilic 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 thermostet 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, chemical 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 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 in aqueous dispersions, help prevent sticking and mold adhesion. Additionally, mica can be compounded in rubber to reduce gas permeation and improve resiliency.

Foundry

Wet ground mica is used in the manufacture of various foundry core and mold release compounds, mold washes, and facing agents. Mica adds excellent sanding and surfacing properties to the finished casting.
Other Applications
The inert-chemical and laminar-physical 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, welding rods, spray mastics, lubricants, anti-seize compounds, cutting oils, wallboard joint cements, dry powder fire extinguishers, and grinding wheels.

Typical Properties

Screen Analysis

<table>
<thead>
<tr>
<th>100% passing 100 mesh</th>
<th>99% min. passing 200 mesh</th>
<th>90% min. passing 325 mesh</th>
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Physical Properties

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<td>Refractive Index</td>
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<tr>
<td>Apparent Density</td>
<td>&lt;12.00</td>
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<tr>
<td>Wet Bulking Value</td>
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<tr>
<td>Surface Area m²/g (BET)</td>
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<tr>
<td>Oili Absorption method</td>
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<tr>
<td>Hardness (Moh)</td>
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</tr>
<tr>
<td>pH</td>
<td>8</td>
</tr>
<tr>
<td>Moisture @100°C</td>
<td>&lt;0.20%</td>
</tr>
</tbody>
</table>

Chemical Properties

<table>
<thead>
<tr>
<th>Component</th>
<th>Percentage</th>
</tr>
</thead>
<tbody>
<tr>
<td>Loss on Ignition</td>
<td>4.80%</td>
</tr>
<tr>
<td>Silica (SiO₂)</td>
<td>48.40%</td>
</tr>
<tr>
<td>Alumina (Al₂O₃)</td>
<td>33.15%</td>
</tr>
<tr>
<td>Potash (K₂O)</td>
<td>9.30%</td>
</tr>
<tr>
<td>Iron Oxide (Fe₂O₃)</td>
<td>2.10%</td>
</tr>
<tr>
<td>Calcium Oxide (CaO)</td>
<td>0.48%</td>
</tr>
<tr>
<td>Magnesia (MgO)</td>
<td>0.68%</td>
</tr>
<tr>
<td>Titanium Dioxide (TiO₂)</td>
<td>0.85%</td>
</tr>
<tr>
<td>Manganese (MnO₂)</td>
<td>0.02%</td>
</tr>
<tr>
<td>Sodium (Na₂O)</td>
<td>0.45%</td>
</tr>
<tr>
<td>Phosphorous (P)</td>
<td>&lt;0.01%</td>
</tr>
<tr>
<td>Sulfur (S)</td>
<td>&lt;0.01%</td>
</tr>
</tbody>
</table>

Service and Support

KMG Minerals, Inc. is an integrated supplier that mines and produces the 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 specific 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 Mica 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.

Additional health and safety guidelines are contained in the Material Safety Data Sheet, which is available upon 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.

Information presented here is based on data believed to be reliable; however, no warranty or guarantee is made or expressed regarding the accuracy of the information or the use of the products. KMG Minerals offers the products in most