CONSULTANT'S REPORT

MARKET STUDY FOR BRITISH COLUMBIA MICA

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MARKET STUDY FOR BRITISH COLUMBIA MICA

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

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

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

Table I

Chemistry and Selected Properties of Various Micas

CHEMICAL CONSTITUENTS	% BY WEIGHT		
	MUSCOVITE	PHLOGOPITE	BIOTITE
SiO_2	46.5	40.0	37.0
Al_2O_3	34.0	17.0	18.0
K_2O	10.0	10.0	9.0
Na_2O	0.8	0.5	1.0
MgO	0.5	26.0	8.0
CaO	0.3	--	--
Fe_2O_3	2.5	0.2	2.0
FeO	1.0	2.8	21.0
Minor Elements	--	0.5	1.0
H_2O	4.5	3.0	3.0
Total	100.0	100.0	100.0
Properties			
Specific gravity	2.77-2.88	2.76-2.90	2.70-3.30
Mohs hardness	2.8-3.2	2.5-3.0	2.5-4.0
Shore hardness	80-150	70-100	--
Specific heat (at 25°C)	0.207	0.207	--
Volume resistivity (ohms/cm^3)	2×10^{13} - 1×10^{17}	less	--
Modulus of elasticity (Pa)	172×10^9	172×10^9	--
Compression strength (Pa)	221×10^6	221×10^6	--
Volume resistivity in ohms/cm^3 @ 25°C	5×10^{13}	--	--
Optical axial angle (2V)	38°-47°	0-10°	0-25°
Temperature of decomposition	400-500°C	850-1000°C	--
Dielectric constant	6.5-9.0	5.0-6.0	--
Linear coefficient of expansion x 10^{-6} cms/°C; range 20°-600°C	58-79	79-97	--
Coefficient of expansion per °C perpendicular to cleavage 20°-100°C (10^{-6})	15-25	$1\text{-}1 \times 10^{-3}$	--
Coefficient of expansion per °C parallel to cleavage 0°-200°C (10^{-6})	8-9	13-14.5	--
Tensile strength Pa x 10^6	225-297	255-297	--
Modulus of elasticity Pa x 10^9	172	172	--
Dielectric strength (0.025-0.030 mm thick) volts/cm x 10^6	2.4-11.2	1.7-0.8	--
Resistivity ohms-cm	10^{12}-10^{15}	10^{10}-10^{13}	--
Thermal conductivity perpendicular to cleavage @ 100°C (K cal/m^2/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.

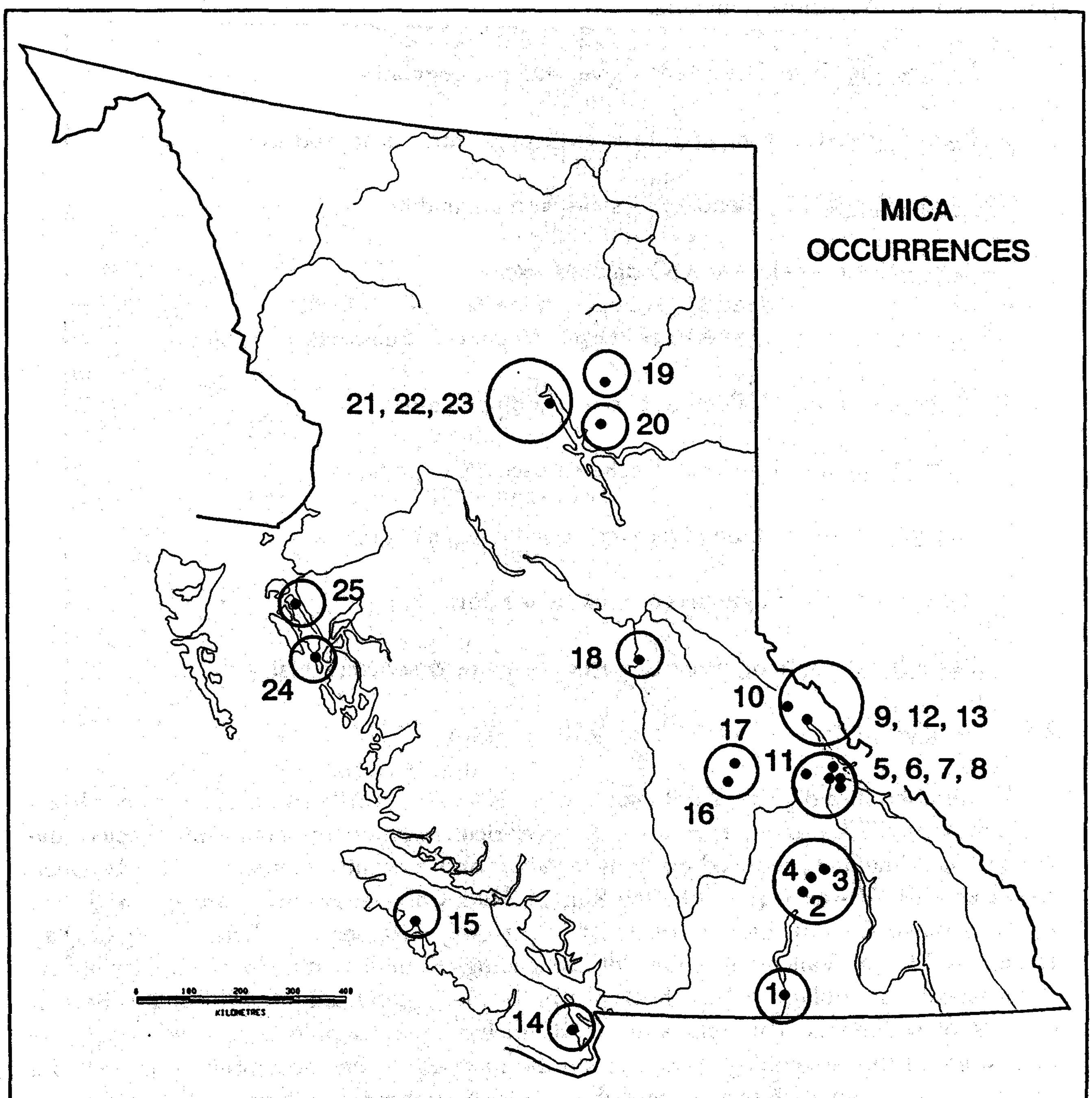
Reports of "commercial size" occurrences of muscovite in pegmatite dikes date back to as early as 1886 in the Provincial Minister of Mines Reports. J.W. McCammon compiled a list of 25 known B.C. mica deposits in 1979, as shown in 1. This had followed a broad exploration program carried out in the late 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. Minster of Mines Annual Report to have been 12,822,050 lbs. with a value of $185,818. In the last year of production, 1961, the 250,000 lbs. sold had a value of $8,025, which converts to 3.2 cents per pound, or $64 per tonne. The last recorded producing mine was at Cedarside, near Valemount, on the North Thompson River. It operated for only a year or two, shipping a few hundred tonnes to joint cement manufacturers. The ore was a muscovite-quartz schist that was dried, crushed, screened, and then air-separated to produce five sizes of mica. The owner was Georgian Mineral Industries Ltd. of Calgary. It is thought that this schist contains significant levels of biotite, an undesirable contaminant, which might have contributed to the early closure of the mine.

Figure 1



MICA
OCCURRENCES
21, 22, 23
19
20
25
24
18
10
9, 12, 13
17
11
5, 6, 7, 8
16
4
3
2
15
1
14
KILOMETRES

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

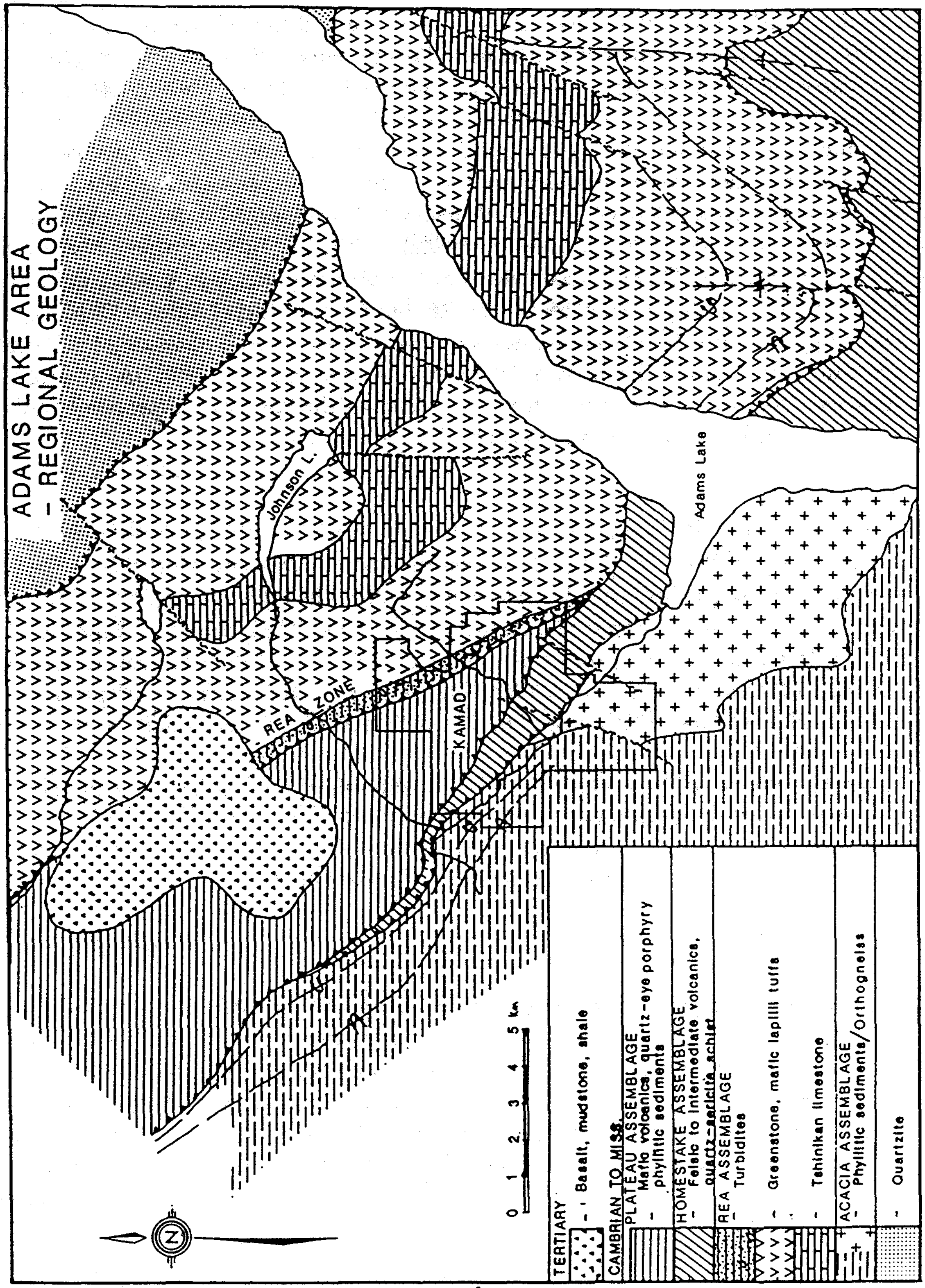
Rafferty - north of Blue River - muscovite schist

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).

Figure 2


ADAMS LAKE AREA
– REGIONAL GEOLOGY
Johnson L.
Adams Lake
REA ZONE
KAMAD
TERTIARY
Basalt, mudstone, shale
CAMBRIAN TO MISS.
PLATEAU ASSEMBLAGE
Mafic volcanics, quartz-eye porphyry
phyllitic sediments
HOMESTAKE ASSEMBLAGE
Felsic to intermediate volcanics,
quartz-sericite schist
REA ASSEMBLAGE
Turbidites
Greenstone, mafic lapilli tuffs
Tshinikan limestone
ACACIA ASSEMBLAGE
Phyllitic sediments/Orthogneiss
Quartzite
0 1 2 3 4 5 km

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.[1] 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 Glimmermahleverk also operates a 1,500-t.p.a. grinding plant. West Germany imports over 5,000 t.p.a. of scrap mica from China, India and Brazil. It also imports 500 t.p.a. of ground mica from France and Belgium. Naintsche GmbH, and Merck (Germany) have entered the pearlescent pigment market and use mica in their paint formulations.

3.1.7 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.[2] Japan Mica Industrial Co. Ltd. is the largest mica processor, using blocks, splittings

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[3]. 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.[4]

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3 Industrial Minerals, May 1994

4 industrial Specialities News, December 26, 1994

Table II

End Use For Suzorite Mica (1991)

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

Source: Canadian Mining Journal

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

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

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

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

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

Table III

Canadian Mica (1991)

TONNES	DESTINATION
13,920	U.S.
4,560	Canada
4,320	Asia
1,200	Europe
24,000	TOTAL

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)

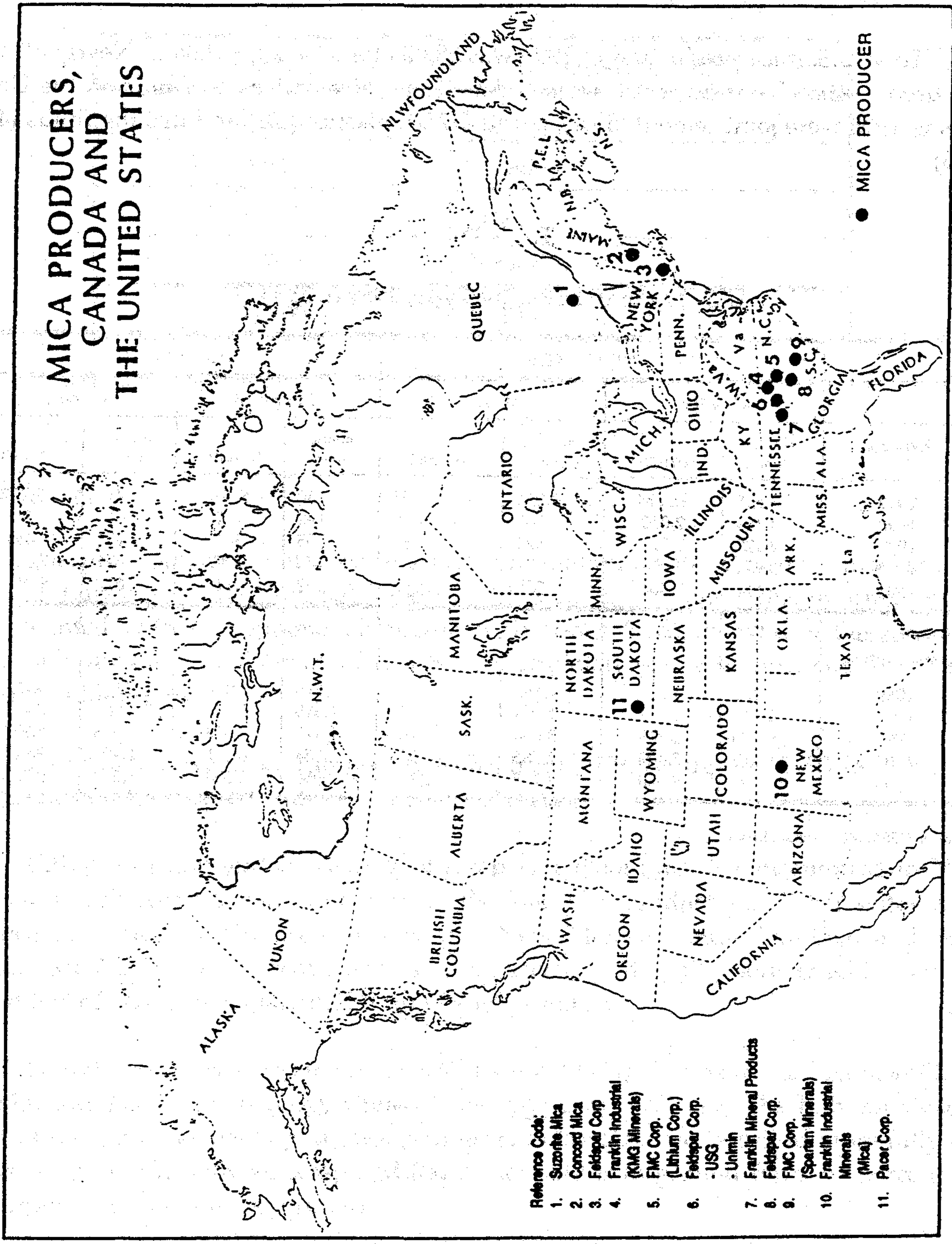
Table IV

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

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

Source: USBM Mica Annual Report

Figure 3



MICA PRODUCERS, CANADA AND THE UNITED STATES
● MICA PRODUCER
Reference Code:
1. Suzorite Mica
2. Concord Mica
3. Feldspar Corp
4. Franklin Industrial (KMG Minerals)
5. FMC Corp. (Lithium Corp.)
6. Feldspar Corp. - USG - Unimin
7. Franklin Mineral Products
8. Feldspar Corp.
9. FMC Corp. (Spartan Minerals)
10. Franklin Industrial Minerals (Mica)
11. Pacer Corp.
ALASKA
YUKON
N.W.T.
BRITISH COLUMBIA
ALBERTA
SASK.
MANITOBA
ONTARIO
QUEBEC
NEWFOUNDLAND
P.E.I.
N.B.
N.S.
MAINE
WASH.
OREGON
CALIFORNIA
NEVADA
IDAHO
MONTANA
WYOMING
UTAH
ARIZONA
COLORADO
NEW MEXICO
NORTH DAKOTA
SOUTH DAKOTA
NEBRASKA
KANSAS
OKLA.
TEXAS
MINN.
IOWA
MISSOURI
ARK.
La
WISC.
ILLINOIS
MICH.
IND.
OHIO
KY
TENNESSEE
MISS.
ALA.
GEORGIA
FLORIDA
S.C.
N.C.
Va
W.Va
PENN.
NEW YORK

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)

	1992			1993		
	Quantity	Value	Unit value[2]	Quantity	Value	Unit value[2]
End use:						
Joint cement	43	6,819	157	49	7,549	155
Paint	16	5,227	323	16	5,416	348
Plastics	4	1,347	357	4	1,647	396
Well-drilling mud	2	281	123	4	560	209
Other[3]	19	8,082	432	19	11,814	616
Total	84	[4]21,755	258	92	26,986	293
Method of grinding:						
Dry	W	W	168	W	W	152
Wet	W	W	745	W	W	838

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,[5] 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[6] (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

Statistics						
	1989	1990	1991	1992	1993	1994*
World Production (tonnes)	228,000	214,000	207,000	200,000	180,000	190,000
U.S. Production of Scrap & Flake Mica (tonnes)	119,000	109,000	103,000	85,000	88,000	96,000
As Mined Production Value: (million dollars)	6.27	5.84	5.54	4.64	4.45	4.90

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, capacitators, 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:

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

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

4.5 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 valcanizing compounds. The main application for mica in rubber is as a dusting agent in the production of rubber tires. Mica, however, has only a small share of the rubber market as less expensive minerals such as kaolin, and carbon black are more extensively used. In the rubber industry, mica is normally wet-ground to a mesh size of between 160 and 325-mesh. Dry-ground powder is used as the dusting agent. This consumption appears to grow in accordance with the tire industry. However, consolidation within the industry and discontinued use by large firms such as Goodyear and Bridgestone appear to threaten this tradition.

4.6 Amphiboles Substitute Products

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

4.7 Other End Uses

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

WELDING RODS	Dry-ground 50-mesh mica is used in the flux coating of arc welding electrodes.
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.[7] 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 ultra-violet rays and rain with no detrimental effect on other paint properties.

In 1988, world sales of paint reportedly hit 19.1 million tonnes.[8] 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[9] 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.[10] 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

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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.[13] 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

[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) and POLYBUTYLENE TEREPHTHATE (PBT)

As already stated earlier polyethylene fibres are 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.[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.[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.[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.[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).

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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 filed 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.

Mitshubishi 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 PBT's marketed under the name"Valox".

Celanese Corporation - produces mica-filled PBT's.

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

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.[20] In recent years there has been a lot of consolidation and rationalisation, resulting in mergers and takeovers. There have been six large mergers or takeovers, each involving an overseas producer purchasing an American producer to secure their position in the American market (which represents half the world tire production).

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

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

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[20] Roskill

Table VII

Tire Production Statistics

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

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.[21] 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.

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

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

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

Table IX

Construction: Trends and Projections, 1990-94

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

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

* estimate
** forecast

One can look at the forecast for gypsum wallboard products also. In 1993 sales rose to 20.5 billion square feet, an increase of 2 percent over the previous year. Gypsum sales are expected to increase to 21 billion square feet, an increase of 1.5 percent for 1994. Gypsum sales are on a modest recovery path after the recession in 1991 and a boom year in 1992 (15 per cent adjusted value growth).[22] 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

[22]Manufacturing USA, 1994

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

Housing Starts in Canada

YEAR	CANADA	% OF INCREASE	B.C.	% OF INCREASE
1992	156,197	-	31,875	
1993	155,443	.5	42,807	+32
1994	156,900	+1	38,800	-10

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.[25] 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

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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.[26] 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).[27] 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.[28] 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

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[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.[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).[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,

29 Roskill, 1991

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.[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[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.

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31 Industrial Minerals, January, 1994

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 manufactures could be a potential market for BC mica if the quality and specifications are acceptable.

5.7.2 Plastic/Resins

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

5.7.3 Oil Well Drilling Muds

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

5.7.4 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 (ie: minimal regional flexibility).

Table XI

Joint Cement Consumption Estimate

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

Source: Market Survey

5.7.6 Other End Users

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

5.7.7 Summary of Mica Demand

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

Table XII

Summary Of Mica Demand In The U.S.

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

Source: Davis 1993

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

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

Table XIII

Pacific Northwest Mica Consumption
tonnes 1994

	B.C.	ALBERTA	WASHINGTON/ OREGON	TOTAL
Joint Cement	-	200	575	775
Oil Well Drilling Mud	-	200	-	200
Paints/Coatings/Plastics	40-60	-	150-200	190/260
Total:	40-60	400	725-775	1,165-1,235

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

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

Source: Industrial Mineral Journal, Nov. 1994
and Roskill

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

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APPENDIX I

B.C. MEMPR Mica "Minfile" Data

MINFILE NUMBER INDEX

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

MINFILE Number	Name	Commodities	Status	NTS Map	Latitude/Longitude		UTM/Northing/Easting		
082ESW127	SHUTTLEWORTH CREEK	AB MI VM	PAPR	082E06W	49 19 06	119 29 24	11	5465608	319041
082FNE110	HELLROARING CREEK	FD MI BE GS	DEPR	082F09E	49 34 00	116 10 29	11	5490561	559677
082LNE002	MOUNT GRIFFIN	MI	SHOW	082L15E	50 55 55	118 33 40	11	5643200	390300
082LNW068	ELMER	MI	SHOW	082L11E	50 35 06	119 12 12	11	5605776	344020
082LSE006	LUMBY (CHAPUT)	AU GT MI AG PB ZN CU	PAPR	082L07W	50 15 53	118 56 24	11	5569645	361731
082LSE048	CHERRYVILLE	MI	SHOW	082L07E	50 16 10	118 37 42	11	5569650	383950
082LSW064	BRETT-BIRD	MI UR	PROS	082L06E	50 28 45	119 06 19	11	5593800	350630
082M 080	STANMACK	AU AG WO MI	SHOW	082M09W	51 42 20	118 26 00	11	5729044	400955
082M 168	YELLOW CREEK	MI BE KY	SHOW	082M16W	51 59 20	118 22 00	11	5760466	406153
082M 175	KINBASKET LAKE	GN KY MI	SHOW	082M16E	51 57 20	118 01 00	11	5756365	430134
082M 180	BIG BEND	MI	SHOW	082M15E	51 49 30	118 30 30	11	5742432	396048
083D 007	YELLOW CREEK	KY MI BE	SHOW	083D01W	52 00 05	118 18 40	11	5761800	410000
083D 012	CANOE NORTH MICA	MI	PAPR	083D14W	52 45 35	119 17 36	11	5847800	345250
083D 017	CANOE SOUTH MICA	MI	PAPR	083D11W	52 43 55	119 17 17	11	5844700	345500
083D 018	ALBREDA	MI KY	SHOW	083D11E	52 40 16	119 13 25	11	5837800	349650
083D 019	MICA MOUNTAIN	MI KY BE	SHOW	083D13E	52 53 56	119 32 43	11	5863850	328800
083D 020	HIGHWAY DEPOSIT LOWER SHOWING	MI KY	SHOW	083D02E	52 01 34	118 34 16	11	5764900	392200
083D 030	NORTH BLUE RIVER	MI	SHOW	083D03W	52 07 00	119 23 00	11	5776475	336814
083D 032	RAFFERTY	MI	PROS	083D11W	52 31 00	119 25 00	11	5821033	336018
092B 028	ROSE	MI SK	SHOW	092B13W	48 53 02	123 48 47	10	5414650	440400
092HNW067	COQUIHALLA	FD SI MI	SHOW	092H11E	49 36 27	121 02 42	10	5496600	641250
092L 277	MICA	SK MI SI	PROS	092L03E	50 03 30	127 06 12	09	5546620	635764
093A 083	MICA MOUNTAIN	MI	PROS	093A01W	52 08 03	120 26 31	10	5778829	675078
093G 047	HIXON MICA	MI	SHOW	093G08W	53 26 37	122 29 25	10	5921524	533857
093J 022	CARP LAKE	MI	SHOW	093J14E	54 47 53	123 11 41	10	6072121	487480
093K 094	CASEY PEGMATITE	FD MI SI	SHOW	093K03E	54 03 30	125 02 10	10	5991713	366724
093N 189	WOLVERINE RANGE	MI FD	SHOW	093N09W	55 43 53	124 19 21	10	6176750	416950
093O 022	FALLS	MI	SHOW	093O11W	55 40 53	123 26 29	10	6170500	472250
094C 034	FAMILY FARM	MI GS	PAPR	094C10E	56 33 19	124 43 57	10	6269000	393500
094C 035	WEST MICA MOUNTAIN	MI GS	PROS	094C10W	56 31 52	124 46 43	10	6266400	390600
094C 036	RAVENAL	MI GS	SHOW	094C07E	56 29 49	124 43 24	10	6262500	393900
094C 037	RUBY CREEK	MI	SHOW	094C07E	56 26 01	124 40 48	10	6255400	396400
094C 092	JACKPINE	MI SI FD	SHOW	094C06W	56 21 22	125 21 46	10	6248000	354000
094C 124	BIRTHDAY	MI	SHOW	094C07W	56 28 52	124 45 30	10	6260800	391700
094C 125	CARIBOU	MI	SHOW	094C10E	56 30 34	124 39 15	10	6263800	398200
094C 126	SUNSET	MI	SHOW	094C07E	56 29 25	124 40 51	10	6261700	396500
103H 043	CAMPANIA IS. MICA	MI	SHOW	103H03W	53 03 42	129 27 18	09	5879000	469500
103H 044	BAKER INLET	MI	PAPR	103H13W	53 49 20	129 54 00	09	5963901	440752

TOTAL NUMBER OF OCCURRENCE(S): 38

* Contains 8 or more commodities

MINFILE NUMBER: **082ESW127** NATIONAL MINERAL INVENTORY:

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

STATUS: Past Producer Open Pit MINING DIVISION: Osoyoos
NTS MAP: 082E06W UTM ZONE: 11
LATITUDE: 49 19 06 NORTHING: 5465608
LONGITUDE: 119 29 24 EASTING: 319041
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 Biotite Vermiculite
ASSOCIATED: Olivine Amphibole Serpentine Magnetite Talc Enstatite
ALTERATION: Amphibole Serpentine Talc
ALTERATION TYPE: Serpentin'zn Talc
MINERALIZATION AGE: Unknown

DEPOSIT
CHARACTER: Vein Stockwork Discordant
CLASSIFICATION: Metamorphic Hydrothermal Epigenetic Industrial Min.
TYPE: Asbestos
SHAPE: Bladed
DIMENSION: 800 x 200 x 30 Metres STRIKE/DIP: TREND/PLUNGE:
COMMENTS: Dimensions for dunite mass.

HOST ROCK
DOMINANT HOST ROCK: Plutonic

STRATIGRAPHIC AGE	GROUP	FORMATION	IGNEOUS/METAMORPHIC/OTHER
Eocene			Okanagan Gneiss

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 PHYSIOGRAPHIC AREA: Okanagan Highland
TERRANE: Undivided Metamorphic Assembl.
METAMORPHIC TYPE: Regional RELATIONSHIP: 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 serpentine and magnetite. The amphibole is in turn partly altered to talc. A few patches and irregular veinlets of enstatite 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):

SiO_2	57.50
Al_2O_2	0.36
Cr_2O_3	0.03
Fe_2O_3	1.10
FeO	5.69
MnO	0.25
MgO	29.21
CaO	2.24
H_2O+	3.60
H_2O-	0.22

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.

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EMPR ASS RPT 17354
GSC SUM RPT 1910, pp. 117, 118
GSC MAP 15-1961; 538A; 1736A
GSC OF 481; 1969

DATE CODED: 850724 CODED BY: GSB FIELD CHECK: N
DATE REVISED: 910528 REVISED BY: PSF FIELD CHECK: N

MINFILE NUMBER: **082FNE110** NATIONAL MINERAL INVENTORY: 082F9 Gem1

NAME(S): **HELLROARING CREEK**, LINDA, LINDA 1

STATUS: Developed Prospect MINING DIVISION: Fort Steele
NTS MAP: 082F09E UTM ZONE: 11
LATITUDE: 49 34 00 NORTHING: 5490561
LONGITUDE: 116 10 29 EASTING: 559677
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 Tourmaline Garnet
ASSOCIATED: Quartz Pyrite Pyrrhotite Galena Arsenopyrite
COMMENTS: Trace pyrite, pyrrhotite, galena and arsenopyrite.
MINERALIZATION AGE: Middle Proterozoic

DEPOSIT
CHARACTER: Massive Disseminated
CLASSIFICATION: Pegmatite Magmatic Syngenetic Industrial Min.
TYPE: Rare element pegmatite - LCT family Muscovite pegmatite Ceramic pegmatite
DIMENSION: 4000 x 1500 Metres STRIKE/DIP: TREND/PLUNGE:
COMMENTS: Pegmatite stock.

HOST ROCK
DOMINANT HOST ROCK: Plutonic

STRATIGRAPHIC AGE	GROUP	FORMATION	IGNEOUS/METAMORPHIC/OTHER
Helikian	Purcell	Aldridge	
Helikian	Purcell	Creston	
Proterozoic			Moyie Intrusions

LITHOLOGY: Medium Grained Pegmatite
Granodiorite Sill
Granodiorite Dike
Argillite
Quartzite
Mica Schist

HOST ROCK COMMENTS: Pegmatite of the Middle Proterozoic Hellroaring Creek stock.

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

INVENTORY

ORE ZONE: NORTH

CATEGORY: Indicated YEAR: 1965
QUANTITY: 450000 Tonnes

COMMODITY	GRADE
Beryllium	0.1000 Per cent

COMMENTS: Grade given for beryllium oxide.
REFERENCE: Assessment Report 13415, page 21.

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-northwest for 4 kilometres within the Aldrige Formation and is up to 1.5 kilometres wide. The stock appears to be a series of large dyke swarms. Most of the

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

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

SiO_2	64.86 to 76.72
Al_2O_3	12.61 to 19.00
K_2O	0.45 to 12.45
Na_2O	1.95 to 6.44
CaO	0.05 to 0.64
Fe_2O_3	0.05 to 4.24

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

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

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GSC P 60-21, p. 12
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N MINER Aug. 30, 1984
CJES *Vol. 8, 1971, pp. 85-95 (Ryan, B.D. and Blenkinsop, J. (1971): Geology and Geochronology of the Hellroaring Creek Stock, British Columbia)

DATE CODED: 850724 CODED BY: GSB FIELD CHECK: N
DATE REVISED: 910322 REVISED BY: PSF FIELD CHECK: N

MINFILE NUMBER: **082LNE002**   NATIONAL MINERAL INVENTORY:

NAME(S): **MOUNT GRIFFIN**

STATUS: Showing   MINING DIVISION: Revelstoke
NTS MAP: 082L15E   UTM ZONE: 11
LATITUDE: 50 55 55   NORTHING: 5643200
LONGITUDE: 118 33 40   EASTING: 390300
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   Industrial Min.
TYPE: Muscovite pegmatite

HOST ROCK
DOMINANT HOST ROCK: Plutonic

STRATIGRAPHIC AGE	GROUP	FORMATION	IGNEOUS/METAMORPHIC/OTHER
Proterozoic-Paleoz.			Shuswap Metamorphic Complex

LITHOLOGY: Pegmatite
Granitic Gneiss
Para Gneiss
Ortho Gneiss
Garnet Sillimanite Schist
Amphibolite
Marble
Quartzite

GEOLOGICAL SETTING
TECTONIC BELT: Omineca   PHYSIOGRAPHIC AREA: Shuswap Highland
TERRANE: Kootenay
METAMORPHIC TYPE: Regional   RELATIONSHIP: 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.

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

DATE CODED: 940110   CODED BY: GO   FIELD CHECK: N
DATE REVISED: 940110   REVISED BY: GO   FIELD CHECK: N

MINFILE NUMBER: **082LNW068** NATIONAL MINERAL INVENTORY:

NAME(S): **ELMER**

STATUS: Showing
NTS MAP: 082L11E
LATITUDE: 50 35 06
LONGITUDE: 119 12 12
ELEVATION: 0609 Metres
LOCATION ACCURACY: Within 1 KM
COMMENTS: Located south of Gardom Lake, about 6 kilometres north-northwest of the community of Enderby (GSC Open File 637 (Occurrence 213)).

MINING DIVISION: Vernon
UTM ZONE: 11
NORTHING: 5605776
EASTING: 344020

COMMODITIES: Mica

MINERALS
SIGNIFICANT: Mica
MINERALIZATION AGE:

DEPOSIT
CHARACTER: Disseminated
CLASSIFICATION: Metamorphic Industrial Min.
TYPE: METAMORPHIC HOSTED

HOST ROCK
DOMINANT HOST ROCK: Metamorphic

STRATIGRAPHIC AGE	GROUP	FORMATION	IGNEOUS/METAMORPHIC/OTHER
Proterozoic-Paleoz.	Mount Ida	Silver Creek	

LITHOLOGY: Micaceous Schist
Pelitic Schist
Quartzite
Micaceous Quartzite
Calcareous Quartzite

GEOLOGICAL SETTING
TECTONIC BELT: Omineca
TERRANE: Kootenay
METAMORPHIC TYPE: Regional RELATIONSHIP: GRADE:
PHYSIOGRAPHIC AREA: Shuswap Highland

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 296) 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).

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GSC MAP 1059A
CJES Vol.21 (Oct.1984), pp. 1171-1193

DATE CODED: 850724 CODED BY: GSB FIELD CHECK: N
DATE REVISED: 950511 REVISED BY: GO FIELD CHECK: N

MINFILE NUMBER: **082LSE006** NATIONAL MINERAL INVENTORY: 082L7 Au1

NAME(S): **LUMBY (CHAPUT)**, BS 2, B.S. 2,
LUMBY, CHAPUT, CHAPUT MINE,
LUM, P.S., B.S.,
M.M., QUIN, TEACHER,
MINE

STATUS: Past Producer   Underground   MINING DIVISION: Vernon
NTS MAP: 082L07W   UTM ZONE: 11
LATITUDE: 50 15 53   NORTHING: 5569645
LONGITUDE: 118 56 24   EASTING: 361731
ELEVATION: 0722 Metres
LOCATION ACCURACY: Within 500M
COMMENTS: Plateau zone is 2.25 kilometres north-northeast of the community of Lumby, east of Bessette Creek, 4.25 kilometres west of Rawlings Lake (Assessment Report 14469).

COMMODITIES: Gold   Graphite   Mica   Silver   Lead
Zinc   Copper

MINERALS
SIGNIFICANT: Pyrite   Graphite   Galena   Sphalerite   Tetrahedrite
Chalcopyrite   Argentite   Pyrrhotite
ASSOCIATED: Quartz
ALTERATION: Graphite   Muscovite   Sericite   Chlorite   Clay
Biotite
COMMENTS: Biotite hornfels.
ALTERATION TYPE: Argillic   Propylitic
MINERALIZATION AGE: Unknown

DEPOSIT
CHARACTER: Vein   Breccia   Shear
CLASSIFICATION: Hydrothermal   Mesothermal   Epigenetic   Industrial Min.
TYPE: Polymetallic veins Ag-Pb-Zn   Gold-quartz veins
SHAPE: Bladed
MODIFIER: Fractured   Sheared
DIMENSION: 150 x 46 Metres   STRIKE/DIP: 110/40   TREND/PLUNGE:
COMMENTS: Plateau zone mineralization.

HOST ROCK
DOMINANT HOST ROCK: Sedimentary

STRATIGRAPHIC AGE	GROUP	FORMATION	IGNEOUS/METAMORPHIC/OTHER
Triassic-Jurassic	Nicola	Undefined Formation	
Jurassic			Nelson Intrusions

LITHOLOGY: Argillite
Lapilli Ash Tuff
Feldspar Crystal Tuff
Phyllite
Siltstone
Granodiorite

GEOLOGICAL SETTING
TECTONIC BELT: Omineca   PHYSIOGRAPHIC AREA: Shuswap Highland
TERRANE: Quesnel

INVENTORY

ORE ZONE: PLATEAU

CATEGORY: Indicated   YEAR: 1993
QUANTITY: 500000 Tonnes

COMMODITY	GRADE
Gold	4.5000 Grams per tonne

COMMENTS: Estimated reserves.
REFERENCE: Information Circular 1993-13, page 11.

ORE ZONE: PLATEAU

CATEGORY: Unclassified   YEAR: 1994
QUANTITY: 27000000 Tonnes

COMMODITY	GRADE
Graphite	100.0000 Per cent
Mica	100.0000 Per cent

COMMENTS: Grades of graphite and mica are unknown.
REFERENCE: Information Circular 1994-19, page 16.

CAPSULE GEOLOGY

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

CAPSULE GEOLOGY

of Lumby.

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

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

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

The Chaput mine, at the western end of the Plateau shear zone, contains silver-lead-zinc mineralization associated with a system of quartz-sulphide veins arranged in a step-like pattern. The quartz veins occur in z-shaped dragfolds on the south limb of the west-northwest trending anticline. The veins are hosted in argillites that are bounded by felsic to intermediate lapilli and ash tuff. The veins, 0.3 to 1.5 metres wide, occur in a zone which strikes 110 to 120 degrees and dips south. The veins pinch and swell along strike and downdip. The best grades occur near the flat portions of the flexures. The sulphides are fine to medium grained and are intergrown with milky white and grey quartz. Sulphides comprise galena, sphalerite, pyrite, tetrahedrite, pyrrhotite, chalcopyrite and argentite. Chlorite, sericite and clay minerals are typical wallrock alteration minerals. Most mineralization in the Chaput mine is reported to occur below 600 metres (ASL) elevation. 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-grained disseminated to locally massive pyrite, minor pyrrhotite and chalcopyrite. Sphalerite and galena are generally rare, but carry sporadic silver values. In many parts of the zone the breccia matrix contains a significant amount of carbonaceous (graphitic) material, where many of the highest gold values have been reported. Two mineralized sub-zones (Hangingwall, Footwall) within the Plateau zone have been outlined.

CAPSULE GEOLOGY

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

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

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

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

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GSC MAP 1059A; 7216G; 8502G
EMR MP CORPFILE (Alberta Gypsum Ltd.)
CANMET IR 72-5
GCNL #140, July 18, 1977; #72,#115, 1984; #1,#165,#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 FIELD CHECK: N
DATE REVISED: 941214 REVISED BY: DEJ FIELD CHECK: N

MINFILE NUMBER: 082LSE006 NAME: LUMBY (CHAPUT) STATUS: Past Producer

Production Year	Tonnes Mined	Tonnes Milled	Commodity	Grams Recovered	Kilograms Recovered
1976	454	454	Silver	206,057	
			Gold	156	
			Copper		654
			Lead		12,746
			Zinc		5,485
1973		5	Silver	8,149	
			Lead		216
			Zinc		196
1969	1,240	1,235	Silver	921,271	
			Gold	840	
			Lead		44,104
			Zinc		35,970
1968	297	297	Silver	561,813	
			Gold	218	
			Lead		15,151
			Zinc		9,196

SUMMARY TOTALS: 082LSE006 NAME: LUMBY (CHAPUT)

	Metric		Imperial	
Mined:	1,991	tonnes	2,195	tons
Milled:	1,991	tonnes	2,195	tons
Recovery:				
Silver:	1,697,290	grams	54,569	ounces
Gold:	1,214	grams	39	ounces
Copper:	654	kilograms	1,442	pounds
Lead:	72,217	kilograms	159,211	pounds
Zinc:	50,847	kilograms	112,098	pounds

Comments:

1976: Pb concentrate - 41 tonnes.
1973: Mill salvage - 5 tonnes.
1969: Crude ore - 777 tonnes; Pb and Fe concentrate - 59 tonnes.

MINFILE NUMBER: **082LSE048**
NATIONAL MINERAL INVENTORY:

NAME(S): **CHERRYVILLE**

STATUS: Showing
NTS MAP: 082L07E
LATITUDE: 50 16 10
LONGITUDE: 118 37 42
ELEVATION: 0800 Metres
LOCATION ACCURACY: Within 5 KM
COMMENTS: Approximate location of an "interesting" mica showing (Minister of Mines Annual Report 1932, page A144).

MINING DIVISION: Vernon
UTM ZONE: 11
NORTHING: 5569650
EASTING: 383950

COMMODITIES: Mica

MINERALS
SIGNIFICANT: Mica
MINERALIZATION AGE: Unknown

DEPOSIT
CHARACTER: Unknown
CLASSIFICATION: Industrial Min.

HOST ROCK
DOMINANT HOST ROCK: Metamorphic

STRATIGRAPHIC AGE	GROUP	FORMATION	IGNEOUS/METAMORPHIC/OTHER
Proterozoic-Paleoz.			Kootenay Assemblage

LITHOLOGY: Gneiss

GEOLOGICAL SETTING
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.

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EMPR OF 1990-30
GSC MAP 7216G; 8502G
GSC OF 637
GSC MEM 296

DATE CODED: 850724
DATE REVISED: 941220
CODED BY: GSB
REVISED BY: DEJ
FIELD CHECK: N
FIELD CHECK: N

MINFILE NUMBER: **082LSW064** NATIONAL MINERAL INVENTORY:

NAME(S): **BRETT-BIRD**, BIRD, BRETT,
ARMSTRONG MICA

STATUS: Prospect MINING DIVISION: Vernon
NTS MAP: 082L06E UTM ZONE: 11
LATITUDE: 50 28 45 NORTHING: 5593800
LONGITUDE: 119 06 19 EASTING: 350630
ELEVATION: 490 Metres
LOCATION ACCURACY: Within 500M
COMMENTS: Adit (Minister of Mines Annual Report 1950, page 226).

COMMODITIES: Mica Uranium

MINERALS
SIGNIFICANT: Muscovite Uraninite
COMMENTS: Radioactive mineral is possibly uraninite. A "few grains" present.
ASSOCIATED: Oligoclase Orthoclase Quartz
MINERALIZATION AGE: Mesozoic-Cenozoic

DEPOSIT
CHARACTER: Disseminated
CLASSIFICATION: Pegmatite Industrial Min.
TYPE: Muscovite pegmatite
SHAPE: Irregular

HOST ROCK
DOMINANT HOST ROCK: Plutonic

STRATIGRAPHIC AGE	GROUP	FORMATION	IGNEOUS/METAMORPHIC/OTHER
Proterozoic	Unnamed/Unknown Group	Silver Creek	
Mesozoic-Cenozoic			Unnamed/Unknown Informal

LITHOLOGY: Pegmatite
Quartz Biotite Schist

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

GEOLOGICAL SETTING
TECTONIC BELT: Omineca PHYSIOGRAPHIC AREA: Shuswap Highland
TERRANE: Plutonic Rocks Kootenay
METAMORPHIC TYPE: Regional RELATIONSHIP: Pre-mineralization GRADE: Greenschist
COMMENTS: The Silver Creek Formation is regionally metamorphosed.

CAPSULE GEOLOGY

The Brett-Bird showing is located 7 kilometres east-northeast of Armstrong, near Sneesby Creek.

This area, east of the Okanagan Valley fault, is underlain by metamorphic rocks of unknown age, metasedimentary rocks of the Proterozoic Silver Creek Formation and volcanic and sedimentary rocks of the Cambro-Ordovician Tsalkom Formation. All these units are probably in low-angle fault contact with each other. Intruding these rocks are Middle Jurassic granitic plutons. Pegmatite bodies of Mesozoic or Cenozoic age intrude the Silver Creek. Eocene Kamloops Group volcanic rocks occur to the north.

Quartz biotite schist of the Silver Creek is intruded by irregular, sheet-like bodies of oligoclase, orthoclase, quartz and muscovite pegmatite. Fresh greenish-tinged muscovite occurs disseminated and in patches throughout the pegmatite, with the grain size of the mica varying with the grain size of the other minerals. Muscovite plates range in size from 1 millimetre to 15 by 25 centimetres in size. In a coarse-grained section of the pegmatite, patches of muscovite, 30 by 60 centimetres in size, cover up to 5 or 10 per cent of the exposure. A few grains of radioactive mineral, possibly uraninite, occur in the pegmatite.

The first record of exploration is from 1927 when an open cut exposed muscovite plates. By 1950, a 10-metre adit and the three main open cuts had been completed. Approximately 100 tonnes of mica were shipped between 1932 and 1950.

BIBLIOGRAPHY

EMPR AR 1927-photo(following p. 192),*213; 1932-144; *1950-226,227; 1958-66
EMPR ASS RPT 49
EMPR OF 1989-5, 1990-30, 1990-32
EMPR MAP 7216G, 8513G
EMPR RGS 1976
EMPR FIELDWORK 1987, pp. B15-22, 55-58; 1988, pp. 355-363
EMPR PF (In 082LSW General - Claim Map, 1966)

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

DATE CODED: 850724 CODED BY: GSB FIELD CHECK: N
DATE REVISED: 930331 REVISED BY: DISC FIELD CHECK: N

MINFILE NUMBER: **082LSW064** NAME: **BRETT-BIRD** STATUS: Prospect

Production Year	Tonnes Mined	Tonnes Milled	Commodity	Grams Recovered	Kilograms Recovered
1950	1		Mica		1,000

SUMMARY TOTALS: 082LSW064 NAME: BRETT-BIRD

		Metric		Imperial	
	Mined:	1	tonnes	1	tons
	Milled:		tonnes		tons
Recovery:					
	Mica:	1,000	kilograms	2,205	pounds

Comments:

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

MINFILE NUMBER: **082M 080**   NATIONAL MINERAL INVENTORY:

NAME(S): **STANMACK**, 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).

MINING DIVISION: Revelstoke
UTM ZONE: 11
NORTHING: 5729044
EASTING: 400955

COMMODITIES: Gold   Silver   Tungsten   Mica

MINERALS
SIGNIFICANT: Pyrite   Pyrrhotite   Gold   Scheelite   Chalcopyrite
Galena   Tetrahedrite   Mica
COMMENTS: Green chromium mica. (Fuchsite).
ASSOCIATED: Quartz   Ankerite
ALTERATION: Ankerite
ALTERATION TYPE: Carbonate
MINERALIZATION AGE: Unknown
ISOTOPIC AGE: DATING METHOD: Unknown   MATERIAL DATED:

DEPOSIT
CHARACTER: Vein   Discordant
CLASSIFICATION: Epigenetic   Industrial Min.
TYPE: Gold-quartz veins
SHAPE: Irregular

HOST ROCK
DOMINANT HOST ROCK: Metasedimentary

STRATIGRAPHIC AGE	GROUP	FORMATION	IGNEOUS/METAMORPHIC/OTHER
Upper Proterozoic	Horsethief Creek	Undefined Formation	

LITHOLOGY: Phyllite
Quartzite
Schist
Greenstone

GEOLOGICAL SETTING
TECTONIC BELT: Omineca   PHYSIOGRAPHIC AREA: Selkirk Mountains
TERRANE: Kootenay
METAMORPHIC TYPE: Regional   RELATIONSHIP: GRADE:

INVENTORY

ORE ZONE: SAMPLE

CATEGORY: Assay/analysis   YEAR: 1942
SAMPLE TYPE: Rock

COMMODITY	GRADE
Tungsten	9.1000 Per cent

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).

BIBLIOGRAPHY

GSC SUM RPT *1928, Part A, pp. 154,155,158,159
EMPR BULL 1, p. 119; 20, Part II, 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 PF (*Newmarch, C.B. (1942): Ole Bull Tungsten)
EMPR ASS RPT *10393, *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 FIELD CHECK: N
DATE REVISED: 860312 REVISED BY: LDJ FIELD CHECK: N

MINFILE NUMBER: **082M 168** NATIONAL MINERAL INVENTORY:

NAME(S): **YELLOW CREEK**, COLUMBIA

STATUS: Showing MINING DIVISION: Golden
NTS MAP: 082M16W UTM ZONE: 11
LATITUDE: 51 59 20 NORTHING: 5760466
LONGITUDE: 118 22 00 EASTING: 406153
ELEVATION: 2100 Metres
LOCATION ACCURACY: Within 1 KM

COMMODITIES: Mica Beryllium Kyanite

MINERALS
SIGNIFICANT: Mica Beryl Kyanite
ASSOCIATED: Quartz Garnet Muscovite Biotite
MINERALIZATION AGE: Unknown
ISOTOPIC AGE: DATING METHOD: Unknown MATERIAL DATED:

DEPOSIT
CHARACTER: Unknown
CLASSIFICATION: Pegmatite Industrial Min.
TYPE: Rare element pegmatite - LCT family Kyanite family

HOST ROCK
DOMINANT HOST ROCK: Metamorphic

STRATIGRAPHIC AGE	GROUP	FORMATION	IGNEOUS/METAMORPHIC/OTHER
Paleozoic	Lardeau	Undefined Formation	

LITHOLOGY: Mica Schist
Pegmatite

GEOLOGICAL SETTING
TECTONIC BELT: Omineca PHYSIOGRAPHIC AREA: Selkirk Mountains
TERRANE: Kootenay
METAMORPHIC TYPE: Regional RELATIONSHIP: GRADE:

CAPSULE GEOLOGY

The area is underlain by probable Lardeau Group consisting of mica-schist cut by quartz veins and pegmatites.

Mica is associated with the quartz veins and kyanite occurs in pegmatite dykes and the schists. Beryllium occurs in muscovite and biotite of pegmatites and in kyanite and garnet of schist.

BIBLIOGRAPHY

Watson, K de P. (1947): American Mineralogist, v. 32, p. 94
EMPR AR 1912-K143; 1952-A258
CANMET IR 285, pp. 42-49
GSC EC GEOL 23, p. 60
GSC P 66-1, p. 51
GSC MAP 12-1964
GSC OF 637

DATE CODED: 850724 CODED BY: GSB FIELD CHECK: N
DATE REVISED: 860313 REVISED BY: LDJ FIELD CHECK: N

MINFILE NUMBER: **082M 175** NATIONAL MINERAL INVENTORY:

NAME(S): **KINBASKET LAKE**

STATUS: Showing
NTS MAP: 082M16E
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).

MINING DIVISION: Golden
UTM ZONE: 11
NORTHING: 5756365
EASTING: 430134

COMMODITIES: Garnet Kyanite Mica

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

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

HOST ROCK
DOMINANT HOST ROCK: Metasedimentary

STRATIGRAPHIC AGE	GROUP	FORMATION	IGNEOUS/METAMORPHIC/OTHER
Hadrynian	Horsethief Creek	Unnamed/Unknown Formation	
Lower Cambrian			Unnamed/Unknown Informal

LITHOLOGY: Garnet Schist
Quartz Kyanite Pegmatite
Quartz Kyanite Vein

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

CAPSULE GEOLOGY

The Big Bend (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
Eichelberger, F. (1953): *Report on Kyanite Deposits - Kinbasket Lake, British Columbia; unpublished Report for Yellow Creek Mica Ltd., 5 pages

DATE CODED: 850724 CODED BY: GSB FIELD CHECK: N
DATE REVISED: 900104 REVISED BY: LDJ FIELD CHECK: N

MINFILE NUMBER: 082M 180   NATIONAL MINERAL INVENTORY:

NAME(S): BIG BEND

STATUS: Showing
NTS MAP: 082M15E
LATITUDE: 51 49 30
LONGITUDE: 118 30 30
ELEVATION: 0800 Metres
LOCATION ACCURACY: Within 1 KM
COMMENTS: Description, Annual Report 1901, p. 1012.

MINING DIVISION: Revelstoke
UTM ZONE: 11
NORTHING: 5742432
EASTING: 396048

COMMODITIES: Mica

MINERALS

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

DEPOSIT

CHARACTER: Unknown
CLASSIFICATION: Industrial Min.

HOST ROCK

DOMINANT HOST ROCK: Metamorphic

STRATIGRAPHIC AGE	GROUP	FORMATION	IGNEOUS/METAMORPHIC/OTHER
Paleozoic	Lardeau	Undefined Formation	

LITHOLOGY: Quartz Mica Schist

GEOLOGICAL SETTING

TECTONIC BELT: Omineca   PHYSIOGRAPHIC AREA: Selkirk Mountains
TERRANE: Kootenay
METAMORPHIC TYPE: Regional   RELATIONSHIP: GRADE: Amphibolite

CAPSULE GEOLOGY

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

BIBLIOGRAPHY

EMPR AR 1901-1012; 1910-K94
GSC P 64-32
GSC MAP 12-1964
GSC OF 637

DATE CODED: 850724   CODED BY: GSB   FIELD CHECK: N
DATE REVISED: 860314   REVISED BY: LDJ   FIELD CHECK: N

MINFILE NUMBER: **083D 007**   NATIONAL MINERAL INVENTORY:

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

STATUS: Showing   MINING DIVISION: Golden
NTS MAP: 083D01W   UTM ZONE: 11
LATITUDE: 52 00 05   NORTHING: 5761800
LONGITUDE: 118 18 40   EASTING: 410000
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).

COMMODITIES: Kyanite   Mica   Beryllium

MINERALS
SIGNIFICANT: Kyanite   Muscovite   Beryl
ASSOCIATED: Biotite   Quartz   Feldspar   Tourmaline   Garnet
MINERALIZATION AGE: Cretaceous

DEPOSIT
CHARACTER: Layered   Stratiform   Vein   Podiform
CLASSIFICATION: Pegmatite   Metamorphic   Industrial Min.
TYPE: Muscovite pegmatite   Rare element pegmatite - LCT family
SHAPE: Tabular
MODIFIER: Folded
DIMENSION: 6   Metres   STRIKE/DIP: 294/66   TREND/PLUNGE:
COMMENTS: The pegmatite sill ranges in thickness from 1.5 to 6 metres. Upper amphibolite facies metamorphic conditions were reached in the northern Monashee Mountains at circa 100 Ma (Geology Vol. 18, 1990).

HOST ROCK
DOMINANT HOST ROCK: Metasedimentary

STRATIGRAPHIC AGE	GROUP	FORMATION	IGNEOUS/METAMORPHIC/OTHER
Hadrynian	Horsethief Creek	Unnamed/Unknown Formation	

LITHOLOGY: Pelitic Kyanite Schist
Mica Schist
Siliceous 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
METAMORPHIC TYPE: Regional   RELATIONSHIP: Syn-mineralization   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, 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

CAPSULE GEOLOGY

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

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

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

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

DATE CODED: 850724 CODED BY: GSB FIELD CHECK: N
DATE REVISED: 911207 REVISED BY: KJM FIELD CHECK: N

MINFILE NUMBER: **083D 012** NATIONAL MINERAL INVENTORY:

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

STATUS: Past Producer Open Pit MINING DIVISION: Cariboo
NTS MAP: 083D14W UTM ZONE: 11
LATITUDE: 52 45 35 NORTHING: 5847800
LONGITUDE: 119 17 36 EASTING: 345250
ELEVATION: 0993 Metres
LOCATION ACCURACY: Within 500M
COMMENTS: Location of drillhole GM-12 on the Canoe North Mica occurrence (Assessment Report 7687).

COMMODITIES: Mica

MINERALS

SIGNIFICANT: Mica Muscovite
ASSOCIATED: Kyanite Staurolite Garnet Biotite Quartz
Feldspar 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. DATING METHOD: MATERIAL DATED:

DEPOSIT

CHARACTER: Concordant Stratiform 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	
Proterozoic-Paleoz.			Shuswap Metamorphic Complex

LITHOLOGY: Pelitic Schist
Muscovite Quartz Schist
Biotite Muscovite Pelite
Psammite
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	60.5000 Per cent

COMMENTS: Fairly assured reserves.
REFERENCE: Canadian Mining Journal, May 1982, page 13.

INVENTORY

ORE ZONE: QUARRY

CATEGORY: Measured YEAR: 1980
QUANTITY: 2290000 Tonnes

COMMODITY	GRADE
Mica	60.5000 Per cent

REFERENCE: Canadian Mining Journal, May 1982, page 13.

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 psammite, amphibolite, marble, calc-silicate, conglomerate, coarse grained grit and diamictite. The foliation of layers within the showing strike 240 degrees and dip 10 degrees northwest. A more detailed description of the regional structure and metamorphism is given in the Canoe South Mica (083D 017) and Albreda (083D 018) occurrences.

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

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

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

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

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

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

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

MINFILE NUMBER: 083D 012 NAME: CANOE NORTH MICA STATUS: Past Producer

Production Year	Tonnes Mined	Tonnes Milled	Commodity	Grams Recovered	Kilograms Recovered
1961		125	Mica		125,000
1960		100	Mica		100,000

SUMMARY TOTALS: 083D 012 NAME: CANOE NORTH MICA

	Metric		Imperial	
Mined:		tonnes		tons
Milled:	225	tonnes	248	tons

Recovery:

	Metric		Imperial	
Mica:	225,000	kilograms	496,040	pounds

Comments:

1961: 125 tonnes of mica product were produced for market (EMPR AR 1961)
1960: 100 tonnes of mica product were produced for market (EMPR AR 1960)

MINFILE NUMBER: **083D 017**   NATIONAL MINERAL INVENTORY:

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

STATUS: Past Producer   Underground   MINING DIVISION: Cariboo
NTS MAP: 083D11W   UTM ZONE: 11
LATITUDE: 52 43 55   NORTHING: 5844700
LONGITUDE: 119 17 17   EASTING: 345500
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   Muscovite
ASSOCIATED: Kyanite   Staurolite   Garnet   Biotite   Quartz
Plagioclase
COMMENTS: The associated mineral assembage 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: MATERIAL DATED:

DEPOSIT

CHARACTER: Concordant   Stratiform   Vein   Disseminated
CLASSIFICATION: Metamorphic   Pegmatite   Industrial Min.
SHAPE: Tabular
MODIFIER: Folded   Faulted
DIMENSION: STRIKE/DIP: 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

STRATIGRAPHIC AGE	GROUP	FORMATION	IGNEOUS/METAMORPHIC/OTHER
Upper Proterozoic	Kaza	Undefined Formation	
Proterozoic-Paleoz.			Shuswap Metamorphic Complex

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   PHYSIOGRAPHIC AREA: Cariboo Mountains
TERRANE: Kootenay   Ancestral North America
METAMORPHIC TYPE: Regional   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

CAPSULE GEOLOGY

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

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

MINFILE NUMBER: **083D 017** NAME: **CANOE SOUTH MICA** STATUS: Past Producer

Production Year	Tonnes Mined	Tonnes Milled	Commodity	Grams Recovered	Kilograms Recovered
1914	4		Mica		1,815

SUMMARY TOTALS: 083D 017 NAME: CANOE SOUTH MICA

		Metric		Imperial	
	Mined:	4	tonnes	4	tons
	Milled:		tonnes		tons
Recovery:					
	Mica:	1,815	kilograms	4,001	pounds

Comments:

1914: 1815 kilograms were packed out and used in Vancouver for roofing.

MINFILE NUMBER: **083D 018**   NATIONAL MINERAL INVENTORY:

NAME(S): **ALBREDA**, DEC GRID

STATUS: Showing   MINING DIVISION: Cariboo
NTS MAP: 083D11E   UTM ZONE: 11
LATITUDE: 52 40 16   NORTHING: 5837800
LONGITUDE: 119 13 25   EASTING: 349650
ELEVATION: 1067 Metres
LOCATION ACCURACY: Within 500M
COMMENTS: Centre of the Dec claim grid (Industrial Minerals File: Report for Mits Development Company Ltd., June 1978).

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   Muscovite pegmatite
SHAPE: Tabular
MODIFIER: Folded
DIMENSION: STRIKE/DIP: 100/48   TREND/PLUNGE: 284/09
COMMENTS: Strike/dip are for regional foliation and trend/plunge are for fold axis near showing (GSC Paper 89-1E, pp. 101-107). Age of mineralization is for the main metamorphic event (GSC Paper 90-1E, pp. 71-80).

HOST ROCK
DOMINANT HOST ROCK: Metasedimentary

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

LITHOLOGY: Biotite Muscovite Pelite
Semi Pelite
Pelitic Schist
Quartz Biotite Muscovite Schist
Amphibolite Schist
Coarse Grained Grit
Quartz Biotite Plagioclase Psammite
Garnet Amphibolite
Pegmatite

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

GEOLOGICAL SETTING
TECTONIC BELT: Omineca   PHYSIOGRAPHIC AREA: Cariboo Mountains
TERRANE: Kootenay   Ancestral North America
METAMORPHIC TYPE: Regional   RELATIONSHIP: GRADE: Amphibolite
COMMENTS: Showing is immediately west of the southern Rocky Mountain Trench.

CAPSULE GEOLOGY

The Albreda showing is located about 6.5 kilometres north-northwest of the Albreda 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 Albreda (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.

CAPSULE GEOLOGY

Horsethief Creek Group strata in the Canoe River area are locally sufficiently pelitic to produce abundant aluminosilicate minerals (kyanite) when subject to high grade regional metamorphism (Open File 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 psammite, 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 psammite 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.

BIBLIOGRAPHY

EMPR AR 1915-K54-K55; 1920-N95-N96; 1931-A148-A149; *1947-A215-A216
1952-A258
EMPR OF *1988-26
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 FIELD CHECK: N
DATE REVISED: 911209 REVISED BY: KJM FIELD CHECK: N

MINFILE NUMBER: **083D 019** NATIONAL MINERAL INVENTORY:

NAME(S): **MICA MOUNTAIN**, BARRON 1-4, BONANZA GROUP, BONANZA, PREMIER, MINNIE SMITH, DREADNOT, ADVENTURE, BOULDER, MAMMOTH, MICA, TETE JAUNE, RELIANCE CLAIM GRP.

STATUS: Showing MINING DIVISION: Cariboo
NTS MAP: 083D13E UTM ZONE: 11
LATITUDE: 52 53 56 NORTHING: 5863850
LONGITUDE: 119 32 43 EASTING: 328800
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 Beryllium

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 90-1E, 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	FORMATION	IGNEOUS/METAMORPHIC/OTHER
Hadrynian	Kaza	Undefined Formation	
Proterozoic-Paleoz.			Shuswap Metamorphic Complex

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

CAPSULE GEOLOGY

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

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

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

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

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

DATE CODED: 850724 CODED BY: GSB FIELD CHECK: N
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
NTS MAP: 083D02E 083D01W
LATITUDE: 52 01 34
LONGITUDE: 118 34 16
ELEVATION: 725 Metres
LOCATION ACCURACY: Within 500M
COMMENTS: Mica-bearing pegmatite dyke at the Highway Deposit Lower Showing (Newmarch, 1942).

MINING DIVISION: Revelstoke
UTM ZONE: 11
NORTHING: 5764900
EASTING: 392200

COMMODITIES: Mica Kyanite

MINERALS
SIGNIFICANT: Muscovite Kyanite
ASSOCIATED: Biotite Tourmaline Quartz Feldspar Garnet
MINERALIZATION AGE: Unknown

DEPOSIT
CHARACTER: Vein Discordant Stratiform Layered
CLASSIFICATION: Pegmatite Metamorphic Industrial Min.
TYPE: Kyanite family Muscovite pegmatite
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 pegmatitie dyke.

HOST ROCK
DOMINANT HOST ROCK: Metaplutonic

STRATIGRAPHIC AGE	GROUP	FORMATION	IGNEOUS/METAMORPHIC/OTHER
Hadrynian	Horsethief Creek	Unnamed/Unknown Formation	

LITHOLOGY: 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 PHYSIOGRAPHIC AREA: Selkirk Mountains
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 Semipelite and Pelite units of the Hadrynian Horsethief Creek Group. Distribution within the northern Semipelite 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 semipelite 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

CAPSULE GEOLOGY

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 Semipelite-Amphibolite division (Geological Society of America Memoir 153), the Aluminous Pelite unit (Open File 1988-26) or Lower Pelite unit (Geological Survey of Canada Open File 2324) of the Horsethief Creek Group. Kyanite porphyroblasts in these horizons are up to 5 centimetres in length.

BIBLIOGRAPHY

EMPR AR 1899-H133
EMPR OF 1988-26
EMPR IND MIN FILE (*Newmarch, C.B. (1942): Preliminary Report on mica deposits on the Mica Creek area)
GSC OF 2324
GSC P 77-1C
GSC EC GEOL NO 19-90
GSA Memoir 153, pp. 445-461
Mitchell, W.J. (1976): *Structure and stratigraphy of the Warsaw Mountain area, British Columbia; unpublished M.Sc thesis, University of Calgary, Alberta.
Perkins, M.J. (1983): Structural geology and stratigraphy, Big Bend of the Columbia River, Selkirk Mountains, British Columbia; unpublished Ph.D. thesis, Carleton University, Ottawa, Ontario.

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

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).

MINING DIVISION: Kamloops
UTM ZONE: 11
NORTHING: 5776475
EASTING: 336814

COMMODITIES: Mica

MINERALS

SIGNIFICANT: Mica, Muscovite
ASSOCIATED: 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.
TYPE: Muscovite pegmatite
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: Metaplutonic

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

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

GEOLOGICAL SETTING

TECTONIC BELT: Omineca PHYSIOGRAPHIC AREA: Cariboo Mountains
TERRANE: Kootenay
METAMORPHIC TYPE: Regional RELATIONSHIP: Pre-mineralization, Post-mineralization GRADE: Amphibolite
COMMENTS: Relationship of metamorphism varies with age of pegmatite.

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, psammite, 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 Hadrynian Horsethief 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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EMPR AR 1888-313; 1893-80A-81A; 1898-39; *1902-1083; 1912-K52-K53; 1913-K59; 1914-K56-K57; 1920-N95-N96; 1921-N95,N96; 1924-152; 1928-C188,C189; 1947-A220
GSC OF 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 CODED BY: GSB FIELD CHECK: N
DATE REVISED: 911209 REVISED BY: KJM FIELD CHECK: N

MINFILE NUMBER: **083D 032** NATIONAL MINERAL INVENTORY:

NAME(S): **RAFFERTY**, M-10

STATUS: Prospect
NTS MAP: 083D11W
LATITUDE: 52 31 00
LONGITUDE: 119 25 00
ELEVATION: 1000 Metres
LOCATION ACCURACY: Within 500M
COMMENTS: Approximate centre of the claim group on the north side of the North Thompson River, 48 kilometres northwest of Blue River (Assessment Report 13844).

MINING DIVISION: Kamloops
UTM ZONE: 11
NORTHING: 5821033
EASTING: 336018

COMMODITIES: Mica

MINERALS

SIGNIFICANT: Mica, Muscovite
ASSOCIATED: Quartz, Feldspar, Biotite, Garnet, Pyrrhotite, Graphite
MINERALIZATION AGE: Lower Cretaceous
ISOTOPIC AGE: 135 +/- 4 Ma DATING METHOD: Unknown MATERIAL DATED: Unknown

DEPOSIT

CHARACTER: Stratiform, Concordant
CLASSIFICATION: Metamorphic, Industrial Min.
SHAPE: Tabular
DIMENSION: 1350 x 65 Metres STRIKE/DIP: 115/ TREND/PLUNGE:
COMMENTS: The Main zone trends 115 degrees for 1350 metres and dips steeply southwest. Mineralization age is assumed to be the age of the main metamorphic event (Geological Survey of Canada Paper 90-1E, pp.71-80).

HOST ROCK

DOMINANT HOST ROCK: Metasedimentary

STRATIGRAPHIC AGE	GROUP	FORMATION	IGNEOUS/METAMORPHIC/OTHER
Upper Proterozoic	Kaza	Undefined Formation	
Proterozoic-Paleoz.			Shuswap Metamorphic Complex

LITHOLOGY: Quartz Muscovite Biotite Schist
Quartz Hornblende Biotite Schist
Quartz Mica Schist
Micaceous Quartzite
Quartzite
Sandstone
Phyllite

HOST ROCK COMMENTS: Hosted in the Lower Kaza Group on the northwestern margin of the Shuswap Metamorphic Complex.

GEOLOGICAL SETTING

TECTONIC BELT: Omineca PHYSIOGRAPHIC AREA: Cariboo Mountains
TERRANE: Cariboo
METAMORPHIC TYPE: Regional RELATIONSHIP: Syn-mineralization GRADE: Amphibolite

INVENTORY

ORE ZONE: SAMPLE

CATEGORY: Assay/analysis YEAR: 1985
SAMPLE TYPE: Grab

COMMODITY	GRADE
Mica	44.4700 Per cent

COMMENTS: Schist samples containing muscovite. Of the 44.47 per cent muscovite, 15 per cent was contaminated with graphite.
REFERENCE: Assessment Report 13844.

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).

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EMPR ASS RPT *12679; *13844
EMPR 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

DATE CODED: 860314 CODED BY: ZDH FIELD CHECK: N
DATE REVISED: 911119 REVISED BY: KJM FIELD CHECK: N

MINFILE NUMBER: **092B 028**   NATIONAL MINERAL INVENTORY:

NAME(S): **ROSE**

STATUS: Showing   MINING DIVISION: Victoria
NTS MAP: 092B13W   UTM ZONE: 10
LATITUDE: 48 53 02   NORTHING: 5414650
LONGITUDE: 123 48 47   EASTING: 440400
ELEVATION: 0500 Metres
LOCATION ACCURACY: Within 500M
COMMENTS: Located within 500 metres to the east of Holyoak Creek, about 2.25 kilometres upstream from the creek's mouth in Chemainus River (Location map in Property File).

COMMODITIES: Mica   Sericite

MINERALS
SIGNIFICANT: Mica   Sericite
ASSOCIATED: Graphite
MINERALIZATION AGE: Unknown

DEPOSIT
CHARACTER: Massive
CLASSIFICATION: Metamorphic

HOST ROCK
DOMINANT HOST ROCK: Metasedimentary

STRATIGRAPHIC AGE	GROUP	FORMATION	IGNEOUS/METAMORPHIC/OTHER
Upper Devonian	Sicker	McLaughlin Ridge	
Carboniferous	Buttle Lake	Fourth Lake	

LITHOLOGY: Sericite Schist
Graphitic Schist

HOST ROCK COMMENTS: Probably McLaughlin Ridge Formation rocks.

GEOLOGICAL SETTING
TECTONIC BELT: Insular   PHYSIOGRAPHIC AREA: Vancouver Island Ranges
TERRANE: Wrangell
METAMORPHIC TYPE: Regional   RELATIONSHIP: GRADE: Greenschist

CAPSULE GEOLOGY

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 Pennsylvanian 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 Karmutsen 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).

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EMPR AR *1965-268
EMPR IND MIN FILE
EMPR OF 1988-8
EMPR FIELDWORK 1979, pp. 49-51
GSC P 72-44; 75-1A, p. 23; 79-30
GSC MEM 13; 36; 96
GSC MAP 42A; 1386A; 1553A
GSC OF 463; 701

DATE CODED: 850724   CODED BY: GSB   FIELD CHECK: N
DATE REVISED: 901003   REVISED BY: GJP   FIELD CHECK: N

MINFILE NUMBER: **092HNW067**

NATIONAL MINERAL INVENTORY:

NAME(S): **COQUIHALLA**

STATUS: Showing
NTS MAP: 092H11E
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.

MINING DIVISION: New Westminster
UTM ZONE: 10
NORTHING: 5496600
EASTING: 641250

COMMODITIES: Feldspar Silica Mica

MINERALS
SIGNIFICANT: Orthoclase Quartz Muscovite
MINERALIZATION AGE: Unknown

DEPOSIT
CHARACTER: Stratabound
CLASSIFICATION: Pegmatite Syngenetic Industrial Min.
TYPE: Ceramic pegmatite

HOST ROCK
DOMINANT HOST ROCK: Plutonic

STRATIGRAPHIC AGE	GROUP	FORMATION	IGNEOUS/METAMORPHIC/OTHER
Jurassic-Cretaceous			Eagle Plutonic Complex

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

PHYSIOGRAPHIC AREA: Cascade Mountains

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.

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EMPR OF 1991-10
GSC MEM 139, p. 94, 109
GSC P 69-47; 88-E1, pp. 177-183
GSC MAP 737A; 12-1969; 41-1989

DATE CODED: 850724
DATE REVISED: 920316

CODED BY: GSB
REVISED BY: DMN

FIELD CHECK: N
FIELD CHECK: N

MINFILE NUMBER: **092L 277** NATIONAL MINERAL INVENTORY: 092L3 Sia1

NAME(S): **MICA**, FAIR HARBOUR, MARK,
LAURA LEE

STATUS: Prospect
NTS MAP: 092L03E
LATITUDE: 50 03 30
LONGITUDE: 127 06 12
ELEVATION: 0010 Metres
LOCATION ACCURACY: Within 500M
COMMENTS: Location of sericite showing on Mica One claim is on the south shore at the head of Fair Harbour off Tahsish Inlet.

MINING DIVISION: Alberni
UTM ZONE: 09
NORTHING: 5546620
EASTING: 635764

COMMODITIES: Sericite Mica Silica

MINERALS

SIGNIFICANT: Sericite Quartz
ASSOCIATED: Pyrite Dumortierite Magnetite
ALTERATION: Quartz Sericite
ALTERATION TYPE: Silicific'n Sericitic
MINERALIZATION AGE: Unknown
ISOTOPIC AGE: DATING METHOD: Unknown MATERIAL DATED:

DEPOSIT

CHARACTER: Massive
CLASSIFICATION: Epigenetic Hydrothermal Industrial Min.
SHAPE: Irregular
MODIFIER: Sheared Faulted
DIMENSION: 0091 x 0003 Metres STRIKE/DIP: 100/50S TREND/PLUNGE:
COMMENTS: Attitude of local stratigraphy is west striking, dipping 40 to 60 degrees south.

HOST ROCK

DOMINANT HOST ROCK: Metavolcanic

STRATIGRAPHIC AGE	GROUP	FORMATION	IGNEOUS/METAMORPHIC/OTHER
Lower Jurassic	Bonanza	Undefined Formation	
ISOTOPIC AGE:	200 Ma		
DATING METHOD:	Fossil		
MATERIAL DATED:	Mollusks		
Jurassic			Island Plutonic Suite
ISOTOPIC AGE:	148 +/- 8 Ma		
DATING METHOD:	Potassium/Argon		
MATERIAL DATED:	Phlogopite		

LITHOLOGY: Siliceous Tuff
Tuff
Chlorite Andesite
Quartz Porphyry Dike
Massive Sericite Rock

HOST ROCK COMMENTS: Bonanza mollusks from Quatsino Sound. Intrusive phlogopite from Zeballos stock (Geological Survey of Canada, Paper 74-8).

GEOLOGICAL SETTING

TECTONIC BELT: Insular PHYSIOGRAPHIC AREA: Vancouver Island Ranges
TERRANE: Wrangell Plutonic Rocks

INVENTORY

ORE ZONE: TRENCH

CATEGORY: Assay/analysis YEAR: 1971
SAMPLE TYPE: Channel

COMMODITY	GRADE
Silica	64.5200 Per cent

COMMENTS: Along 3.4 metres in shallow trench, commodity is SiO2.
REFERENCE: Geology, Exploration and Mining 1971, page 481

CAPSULE GEOLOGY

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,

CAPSULE GEOLOGY

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 silicifed zone is pale, creamy white, often brown weathering, hard and fine-grained. A streaky foliation visible in some outcrops probably represents original bedding. In thin sections the rock is seen to consist of recrystallized quartz in grains with diameters of 0.01 to 0.12 millimetres, occasionally reaching 0.20 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_2O_3 = 22.11, K_2O = 1.21, Na_2O=0.22, Fe(total) = 4.50, H_2O(+105 degrees C) = 4.20, SO_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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EMPR GEM *1971-479,481
EMPR OF 1987-15
GSC OF 9; 170; 463
GSC SUM RPT 1913; 1920A
GSC P 69-1A; 70-1A; 72-44; 74-8
GSC ANN RPT 1886
GSC MAP 4-1974; 255A
Carson, D.J.T., (1968): Metallogenic Study of Vancouver Island with emphasis on the Relationship of Plutonic Rocks to Mineral Deposits, Ph.D. Thesis, Carleton University, Ottawa

DATE CODED: 850724 CODED BY: GSB FIELD CHECK: N
DATE REVISED: 890125 REVISED BY: WV FIELD CHECK: N

MINFILE NUMBER: **093A 083** NATIONAL MINERAL INVENTORY:

NAME(S): **MICA MOUNTAIN**, CLEARWATER MICA

STATUS: Prospect
NTS MAP: 093A01W
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 Grey Provinial Park.

MINING DIVISION: Cariboo
UTM ZONE: 10
NORTHING: 5778829
EASTING: 675078

COMMODITIES: Mica

MINERALS
SIGNIFICANT: Muscovite
ASSOCIATED: Quartz Feldspar
MINERALIZATION AGE: Unknown

DEPOSIT
CHARACTER: Concordant Podiform
CLASSIFICATION: Pegmatite Magmatic Industrial Min.
TYPE: Muscovite pegmatite
SHAPE: Irregular
DIMENSION: 60 Metres STRIKE/DIP: TREND/PLUNGE:
COMMENTS: A 60-metre wide north-trending zone of pegmatite pods and dikes 1.5 to 9 metres wide.

HOST ROCK
DOMINANT HOST ROCK: Metasedimentary

STRATIGRAPHIC AGE	GROUP	FORMATION	IGNEOUS/METAMORPHIC/OTHER
Proterozoic-Paleoz.	Snowshoe	Undefined Formation	

LITHOLOGY: Quartz Mica Schist
Quartz Pegmatite Dike

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

GEOLOGICAL SETTING
TECTONIC BELT: Omineca PHYSIOGRAPHIC AREA: Quesnel Highland
TERRANE: Barkerville
METAMORPHIC TYPE: Regional RELATIONSHIP: GRADE:

INVENTORY

ORE ZONE: SAMPLE

CATEGORY: Assay/analysis YEAR: 1931
SAMPLE TYPE: Grab

COMMODITY	GRADE
Mica	30.0000 Per cent

COMMENTS: Early work indicated 25 to 30 per cent mica.
REFERENCE: Minister of Mines Annual Report 1931, page 109.

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

EMPR AR *1931-109
EMPR PF (Mellin, R.C. 1930, Report on the Clearwater Mica Mine; Calquhoun, M.E. circa 1930, excerpt from Report on Clearwater Mica Mine; Claim Map of Area, date unkown)
GSC P 70-1A
GSC MAP 42-1961; 1-1963; 1424A

DATE CODED: 850724 CODED BY: GSB FIELD CHECK: N
DATE REVISED: 910612 REVISED BY: PSF FIELD CHECK: N

MINFILE NUMBER: **093G 047** NATIONAL MINERAL INVENTORY:

NAME(S): **HIXON MICA**

STATUS: Showing MINING DIVISION: Cariboo
NTS MAP: 093G08W UTM ZONE: 10
LATITUDE: 53 26 37 NORTHING: 5921524
LONGITUDE: 122 29 25 EASTING: 533857
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 Industrial Min.

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 PHYSIOGRAPHIC AREA: Cariboo Plateau
TERRANE: Barkerville

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 PF (See 93G General File - 8W Area and Quesnel Area)
GSC MAP 1424A

DATE CODED: 850724 CODED BY: GSB FIELD CHECK: N
DATE REVISED: 890220 REVISED BY: DGB FIELD CHECK: N

MINFILE NUMBER: **093J 022** NATIONAL MINERAL INVENTORY: 093J14 Mic1

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.

MINING DIVISION: Cariboo
UTM ZONE: 10
NORTHING: 6072121
EASTING: 487480

COMMODITIES: Mica

MINERALS
SIGNIFICANT: Muscovite
MINERALIZATION AGE: Unknown

DEPOSIT
CHARACTER: Disseminated
CLASSIFICATION: Syngenetic Pegmatite Industrial Min.
TYPE: Muscovite pegmatite

HOST ROCK
DOMINANT HOST ROCK: Plutonic

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

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 GEOL 19, p. 83

DATE CODED: 860908 CODED BY: GRF FIELD CHECK: N
DATE REVISED: 890222 REVISED BY: DGB FIELD CHECK: N

MINFILE NUMBER: **093K 094**
NATIONAL MINERAL INVENTORY:

NAME(S): **CASEY PEGMATITE**

STATUS: Showing
NTS MAP: 093K03E
LATITUDE: 54 03 30
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.

MINING DIVISION: Omineca
UTM ZONE: 10
NORTHING: 5991713
EASTING: 366724

COMMODITIES: Feldspar Mica Silica

MINERALS
SIGNIFICANT: Orthoclase Plagioclase Biotite Quartz
ASSOCIATED: Perthite
MINERALIZATION AGE: Unknown

DEPOSIT
CHARACTER: Discordant
CLASSIFICATION: Pegmatite Industrial Min.
SHAPE: Tabular
DIMENSION: 0009 Metres STRIKE/DIP: TREND/PLUNGE:
COMMENTS: Largest dike is 9 metres wide.

HOST ROCK
DOMINANT HOST ROCK: Plutonic

STRATIGRAPHIC AGE	GROUP	FORMATION	IGNEOUS/METAMORPHIC/OTHER
Upper Jurassic			Francois Lake Intrusive Suite

LITHOLOGY: Pegmatite Dike
Aplite 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 aplite 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.

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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 CODED BY: GSB FIELD CHECK: N
DATE REVISED: 950314 REVISED BY: DGB FIELD CHECK: N

MINFILE NUMBER: **093N 189**   NATIONAL MINERAL INVENTORY:

NAME(S): **WOLVERINE RANGE**

STATUS: Showing   MINING DIVISION: Omineca
NTS MAP: 093N09W   UTM ZONE: 10
LATITUDE: 55 43 53   NORTHING: 6176750
LONGITUDE: 124 19 21   EASTING: 416950
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
ASSOCIATED: Quartz   Plagioclase   Biotite   Garnet
MINERALIZATION AGE: Unknown

DEPOSIT
CHARACTER: Massive
CLASSIFICATION: Pegmatite   Syngenetic   Industrial Min.
TYPE: Ceramic pegmatite

HOST ROCK
DOMINANT HOST ROCK: Plutonic

STRATIGRAPHIC AGE	GROUP	FORMATION	IGNEOUS/METAMORPHIC/OTHER
Proterozoic			Wolverine Complex
Tertiary			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   PHYSIOGRAPHIC AREA: Omineca Mountains
TERRANE: Cassiar

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).

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EMPR BULL Ferri, F. 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: 850724   CODED BY: GSB   FIELD CHECK: N
DATE REVISED: 921129   REVISED BY: DMM   FIELD CHECK: N

MINFILE NUMBER: **093O 022**
NATIONAL MINERAL INVENTORY:

NAME(S): **FALLS**

STATUS: Showing
NTS MAP: 093O11W
LATITUDE: 55 40 53
LONGITUDE: 123 26 29
ELEVATION: 915 Metres
LOCATION ACCURACY: Within 5 KM
COMMENTS: The Falls claims are situated on the north fork of Six Mile Creek (Minister of Mines Annual Report 1904, page G112).

MINING DIVISION: Omineca
UTM ZONE: 10
NORTHING: 6170500
EASTING: 472250

COMMODITIES: Mica

MINERALS

SIGNIFICANT: Mica
MINERALIZATION AGE: Unknown

DEPOSIT

CHARACTER: Unknown
CLASSIFICATION: Industrial Min.
COMMENTS: A detailed description for this occurrence is not available.

HOST ROCK

DOMINANT HOST ROCK: Metasedimentary

STRATIGRAPHIC AGE	GROUP	FORMATION	IGNEOUS/METAMORPHIC/OTHER
Upper Proterozoic	Misinchinka	Unnamed/Unknown Formation	

LITHOLOGY: Unknown

HOST ROCK COMMENTS: The Falls claims may be underlain by Misinchinka Group sediments.

GEOLOGICAL SETTING

TECTONIC BELT: Foreland
TERRANE: Ancestral North America
PHYSIOGRAPHIC AREA: Northern Rocky Mountain Trench

CAPSULE GEOLOGY

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.

The Falls occurrence lies within Ancestral North America terrane sediments, possibly within the Upper Proterozoic Misinchinka Group. 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.

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EMPR AR *1904-G112
GSC OF 925

DATE CODED: 850724
DATE REVISED: 910315
CODED BY: GSB
REVISED BY: GKK
FIELD CHECK: N
FIELD CHECK: N

MINFILE NUMBER: **094C 034** NATIONAL MINERAL INVENTORY: 094C10 Mic1

NAME(S): **FAMILY FARM**, GENERAL HOLDING CO., MICA MOUNTAIN, EAST MICA MOUNTAIN

STATUS: Past Producer Underground MINING DIVISION: Omineca
NTS MAP: 094C10E UTM ZONE: 10
LATITUDE: 56 33 19 NORTHING: 6269000
LONGITUDE: 124 43 57 EASTING: 393500
ELEVATION: 1750 Metres
LOCATION ACCURACY: Within 1 KM
COMMENTS: Area of main workings near the General Holding Company main camp on the north end of East Mica Mountain (Mica Mountain), about 9 kilometres southwest of where Fort Graham used to be (presently under Williston Lake) (Minister of Mines Annual Report 1926, page 154; Geological Survey of Canada Summary Report 1927A, pages 32,33).

COMMODITIES: Mica Gemstones

MINERALS
SIGNIFICANT: Muscovite Feldspar Quartz Tourmaline Garnet Beryl
COMMENTS: Beryl was reported from one dike in the district, but not necessarily from this occurrence.
ASSOCIATED: Pyrite
MINERALIZATION AGE: Unknown

DEPOSIT
CHARACTER: Vein Disseminated Concordant
CLASSIFICATION: Pegmatite Industrial Min.
TYPE: Muscovite pegmatite
SHAPE: Bladed
DIMENSION: 100 x 12 x 10 Metres STRIKE/DIP: 150/70W TREND/PLUNGE: 150/12
COMMENTS: The pegmatite dike is ellipsoidal in shape with a long axis 100 metres in length and an intermediate axis 12 metres in length oriented parallel to schistosity.

HOST ROCK
DOMINANT HOST ROCK: Metasedimentary

STRATIGRAPHIC AGE	GROUP	FORMATION	IGNEOUS/METAMORPHIC/OTHER
Hadrynian	Ingenika	Unnamed/Unknown Formation	

LITHOLOGY: Schist
Quartzite
Pegmatite Dike

GEOLOGICAL SETTING
TECTONIC BELT: Omineca PHYSIOGRAPHIC AREA: Omineca Mountains
TERRANE: Cassiar
METAMORPHIC TYPE: Regional RELATIONSHIP: Pre-mineralization GRADE:

CAPSULE GEOLOGY

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 dike 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 dike forms an elongate ellipsoid that strikes 150 degrees, dips 70 degrees west and plunges up to 12 degrees towards 150 degrees, with long and intermediate axes of 100 metres and 12 metres respectively. This dike varies up to 10 metres wide. Muscovite crystals, up to 13 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 dike of similar shape occurs about a hundred metres northeast of the larger one. Although pyrite, tourmaline and garnet are more abundant, only minor amounts of

CAPSULE GEOLOGY

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 raw mica from the workings in 1927 (Minister of Mines Annual Report 1927, page 161).

BIBLIOGRAPHY

EMPR AR 1925-1451; *1926-153-155; 1927-161
GSC MEM 274, pp. 101,102
GSC SUM RPT *1927A, pp. 31-35
GSC P 75-33, p. 17, 77-19
GSC MAP 2-1975
GSC EC GEOL No. 19, pp. 83,90
EMR MP CORPFILE (General Holding Company Limited)
CANMET RPT No. 701, pp. 78-80

DATE CODED: 850724 CODED BY: GSB FIELD CHECK: N
DATE REVISED: 920824 REVISED BY: GJP FIELD CHECK: N

MINFILE NUMBER: **094C 034** NAME: **FAMILY FARM** STATUS: Past Producer

Production Year	Tonnes Mined	Tonnes Milled	Commodity	Grams Recovered	Kilograms Recovered
1927	2		Mica		2,300

SUMMARY TOTALS: 094C 034 NAME: FAMILY FARM

		Metric		Imperial	
	Mined:	2	tonnes	2	tons
	Milled:		tonnes		tons
Recovery:					
	Mica:	2,300	kilograms	5,071	pounds

Comments:

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

MINFILE NUMBER: **094C 035** NATIONAL MINERAL INVENTORY: 094C10 Mic1

NAME(S): **WEST MICA MOUNTAIN**

STATUS: Prospect
NTS MAP: 094C10W
LATITUDE: 56 31 52
LONGITUDE: 124 46 43
ELEVATION: 2000 Metres
LOCATION 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: 390600

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	GROUP	FORMATION	IGNEOUS/METAMORPHIC/OTHER
Hadrynian	Ingenika	Undefined Formation	

LITHOLOGY: Pegmatite
Mica Schist
Gneiss
Quartzite

GEOLOGICAL SETTING
TECTONIC BELT: Omineca
TERRANE: Cassiar
METAMORPHIC TYPE: Regional RELATIONSHIP: GRADE: Amphibolite
COMMENTS: Kyanite zone (Paper 75-33, Map 2-1975).

PHYSIOGRAPHIC AREA: Omineca Mountains

CAPSULE GEOLOGY

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

DATE CODED: 920310 CODED BY: RHM FIELD CHECK: N
DATE REVISED: 920824 REVISED BY: GJP FIELD CHECK: N

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).

MINING DIVISION: Omineca
UTM ZONE: 10
NORTHING: 6262500
EASTING: 393900

COMMODITIES: Mica Gemstones

MINERALS
SIGNIFICANT: Muscovite Feldspar Quartz Tourmaline Garnet
ASSOCIATED: Pyrite
MINERALIZATION AGE: Unknown

DEPOSIT
CHARACTER: Vein
CLASSIFICATION: Pegmatite Industrial Min.
TYPE: Muscovite pegmatite

HOST ROCK
DOMINANT HOST ROCK: Metamorphic

STRATIGRAPHIC AGE	GROUP	FORMATION	IGNEOUS/METAMORPHIC/OTHER
Hadrynian	Ingenika	Undefined Formation	

LITHOLOGY: Pegmatite
Mica Schist
Quartzite
Gneiss

GEOLOGICAL SETTING
TECTONIC BELT: Omineca PHYSIOGRAPHIC AREA: Cassiar Mountains
TERRANE: Cassiar
METAMORPHIC TYPE: Regional RELATIONSHIP: GRADE: Amphibolite
COMMENTS: Kyanite zone (Paper 75-33, Map 2-1975).

CAPSULE GEOLOGY

The Ravenal mica occurrence is located on the south side of Mount Henri, 80 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. 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

EMPR 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** NATIONAL MINERAL INVENTORY: 094C7 Au1

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

STATUS: Showing
NTS MAP: 094C07E
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).

MINING DIVISION: Omineca
UTM ZONE: 10
NORTHING: 6255400
EASTING: 396400

COMMODITIES: Mica

MINERALS
SIGNIFICANT: Mica Pyrrhotite Quartz Feldspar
MINERALIZATION AGE: Unknown

DEPOSIT
CHARACTER: Vein
CLASSIFICATION: Pegmatite Industrial Min.
TYPE: Muscovite pegmatite

HOST ROCK
DOMINANT HOST ROCK: Metasedimentary

STRATIGRAPHIC AGE	GROUP	FORMATION	IGNEOUS/METAMORPHIC/OTHER
Hadrynian	Ingenika	Undefined Formation	

LITHOLOGY: Pegmatite
Mafic Gneiss
Mica Schist
Quartzite

GEOLOGICAL SETTING
TECTONIC BELT: Omineca PHYSIOGRAPHIC AREA: Omineca Mountains
TERRANE: Cassiar
METAMORPHIC TYPE: Regional RELATIONSHIP: GRADE: Amphibolite
COMMENTS: Kyanite zone (Geological Survey Paper 75-33, Map 2-1975).

CAPSULE GEOLOGY

The Ruby Creek mica occurrence is located on Ruby (Lorimer (?)) Creek (Minister of Mines Annual Report 1930, page A152), 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-C161, *1930-152
GSC P 75-33, p. 17
GSC SUM RPT *1927, Part A, pp. 31A-35A
GSC EC GEOL No. 19, pp. 83, 90
GSC MAP 2-1975

DATE CODED: 850724 CODED BY: GSB FIELD CHECK: N
DATE REVISED: 920310 REVISED BY: RHM FIELD CHECK: N

MINFILE NUMBER: **094C 092** NATIONAL MINERAL INVENTORY:

NAME(S): **JACKPINE**, BLACKPINE LAKE

STATUS: Showing
NTS MAP: 094C06W
LATITUDE: 56 21 22
LONGITUDE: 125 21 46
ELEVATION: 1500 Metres
LOCATION ACCURACY: Within 5 KM
COMMENTS: Location of the main granodorite body, northeast of Blackpine Lake (Geological Survey of Canada Memoir 274).

MINING DIVISION: Omineca
UTM ZONE: 10
NORTHING: 6248000
EASTING: 354000

COMMODITIES: Mica Silica Feldspar

MINERALS
SIGNIFICANT: Muscovite Quartz Feldspar
ASSOCIATED: Plagioclase
MINERALIZATION AGE: Unknown

DEPOSIT
CHARACTER: Massive
CLASSIFICATION: Pegmatite Magmatic Industrial Min.
TYPE: Muscovite pegmatite
SHAPE: Tabular

HOST ROCK
DOMINANT HOST ROCK: Plutonic

STRATIGRAPHIC AGE	GROUP	FORMATION	IGNEOUS/METAMORPHIC/OTHER
Hadrynian	Ingenika	Unnamed/Unknown Formation	
Mesozoic-Cenozoic			Wolverine Complex

LITHOLOGY: Pegmatite
Granodiorite
Migmatite
Gneiss
Schist
Granite

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

GEOLOGICAL SETTING
TECTONIC BELT: Omineca PHYSIOGRAPHIC AREA: Omineca Mountains
TERRANE: Cassiar
METAMORPHIC TYPE: Regional RELATIONSHIP: GRADE: Granulite

CAPSULE GEOLOGY

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

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

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

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

CAPSULE GEOLOGY

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).

BIBLIOGRAPHY

GSC MEM *274, pp. 91-102
GSC MAP 1030A
Parrish, R.R. (1976): Structure, Metamorphism and Geochronology of the Northern Wolverine Complex Near Chase Mountain, Aiken Lake Map-Area, British Columbia, M.Sc. Thesis, University of British Columbia

DATE CODED: 850724 CODED BY: GSB FIELD CHECK: N
DATE REVISED: 920316 REVISED BY: RHM FIELD CHECK: N

MINFILE NUMBER: **094C 124**

NATIONAL MINERAL INVENTORY:

NAME(S): **BIRTHDAY**

STATUS: Showing
NTS 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).

MINING DIVISION: Omineca
UTM ZONE: 10
NORTHING: 6260800
EASTING: 391700

COMMODITIES: Mica

MINERALS
SIGNIFICANT: Muscovite
MINERALIZATION AGE: Unknown

DEPOSIT
CHARACTER: Massive Discordant
CLASSIFICATION: Pegmatite Magmatic Industrial Min.
TYPE: Muscovite pegmatite

HOST ROCK
DOMINANT HOST ROCK: Metamorphic

STRATIGRAPHIC AGE	GROUP	FORMATION	IGNEOUS/METAMORPHIC/OTHER
Hadrynian	Ingenika	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 Birthday mica occurrence is located southwest of Pyramid Peak (Minister of Mines Annual Report 1926, page A154), 78 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 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

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

MINFILE NUMBER: **094C 125** NATIONAL MINERAL INVENTORY:

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 A154).

MINING DIVISION: Omineca
UTM ZONE: 10
NORTHING: 6263800
EASTING: 398200

COMMODITIES: Mica

MINERALS
SIGNIFICANT: Muscovite Quartz Feldspar
MINERALIZATION AGE: Unknown

DEPOSIT
CHARACTER: Vein Massive
CLASSIFICATION: Pegmatite Magmatic Industrial Min.
TYPE: Muscovite pegmatite

HOST ROCK
DOMINANT HOST ROCK: Metamorphic

STRATIGRAPHIC AGE	GROUP	FORMATION	IGNEOUS/METAMORPHIC/OTHER
Hadrynian	Ingenika	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 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 GEOL No. 19, pp. 83,90
EMR MP CORPFILE (General Holding Company Limited)
CANMET 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: **094C 126** NATIONAL MINERAL INVENTORY:

NAME(S): **SUNSET**

STATUS: Showing
NTS MAP: 094C07E
LATITUDE: 56 29 25
LONGITUDE: 124 40 51
ELEVATION: 1800 Metres
LOCATION ACCURACY: Within 1 KM
COMMENTS: Located from map showing claims (Minister of Mines Annual Report 1926, page A154).

MINING DIVISION: Omineca
UTM ZONE: 10
NORTHING: 6261700
EASTING: 396500

COMMODITIES: Mica

MINERALS
SIGNIFICANT: Muscovite Quartz Feldspar
MINERALIZATION AGE: Unknown

DEPOSIT
CHARACTER: Vein
CLASSIFICATION: Pegmatite Industrial Min.
TYPE: Muscovite pegmatite

HOST ROCK
DOMINANT HOST ROCK: Metamorphic

STRATIGRAPHIC AGE	GROUP	FORMATION	IGNEOUS/METAMORPHIC/OTHER
Hadrynian	Ingenika	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 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

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

MINFILE NUMBER: **103H 043** NATIONAL MINERAL INVENTORY:

NAME(S): **CAMPANIA 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.

MINING DIVISION: Skeena
UTM ZONE: 09
NORTHING: 5879000
EASTING: 469500

COMMODITIES: Mica

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

DEPOSIT
CHARACTER: Vein
CLASSIFICATION: Pegmatite Industrial Min.
TYPE: Muscovite pegmatite
SHAPE: Irregular
DIMENSION: 0020 Metres STRIKE/DIP: TREND/PLUNGE:
COMMENTS: Average length of pegmatite bands.

HOST ROCK
DOMINANT HOST ROCK: Plutonic

STRATIGRAPHIC AGE	GROUP	FORMATION	IGNEOUS/METAMORPHIC/OTHER
Lower Cretaceous			Coast Plutonic Complex

ISOTOPIC AGE: 115 +/- 6 Ma
DATING METHOD: Potassium/Argon
MATERIAL DATED: Biotite

LITHOLOGY: Biotite Quartz Monzonite
Granodiorite
Pegmatite

HOST ROCK COMMENTS:

GEOLOGICAL SETTING
TECTONIC BELT: Coast Crystalline
PHYSIOGRAPHIC AREA: Fiord Ranges (Northern)
TERRANE: Plutonic Rocks
METAMORPHIC TYPE: Regional RELATIONSHIP: 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 CODED BY: LDJ FIELD CHECK: N
DATE REVISED: 890803 REVISED BY: LDJ FIELD CHECK: N

MINFILE NUMBER: **103H 044** NATIONAL MINERAL INVENTORY:

NAME(S): **BAKER INLET**, MICA MAID, MICA BOY,
SERICITE, BAKER MICA

STATUS: Past Producer Open Pit MINING DIVISION: Skeena
NTS MAP: 103H13W UTM ZONE: 09
LATITUDE: 53 49 20 NORTHING: 5963901
LONGITUDE: 129 54 00 EASTING: 440752
ELEVATION: 0120 Metres
LOCATION ACCURACY: Within 500M
COMMENTS: Located on north side of Baker Inlet, 60 kilometres south-southeast of Prince Rupert (Minister of Mines Annual Report 1934).

COMMODITIES: Mica

MINERALS
SIGNIFICANT: Mica Sericite
MINERALIZATION AGE: Unknown

DEPOSIT
CHARACTER: Unknown
CLASSIFICATION: Pegmatite Industrial Min.
TYPE: Muscovite pegmatite
SHAPE: Irregular
DIMENSION: 3 x 1 Metres STRIKE/DIP: 360/17W TREND/PLUNGE:
COMMENTS: Pockets and lenses of good grade mica in pegmatitc zone.

HOST ROCK
DOMINANT HOST ROCK: Metasedimentary

STRATIGRAPHIC AGE	GROUP	FORMATION	IGNEOUS/METAMORPHIC/OTHER
Paleozoic			Coast Plutonic Complex

LITHOLOGY: Mica Schist
Pegmatite
Quartz Monzonite

GEOLOGICAL SETTING
TECTONIC BELT: Coast Crystalline PHYSIOGRAPHIC AREA: Fiord Ranges (Northern)
TERRANE: Alexander
METAMORPHIC TYPE: Regional RELATIONSHIP: GRADE: Greenschist

CAPSULE GEOLOGY

A small amount of mica was mined from the north shore of Baker Inlet, east of Grenville Channel, 60 kilometres south-southeast of Prince Rupert.

A belt of metasediments of the Alexander Terrane, up to 1 kilometre wide, extends southeast from Telegraph Passage along the east side of Grenville Channel for 60 kilometres. The belt is locally intruded and bounded to the northeast by quartz monzonites of the Coast Plutonic Complex.

A pegmatitic zone outcrops along a bluff at 88 metres elevation, 300 metres north of Baker Inlet, within northwest trending mica schists. The zone strikes north, dips 17 degrees west and has been traced along strike for 60 metres. Trenching has uncovered pockets and lenses of good grade mica within the pegmatite up to 3 metres long and 1.5 metres wide. Pulverizing tests carried out by ore testing labs in Ottawa are as follows (Minister of Mines Annual Report 1934, page B10):

Size fraction	Per cent of raw feed	Mica grade (per cent)
+100 mesh	77	99
-100 to +200	88	99
-200 mesh	68	80

A second deposit of mica outcrops in the vicinity, at 120 metres elevation, 180 metres from Baker Inlet. A micaceous zone in altered mica schists has been traced for 200 metres and contains 10 to 90 per cent sericite across widths of 0.6 to 2.1 metres (Minister of Mines Annual Report 1940, page 99). In 1940, 73 tonnes of crude sericite mica were shipped from this deposit to Vancouver. An unknown amount was also shipped in 1941.

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EMPR AR 1932-50; 1933-45; *1934-B10; *1940-99; 1941-93,94
GSC P 70-41
GSC MAP 23-1970; 1385A

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DATE CODED: 860801 CODED BY: LDJ FIELD CHECK: N
DATE REVISED: 910612 REVISED BY: PSF FIELD CHECK: N

APPENDIX II

Japanese Importers of Mica

POTENTIAL IMPORTERS

JETRO

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

APPENDIX III

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APPENDIX IV

Suzorite Mica Specifications Sheet

SUZORITE®

DESCRIPTION
40-2

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 substitute - 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-foofing and shingles - Used as an anti-stick agent.

Insulating heat shields.

SPECIFICATION

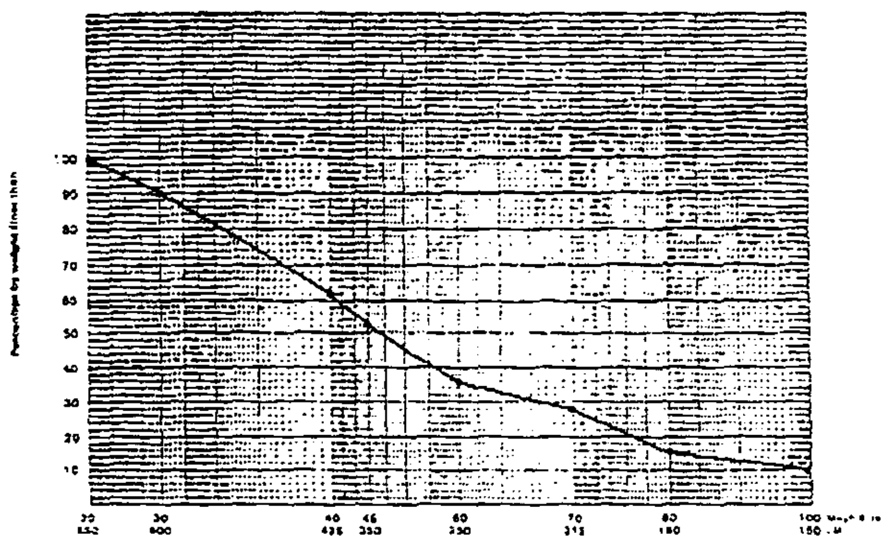
Screen Analysis

U.S. Sieve		μM
+20 mesh	<1%	+850
−20 +40 mesh	25-50%	−850 +425
−40 +70 mesh	25-40%	−425 +212
−70 mesh	10-45%	−212

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

Moisture Content - <0.4%

PARTICLE SIZE DISTRIBUTION



Particle Size in Mesh (US Sieve) and Microns
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

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 Corona Corporation

CANADA & INTERNATIONAL
1475 Graham Bell Street
Boucherville, Quebec J4B 6A1
(514) 655-2450
FAX: (514) 655-9842
TWX: SUZORITE MTL 05-257641

SUZORITE®

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

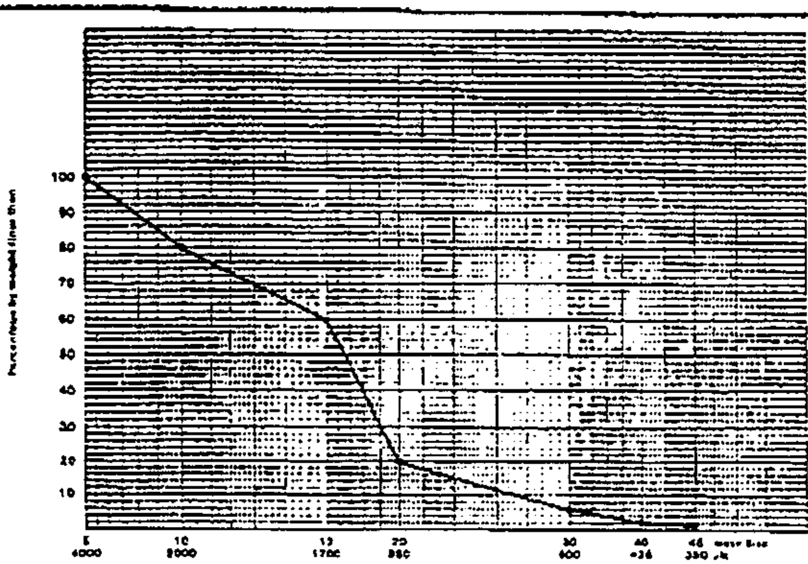
Screen Analysis

U.S. Sieve		µM
+10 mesh	20-40%	+2mm
−10 +20 mesh	45-65%	−2mm +850
−20 mesh	5-25%	−850

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

Moisture Content - <0.4%

PARTICLE SIZE DISTRIBUTION



Particle Size in Mesh (US Sieve) and Microns
Average Particle Size 15 Mesh - 1300 µM

(continued)

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

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

Suzorite® mica

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.
NOMINAL SCREEN ANALYSIS	U.S. Sieve – ¼" 0 - 5% –¼" – 4 mesh 20 - 35% –4 +10 mesh 50 - 75% –10 mesh 0 - 10%
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.

NE: (301)584-1355

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

one (514) 655-2450.

Effective October 1, 1983

APPENDIX V

KMG Mica Specifications

CASCADE MARKETING LTD.
#210 - 3540 W. 41st AVENUE
VANCOUVER, B.C.
V6N 3E6

KMG. . . worldwide

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, waterproof and have outstanding dielectric and insulating characteristics. This combination of properties is not duplicated in any other known mineral.

In a specialized high presure air jet milling process, muscovite mica is reduced and delaminated into 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.

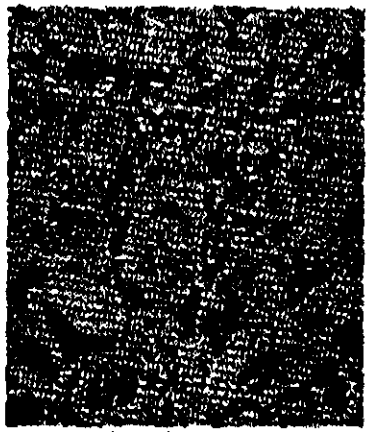
The result is a unique functional pigment consisting of tough, chemically inert flakes with high hydrophyllic properties, a low index of refraction and a variety of physical properties beneficial in a number of end uses.

Muscovite mica should not be confused with various other micaceous 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



Photomicrograph of MICRO-MICA C-3000

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

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

• The mica flakes serve as a foci 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 TiO_2, and intensifies colored pigments.

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

Rubber

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

MICRO-MICA™

KMG...worldwide

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
99.0% min. passing 325 mesh
*Avg. particle size 1/2 micron or less thick by 5-10 microns in diameter

Micro-Mica C-4000*

100.0% passing 100 mesh
99.9% min. passing 325 mesh
*Avg. particle size 1/2 micron or less thick by 1-5 microns in diameter

Physical Properties

Specific Gravity		2.82
Refractive Index		1.58
Apparent Density lbs./cu.ft.		12.00-14.00
Wet Bulking Value gal./lb.		0.04257
Surface Area m.²/g.(BET)	*C-1000*	4.48
	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 (SiO_2)	48.40%
Alumina (Al_2O_3)	33.15%
Potash (K_2O)	9.30%
Iron Oxide (Fe_2O_3)	2.10%
Calcium Oxide (CaO)	0.48%
Magnesia (MgO)	0.68%
Titanium Dioxide (TiO_2)	0.65%
Manganese (MnO_2)	0.02%
Sodium (Na_2O)	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.

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.

CASCADE [illegible] LTD.
#210 - 3540 W. 41st AVENUE
VANCOUVER, B.C.
V6N [illegible]

KMG

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.

MICAS FOR PAINT

Product	Mesh Size
C-4000	99.9% - 325
C-3000	99.6% - 325
WG 325	93.0% - 325
C-500	93.0% - 325
2300	93.0% - 325

KMG . . . worldwide

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 in dry grinding or other wet processes.

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

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

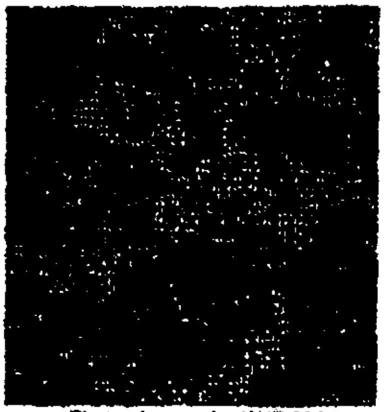
Wet ground mica should not be confused with various other micaceous minerals which do not have the same basal cleavage and laminar particle shape.

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.



Photomicrograph of WG 325 Wet Ground White Muscovite Mica

- 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 TiO_2 and intensifies colored pigments.
- WG 325 stays uniformly dispersed and is a hydrophyllic pigment suitable for formulation in aqueous and oleoresinous systems.

Plastics

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

- Addition of WG 325 results in improved dimensional stability, flexural strength, heat distortion temperature, 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 parting and surfacing properties to the finished casting.

KMG...worldwide

WG 325™

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

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

Physical Properties

Specific Gravity	2.82
Refractive Index	1.58
Apparent Density lbs./cu.ft.	<12.00
Wet Bulking Value gal./lb.	0.04257
Surface Area m^2/g. (BET)	3.80
Oil Absorption spatula method	42.00
Hardness (Moh)	2.5
pH	8
Moisture @100° C	<0.20%

Chemical Properties

Loss on Ignition	4.80%
Silica (SiO_2)	48.40%
Alumina (Al_2O_3)	33.15%
Potash (K_2O)	9.30%
Iron Oxide (Fe_2O_3)	2.10%
Calcium Oxide (CaO)	0.48%
Magnesia (MgO)	0.68%
Titanium Dioxide (TiO_2)	0.85%
Manganese (MnO_2)	0.02%
Sodium (Na_2O)	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 1906. 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

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Kings Mountain, North Carolina 28086.
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Call for the name of your local distributor.