Energy, Mines and Resources Canada
Énergie, Mines et Ressources Canada

CANMET

Canada Centre for Mineral and Energy Technology
Centre canadien de la technologie des minéraux et de l'énergie

Summary Report No. 3: Fluorite

R.K. Collings and P.R.A. Andrews
Mineral Sciences Laboratories

CANMET Report 88-4E

SUMMARY REPORT NO. 3: FLUORITE

R.K. COLLINGS and P.R.A. ANDREWS
Mineral Processing Laboratory

MINERAL SCIENCES LABORATORIES
CANMET REPORT 88-4E

January 1988

Available in Canada through

Associated Bookstores
and other booksellers

or by mail from

Canadian Government Publishing Centre
Supply and Services Canada
Ottawa, Canada K1A 0S9

Catalogue No. M38-13/88-4E

ISBN 0-660-13120-X

SUMMARY REPORT No. 3: FLUORITE

by

R.K. Collings* and P.R.A. Andrews**

Abstract

More than 300 occurrences or deposits of fluorite (calcium fluoride, CaF_2) have been recorded in Canada; however, deposits of economic significance are confined largely to Newfoundland, Nova Scotia, Ontario and British Columbia. There is only one producer at present, Minworth Ltd., with a mine and concentrator near St. Lawrence on the Burin Peninsula of Newfoundland.

Fluorite occurs in the form of vein, replacement and residual deposits; vein deposits predominate and form the chief source of commercial fluorite. Although some deposits are relatively high grade, most require beneficiation. Beneficiation commonly includes gravity separation, e.g., jigging and tabling, magnetic separation and flotation.

Fluorite has important uses in the chemical, metallurgical and ceramic industries, and is produced in three grades – acid, metallurgical and ceramic – to supply industry requirements.

Fluorite has been the subject of many laboratory studies by CANMET and other organizations. This report references 31 fluorite studies by CANMET and nine by others. Summaries of the most important CANMET studies are presented in the Appendix.

Keywords: fluorite, deposits, processing, uses, specifications, production, trade, consumption, research, CANMET reports.

*Former Head and **Minerals Engineer, Mineral Processing Laboratory, Mineral Sciences Laboratories, CANMET, Energy, Mines and Resources Canada, Ottawa, Ontario K1A 0G1.

RAPPORT SOMMAIRE N° 3 : LA FLUORINE

par

R.K. Collings* et P.R.A. Andrews**

Résumé

Plus de 300 manifestations ou gisements de fluorine (fluorure de calcium, CaF_2) ont été enregistrés au Canada; toutefois, les gisements d'importance économique se trouvent surtout à Terre–Neuve, en Nouvelle–Écosse, en Ontario et en Colombie–Britannique. À l'heure actuelle, il n'existe qu'un seul producteur, la Minworth Ltd., qui possède une mine et une usine de concentration près de St. Lawrence, sur la péninsule Burin, à Terre–Neuve.

La fluorine se présente sous forme de gîtes filoniens, de remplacement et résiduels; les gîtes filoniens prédominent et constituent la principale source de la fluorine commerciale. Bien que certains gisements soient d'une teneur relativement forte, le minerai pour la plupart a encore besoin d'un enrichissement qui consiste généralement en une séparation par gravité, par exemple lavage sur crible et concentration sur table, séparation magnétique et flottation.

La fluorine a une grande importance pour les industries chimique, métallurgique et céramique, et est donc produite en trois qualités différentes (acide, métallurgique et céramique) pour les besoins de ces industries.

CANMET et d'autres organismes ont effectué de nombreuses études en laboratoire sur la fluorine. Le présent rapport consigne 31 études sur la fluorine menées par CANMET et neuf par d'autres organismes. Des résumés des plus importantes études de CANMET sont présentés dans l'annexe.

Mots clés : fluorine; gisements; traitement; utilisations; spécifications; production; commerce; consommation; recherche; rapports de CANMET.

*Ancien chef et **Ingénieur, Laboratoire de traitement des minéraux, Laboratoires des sciences minérales, CANMET, Énergie, Mines et Ressources Canada, Ottawa (Ontario) K1A 0G1.

CONTENTS

TABLES

FIGURE

APPENDIX

INTRODUCTION

More than 300 occurrences or deposits of fluorite (calcium fluoride, CaF_2) have been recorded in Canada; however, deposits of economic significance are confined largely to Newfoundland, Nova Scotia, Ontario and British Columbia. There is only one producer at present, Minworth Ltd., which operates a mine and concentrator near St. Lawrence on the Burin Peninsula of Newfoundland.

A CANMET survey of Canadian industrial mineral producers (1) identified a number of problems specific to the industry as well as potential opportunities for further growth and development. The response to this survey, and subsequent discussions with industry and government specialists, further identified a requirement for information in a number of areas, including mineral deposits, processing, beneficiation studies and new developments, as well as information on product specifications and potential markets for Canadian industrial minerals.

In response to this requirement and in light of the fact that CANMET and its predecessor, Mines Branch, have been directly involved in R&D studies on mineral samples from many of the industrial mineral deposits of Canada, a decision was made to compile related information on file in CANMET and EMR generally, in provincial government offices and, as available, from the private sector, in a series of Summary Reports on a number of industrial minerals. Reports for each mineral would contain information pertaining to mineral occurrences, deposits of specific interest, current activities, product uses and specifications, process technology and summaries of past R&D on specific deposits by CANMET and others, as available. This report, *Summary Report No. 3: Fluorite*, is the third in this planned series; the first two are on barite and celestite.

FLUORITE

Fluorite is a glassy, nonmetallic mineral exhibiting a wide range of colours from green or amber to deep purple; normally it is translucent to transparent. The colour is sensitive to light, heat and pressure, and on exposure to sunlight the colour fades to grey or becomes colourless. Some varieties exhibit a mild fluorescence in ultraviolet light. Fluorite occurs in fine-grained to massive-crystalline forms; it may sometimes be banded in colour and may frequently be interbanded with calcite, barite and quartz. Fluorite crystallizes in the isometric system, and crystals of cubic and octahedral habit are common as linings in rock cavities. Coarsely crystalline varieties have a specific gravity of 3.2, whereas the specific gravity of massive forms may vary between 3.0 and 3.6. Fluorite has perfect octahedral cleavage, is brittle and has a hardness of 4.

MODE OF OCCURRENCE

Fluorite occurs in vein, replacement and, more rarely, in pegmatite and residual deposits.

Vein Deposits

Vein deposits (2) are, and have been, the most important sources of fluorite in Canada. Fluorite deposits in the Madoc area of southeastern Ontario and in the Burin Peninsula of Newfoundland are vein occurrences of marked similarity. All occupy cavities formed mainly by small horizontal displacements along fault planes. Deposits are discontinuous, irregularly shaped, nearly vertical bodies, distributed in line *en échelon*. Below the zone of weathering, the walls are strong and sharp, and the vein typically occupies a single break. The limits of individual deposits are sometimes marked by zones of fractured rock but, in most cases, fracturing is unrelated to jointing.

The main vein–forming process appears to have been one of repeated faulting and fissure–filling, resulting in banded and brecciated vein material. Both colour banding of the fluorite and interbanding of the various vein minerals are typical. Vein minerals, in addition to fluorite, may include calcite, barite, quartz, celestite and base–metal sulphides. Proportions of the individual vein minerals vary greatly, even within a single deposit, and fluorite, barite and calcite may predominate locally. Regional zoning of barite is pronounced in the Newfoundland deposits (3) and is also apparent at Madoc.

Replacement Deposits

Replacement deposits are formed when replacement of pre–existing minerals by calcium fluoride precipitation from solution occurs. Sedimentary rocks, especially limestone, sandstone and shale, are particularly susceptible to replacement. Bedded sedimentary rocks in many cases give rise to banded fluorite deposits, due to either incomplete replacement or the persistence of sedimentary textures. Minerals associated with fluorite replacement deposits typically include calcite, quartz, base–metal sulphides, barite, celestite, strontianite and witherite. Replacement deposits are typically irregular in shape and, in many cases, tabular. There are no known replacement deposits in Canada (2).

Residual Deposits

Although fluorite is readily broken down by mechanical weathering, it resists chemical decomposition and consequently is occasionally preserved as fragments in residual soils. Residual fluorite deposits, also known as "gravel spar" or "sugar spar," occur in the Madoc area of southeastern Ontario as friable, granular aggregates of fluorite and calcite in the zone between high and low groundwater levels. The friable, granular texture is principally the result of the partial leaching of calcite in a calcite–fluorite mosaic. Post ore movement along fault fractures may also have contributed to the friability of the fluorite.

FLUORITE OCCURRENCES AND DEPOSITS

Fluorite occurrences have been identified in Newfoundland, Nova Scotia, New Brunswick, Quebec, Ontario and British Columbia; however, deposits having economic potential are restricted essentially to Newfoundland, Nova Scotia, Ontario and British Columbia.

Ontario was the principal producer of fluorite before the 1950s, but was gradually superseded by Newfoundland following the development of fluorite mining in the Burin Peninsula. The deposits of principal interest are described below and the locations are shown in Figure 1.

Newfoundland

Fluorite at St. Lawrence, on the Burin Peninsula, was discovered in 1843 in an area where the fluorite occurs in fault fissures, mainly in granite. Much of the fluorite occurs as crystals or as massive–crystalline veins, but some intermixing with silica and carbonate does occur.

The development of mining in the area was by two companies: St. Lawrence Corporation of Newfoundland Ltd. and Newfoundland Fluorspar Ltd., a subsidiary of Alcan, which also eventually acquired control of St. Lawrence Corporation. In March 1933, the St. Lawrence Corporation of Newfoundland Ltd. began surface mining. Two grades of fluorite were produced: an acid grade, by flotation, and a metallurgical grade. Metallurgical–grade fluorite was delivered to a steel plant at Sydney,

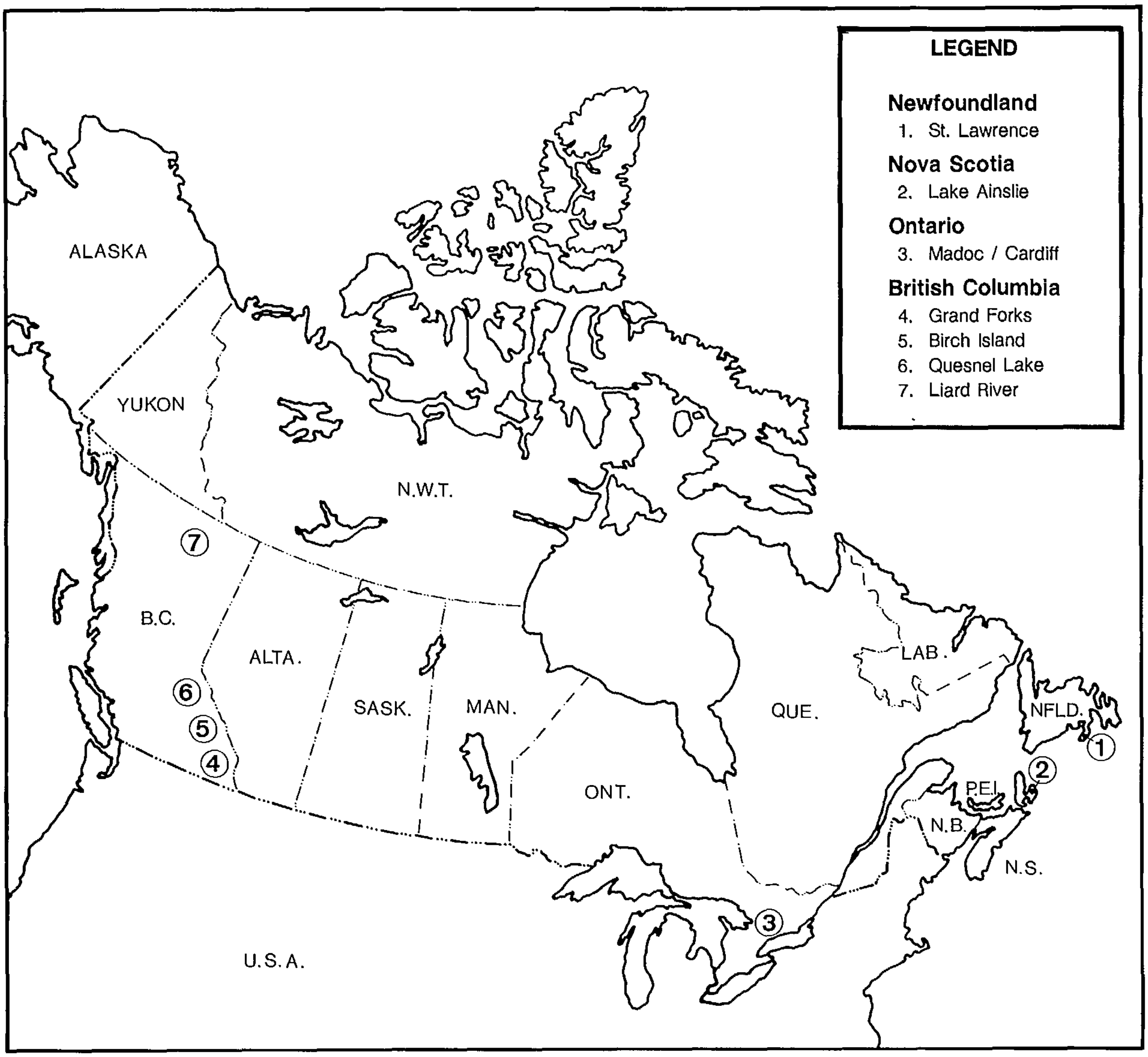

Fig. 1 – Principal fluorite deposits in Canada

N.S., and to Wilmington, Delaware, U.S.A., where it was further upgraded by flotation. In 1936, Newfoundland Fluorspar Ltd. was formed, and production of metallurgical-grade fluorite by heavy-media separation commenced in 1942. A sub-metallurgical grade fluorite was transported to Arvida, Que., where it was upgraded by flotation and used in the manufacture of aluminum.

Descriptions of the geology of the area and early operations by the two companies are provided by Carr (4) and more recently by Howse et al. (5). Fluorite was found in about 40 veins in the St. Lawrence area, nine of which were of economic importance. Of these nine deposits, six were the most productive: Director, Lord and Lady Gulch, Tarefare, Blue Beach, Black Duck and Iron Springs. These veins collectively accounted for about 95% of the total fluorite production during the period 1933–77. The remaining three deposits, being minor, are reported in Table 1. The largest vein was in the Director mine where the ore analyzed approximately 50% CaF_2, 40% SiO_2 and 10% $CaCO_3$, with minor base-metal sulphides, barite, etc. The high-grade veins averaged 1.2 to 1.5 m in width and often contained 95% CaF_2. Low-grade veins, 4.6 to 6.0 m in width, averaged 75% CaF_2 and 10 to 15% SiO_2.

During the 44 years of operation, 4.2 Mt of fluorite were produced from this area. Substantial tonnages still remain; proved, probable and possible reserves in the Blue Beach, Director, Grebes Nest and Tarefare veins have been estimated at 8 Mt at a cut-off grade of 35% CaF_2 (6).

St. Lawrence Corporation of Newfoundland Ltd. ceased mining in 1957 because of cheaper imported fluorite from Mexico; the last concentrate shipments were made in 1961. Newfoundland Fluorspar Ltd. continued production until 1977, when it closed because of high costs, poor market conditions and labour-relations problems.

A study by Hodge et al. (6) concluded that a change of mining method to sublevel, long-hole stoping would decrease mining costs as well as health hazards. In 1983 mineral rights to the property reverted to the Crown. In 1984 Minworth Ltd., a U.K.-based company, obtained an application to reopen several mines in this area, and construction of a new beneficiation plant was completed in early 1987. Flotation is used to produce acid-grade concentrate, and mining is restricted initially to the Blue Beach and Tarefare veins. When initial start-up problems have been brought under control, a high-grade product is expected to average 98 to 99% CaF_2 with less than 1% SiO_2, which will be sold to North American and overseas markets (7).

Nova Scotia

The Lake Ainslie (Trout River) barite–fluorite deposit on Cape Breton Island, although principally a barite ore, is also of interest because of the associated fluorite. This deposit is comprised of several vein systems. The Campbell/MacMillan and the Upper Johnson vein systems, which contain the major tonnage of ore minerals, are the two most important veins.

The principal vein minerals are barite and fluorite. Gangue minerals are mainly calcite with minor to trace amounts of manganiferous limonite, pyrite and chalcopyrite. The barite varies in colour from white to creamy white to pink. It occurs in comb-like crystals and rosettes but is mainly massive. Significant amounts of strontium form a solid solution with the barite. Fluorite occurs in many varieties and is commonly green to colourless. The enclosing wall rock is impregnated with disseminations of the purple variety that occur as granular aggregates. Reserves in the Upper Johnson vein are estimated at 1 Mt of 50% $BaSO_4$ with 17% CaF_2; reserves in the Campbell/MacMillan vein are estimated at 3 Mt averaging 27.8% $BaSO_4$ and 19.0% CaF_2. Apart from a small but continuous production before 1931, there has been no major production of either barite or fluorite from these deposits (8).

Table 1 – Minor occurrences of fluorite (5, 9, 10, 11)

Province	Region	Location	Production	Mineralogy
Newfoundland	St. Lawrence	Hares Ears vein	not recorded	Small, high-grade vein
	St. Lawrence	Scrape vein	not recorded	Small vein consisting mainly of red to white fluorite with minor galena and granite inclusions, reported to be highly brecciated
	St. Lawrence	Doctor's Pond vein	not recorded	Small, high-grade fluorite vein
New Brunswick	Charlotte	Mt Pleasant	nil	Quartz, chlorite and fluorite rock with minor mica, feldspar and kaolin; fluorite content estimated at 5% CaF_2
Quebec	Pontiac	Huddersfield	nil	Fluorite occurs disseminated throughout a pegmatite structure; grade varies from 5 to 25% CaF_2 over a width of 1.5 m
Ontario	Haliburton	Cardiff	117 t	Fluorite as a major constituent of narrow lenticular veins and a minor constituent of syenite pegmatites occurring in a gneiss complex
	Carleton	Fitzroy	not recorded	Fluorite occurring in a small calcite–galena vein at Kingdom mine
	Renfrew	Ross	not recorded	Calcite–fluorite veins; large crystals of biotite, feldspar and apatite present in the wall zone
	Thunder Bay	Lybster	not recorded	Calcite–barite–quartz–fluorite veins mined at East End Silver mine

New Brunswick

A minor occurrence of fluorite has been reported in the cassiterite, base–metal sulphide deposit of Mount Pleasant Tin Mines, Charlotte County, N.B. (9), which contains an estimated 5% CaF_2. This occurrence and associated minerals are listed in Table 1.

Quebec

An occurrence of fluorite at the Lake Otter Uranium Mines, Huddersfield, Que., was described by Bartley (10). The fluorite occurs in two zones: a matte zone and a mica zone. The matte zone was originally explored for uranium and thorium, whereas the mica zone was explored for biotite.

The matte zone, which is pegmatitic in character, contains most of the fluorite mineralization. The fluorite content is estimated to range from 5 to 25% CaF_2 over a width of 1.5 m. Purple fluorite occurs as stringers, patches and as finely disseminated crystals. Smoky–grey fluorite is also found and is generally more coarsely crystallized.

Although no estimate of reserves is reported, fluorite reserves are apparently insufficient to warrant primary production. Recovery of fluorite could be considered only in conjunction with other minerals, e.g., mica.

The ore contains a variety of minerals, including fluorite, calcite, apatite, uranium and thorium. The calcite is pink and coarse grained.

Ontario

Ontario's deposits produced 110 703 t of metallurgical–grade fluorite from the commencement of mining in 1905 to the last recorded activity in 1961 (11). The bulk of production was from vein deposits in the vicinity of Madoc, in the southeast of the province. Minor occurrences of economic importance are presented in Table 1. The bulk of production from the Madoc mines was metallurgical–grade fluorite; small amounts of high–quality optical spar were also recovered from other mines, such as Cardiff.

Fluorite in the Madoc area consists of impersistent shallow veins that fill fractures in limestone, with the vein zone extending for several kilometres adjacent to the major fault. The largest producer was Reliance Fluorspar Mining Syndicate Ltd., which produced metallurgical–grade fluorite. Beneficiation was confined to removal of fines from run–of–mine ore, followed by crushing and wet picking of coarse lump ore.

British Columbia

Fluorite deposits of interest in British Columbia include the Rock Candy deposit in the southeast, the Quesnel Lake and Birch Island deposits in the north–central part of the province and the Liard River deposit in the north.

The Rock Candy mine, located 25 km north of Grand Forks, was operated intermittently between 1918 and 1929. A total of 27 240 t of concentrate was produced, most of which was used in the production of hydrofluosilicic acid for use in the electrolytic purification of lead at Trail, B.C.

The Quesnel Lake fluorite deposits are located some 200 km north of Kamloops in the interior of the province. Mineralization is disseminated throughout a host rock of fine–grained massive granite in random veinlets and in higher grade slabs and lenses within sheared material. Estimates of fluorite content range from 2 to 3% CaF_2 as very fine disseminations in massive rock, up to 20 to 30% CaF_2 in larger disseminations, veinlets and blebs. Minor minerals include pyrite, argentiferous galena, sphalerite and scheelite. The fluorite is mainly dark blue to purple. The mineralized area covers some 40 km^2. Eaglet Mines Ltd. of Vancouver holds a deposit in this area that reportedly contains 24 Mt of ore grading 11.5% CaF_2.

The Birch Island fluorite deposit, located 3 km south of Birch Island, was discovered in 1918. The presence of galena was investigated in 1926, and bog manganese was found in 1929. During the 1960s the property was owned by Rexspar Minerals and Chemicals Ltd. The presence of rare earths and uraninite led to detailed studies of the geological features of the radioactive deposits by Joubin and James (12) and Lang et al. (13). Several mineralogical studies have confirmed the presence of fluorite, base–metal sulphides, celestite, feldspar, quartz, sericite and bastnaesite (14). Most of the fluorite contains inclusions, particularly of bastnaesite and celestite, with minor sericite. Reserves of fluorite have been estimated at 1.8 Mt grading 29% CaF_2. In addition to fluorite, 227 000 t of celestite, 18 000 t of rare earths and 900 t of thorium were indicated (14).

Liard Fluorite Mines Ltd. holds a fluorite property north of Liard River at mile 497 on the Alaska Highway. Reserves have been reported at 500 000 t grading 37% CaF_2 (2).

TECHNOLOGY

The mineral fluorite, CaF_2, is composed of 51.1% Ca and 48.9% F. It has a hardness of 4 on the Mohs' scale and a specific gravity of 3.2. Although fluorite may occur in veins as high–purity, coarsely crystallized ore, it is more commonly associated with calcite, quartz, barite, celestite, sulphide and phosphate minerals as impurities.

Mining

Surface or near–surface deposits are mined by standard open–pit methods, whereas underground deposits are commonly mined by shrinkage stoping or room–and–pillar methods, depending on the extent and attitude of the orebody. Following mining, the ore may be upgraded by hand–sorting before beneficiation, if liberation of the gangue minerals is at a relative coarse size, e.g., 25 mm.

Beneficiation

Gravity concentration methods, including heavy media, jigs and tables, are used to separate calcite and silicate mineral impurities. Heavy–media drums or cones and mineral jigs are ideal for the production of metallurgical flux where a coarse, +5 mm, product is required. Separation of calcite and silicate impurities at a finer size may be accomplished by tabling. Tabling would typically be conducted on ground, deslimed ore sized at −2 mm.

The noted gravity concentration methods of separation are not particularly applicable, however, when barite, celestite or metallic–sulphide minerals occur as impurities. These minerals, being generally heavier than fluorite, usually appear together with the fluorite concentrate. Flotation is the recommended alternative method for the removal of such impurities.

Flotation requires a relatively fine size of feed, e.g., 300 to 75 µm, and grinding to this size is usually necessary to liberate impurities. Flotation can produce either ceramic– or acid–grade fluorite, which must meet a 97% CaF_2 grade specification. Fluorite ores may be treated by both reverse and direct flotation. Reverse flotation, the preferred method, involves an initial float to remove base–metal sulphides followed by the removal of barite and/or celestite. The fluorite, being depressed, is concentrated in the flotation tailings. In direct flotation, fluorite is floated and other minerals are depressed. Flotation techniques and reagents are described in greater detail later in this report.

Table and flotation fluorite concentrates, being fine, are ideal for ceramic and chemical applications but require pelletizing or briquetting for use as metallurgical flux where a coarser product is required.

Various other techniques may be employed to separate fluorite from mineral contaminants. Electronic or colour sorting may be applicable where liberation is at a relatively coarse size, e.g., 5 mm or coarser, and where there is a distinct colour difference between the fluorite particles and contaminants. Heating followed by slaking has been used to separate amorphous calcite, the resulting slaked lime being removed by water washing to yield a finely divided, high–purity fluorite concentrate.

Uses and Specifications

Fluorite has important uses in the chemical, metallurgical and ceramic industries and is produced in three grades – acid, metallurgical and ceramic – to supply industry requirements.

Chemical Manufacture

Fluorite is used in the manufacture of hydrofluoric acid, which is produced by treating acid–grade fluorite (97% CaF_2) with concentrated sulphuric acid in a heated retort. The products are gaseous hydrofluoric acid and by–product calcium sulphate (fluorogypsum). The hydrofluoric acid vapour is condensed and absorbed in water to form hydrofluoric acid, and the fluorogypsum is pumped to waste disposal sites.

Bartley (10) states that 40% of hydrofluoric acid production is consumed by the aluminum industry in the production of aluminum fluoride and artificial cryolite for aluminum metal manufacture by the Hall process. About 30% is used in the production of fluorocarbon refrigerants, in the manufacture of pressurized gases for aerosol containers, and for plastic fibres and tapes such as Teflon. The remaining 30% is used for a number of diverse applications including the refining of uranium, the production of high–octane gasoline, in water treatment, and in the manufacture of fluorinated toothpaste.

Acid–grade fluorite, by definition, should contain not less than 97% CaF_2. Limits are set for various deleterious contaminants, e.g., silica, 1.5%; alumina, calcium carbonate and iron oxide, less than 1% each; arsenic, lead, phosphorus and sulphur should be low, preferably less than 0.1% each. Particle size is about 150 µm (100 mesh), as most acid–grade fluorite is produced by flotation.

Metallurgical Applications

Metallurgical–grade fluorite is used as a flux in the melting and refining of iron, steel, magnesium, calcium and other metals and alloys. The fluorite aids melting and promotes fluidity of the slag and the removal of sulphur, phosphorous and various detrimental impurities.

Guillet (11) notes typical specifications for metallurgical–grade fluorite for three Ontario steel plants (see Table 2).

Table 2 – Chemical specifications for metallurgical–grade fluorite at Ontario steel plants

	Plant 1	Plant 2	Plant 3
	%	%	%
Effective CaF_2* (min)	80	75	80
SiO_2 (max)	2	6	5
$CaCO_3$ (max)	2	3	unspecified
S (max)	0.01	trace	1.0
Pb (max)	unspecified	0.02	0.25

*Effective CaF_2 is equivalent to the fluorite content less 2.5 times the silica content.

The size grading is as follows:

Plant 1: at least 75% is 5 to 25 mm; not more than 15% is finer than 5 mm; not more than 5% is coarser than 50 mm.

Plant 2: 3 to 35 mm; not more than 3% is finer than 3 mm.

Plant 3: 0.5 to 60 mm; not more than 15% is finer than 0.5 mm.

In some cases limitations are also specified for the amounts of barite, alumina, iron, zinc, phosphorus and moisture.

Ceramic Applications

Fluorite is used in a variety of applications in ceramics, e.g., in the manufacture of flint (clear) and opal glass; in enamels for iron stoves, refrigerators, and bathtubs; and as facing on brick and tile. Lower grades of fluorite are used in the manufacture of fibreglass insulation, as a vanadium scumming inhibitor in buff–coloured face brick, and as an abrasive in some sandpapers.

There are two standard fluorite grades for ceramic applications: No.1, containing 95 to 96% CaF_2, and No. 2, customarily containing 85 to more than 90% CaF_2. A medium grade of about 93 to 94% CaF_2 is specified by some users. In some instances, buyers of ceramic grades may specify not more than 3.0% each of silica and calcium carbonate, less than 0.1% ferric oxide, and only traces of lead and zinc sulfides.

CURRENT INTEREST

Following a period of mine development and plant construction, St. Lawrence Fluorspar Ltd., a wholly owned subsidiary of Minworth Ltd. of England, brought its Newfoundland–based fluorite mine and processing facility on stream in February 1987. The ore, grading 45 to 50% CaF_2, is mined from the Blue Beach and other deposits in the St. Lawrence area on Burin Peninsula and is processed by flotation to produce acid–grade fluorite (>97% CaF_2). Plant capacity is about 80 000 tpa, and concentrates will be sold to both North American and overseas markets.

A number of other companies hold fluorite properties in Canada, particularly in British Columbia. These include Eaglet Mines Ltd. of Vancouver, with a deposit in the Quesnel Lake area, about 200 km north of Kamloops; Consolidated Rexspar Ltd., with a uranium–fluorite deposit near Birch Island Station, about 130 km north of Kamloops; and Liard Fluorite Mines Ltd., with a deposit north of Liard River at mile 497 on the Alaska Highway. There is little likelihood that these deposits will be developed in the near future, however, because of competition from world producers. Domestic requirements for fluorite in recent years have been met by imports from Morocco, Spain, the United States and, more recently, China. A current study under the Canada–Nova Scotia Mineral Development Agreement will determine the feasibility of the recovery of barite for barium chemicals manufacture from Conwest Exploration Company Ltd.'s barite–fluorite deposit at Lake Ainslie, Cape Breton. The development of this deposit for barite would undoubtedly include the coproduction of fluorite.

PRODUCTION, TRADE AND CONSUMPTION

Minworth Ltd., with a mine and plant near St. Lawrence on the Burin Peninsula of Newfoundland, is the only current producer of fluorite in Canada. Plant capacity, as previously noted, is about 80 000 tpa of acid–grade fluorite, with concentrates being sold to North American and overseas markets.

Canada continues to import significant quantities of fluorite from traditional sources, chiefly Mexico, Morocco, Spain and the United States, as noted in the summation of imports, Table 3. Imports in 1987 amounted to 134 566 t, 50% of which was from Mexico.

Available data on consumption, noted in Table 4, show the bulk of the consumption under "other," 147 140 t in 1986, which includes two major uses: the production of aluminum and hydrofluoric acid.

A list of major consumers of fluorite, subdivided on the basis of grade of fluorite, is shown in Table 5. This table also identifies the end use which, as previously noted, is predominantly the manufacture of hydrofluoric acid and aluminum.

CANMET STUDIES

Thirty–one studies of fluorite deposits were conducted by CANMET and its predecessor, Mines Branch, between 1920 and 1970. The provinces represented were Newfoundland, Nova Scotia, Quebec, Ontario and British Columbia. Although the largest deposits are located on the Burin Peninsula near St. Lawrence, Nfld., the majority of studies were concerned with deposits in Ontario and British Columbia.

A summary of process data for fluorite ores from the Madoc/Cardiff area of southeastern Ontario is reported in Table 6, with analytical data in Table 6a. This area of Ontario accounted for 14 studies. A summary of process data for the remaining fluorite deposits is reported in Table 7, with analytical data in Table 7a.

Scale of Studies

Most studies were conducted on feed material weighing less than 500 kg; six studies were made on samples weighing in excess of 1 t (Table 6).

Head Sample Analyses

The fluorite content of the various samples investigated varied from 12.3% CaF_2 for an ore from Birch Island, B.C., to 73.9% CaF_2 for ore from the former Reliance Fluorspar mine near Madoc, Ont. Most fluorite ores contained between 40 and 60% CaF_2. Generally fluorite from the Madoc area was of fairly high grade, whereas fluorite from the Cardiff area was of low grade. The Birch Island fluorite deposit was markedly variable and contained from 12.3 to 58.0% CaF_2.

Table 3 – Canada, fluorite shipments and trade, 1986–87

		1986		1987	
		(tonnes)	($000)	(tonnes)	($000)
Shipments					
Fluorite		0	0	*	*
Imports					
Cryolite, natural					
United States		1 156	805	1 045	720
Netherlands		250	123	7 332	251
Denmark		216	126	230	136
France		1 912	1 538	0	0
	Total	3 534	2 592	8 607	1 107
Cryolite, synthetic					
United States		3 492	2 681	2 967	2 400
Other countries		9 077	7 163	0	0
	Total	12 569	9 844	2 967	2 400
Fluorite					
Mexico		87 620	11 340	66 586	7 640
Morocco		33 089	4 484	22 500	3 209
China		4 882	507	14 433	1 753
Italy		0	0	7 805	976
United States		10 632	2 388	8 991	2 244
Spain		27 654	3 969	14 251	2 034
France		234	71	0	0
	Total	164 111	22 759	134 566	17 856
Hydrofluoric acid					
United States		1 162	1 373	5 169	4 520
Japan		171	175	142	130
United Kingdom		220	224	70	69
West Germany		2	2	20	8
	Total	1 555	1 774	5 401	4 727

Sources: Statistics Canada; Energy, Mines and Resources Canada
*confidential

Table 4 – Canada, reported fluorite consumption, 1985–86

Reported consumption[1]		Fluorite consumption (in tonnes) 1985	1986[3]
Metallurgical flux		17 064	14 765
Foundries		6 945	6 222
Other[2]		127 082	126 153
	Total	151 091	147 140

Source: Energy, Mines and Resources Canada

[1] Reported from EMR survey on the consumption of nonmetallic minerals by Canadian manufacturing plants.
[2] Includes consumption for the production of aluminum, chemicals, ferro–alloys and miscellaneous uses.
[3] Preliminary.

Table 5 – Major consumers of fluorite, by grade, in Canada

Product	Major consumers
Metallurgical grade (used as gravel or briquettes)	Stelco Inc. Ford Motor Company of Canada, Ltd. Sydney Steel Corporation Dofasco Inc. Atlas Steels, Division of Rio Algom Ltd.
Ceramic grade (used as powder)	The Algoma Steel Corporation, Ltd. Ferro Industrial Products Ltd. A.P. Green Refractories
Acid grade (used as powder or as hydrofluoric acid)	Alcan Aluminum Ltd. Du Pont Canada Inc. General Chemical Canada Ltd. Timminco Ltd.

Source: Energy, Mines and Resources Canada

Table 6 – Summary of beneficiation test work on fluorite ores from the Madoc/Cardiff area of southeastern Ontario: process data

Mine identification	Sample no.	Sample wt (kg)	Product size	Process methods	Ref. no.
Madoc area					
Fluoroc	1	726	n.s.	jigging, tabling	40
Keene	1	104	−210 µm	not stated	38
	2	n.s.	−210 µm	grinding, flotation	
	3	41 500	−210 µm	grinding, washing, thickening, flotation	
Gilman	1	n.s.	−150 µm	grinding, flotation	36
Reliance	1	n.s.	−19 mm	jigging of coarse fraction, tabling of fine fraction	34
	2	n.s.	−19 mm	jigging of coarse fraction, tabling of fine fraction	
	3	n.s.	−19 mm	jigging of coarse fraction, tabling of fine fraction	
Millwood	1	1 200	−30 mm	jigging	39
Coe	1	22	−7 mm	grinding, jigging of coarse fraction, tabling of fine fraction	35
Madoc	1	1 600	−10 +5 mm	crushing, sizing, heavy–media separation	33
Madoc	1	45	−12 +3 mm	crushing, sizing, heavy–media separation	32
	2	84	−19 +3 mm	crushing, sizing, heavy–media separation	
Moira	1	1 360	+1 mm; −420 +210 µm; −210 µm	hydrosizing, tabling	31
	2	454	−2 mm; +710 µm; −710 +425 µm	screening, tabling	
Marmora	1	908	−10 +3 mm; −3 mm to 250 µm	sizing, jigging of coarse fraction, tabling of fine fractions	30

n.s. – not stated

Table 6 – (Cont'd)

Mine identification	Sample no.	Sample wt (kg)	Product size	Process methods	Ref. no.
Wallbridge	1	850	−35 mm + 180 µm; −180 µm	sizing, jigging of coarse fraction, tabling of fine fraction, decrepitation, calcining and slaking	29
Wallbridge	1	127	−180 µm	tabling	28
Cardiff area					
Cardiff	1	78	−210 µm	grinding, desliming, flotation	42
	2	2 270	−210 µm	grinding, desliming, flotation	
Wilberforce	1	n.s.	n.s.	flotation	37

Table 6a – Summary of beneficiation test work on fluorite ores from the Madoc/Cardiff area of southeastern Ontario: analytical data

Mine identification	Sample no.	Head analysis % CaF_2	$BaSO_4$	$CaCO_3$	SiO_2	P_2O_5	Product Grade % CaF_2	$BaSO_4$	$CaCO_3$	SiO_2	P_2O_5	Distn % CaF_2	Ref. no.
Madoc area													
Fluoroc	1	60.3	21.1	16.3	–	–	71.1	5.4	20.4	–	–	86.4	40
Keene	1	32.5	16.1	44.7	5.2	–	n.s.	n.s.	n.s.	n.s.	–	n.s.	38
	2	34.4	14.6	44.6	1.7	–	n.s.	n.s.	n.s.	n.s.	–	n.s.	
	3	30.7	12.3	51.0	1.0	–	86.2	1.4	7.5	0.1	–	91.7	
Gilman	1	61.9	14.2	–	–	–	97.0	n.s.	–	–	–	72.5	36
Reliance	1	49.5	25.5	22.1	1.2	–	77.5*	n.s.	n.s.	n.s.	–	n.s.	34
	2	67.0	17.4	14.2	0.6	–	n.s.	n.s.	n.s.	n.s.	–	n.s.	
	3	73.9	12.5	1.7	6.1	–	77.5*	n.s.	n.s.	n.s.	–	n.s.	
Millwood	1	62.0	2.9	30.2	1.4	–	73.6	3.1	19.9	0.5	–	71.7	39
Coe	1	73.9	12.5	1.7	6.1	–	91.1	n.s.	n.s.	n.s.	–	77.5	35
Madoc	1	n.s.	n.s.	n.s.	n.s.	–	80.4	4.8	9.1	n.s.	–	n.s.	33
Madoc	1	54.9	11.9	30.5	–	–	39.6	47.2	10.0*	–	–	n.s.	32
	2	37.7	13.1	42.1	–	–	49.7	37.6	10.0*	–	–	n.s.	
Moira	1	n.s.	n.s.	n.s.	–	–	n.s.	n.s.	n.s.	–	–	n.s.	31
	2	n.s.	n.s.	n.s.	–	–	70.0*	n.s.	n.s.	–	–	n.s.	

n.s. – not stated
*estimated

Table 6a – (Cont'd)

Mine	Sample	Head analysis %					Product						Ref.
							Grade %					Distn %	
identification	no.	CaF_2	$BaSO_4$	$CaCO_3$	SiO_2	P_2O_5	CaF_2	$BaSO_4$	$CaCO_3$	SiO_2	P_2O_5	CaF_2	no.
Marmora	1	53.8	32.0	n.s.	–	–	85.0*	n.s.	n.s.	–	–	35.0	30
Wallbridge	1	75.4	6.0	15.5	–	–	93.1	n.s.	n.s.	–	–	77.2	29
Wallbridge	1	48.4	4.4	40.0	3.1	–	74.8	n.s.	n.s.	n.s.	–	65.0	28
<u>Cardiff area</u>													
Cardiff	1	13.8	–	45.4	20.1	0.7	98.2	–	0.4	n.s.	0.1	66.4	42
	2	15.1	–	n.s.	n.s.	n.s.	73.6	–	20.5	n.s.	1.3	52.5	
Wilberforce	1	30.9	–	56.2	n.s.	3.0	98.0	–	n.s.	n.s.	1.1	78.4	37

Table 7 – Summary of beneficiation test work on miscellaneous fluorite ores: process data

Location	Sample no.	Sample wt (kg)	Product size	Process methods	Ref. no.
St. Lawrence. Nfld.	1	7	n.s.	grinding, flotation	20
Lake Ainslie. N.S.	1	31	−12 mm; −6 mm; −1.7 mm	sizing, heavy–media separation	25
	1	908	−210 μm	grinding, tabling, flotation	23
	2	14 200	−210 μm	grinding, tabling, flotation	
	1	91	−7 +3 mm; −3 +1 mm; −1 mm	sizing, jigging of +1 mm, tabling of −1 mm	22
	1	3 640	−300 μm	grinding, gravity concentration, flotation	24
	1	29	82% −44 μm	grinding, flotation	26
Whycocomagh, N.S.	1	45	−25 mm to +3 mm	sizing, heavy–media separation	21
Beauchastel, Que.	1	136	−1 mm +600 μm; −600 +300 μm; 70% −75 μm	sizing, tabling, flotation of −75 μm ore	27
Thunder Bay. Ont.	1	227	84% −75 μm	grinding, flotation	41
Birch Island. B.C.	1	908	98% −75 μm	grinding, flotation	49
	1	n.s.	n.s.	grinding, flotation	48
	2	n.s.	n.s.	grinding, flotation	
	1	23	95% −210 μm	magnetic separation, heavy–media separation	44
	1	n.s.	n.s.	flotation	45
	1	18 000	85% −75 μm	grinding, flotation, tabling	43
Liard River, B.C.	1	545	n.s.	heavy–media separation, jigging, tabling, flotation of deslimed ore	46
	1	n.s.	−150 μm	grinding, flotation of deslimed ore	47

n.s. – not stated

Table 7a – Summary of beneficiation test work on miscellaneous fluorite ores: analytical data

	Sample	Head analysis %					Product						Ref.
							Grade %					Distn %	
Location	no.	CaF_2	$BaSO_4$	$CaCO_3$	S	SiO_2	$SrSO_4$	CaF_2	$BaSO_4$	SiO_2	S	CaF_2	no.
St. Lawrence. Nfld.	1	n.s.	–	–	–	–	–	98.6	–	0.29	–	86.9	20
Lake Ainslie. N.S.	1	n.s.	n.s.	n.s.	n.s.	n.s.	–	37.4	50.1	n.s.	n.s.	9.5	25
	1	44.6	27.4	23.4	n.s.	n.s.	–	–	–	–	–	–	23
	2	47.2	23.4	26.5	n.s.	n.s.	–	95.0	2.0	0.3	0.3	84.9	
	1	55.6	18.0	24.1	2.6	n.s.	–	63.0	6.0	–	<1.0	70.4	22
	1	34.5	52.4	13.4	–	–	–	97.6	n.s.	–	–	83.3	24
	1	19.3	45.9	15.1	–	–	–	97.5	n.s.	–	–	85.8	26
Whycocomagh. N.S.	1	n.s.	n.s.	n.s.	–	–	–	n.s.	n.s.	–	–	n.s.	21
Beauchastel. Que.	1	53.4	–	–	1.7	35.5	–	96.8	–	1.6	n.s.	66.0	27
Thunder Bay. Ont.	1	20.5	–	–	0.3	–	–	92.1	–	–	tr	84.0	41
Birch Island, B.C.	1	29.6	n.s.	–	n.s.	–	n.s.	88.5	n.s.	–	n.s.	45.0	49
	1	58.0	n.s.	–	0.8	–	9.0	97.1	n.s.	–	n.s.	70.9	48
	1	34.1	1.5	–	n.s.	–	22.2	n.s.	n.s.	–	n.s.	n.s.	44
	1	12.3	n.s.	–	n.s.	–	n.s.	72.5	n.s.	–	n.s.	61.9	45
	1	27.5	n.s.	–	n.s.	–	21.5	85.7	n.s.	–	n.s.	72.4	43
Liard River, B.C.	1	44.8	41.6*	4.0	–	6.9	–	92.3	n.s.	–	–	80.1	46
	1	44.8	41.6*	4.0	–	6.9	–	98.5	n.s.	–	–	73.4	47

n.s. – not stated
tr – trace
*includes witherite

Mineralogy

The mineralogy of fluorite ore samples with lesser quantities of barite is similar to barite ores with lesser fluorite. Lake Ainslie fluorite–barite ore samples were principally fluorite with barite and calcite. The Madoc fluorite ores were predominantly fluorite with barite, calcite and minor quartz, feldspar and pyrite; some deposits have limestone and calcite. Fluorite samples from the Cardiff area were fine grained with limestone, quartz, minor mica and apatite. The Birch Island sample was relatively low–grade fluorite–celestite ore with an array of numerous minor minerals including barite, quartz, feldspar, mica, biotite, apatite, bastnaesite (lanthanum carbonate), base–metal sulphides and radioactive minerals. The fluorite–witherite deposit near Liard River, B.C., is the only known significant witherite deposit in Canada; the fluorite is mainly coarse grained, and minor minerals include barite, quartz and calcite.

As a general rule, coarse–grained fluorite deposits are of high grade, whereas deposits of finely disseminated fluorite with intergrown barite or celestite are usually of low grade.

Beneficiation

Gravity Concentration

Fluorite ores, like barite ores, usually occur with quartz and calcite. Unlike barite, which has a specific gravity of 4.5, fluorite normally does not respond to selective gravity concentration, as its specific gravity is only 3.2. However, when the liberation size is sufficiently coarse, >2 mm, there is some justification for applying heavy–media separation and jigging.

Several studies applied heavy–media separation to concentrate fluorite, with limited success. One study, on ore from Madoc, successfully separated calcite, at 2.75 sp gr, and fluorite, at 3.05 sp gr, with the barite remaining in the sink fraction (33). Jigging appeared to be more successful than heavy–media separation in concentrating coarse–grained fluorite ores. When coarse and fine fractions were present, the coarse fraction was concentrated by jigging and the fine fraction by tabling. Even with this combination, jigging was not always successful because of the relatively fine liberation sizes.

Tabling of fluorite ores in the intermediate size range, −1.7 mm to 75 µm, appeared to have only moderate success. Two studies reported a separation between barite as the table concentrate, fluorite as the table middling, and calcite as the table tailing (28, 31); the best grade of fluorite, however, was only 74.8% CaF_2 (28).

The production of acid–grade concentrates, >97% CaF_2, was not possible by gravity concentration. High–grade concentrates analyzing 90 to 93% CaF_2 were, however, produced with samples from the Coe and the Wallbridge deposits of the Madoc area. In both studies it was significant that the feed grade analysis was approximately 70% CaF_2 (29, 35).

Flotation

When the liberation size is very fine, <75 µm, flotation is the preferred method. In fact, flotation is probably the most selective beneficiation method for producing acid–grade fluorite. Fluorite ores are concentrated by either reverse or direct flotation. Reverse flotation, the method generally employed, usually involves flotation of base–metal sulphide minerals, followed by either barite or celestite flotation, the flotation tailing being the fluorite concentrate. Direct flotation of fluorite is assisted by depression of other minerals.

A summary of principal parameter data is reported in Table 8, with analytical data in Table 8a. A considerable amount of test work was conducted on the Lake Ainslie fluorite–barite deposit; these beneficiation studies are discussed separately.

The principal collector types for fluorite flotation are oleic acid and the Aerofloat 700 series, fatty–acid derivatives. The general level of collector concentration for oleic acid was between 500 and 1000 g/t and for Aerofloat 708 was between 300 and 500 g/t. The rougher flotation time varied from very fast at 2 min (52) to moderate at 10 min (27, 50, 51). The pH was slightly alkaline, between 7.4 and 8.8, and the pulp density was between 12 and 33% solids.

A unique feature of fluorite flotation is the use of elevated temperatures, which seems to be correlated with the use of oleic acid and fatty–acid derivatives. The phenomenon of elevated temperature aspect of fluorite flotation has been previously reviewed (15); an early example of its use was recorded in 1939 (16). In related studies, the preferred method was to conduct cleaner flotation at elevated temperatures. In one study, a rougher concentrate was reground and conditioned at 100°C (20); another study conducted cleaner flotation at 49°C (45). The reason for the successful use of elevated temperatures is not clear; one explanation is the greater bonding capacity between fluorite and the collector species (17). The solubility of calcium increases from 60 to 90 mg/L at room temperature to 320 mg/L at 50°C (18).

Elevated temperatures can, however, be a troublesome cause of extraneous calcium ions, especially as fluorite ores usually contain calcite. This effect can result in either precipitated oleate collector or calcium activation of quartz, which also occurs in fluorite ores. The use of sequestering agents, e.g., metaphosphates, can overcome this difficulty. The modifiers and depressants used in the various studies included sodium hydroxide, sodium carbonate, sodium silicate, quebracho, tannic acid and oxalic acid. Sodium hydroxide and sodium carbonate were used as pH modifiers. Sodium silicate served as a slime dispersant and as a depressant for quartz; it also hindered the precipitation of calcium soaps from hard water and so promoted the formation and stabilization of froths. Sodium carbonate also has an inhibiting effect on quartz flotation.

The separation of fluorite from quartz is relatively easier than the separation of fluorite from calcite. Both fluorite and calcite are calcium based and the situation is further complicated if apatite is present. Apatite is known to occur in the Cardiff (37) and Birch Island (45) fluorite deposits. The use of oleic acid collector is another factor to consider because calcite, like fluorite, is floated by sodium oleate at pH 7. Calcite is depressed by the use of quebracho or tannic acid reagents, which function through the formation of colloidal hydroxides on the calcite surface.

When celestite is present in a fluorite ore, depression is achieved by using oxalic acid (43); the use of potassium dichromate also depresses celestite. In one study, on Gilman fluorite ore, potassium dichromate was used to depress calcite (52). The function of potassium dichromate in depressing calcite is unclear. Moser (19) observed that when a mixture of fluorite and calcite was treated with chromic nitrate, a grey–green coating formed on the calcite, whereas the fluorite remained unchanged. A possible explanation is that chromic fluoride is more stable than the basic chromic carbonate; being less soluble, the chromic carbonate would form a gelatinous coating on the surface of calcite.

Lake Ainslie Ore

A summary of parameter data for fluorite flotation of Lake Ainslie ore is reported in Table 9, with analytical data in Table 9a. The variability of the feed grade was evident from the reported head analyses of the various studies. The fluorite content varied from 13.3 to 55.6% CaF_2. Although concentrate grades varied from 82.4 to 98.4% CaF_2, no relationship was apparent between head grade and final concentrate grade. The grind size was generally 80% −44 µm, indicating a fine liberation size. Rougher flotation time was moderately fast, between 4 and 10 min; pilot–plant studies generated flotation times of up to 30 min (23). Flotation was conducted under slightly alkaline conditions, pH 8.0 to 9.8, and multistage cleaning was necessary to achieve high grades. Generally up to four cleaning stages produced concentrates analyzing between 82.4 and 93.9% CaF_2. The production of acid–grade fluorite was possible only by increasing the number of cleaning stages from 10 to 13 (54).

Table 8 – Summary of principal parameter data for fluorite flotation

Location	Grind size µm	Rgh float min	pH	Temp °C	Pulp density % solid	No. of cleaner stages	Remarks	Ref no.
St. Lawrence, Nfld.	70% −44	n.s.	8.0	100	n.s.	6*	primary grind and rougher conc conditioned hot	20
Beauchastel, Que.	70% −75	10	8.0	n.s.	n.s.	4		27
Madoc, Ont.	97% −150	10	7.4	n.s.	20	2		51
	100% −300	2	n.s.	n.s.	22	4	deslimed at 44 µm	52
	100% −150	n.s.	n.s.	n.s.	n.s.	4	prior barite flotation	36
Hastings, Ont.	100% −210	3.5	7.9	25	n.s.	3	prior barite flotation	38
Thunder Bay, Ont.	84% −75	n.s.	8.2	n.s.	n.s.	3	prior sulphide flotation	41
Wilberforce, Ont.	100% −210	4	8.6	25	n.s.	7		42
Birch Island, B.C.	90% −75	n.s.	8.3	25	33	4	prior pyrite flotation acted as a desliming aid	43
	87% −75	n.s.	7.6	49	20	4	prior pyrite flotation; fluorite cleaner conditioned hot	45
	83% −75	n.s.	n.s.	n.s.	12	3	prior pyrite flotation followed by celestite flotation	38
	98% −75	n.s.	n.s.	n.s.	n.s.	7	prior celestite flotation	49
	100% −44	10	n.s.	n.s.	n.s.	5		50
Liard River, B.C.	100% −210	n.s.	8.8	n.s.	n.s.	2	prior barite–witherite flotation	46
	100% −150	n.s.	7.9	n.s.	n.s.	4	prior barite–witherite flotation	47

n.s. – not stated

*rougher concentrate reground before cleaner flotation

Table 8a – Summary of reagent concentration data for fluorite flotation

	Collectors, g/t		Modifiers, depressants, g/t					
Location	Aerofloat 708*	Oleic acid	NaOH	Na_2CO_3	Na_2SiO_3	Quebracho	Oxalic acid	Ref. no.
Rougher								
St. Lawrence, Nfld.	–	900	–	2 000	–	–	–	20
Beauchastel, Que.	300	–	–	500	1 200	200	–	27
Madoc, Ont.	–	275	–	750	–	100	–	51
	350	–	–	500	500	–	–	52
	–	1 000	–	500	–	1 000	–	36
Hastings, Ont.	–	885	–	–	–	520	–	38
Thunder Bay, Ont.	–	760	–	200	375	–	–	41
Wilberforce, Ont.	500	–	–	–	600	300	–	42
Birch Island, B.C.	–	90	–	–	1 250	–	200	43
	–	700	60	2 000	650	–	–	45
	–	250	–	–	–	–	–	48
	–	500	–	2 000	–	–	–	49
	–	500	–	2 000	–	250	–	50
Liard River, B.C.	–	750	–	–	–	350	–	47
	–	600	–	–	500	200	–	46

*Aerofloat 708 – fatty–acid derivative

Table 8a – (Cont'd)

Location	Collectors, g/t		Modifiers, depressants, g/t					Ref. no.
	Aerofloat 708*	Oleic acid	NaOH	Na_2CO_3	Na_2SiO_3	Quebracho	Tannic acid	
<u>Cleaner</u>								
St. Lawrence, Nfld.	–	–	–	–	250	–	–	20
Beauchastel, Que.	150	192	–	–	200	–	–	27
Madoc, Ont.	–	10	500	–	100	–	–	51
	125	–	–	250	–	375	175	52
	–	–	–	–	1 500	–	–	36
Hastings, Ont.	–	–	–	–	210	–	–	38
Thunder Bay, Ont.	–	–	–	300	300	–	–	41
Wilberforce, Ont.	250	–	–	2 900	900	–	–	42
Birch Island, B.C.	–	25	–	–	–	700	–	43
	–	–	–	2 000	–	–	–	45
	–	–	–	–	–	–	–	48
	–	–	–	–	–	–	–	49
	–	–	–	–	–	–	–	50
Liard River, B.C.	–	–	–	250	250	–	–	47
	–	200	–	650	250	–	–	46

*Aerofloat 708 – fatty–acid derivative

Table 9 – Summary of process parameter data for fluorite flotation of Lake Ainslie barite–fluorite ore

Grind size µm	Rgh float min	Temp °C	pH	No. of cleaner stages	Concentrate Grade % CaF_2	Concentrate Distn %	Remarks	Ref. no.
93% –44	15	96	8.5	6	97.5	85.8	ground before heating	26
n.s.	9	n.s.	9.3	4	91.4	91.9	no regrind or preheating	53
99% –44	10	90	8.8	13	98.4	38.5	regrind rougher concentrate, heated	54
98% –44	10	90	9.7	10	97.8	73.5	before cleaner flotation	54
100% –44	10	90	9.1	9	97.5	43.4		54
100% –300	n.s.	n.s.	8.8	rgh	48.7	44.4	rougher flotation only, feed size too coarse	55
100% –210	6	53	9.8	3	82.5	74.2	fluorite flotation before barite flotation	56
96% –75	4	90	9.2	5	95.4	86.3	fluorite flotation before barite flotation	57
100% –75	n.s.	n.s.	n.s.	2	82.4	77.1	diamine collector removed by hypochlorite washing	58
93% –210	30	25	8.0	n.s.	n.s.	n.s.		23
100% –300	16	33	8.1	n.s.	97.6	83.3		24
n.s.	n.s.	n.s.	n.s.	n.s.	63.0	70.4	jigging and tabling, no flotation	22

n.s. – not stated

Table 9a – Summary of reagent concentration data for fluorite flotation of Lake Ainslie barite–fluorite ore

	Collectors, g/t			Modifiers, depressants, g/t								
	Oleic acid	Diamine	Fatty acids*	Aero 610	Na_2CO_3	NaF	Na_2SiO_3	Quebracho	Ca lignin sulphonate	$AlCl_3$	$KHCO_3$	Ref. no.
Rougher												
	600	–	–	–	2 000	–	–	250	–	–	–	26
	–	–	800	–	–	–	–	500	–	–	–	53
	–	–	750	–		–	–	–	–	–	–	54
	–	–	900	–	–	–	–	–	–	–	–	54
	–	–	1 100	–	–	–	–	–	–	–	–	54
	–	–	1 000	1 000	–	1 000	500	–	–	–	–	55
	–	–	250	–	500	3 000	–	–	3 000	500	–	56
	–	–	3 345	–	3 500	1 350	315	–	–	–	–	57
	–	400	–	–	–	NH_4F	–	–	–	–	n.s.	58
	700	–	–	–	–	–	–	125	–	–	–	23
	750	–	–	–	–	–	–	200	–	–	–	24
Cleaner												
	–	–	–	–	–	–	–	1 200	–	–	–	54
	–	–	–	–	–	–	–	1 400	–	–	–	54
	–	–	–	–	–	–	–	2 250	–	–	–	54
	–	–	50	–	–	300	–	45	300	–	–	56
	–		675	–	–	125	675	–	–	–	–	57
	60	80	–	–	–	NH_4F	–	–	–	–	n.s.	58
	–	–	–	–	–	–	–	275	–	–	–	23
	–	–	–	–	–	–	–	395	–	–	–	24

*Aerofloat 765

n.s. – not stated

The collectors employed for fluorite flotation were oleic acid and Aerofloat 765, a fatty–acid derivative. The preferred collector, Aerofloat 765, was added at a rate of 1000 g/t although the range of collector concentration varied from 250 to 3345 g/t. Oleic acid addition was between 600 and 750 g/t. Elevated temperatures, between 53 and 96°C, were employed, although 90 to 96°C was the usual temperature range. In some studies the heat was applied at the beginning of the rougher flotation stage whereas in others the reground rougher concentrate was heated. One study employed the use of a cationic collector, diamine, with ammonium fluoride and potassium bicarbonate as modifiers. What function these modifiers had on fluorite flotation is not clear, but it seems that the fluoride ion was acting as an activator for fluorite, although it was reported to depress barite. Potassium bicarbonate was also reported to be a barite depressant.

The modifiers employed included sodium carbonate, sodium fluoride, sodium silicate, quebracho, lignin sulphonate and aluminum chloride. The function of some of these has already been discussed. Aluminum chloride and lignin sulphonate were employed as calcite depressants (56); sodium fluoride was a depressant for barite where fluorite was floated before barite (56, 57).

Miscellaneous Techniques

Magnetic separation was used to pre–concentrate Birch Island fluorite–celestite ore by removing biotite. Decrepitation, calcining and slaking were employed on an ore from the Wallbridge mine, Madoc, Ont., to separate fluorite from calcite. A considerable portion of the calcite was removed by this method (29).

CONCLUDING COMMENTS

As previously noted, this report is the third in a Summary Report series on industrial minerals. It is hoped that the information presented in these and subsequent reports will be useful to all who are interested in industrial minerals in Canada.

A wide distribution of the Summary Report series is planned as a means of encouraging interest in and further development of industrial minerals for use in many diverse applications, e.g., fillers for everyday products such as paint and rubber, and in the high–technology sector for products such as high–performance plastics, silicon chips and fibre–optic filaments.

The authors encourage feedback from reports in this series. Comments and suggestions for further R&D will be invaluable to CANMET and associated government and industry groups in planning and conducting research on industrial minerals.

ACKNOWLEDGEMENTS

The authors are indebted to a number of companies and individuals in the private sector and to industrial mineral specialists in provincial and federal governments for providing background data and information on fluorite deposits. Without their help and interest, this report would not have been possible.

GENERAL REFERENCES

1. Collings, R.K. and Andrews, P.R.A. "Industrial minerals: problem areas and opportunities"; *CANMET Rep* 85–5E; CANMET, Energy, Mines and Resources Canada; 1983.

2. Dawson, K.R. "Geology of barium, strontium, and fluorine deposits in Canada"; *Econ Geol Rep* 34; Geological Survey of Canada; 1985.

3. Van Alstine, R.E. "The fluorspar deposits of St. Lawrence, Nfld."; *Econ Geol Rep* 39(2):109–132; Geological Survey of Canada; 1944.

4. Carr, G.F. "Newfoundland fluorspar"; *Can Min and Metall Bull* 57:55–59; 1954.

5. Howse, A. et al. "Fluorspar deposits of St. Lawrence area, Nfld.: geology and economic potential"; *Rep* 83–9; Dept of Mines and Energy, St. John's, Nfld.; 1983.

6. Hodge, B.L. et al. "Appraisal of the Alcan production operations based on St. Lawrence fluorspar deposits"; *Rep* IL/13, 14, IM/3; Dept of Mines and Energy, St. John's, Nfld.; 1977.

7. Clarke, G. (ed.) "The world's fluorspar industry – following the market"; *Ind Miner (London)*, 234:25; 1987.

8. Zurowski, M. "Barite/fluorite deposits of Lake Ainslie – an economical appraisal"; *Trans Can Inst Min Metall* 75:318–321; 1972.

9. Buchanan, R.M. "Mineralogical examination of fluorite and kaolin from Mount Pleasant Mines Ltd., N.B."; *Miner Process Test Rep* MPT 63–5; CANMET, Energy, Mines and Resources Canada; 1963.

10. Bartley, C.M. "Fluorspar – flux to fluorocarbons"; AGM, Can Inst Min Metall, Ottawa; 1962.

11. Guillet, G.R. "Fluorspar in Ontario"; *Ind Miner Rep* 12; Ontario Min Nat Res, Toronto, Ont.; 1964.

12. Joubin, J.H. and James, D.H. "Geological features of the Rexspar uranium deposits"; *Can Min J* 77(7):59–60; 1956.

13. Lang, A.H. et al. "Canadian deposits of uranium and thorium"; *Econ Geol Ser* 16; Geological Survey of Canada; 1962.

14. Wyman, R.A. "Digest of information on Rexspar property, Birch Island, B.C."; *Internal Rep* MPI 70–23; CANMET, Energy, Mines and Resources Canada; 1970.

15. Trahar, W.J. "The flotation of fluorite – a review"; *Inf Cir* 4; CSIRO, *Ore Dress Invest* Univ of Melbourne, Australia; 1958.

16. Clemmer, J.B. et al. "Flotation of southern Illinois lead–zinc–fluorspar ores"; *Rep Invest* 3437; U.S. Bur Mines; 1939.

17. Cook, M.A. et al. "Fluorite flotation"; *Bull* 40:14, Parts 1 to 3; Univ of Utah; 1950.

18. Sutherland, K.L. and Wark, I.W. "Principles of flotation"; 2nd edn., *Australas Inst Min Metall*, Melbourne; 1955.

19. Moser, K. "Investigations of the flotative separation of fluorite from calcite"; Berg. U. Huettenm, Jahrb., Vienna 83:109 and 133; 1935.

CANMET BENEFICIATION STUDIES

Newfoundland

20. (Nfld.–1)* Hartman, F.H. "Flotation of fluorite ore submitted by Alcan, Arvida, Que."; *Miner Process Test Rep* 67–13; CANMET, Energy, Mines and Resources Canada; 1967.

Nova Scotia

21. (N.S.–1) Johnson, J.D. "Sink–float tests on Whycocomagh fluorite ore, Cape Breton, N.S."; *Ore Dress Invest Rep* 925; CANMET, Energy, Mines and Resources Canada; 1940.

22. (N.S.–2) Anon. "Concentration of fluorite in a barite/fluorite/calcite ore from Lake Ainslie, N.S."; *Ore Dress Invest Rep* 1014, CANMET, Energy, Mines and Resources Canada; 1941.

23. (N.S.–3) Carr, E.L. "Concentration tests on fluorite/barite ore from the Papke vein, Lake Ainslie, N.S."; *Ore Dress Invest Rep* 1811; CANMET, Energy, Mines and Resources Canada; 1945.

24. (N.S.–4) Carr, E.L. "Concentration tests on barite/fluorite ore from the Johnson mine, Lake Ainslie, N.S."; *Ore Dress Invest Rep* 1851; CANMET, Energy, Mines and Resources Canada; 1945.

25. (N.S.–5) Haw, V.A. "Report on heavy–media tests on Lake Ainslie fluorite/barite ore"; *Ind Miner Rep* 330; CANMET, Energy, Mines and Resources Canada; 1955.

26. (N.S.–6) Wyman, R.A. and Hartman, F.H. "Beneficiation of barite/fluorite ore from Lake Ainslie, N.S."; *Div Rep* 68–70 (IR); CANMET, Energy, Mines and Resources Canada; 1968.

Quebec

27. (Que.–1) McClelland, W.R. "Concentration of fluorite from Beauchastel Lake, Rouyn–Noranda, Que."; *Ore Dress Invest Rep* 852; CANMET, Energy, Mines and Resources Canada; 1940.

Ontario

28. (Ont.–1) Carnochan, R.K. "Separation of fluorite, calcite, and barite from the Wallbridge mine, Madoc, Ont."; *Ore Dress Invest Rep* 115; CANMET, Energy, Mines and Resources Canada; 1920.

*Reference no. with CANMET identification in brackets.

29. (Ont.–2) Carnochan, R.K. "Concentration of fluorite and barite from the Wallbridge mine, Madoc, Ont."; *Ore Dress Invest Rep* 166; CANMET, Energy, Mines and Resources Canada; 1924.

30. (Ont.–3) Carnochan, R.K. "Evaluation of barite, fluorite, and calcite from Marmora Minerals Ltd.; *Ore Dress Invest Rep* (not numbered); CANMET, Energy, Mines and Resources Canada; 1939.

31. (Ont.–4) Anderson, A.K. "Table concentration of barite/fluorite ore from the Moira fluorspar mine, Madoc, Ont."; *Ore Dress Invest Rep* 888; CANMET, Energy, Mines and Resources Canada; 1940.

32. (Ont.–5) Johnson, J.D. "Sink–float tests on fluorite ore from Madoc, Ont."; *Ore Dress Invest Rep* 934; CANMET, Energy, Mines and Resources Canada; 1940.

33. (Ont.–6) Johnson, J.D. "Sink–float tests on fluorite ore from Madoc, Ont."; *Ore Dress Invest Rep* 959; CANMET, Energy, Mines and Resources Canada; 1941.

34. (Ont.–7) Bennett, R.L. "Concentration of fluorite/barite/calcite ore from Reliance Fluorspar, Madoc, Ont."; *Ore Dress Invest Rep* 4151; CANMET, Energy, Mines and Resources Canada; 1941.

35. (Ont.–8) Anon. "Concentration of fluorite from a fluorite/barite/calcite ore from Coe mine, Ont."; *Ore Dress Invest Rep* (not numbered); CANMET, Energy, Mines and Resources Canada; 1941.

36. (Ont.–9) Anon. "Results of batch test on Gilman fluorite ore from Madoc, Ont."; *Ore Dress Invest Rep* (not numbered); CANMET, Energy, Mines and Resources Canada; 1941.

37. (Ont.–10) Turrall, W.T. "Concentration of fluorite from fluorite/calcite/apatite ore from Wilberforce, Ont."; *Ore Dress Invest Rep* 4401; CANMET, Energy, Mines and Resources Canada; 1944.

38. (Ont.–11) Smedley, H. "Treatment of fluorite ore from Keene Mines, Hastings Twp, Madoc, Ont."; *Ore Dress Invest Rep* 4402; CANMET, Energy, Mines and Resources Canada; 1944.

39. (Ont.–12) Anon. "Jigging tests on fluorite ore from Millwood Fluorspar Mines, Madoc, Ont."; *Ore Dress Invest Rep* 1989; CANMET, Energy, Mines and Resources Canada; 1946.

40. (Ont.–13) Beer, H.L. "Gravity concentration of barite and fluorite ore from Fluoroc Mines Ltd., Johnson, Madoc, Ont."; *Ore Dress Invest Rep* 2235; CANMET, Energy, Mines and Resources Canada; 1948.

41. (Ont.–14) Beer, H.L. "Flotation tests on fluorite ore from the East End Silver mine, Thunder Bay, Ont."; *Ore Dress Invest Rep* 2412; CANMET, Energy, Mines and Resources Canada; 1948.

42. (Ont.–15) Beer, H.L. "Flotation concentration tests on a shipment of fluorite ore from Cardiff Fluorite Mines Ltd., Wilberforce, Ont."; *Miner Dress Rep* 2829; CANMET, Energy, Mines and Resources Canada; 1951.

British Columbia

43. (B.C.–1) Beer, H.L. "Concentration of fluorite ore from Birch Island, B.C."; *Ore Dress Invest Rep* 4501; CANMET, Energy, Mines and Resources Canada; 1945.

44. (B.C.–2) Beer, H.L. "Differential separation procedure for a fluorite/celestite ore from Birch Island, B.C."; *Ore Dress Invest Rep* 2437; CANMET, Energy, Mines and Resources Canada; 1948.

45. (B.C.–3) Beer, H.L. "Flotation of radioactive fluorite ore from Birch Island, B.C."; *Ore Dress Invest Rep* (not numbered); CANMET, Energy, Mines and Resources Canada; 1952.

46. (B.C.–4) Beer, H.L. "Report on a sample of fluorite/witherite ore from Conwest Exploration Co., B.C."; *Ind Miner Rep* 239; CANMET, Energy Mines and Resources Canada; 1952.

47. (B.C.–5) Beer, H.L. "Further flotation concentration tests on a fluorite/witherite ore from Conwest Exploration Co., B.C."; *Ind Miner Rep* 244; CANMET, Energy, Mines and Resources Canada; 1953.

48. (B.C.–6) Wyman, R.A. "Concentration of fluorite ore from Birch Island, B.C."; *Div Rep* 59–13 (IR); CANMET, Energy, Mines and Resources Canada; 1959.

49. (B.C.–7) Hartman, F.M. and Wyman, R.A. "Concentration of Birch Island, B.C., fluorite ore to metallurgical grade"; *Div Rep* 63–33 (IR); CANMET, Energy, Mines and Resources Canada; 1963.

50. (B.C.–8) Wyman, R.A. "Digest of information on Rexspar fluorite, Birch Island, B.C."; *Miner Process Inf Rep* 70–23; CANMET, Energy, Mines and Resources Canada; 1970.

OTHER R&D REPORTS

51. Thom, C. "Beneficiation of fluorite ore from Madoc, Ont."; Denver Equipment Company, Denver, Colorado, U.S.A.; 1940.

52. Gieseke, E.W. "Beneficiation of fluorite ore from Madoc, Ont."; American Cyanamid Company, Mining Chemicals, Wayne, New Jersey, U.S.A.; 1943.

53. Grice, M.A.K. "Flotation lock–cycle tests on Lake Ainslie barite/fluorite ore"; Dept of Mines and Energy, Halifax, N.S.; 1972.

54. *Ibid.*

55. Goodman, G.P. "Beneficiation of Lake Ainslie barite/fluorite ore"; *Rep* 0–66338; Ontario Research Foundation, Mississauga, Ont.; 1966.

56. Scobie, A.G. "The recovery of barite, fluorite and calcite from Lake Ainslie ore"; *Prog Rep* 1; Lakefield Research, Lakefield, Ont.; 1966.

57. Hurd, H.C. "Laboratory batch gravity and flotation evaluation of Lake Ainslie barite/fluorite ore"; Denver Equipment Company, Denver, Colorado, U.S.A.; 1967.

58. Noblitt, H.L. "Lake Ainslie barite/fluorite test work"; Yale Lead and Zinc Mines Ltd.; 1968.

59. Day, A. "Flotation investigation of Lake Ainslie barite/fluorite ore"; *Project* 1986; Cyanamid International, Mining Chemicals, Wayne, New Jersey, U.S.A.; 1971.

APPENDIX

SUMMARIES OF FLUORITE BENEFICIATION STUDIES BY CANMET

NEWFOUNDLAND

Identification	:	Nfld.–1 (Ref. No. 20)*
Report – Title	:	FLOTATION OF FLUORITE ORE SUBMITTED BY ALCAN, ARVIDA, QUE.
– Authors	:	F.H. Hartman
– No. and Date	:	*Mineral Processing Test Report* 67–13 (1967)
Sample Description	:	7 kg of heavy–media sinks; analysis not stated.
Mineralogy	:	Fluorite with minor silica and calcite.
Purpose	:	To reduce the silica content to <1% SiO_2.
Beneficiation	:	Primary grinding and rougher flotation followed by regrinding of the rougher concentrate with hot conditioning preparatory to cleaner flotation.
Results	:	A fluorite concentrate analyzing 98.6% CaF_2 and 0.29% SiO_2 was obtained with a recovery of 86.9%.

*CANMET identification with reference no. in brackets.

NOVA SCOTIA

Identification : N.S.-1 (Ref. No. 21)

Report - Title : SINK-FLOAT TESTS ON WHYCOCOMAGH FLUORITE ORE, CAPE BRETON, N.S.
- Author : J.D. Johnson
- No. and Date : *Ore Dressing Investigation Report* 925 (1940)

Sample Description : 45 kg of lump ore; analysis not stated.

Mineralogy : The ore contained calcite, fluorite and barite in moderately close association.

Beneficiation : Crushing to pass 25 mm and screening at 3 mm; sizing at intermediate size fractions; heavy-media sink-float analysis using galena as the media.

Results : An unsatisfactory separation between fluorite and barite at the sizes examined.

Remarks : It is necessary to grind the ore finer and to concentrate the barite and fluorite by flotation.

Identification : N.S.-2 (Ref. No. 22)

Report - Title : CONCENTRATION OF FLUORITE IN A BARITE/ FLUORITE/CALCITE ORE FROM LAKE AINSLIE, N.S.
- Author : Anon.
- No. and Date : *Ore Dressing Investigation Report* 1014 (1941)

Sample Description : 91 kg of lump ore; 55.61% CaF_2, 24.07% $CaCO_3$, 17.96% $BaSO_4$, 2.59% S.

Mineralogy : Green fluorite, yellow-white barite and grey-white calcite.

Purpose : To produce a fluorite concentrate with <1% S.

Beneficiation : Sizing to -7 +3 mm; -3 +1 mm; jigging of both size fractions and tabling of the -1 mm fraction.

Results : Low grades and recoveries of fluorite were obtained; the concentrate analyzed 62.98% CaF_2, 5.96% $BaSO_4$, 28.04% $CaCO_3$ with a recovery of 70.38%; S was <1%.

Investigation : N.S.–3 (Ref. No. 23)

Report – Title : CONCENTRATION TESTS ON FLUORITE/BARITE ORE FROM THE PAPKE VEIN, LAKE AINSLIE, N.S.
– Author : E.L. Carr
– No. and Date : *Ore Dressing Investigation Report* 1811 (1945)

Sample Description : 908 kg for laboratory evaluation; 44.60% CaF_2, 27.35% $BaSO_4$, 23.40% $CaCO_3$; 14.2 t for pilot–plant evaluation; 47.22% CaF_2, 23.44% $BaSO_4$, 26.52% $CaCO_3$.

Mineralogy : Green fluorite, white to buff barite, purple to pink calcite.

Purpose : To produce separate barite and fluorite concentrates with <1% SiO_2 and <1% S, respectively.

Beneficiation : Laboratory sample: grinding to –210 µm, tabling to remove majority of barite, and flotation to remove the remaining barite. Pilot–plant sample: same as for the laboratory evaluation with the addition of fluorite flotation.

Results : A combined table and flotation barite concentrate analyzing 94.81% $BaSO_4$, 4.27% CaF_2, 0.50% SiO_2 was obtained with a recovery of 84.50%. A fluorite concentrate analyzing 94.97% CaF_2, 1.96% $BaSO_4$, 0.25% SiO_2, 0.30% S was obtained with a recovery of 84.86%.

Investigation : N.S.–4 (Ref. No. 24)

Report – Title : CONCENTRATION TESTS ON BARITE/FLUORITE ORE FROM THE JOHNSON MINE, LAKE AINSLIE, N.S.
– Author : E.L. Carr
– No. and Date : *Ore Dressing Investigation Report* 1851 (1945)

Sample Description : 1.82 t of Johnson ore; 77.9% $BaSO_4$, 19.2% CaF_2, 2.4% $CaCO_3$; 1.82 t of Trout River ore; 25.0% $BaSO_4$, 48.0% CaF_2, 27.0% $CaCO_3$; blended ore, 1:1, analyzed 52.4% $BaSO_4$, 34.5% CaF_2, 13.4% $CaCO_3$.

Mineralogy : Buff–coloured barite, green fluorite, and white calcite.

Beneficiation : Pilot–plant treatment: blended 1:1 ore was crushed to 12 mm, screening at 300 µm, and grinding to –300 µm; gravity concentration, followed by barite flotation and fluorite flotation.

Results : Heavy–media separation does not appear to be a suitable method for preconcentration of this ore.

Potential Use : Fluorite was suitable for manufacture of fluorine chemicals.

Investigation	:	N.S.–5 (Ref. No. 25)
Report – Title	:	REPORT ON HEAVY–MEDIA TESTS ON LAKE AINSLIE FLUORITE/BARITE ORE
– Author	:	V.A. Haw
– No. and Date	:	*Industrial Minerals Report* 330 (1955)
Sample Description	:	31 kg of –150 mm ore; analysis not stated.
Mineralogy	:	Green fluorite, barite and calcite.
Beneficiation	:	Crushing to –25 mm, sizing at 12 mm, 6 mm and 2 mm; heavy–media sink–float analysis was conducted on the sized products using sp gr of 3.20 to 3.25.
Results	:	The best concentration was achieved in the –6 +2 mm fraction where a product analyzing 50.1% $BaSO_4$ and 37.4% CaF_2 was obtained, but with a weight recovery of only 9.5%.
Remarks	:	Heavy–media separation does not appear to be suitable for preconcentration of this ore.

Identification	:	N.S.–6 (Ref. No. 26)
Report – Title	:	BENEFICIATION OF BARITE/FLUORITE ORE FROM LAKE AINSLIE, N.S.
– Author	:	R.A. Wyman and F.H. Hartman
– No. and Date	:	*Division Report* 68–70 (1968)
Sample Description	:	29 kg of –4.8 mm drill ore; 45.9% $BaSO_4$, 19.3% CaF_2, 15.1% $CaCO_3$.
Mineralogy	:	Barite, fluorite and calcite with interpenetration and inclusions of barite in the fluorite; minor quartz, celestite and iron oxides.
Beneficiation	:	Lump ore was used to assess the potential of autogenous grinding; flotation was used to produce separate barite and fluorite concentrates after multistage cleaning.
Results	:	A barite concentrate analyzing 95.0% $BaSO_4$ with a 90% recovery and a fluorite concentrate analyzing 97.5% CaF_2 with an 85.8% recovery were obtained. Autogenous grinding was an efficient method of size reduction.
Potential Use	:	Fluorite suitable for manufacture of fluorine chemicals.

QUEBEC

Identification	:	Que.–1 (Ref. No. 27)
Report – Title	:	CONCENTRATION OF FLUORITE FROM BEAUCHASTEL LAKE, ROUYN–NORANDA, QUE.
– Author	:	W.R. McClelland
– No. and Date	:	*Ore Dressing Investigation Report* 852 (1940)
Sample Description	:	136 kg of lump ore; 53.40% CaF_2, 35.50% SiO_2, 1.68% S.
Mineralogy	:	The ore consisted essentially of purple fluorite, intimately intergrown with quartz and brecciated, siliceous wall rock, with minor sphalerite, pyrite and galena.
Beneficiation	:	Tabling of –1 mm +600 µm and –600 +300 µm fractions; flotation of ore ground to 70% –75 µm; sulphides prefloated before fluorite flotation.
Results	:	Tabling was unsatisfactory in concentrating the fluorite; flotation produced a concentrate analyzing 96.82% CaF_2 and 1.59% SiO_2 with a recovery of 66%.

ONTARIO

Identification	:	Ont.–1 (Ref. No. 28)
Report – Title	:	SEPARATION OF FLUORITE, CALCITE, AND BARITE FROM THE WALLBRIDGE MINE, MADOC, ONT.
– Author	:	R.K. Carnochan
– No. and Date	:	*Ore Dressing Investigation Report* 115 (1920)
Sample Description	:	127 kg of ore; 48.35% CaF_2, 40.00% $CaCO_3$, 4.40% $BaSO_4$, 3.10% SiO_2.
Mineralogy	:	Not stated.
Beneficiation	:	Tabling of −180 µm ore.
Results	:	A fluorite concentrate analyzing 74.8% CaF_2 with a recovery of 65%, a barite concentrate analyzing 81.8% $BaSO_4$ with a recovery of 75%, and a calcite concentrate analyzing 59.2% $CaCO_3$ with a recovery of 64% were obtained.

Identification	:	Ont.–2 (Ref. No. 29)
Report – Title	:	CONCENTRATION OF FLUORITE AND BARITE FROM THE WALLBRIDGE MINE, MADOC, ONT.
– Author	:	R.K. Carnochan
– No. and Date	:	*Ore Dressing Investigation Report* 166 (1924)
Sample Description	:	850 kg of ore; 75.43% CaF_2, 15.50% $CaCO_3$, 6.00% $BaSO_4$.
Mineralogy	:	Essentially fluorite with calcite and minor barite and quartz.
Beneficiation	:	Jigging, tabling, decrepitation, calcining, slaking, washing and tabling.
Results	:	Jigging was not suitable at −5 mm; tabling at −180 µm produced high–grade fluorite and barite concentrates. Decrepitation successfully reduced fluorite in size but also reduced crystalline calcite in size. Calcining, slaking and washing removed a considerable portion of the calcite; a high grade 93.1% CaF_2 fluorite concentrate was obtained by tabling at −180 µm with a recovery of 77.2%. A barite concentrate analyzing 52.5% $BaSO_4$ was obtained with a recovery of only 16%.
Remarks	:	Amorphous calcite does not decrepitate.

Identification	: Ont.–3 (Ref. No. 30)
Report – Title	: EVALUATION OF BARITE, FLUORITE, AND CALCITE FROM MARMORA MINERALS LTD.
– Author	: R.K. Carnochan
– No. and Date	: *Ore Dressing Investigation Report* (not numbered) (1939)
Sample Description	: 908 kg of –25 mm ore; 53.76% CaF_2, 31.95% $BaSO_4$.
Mineralogy	: Green fluorite, white barite, grey–white calcite.
Beneficiation	: Jigging of sized fractions, –10 mm to 3 mm, and tabling of sized fractions from 3 mm to 250 µm.
Results	: Tabling of the –250 µm fractions produced the highest grade of barite concentrate, 76.7% $BaSO_4$. A –2 mm +250 µm fluorite concentrate analyzing approximately 85% CaF_2 was obtained but with a recovery of only 35%. Jigging produced low–grade barite and fluorite concentrates.
Remarks	: Jigging was not successful because of unliberated grains and grain fracturing during jigging with the result that fine, heavy mineral grains were found with coarse, lighter grains.

Identification	: Ont.–4 (Ref. No. 31)
Report – Title	: TABLE CONCENTRATION OF BARITE/FLUORITE ORE FROM THE MOIRA FLUORSPAR MINE, MADOC, ONT.
– Author	: A.K. Anderson
– No. and Date	: *Ore Dressing Investigation Report* 888 (1940)
Sample Description	: 1.36 t of Moira ore and 454 kg of Parry ore; analysis not stated.
Mineralogy	: Barite, fluorite and calcite with coloured gangue.
Beneficiation	: Moira ore was treated by hydraulic classification and tabling of –210 µm, –420 +210 µm and +1 mm fractions. Parry ore was crushed and screened through 2 mm, followed by tabling of –2 mm +710 µm and –710 +425 µm.
Results	: Tabling was not successful on Moira ore because of inefficient classification. The beneficiation of Parry ore was more successful. The table concentrate was mostly barite; the middlings were fluorite; and the tailing was calcite. The grade was estimated to be 70% CaF_2, but no recovery figures were reported.

Identification : Ont.–5 (Ref. No. 32)

Report – Title : SINK–FLOAT, TESTS ON FLUORITE ORE FROM MADOC, ONT.

– Author :, J.D. Johnson

– No. and Date : *Ore Dressing Investigation Report* 934 (1940)

Sample Description : Lot 1: 45 kg of unscreened –100 mm ore; 54.88% CaF_2, 30.50% $CaCO_3$, 11.86% $BaSO_4$;
Lot 2: 84 kg of –31 +2 mm screen rejects; 37.69% CaF_2, 42.07% $CaCO_3$, 13.10% $BaSO_4$.

Mineralogy : Fluorite and barite with limestone and calcite as the chief gangue minerals, minor quartz.

Benefication : Crushing and sizing followed by heavy–media separation using galena as the media at sp gr 2.80; unscreened ore was sized at –12 +3 mm and screen rejects were sized at –19 +3 mm.

Results : The floats contained some fluorite, and the sinks contained most of the barite with about 10% $CaCO_3$; the sink fraction for Lot 1 analyzed 39.56% CaF_2, 47.19% $BaSO_4$ and for Lot 2, 49.74% CaF_2, 37.56% $BaSO_4$. No recoveries were reported.

Remarks : Further upgrading of the sinks by jigging was recommended.

Identification : Ont.–6 (Ref. No. 33)

Report – Title : SINK–FLOAT TESTS ON FLUORITE ORE FROM MADOC, ONT.

– Author : J.D. Johnson

– No. and Date : Ore *Dressing Investigation Report* 959 (1941)

Sample Description : 1.6 t of lump ore; analysis not stated.

Mineralogy : Fluorite and barite with limestone, calcite and quartz as gangue minerals.

Beneficiation : Crushing to 16 mm and sizing at 3 mm; sink–float heavy–media separation using galena as the media.

Results : Calcite was separated at sp gr 2.75, and fluorite from barite at sp gr 3.05; a concentrate analyzing 80.43% CaF_2, 9.11% $CaCO_3$, 4.76% $BaSO_4$ for the –10 +5 mm fraction was obtained; recovery was not stated.

Remarks : The sink–float method used was the Huntington–Heberlein process.

Identification : Ont.–7 (Ref. No. 34)

Report – Title : CONCENTRATION OF FLUORITE FROM A FLUORITE/BARITE/CALCITE ORE FROM RELIANCE FLUORSPAR, MADOC, ONT.

– Author : R.L. Bennett

– No. and Date : *Ore Dressing Investigation Report* 4151 (1941)

Sample Description : Lot 1, Lot 2 and Lot 3, −19 mm lump ore, weight not stated.
Lot 1: 49.54% CaF_2, 25.52% $BaSO_4$, 22.14% $CaCO_3$, 1.24% SiO_2;
Lot 2: 67.02% CaF_2, 17.42% $BaSO_4$, 14.19% $CaCO_3$, 0.58% SiO_2;
Lot 3: 73.86% CaF_2, 12.52% $BaSO_4$, 1.69% $CaCO_3$, 6.11% SiO_2.

Mineralogy : Lots 1 and 2 were similar mineralogically; fluorite was present as greenish to grey, transparent to translucent, coarsely crystalline masses that were relatively free of other minerals. A fine-grained brownish limestone and white barite occurred in considerable amounts with minor amounts of white calcite. In Lot 2, there was more interpenetration of other minerals. Lot 3 contained very little carbonates, and no intergrowth of fluorite with barite or gangue was apparent.

Beneficiation : Jigging and tabling.

Results : Concentrates analyzing between 75 and 80% CaF_2 were obtained; the separation of calcite from fluorite was more difficult in Lot 2 because of interlocking of calcite with fluorite.

Identification : Ont.–8 (Ref. No. 35)

Report – Title : CONCENTRATION OF FLUORITE FROM A FLUORITE/BARITE/CALCITE ORE FROM COE MINE, ONT.

– Author : Anon.

– No. and Date : *Ore Dressing Investigation Report* (not numbered) (1941)

Sample Description : 22 kg of −50 +19 mm lump ore; 73.86% CaF_2, 12.52% $BaSO_4$, 6.11% SiO_2, 1.69% $CaCO_3$.

Mineralogy : Not stated.

Beneficiation : Grinding to 7 mm, jig and table concentration.

Results : A concentrate analyzing 91.11% CaF_2 was obtained with a recovery of 77.5%.

Identification : Ont.–9 (Ref. No. 36)

Report – Title : RESULTS OF BATCH TEST ON GILMAN FLUORITE ORE FROM MADOC, ONT.
– Author : Anon.
– No. and Date : *Ore Dressing Investigation Report* (not numbered) (1941)

Sample Description : Weight not stated; 61.9% CaF_2, 14.2% $BaSO_4$.

Mineralogy : Not stated.

Beneficiation : Grinding to −150 μm, barite flotation followed by fluorite flotation.

Results : A barite concentrate analyzing 96.4% $BaSO_4$ was obtained with a recovery of 87.9%; a fluorite concentrate analyzing 97.0% CaF_2 was obtained with a recovery of 72.5%.

Identification : Ont.–10 (Ref. No. 37)

Report – Title : CONCENTRATION OF FLUORITE FROM FLUORITE/CALCITE/APATITE ORE FROM WILBERFORCE, ONT.
– Author : W.T. Turrall
– No. and Date : *Ore Dressing Investigation Report* 4401 (1944)

Sample Description : Weight not stated; 30.85% CaF_2, 56.22% $CaCO_3$, 6.55% $Ca_3(PO_4)_2$.

Mineralogy : Not stated.

Beneficiation : Flotation of fluorite with depression of apatite.

Results : A fluorite concentrate analyzing 98.00% CaF_2 with 0.23% P was obtained with a recovery of 78.4%.

Identification	: Ont.–11 (Ref. No. 38)
Report – Title	: TREATMENT OF FLUORITE ORE FROM KEENE MINES, HASTINGS TWP, MADOC, ONT.
– Author	: H. Smedley
– No. and Date	: *Ore Dressing Investigation Report* 4402 (1944)
Sample Description	: Lot 1: 104 kg of –25 mm washed screen rejects; 32.50% CaF_2, 44.71% $CaCO_3$, 16.09% $BaSO_4$, 5.21% SiO_2; Lot 2 and 3: 41.5 t of –25 mm washed screen rejects; Lot 2: 34.38% CaF_2, 44.62% $CaCO_3$, 14.56% $BaSO_4$, 1.72% SiO_2; Lot 3: 30.71% CaF_2, 50.48% $CaCO_3$, 12.30% $BaSO_4$, 1.00% SiO_2.
Mineralogy	: Green fluorite, barite, calcite with minor quartz, feldspar and pyrite.
Beneficiation	: A laboratory flotation study was conducted on Lot 2, floating barite first followed by fluorite; a pilot–plant flotation evaluation was conducted on Lot 3; this process included grinding to 210 µm, washing, thickening, barite flotation, thickening and fluorite flotation.
Results	: A barite concentrate analyzing 54.17% $BaSO_4$, 5.36% CaF_2 with a recovery of 88.03%, and a fluorite concentrate analyzing 86.18% CaF_2, 1.37% $BaSO_4$, 7.48% $CaCO_3$, 0.11% SiO_2 with a recovery of 91.74% were obtained.
Remarks	: The poor barite performance was due to the presence of dissolved calcium sulphate. Lot 2 was originally intended for a pilot–plant study, but severe contamination resulted in a third shipment, Lot 3, for pilot–plant study; part of Lot 2 was salvaged.

Identification	: Ont.–12 (Ref. No. 39)
Report – Title	: JIGGING TESTS ON FLUORITE ORE FROM MILLWOOD FLUORSPAR MINES, MADOC, ONT.
– Author	: Anon.
– No. and Date	: *Ore Dressing Investigation Report* 1989 (1946)
Sample Description	: 1.2 t of –31 mm fluorite ore; 62.04% CaF_2, 2.86% $BaSO_4$, 30.19% $CaCO_3$, 1.44% SiO_2.
Mineralogy	: Not stated.
Beneficiation	: Jigging.
Results	: A concentrate analyzing 73.6% CaF_2, 3.1% $BaSO_4$, 19.9% $CaCO_3$ and 0.5% SiO_2 was obtained with a recovery of 71.7%.
Remarks	: The increased barite content in the concentrate is undesirable for metallurgical flux.

Identification	: Ont.–13 (Ref. No. 40)
Report – Title	: GRAVITY CONCENTRATION OF BARITE AND FLUORITE ORE FROM FLUOROC MINES LTD., JOHNSON, MADOC, ONT.
– Author	: H.L. Beer
– No. and Date	: *Ore Dressing Investigation Report* 2235 (1948)
Sample Description	: 726 kg of fluorite–barite ore; 60.30% CaF_2, 21.12% $BaSO_4$, 16.29% $CaCO_3$.
Mineralogy	: Not stated.
Beneficiation	: Jigging and tabling.
Results	: A fluorite concentrate analyzing 71.1% CaF_2, 5.4% $BaSO_4$ and 20.4% $CaCO_3$ was obtained with a recovery of 86.4%.

Identification	: Ont.–14 (Ref. No. 41)
Report – Title	: FLOTATION TESTS ON FLUORITE ORE FROM THE EAST END SILVER MINE, THUNDER BAY, ONT.
– Author	: H.L. Beer
– No. and Date	: *Ore Dressing Investigation Report* 2412 (1948)
Sample Description	: 227 kg of fluorite ore; 20.53% CaF_2, 0.26% S.
Mineralogy	: The ore is composed of quartz with fluorite and minor amounts of pyrite, chalcopyrite and sphalerite; the fluorite is present in grain sizes ranging from large patches to fine grains intimately mixed with fine–grained quartz.
Beneficiation	: Crushing to 1 mm, grinding to 83.8% –75 μm; prior sulphide flotation followed by fluorite flotation.
Results	: A concentrate analyzing 92.07% CaF_2 with a recovery of 84% was obtained with only a trace of S.

Identification	:	Ont.–15 (Ref. No. 42)
Report – Title	:	FLOTATION CONCENTRATION TESTS ON A SHIPMENT OF FLUORITE ORE FROM CARDIFF FLUORITE MINES LTD., WILBERFORCE, ONT.
– Author	:	H.L. Beer
– No. and Date	:	*Mineral Dressing Report* 2829 (1951)
Sample Description	:	Lot 1: 78 kg of –6 mm fluorite–rich uranium tailings; 13.78% CaF_2, 45.40% $CaCO_3$, 20.10% SiO_2, 0.65% P_2O_5; Lot 2: 2.27 t of ore for pilot–plant study; 15.12% CaF_2.
Mineralogy	:	A gneissic appearance was due to strings of very fine crystals of fluorite aligned in the direction of the carbonate host; recrystallization of the carbonate resulted in fine–grained fluorite; coarse mica was also present.
Beneficiation	:	Lot 1, laboratory evaluation; sample was dry ground to 1.2 mm; +1.2 mm was discarded as being mainly mica; –1.2 mm was dry ground to 210 μm, –1.2 +210 μm being discarded as mostly mica; the –210 μm material remaining was deslimed and fluorite flotation was conducted.
Results	:	A concentrate analyzing 98.20% CaF_2, 0.35% $CaCO_3$, 0.03% P_2O_5 with a recovery of 66.4% was obtained for Lot 1. Only Lot 1 performed satisfactorily resulting in a concentrate analyzing 73.60% CaF_2, 20.49% $CaCO_3$ and 1.31% P_2O_5 with a recovery of 52.5%.
Remarks	:	The poor recovery was due to the presence of mica, which had not been removed before processing.

BRITISH COLUMBIA

Identification	: B.C.–1 (Ref. No. 43)
Report – Title	: CONCENTRATION OF FLUORITE ORE FROM BIRCH ISLAND, B.C.
– Author	: H.L. Beer
– No. and Date	: *Ore Dressing Investigation Report* 4501 (1945)
Sample Description	: 18 t of fluorite ore; 27.5% CaF_2, 21.5% $SrSO_4$.
Mineralogy	: Predominantly feldspar with fluorite, celestite, sericite, pyrite and trace biotite.
Beneficiation	: Grinding to 85% –75 µm, pyrite flotation to recover trace Ag and Au, followed by fluorite flotation. The fluorite rougher tails were tabled to recover celestite.
Results	: A fluorite concentrate analyzing 85.70% CaF_2, 1.44% $SrSO_4$ and 0.20% Fe was obtained with a recovery of 72.4%; a celestite table concentrate that analyzed 90.60% $SrSO_4$ was obtained, but with a recovery of only 12.1%.
Remarks	: By leaching with Na_2CO_3, the celestite content of the fluorite concentrate could be lowered, thus increasing the fluorite content from 85.7% to 92.0% CaF_2.

Identification	: B.C.–2 (Ref. No. 44)
Report – Title	: DIFFERENTIAL SEPARATION PROCEDURE FOR A FLUORITE/CELESTITE ORE FROM BIRCH ISLAND, B.C.
– Author	: H.L. Beer
– No. and Date	: *Ore Dressing Investigation Report* 2437 (1948)
Sample Description	: 23 kg of ore; 34.1% CaF_2, 22.2% $SrSO_4$, 1.5% $BaSO_4$.
Mineralogy	: Predominantly feldspar with fluorite and celestite, sericite, pyrite and trace biotite.
Beneficiation	: Magnetic separation using the Franz isodynamic separator on ore ground to 95% –210 µm; sink–float heavy–media separation on sized fractions from 210 µm to 44 µm.
Results	: It was not possible to separate fluorite selectively from celestite at any size tested.

Identification	:	B.C.–3 (Ref. No. 45)
Report – Title	:	FLOTATION OF RADIOACTIVE FLUORITE ORE FROM BIRCH ISLAND, B.C.
– Author	:	H.L. Beer
– No. and Date	:	*Ore Dressing Investigation Report* (not numbered) (1952)
Sample Description	:	Weight not stated; 12.3% CaF_2, 2.9% P_2O_5.
Mineralogy	:	Predominantly feldspar with fluorite, celestite, sericite, pyrite and apatite.
Beneficiation	:	Flotation of fluorite and apatite.
Results	:	A low–grade fluorite concentrate analyzing 72.5% CaF_2 and 6.5% P_2O_5 was obtained with a recovery of 61.9% of the fluorite and 23.2% of the apatite.

Identification	:	B.C.–4 (Ref. No. 46)
Report – Title	:	REPORT ON A SAMPLE OF FLUORITE/WITHERITE ORE FROM CONWEST EXPLORATION CO., B.C.
– Author	:	H.L. Beer
– No. and Date	:	*Industrial Minerals Report* 239 (1952)
Sample Description	:	545 kg of fluorite ore; 44.8% CaF_2, 34.3% $BaCO_3$, 7.3% $BaSO_4$, 6.9% SiO_2, 4.0% $CaCO_3$.
Mineralogy	:	Coarse–grained purple fluorite with white witherite accounted for 75% of the sample; the remaining 25% was a fine–grained mixture of fluorite, quartz and witherite.
Beneficiation	:	Sink–float heavy–media separation, jigging and tabling; flotation on dry ground ore, pulped and deslimed; fluorite flotation before barite–witherite flotation, and barite–witherite flotation before fluorite flotation were both attempted.
Results	:	The best approach was to float barite–witherite before fluorite. A barite–witherite concentrate analyzing 83.4% $BaSO_4/BaCO_3$ with a recovery of 35.8% was obtained, and a fluorite concentrate analyzing 95.6% CaF_2 with a recovery of 44.8% was obtained. A combination of tabling and flotation produced a concentrate analyzing 92.3% CaF_2 with a recovery of 80.1%; the barite table concentrate analyzed 52.3% $BaSO_4/BaCO_3$ with a recovery of only 26.5%.

Identification : B.C.–5 (Ref. No. 47)

Report – Title : FURTHER FLOTATION CONCENTRATION TESTS ON A FLUORITE/WITHERITE ORE FROM CONWEST EXPLORATION CO., B.C.
– Author : H.L. Beer
– No. and Date : *Industrial Minerals Report* 244 (1953)

Sample Description : Fluorite ore, weight not stated; 44.8% CaF_2, 34.3% $BaCO_3$, 7.3% $BaSO_4$.

Mineralogy : Similar to previous investigation.

Beneficiation : Dry grinding to −150 µm, pulped, deslimed, followed by barite–witherite flotation before fluorite flotation.

Results : A barite–witherite concentrate analyzing 87.6% $BaSO_4/BaCO_3$ was obtained with a recovery of 63.8%; a fluorite concentrate analyzing 98.5% CaF_2 was obtained with a recovery of 73.4%.

Identification : B.C.–6 (Ref. No. 48)

Report – Title : CONCENTRATION OF FLUORITE ORE FROM BIRCH ISLAND, B.C.
– Author : R.A. Wyman
– No. and Date : *Division Report* 59–13 (1959)

Sample Description : Lot 1: surface material, weight not stated; 58% CaF_2, 9% $SrSO_4$, 3% FeS_2;
Lot 2: drill core, weight not stated; 21% CaF_2, 9% $SrSO_4$, 6% FeS_2.

Mineralogy : Lot 1 was mainly fluorite, quartz and feldspar with minor celestite, barite, pyrite and mica. Lot 2 was mainly sericite and fluorite with minor celestite, barite and bastnaesite.

Beneficiation : Flotation of pyrite, followed by celestite flotation, followed by fluorite flotation; superpanning of bastnaesite.

Results : The best results were obtained on Lot 1 for which a concentrate analyzing 97.1% CaF_2 was obtained with a recovery of 70.9%; a celestite concentrate analyzing 81.1% $SrSO_4$ was also obtained. The rare earth, bastnaesite, concentrated with the fluorite, as did uraninite.

Identification : B.C.-7 (Ref. No. 49)

Report - Title : CONCENTRATION OF BIRCH ISLAND, B.C., FLUORITE ORE TO METALLURGICAL GRADE

- Author : F.H. Hartman and R.A. Wyman
- No. and Date : *Division Report* 63-33 (1963)

Sample Description : 908 kg of ore; 29.6% CaF_2, 1.23% rare earths (including ThO_2).

Mineralogy : Fluorite, celestite, barite, quartz, feldspar, sulphides, bastnaesite and mica; very fine intergrowths of celestite and fluorite with bastnaesite inclusions.

Beneficiation : Crushing to 600 μm followed by grinding to 98% -75 μm; flotation involved floating celestite and depressing sulphides, followed by fluorite flotation.

Results : Metallurgical-grade fluorite was produced; a concentrate analyzing 88.5% CaF_2 and 2.2% rare earths was obtained, but with a recovery of only 45%.

Identification : B.C.-8 (Ref. No. 50)

Report - Title : DIGEST OF INFORMATION ON REXSPAR FLUORITE, BIRCH ISLAND, B.C.

- Author : R.A. Wyman
- No. and Date : *Mineral Processing Information Report* 70-23 (1970)

Previous Studies : Flotation produced a concentrate analyzing 92.1% CaF_2 with a recovery of 77%. Results indicate that the maximum fluorite grade possible with this ore is 95% CaF_2, which is below acid-grade fluorite. Furthermore, to achieve 95% CaF_2, it is necessary to regrind the fluorite rougher concentrate to at least 44 μm.

The separation of celestite was not perfected; the best result was a concentrate that analyzed 84.5% $SrSO_4$ with a recovery of 78%, using Igepon T33 as a celestite collector.

The presence of rare earths, notably bastnaesite (lanthanum carbonate) as 5 μm inclusions further prohibits the achievement of selective fluorite and celestite flotation.

Approximately 5% of the sample could not be accounted for mineralogically.