CANADA
DEPARTMENT OF MINES
HON. CHARLES STEWART, MINISTER; CHARLES CAMSELL, DEPUTY MINISTER

GEOLOGICAL SURVEY
W. H. COLLINS, DIRECTOR

ECONOMIC GEOLOGY SERIES
No. 6

Fluorspar Deposits of Canada

BY
M. E. Wilson

OTTAWA
F. A. ACLAND
PRINTER TO THE KING'S MOST EXCELLENT MAJESTY
1929

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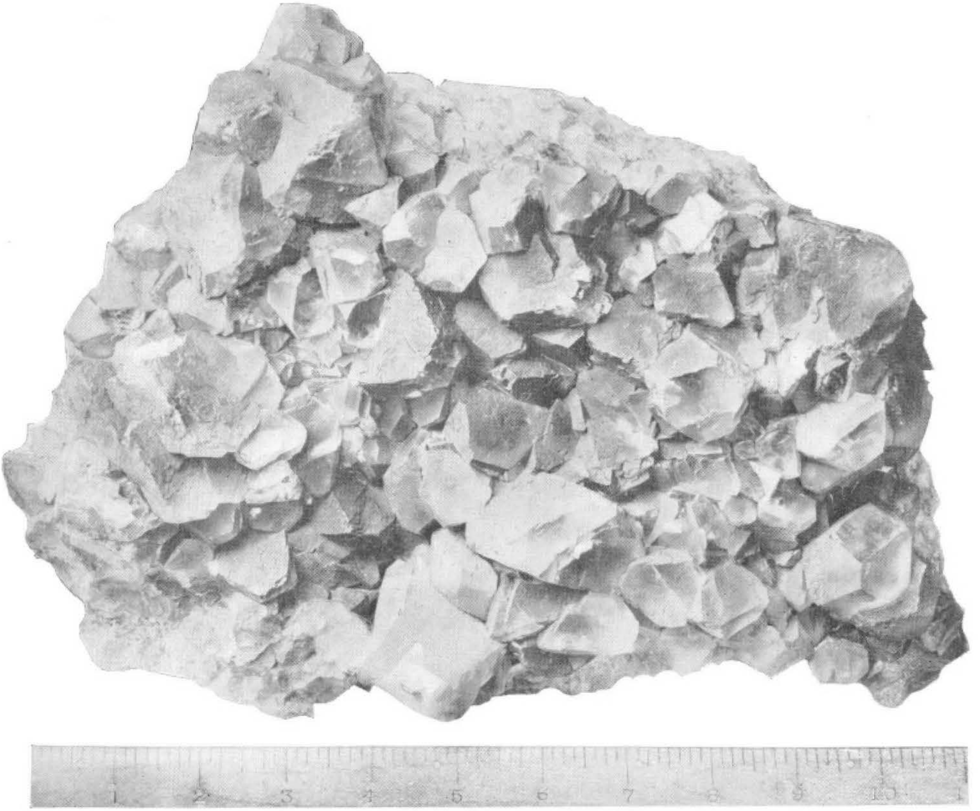
PLATE I



Crystals of transparent, pale green fluorspar, Perry mine, Huntingdon township, Hastings county, Ontario.

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PREFACE

The present report includes descriptions of all deposits of fluorspar in Canada of which there is any published record prior to May, 1929. The important deposits or groups of deposits, that is the deposits from which fluorspar has been produced—the Rock Candy mine in British Columbia, and the veins of Madoc district in Ontario—have been especially examined for this report, the former by V. Dolmage and the latter by the writer. Mr. Dolmage's report is included under his name.

The writer is especially indebted to the mine owners, mine managers, and other residents of Madoc district for their co-operation while in the field. Thanks are especially due to Mr. R. C. Bryden, manager of the Noyes mine while it was in operation, Mr. George H. Gillespie of George H. Gillespie and Company, Mr. C. M. Wallbridge, the late Stephen Wellington and his associate, Mr. G. Munro, Mr. Donald Henderson, Mr. Chesley Pitt, and Mr. Jas. O'Reilly, all of whom placed the information in their possession at the writer's disposal and in other ways assisted in the carrying on of the work.

Fluorspar Deposits of Canada

CHAPTER I

INTRODUCTION

Fluorspar is one of the most beautiful of the common minerals and occurs in well-developed crystals possessing a wide range of colours. The beauty of the mineral long ago attracted the attention of man, for it is said that ornaments of fluorspar were found among the ruins of Pompeii and in the prehistoric mounds of North America.[1] For nearly 160 years a laminated variety of fluorspar with a radial structure, known as "Blue John", has been mined in small amounts in Derbyshire for carving into vases and other ornaments. The commercial importance of fluorspar at present, however, arises chiefly from its use as a flux in the metallurgical industries, a use from which it derives its name.[2]

Fluorspar is almost unique among minerals in the wide range of geological conditions under which it may be formed, for it occurs in all types of mineral deposits, from those whose relationships indicate that they developed at exceedingly high temperatures to those in which it is doubtful whether igneous action played any part in their development. For this reason its occurrence is not restricted necessarily to any particular part of Canada. It is known to occur in all the physiographic provinces with the exception of the Great Plains and it is possible that deposits may be present in that region, especially if the strata at any point are cut by fractures or fault-fissures. Up to the present deposits of fluorspar have been worked in Canada in only two localities, near Madoc, Ontario, and near Grand Forks, British Columbia. However, in view of the rapid mining development in Canada and the wide distribution of the mineral, it is possible that at any time mineral deposits may be found from which fluorspar may be produced either as the principal product or as a by-product.

The total consumption of fluorspar in Canada in 1928 amounted to 14,362 tons having a value of $153,046. For the present, at least, there is a market in Canada for only this amount, and any production in excess of this amount would have to be marketed in United States against an adverse tariff of $7.50 a ton. Under these conditions, it would be scarcely possible to dispose of fluorspar profitably outside of Canada, unless, owing to the immense size of the deposit or the occurrence of the fluorspar as a by-product, the cost of production were exceedingly small.

[1]Egglestone, W. M.: Trans. Inst. Min. Eng., vol. 35, p. 237 (1907–08).
Kunz, G. F.: Min. Res. of United States, 1882, p. 497.

[2]From the Latin *fluo*, to flow.

MINERALOGY

Fluorspar or fluorite in chemical nomenclature is calcium fluoride (CaF_2) consisting of 51·1 per cent of calcium and 48·9 per cent of fluorine. It is a relatively soft mineral, being number 4 in Mohs' scale of hardness.[1] It has a specific gravity of 3·1, crystallizes in the cubic system, and has a well-developed octahedral cleavage. It occurs both in the massive form and in well-developed crystals. The latter are found where cavities are present, and hence chiefly in deposits of the low temperature type, of which those of Madoc district, Ontario, are typical examples. The predominant crystal form is a combination of the cube and the octahedron (*See* Plate I). Its colour ranges from white through yellow, green, blue, rose, and purple to violet. So far as the writer's observations have gone, most of the fluorspar in pegmatites and other deposits of the high temperature class is purple or violet, whereas the more delicate hues such as honey yellow, pale green, and rose prevail in the deposits of the low temperature type.

There are few minerals from which fluorspar cannot be readily distinguished by its transparency, octahedral cleavage, white streak, and relative softness. It decrepitates and phosphoresces when heated in a closed tube, and when treated with sulphuric acid produces hydrofluoric acid which etches glass. It differs from calcite in that it does not effervesce with acid.

OTHER FLUORINE-BEARING MINERALS

The principal fluorine-bearing minerals and their chemical compositions are included in the following table:

I	II	III
Fluorspar CaF_2	Lepidolite $KLi\,[Al\,(OH, F_2)_2]\,Al\,(SiO_3)_3$	Tysonite (Ce, La, Di) F_3
Cryolite $Na_3\,AlF_6$	Fluor-apatite (CaF) $Ca_4\,(PO_4)_3$	Sellaite MgF_2
		Fluocerite $(Ce, La, Di)_2\,OF_4$
		Fluellite AlF_3H_2O
		Prosopite $CaF_22Al\,(F, OH)_3$
		Pachnolite $NaF.\,CaF_2.\,AlF_3.\,H_2O$
		Thomsenolite $NaF.\,CaF_2.\,AlF_3.\,H_2O$

Group one includes cryolite, the only mineral of this class in addition to fluorspar that contains a considerable proportion of fluorine and occurs in an extensive deposit. The minerals of group two are common, but contain a very small amount of fluorine. The minerals of group three are uncommon and, so far as known, do not occur in Canada.

Cryolite is a colourless, white, brown, brick-red, or even black mineral named cryolite (ice-like) because of its resemblance in its most common phase to ice. It is a relatively soft mineral having a hardness of 2·1 and crystallizes in the cubic system. It can be distinguished from other

[1]Quartz is 7.

minerals by its softness, its rather dull appearance, and, where exposed on a rock surface, by the ease with which it weathers. It is found extensively associated with galena, sphalerite, siderite, pyrite, and other minerals in a pegmatite mass at Ivigtut in southwest Greenland where it is mined and shipped to Denmark and United States. This mineral is of interest to the Canadian prospector because of its value[1] and because it is possible that it occurs in Canada, especially in localities where nepheline or other soda-rich minerals are present.

USES[2]

Fluorspar is utilized for a variety of purposes of which the following are the most important:

(1) As a flux in the metallurgical and related industries.

(2) In the glass and ceramic industries for the manufacture of opalescent glass, enamels, and other products.

(3) In the chemical industries for the manufacture of hydrofluoric acid and other fluorine compounds.

(4) For the manufacture of artificial cryolite.

(5) In the case of transparent, colourless or almost colourless fluorspar, for optical purposes.

The proportions of the total consumption of fluorspar in United States used in these different industries in 1928 were approximately as follows: steel and iron, 80·0 per cent; glass and ceramic, 7·9 per cent; chemical, 10·6; miscellaneous, 1·5 per cent.

In the metallurgical and related industries fluorspar is used as a flux in the manufacture of steel by the basic open-hearth process, in foundry work, in the manufacture of steel, cast iron, and ferro-alloys in electric furnaces, and in the smelting of refractory ores of copper, silver, and gold. It is also used in the electrolytic refining of antimony and lead, as a flux in melting of gold and silver concentrates, in the manufacture of alundum and other artificial abrasives, and in the manufacture of Portland cements. The reactions that take place when fluorspar is used as a flux are not positively known, but it has the effect of lowering the temperature of the slag, thus promoting the formation of silicates, and it facilitates the elimination of silica, phosphorus, and sulphur. It is thought that the silica is removed by the formation of a volatile tetrafluoride of silicon and that under not too strongly oxidizing conditions phosphorus also volatilizes as a fluoride.

In the glass and ceramic industries fluorspar is used in the manufacture of opalescent glass and enamels. Translucent opal glass is used in ornamental glassware and for diffusing light in electric light bulbs, electric fixtures, and lamp shades. The dense or opaque opal glass is used for glass containers, table tops, shelving, refrigerator lining, and for similar purposes. Fluorspar is also used in white and coloured enamel-coating on iron and steel for enamelware, sanitary ware, and in the manufacture

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[1]About $70 a ton

[2]*See* Ladoo, R. B.: Fluorspar, U.S. Bureau of Mines, pp. 57–73, 1927, for more complete information regarding the uses of fluorspar.

of enamelled brick, vitrolite, tiling, and for other purposes where an opaque, easily fusible enamel is required. For these purposes a ground fluorspar averaging about 95 per cent CaF_2 is demanded.

In the chemical industries fluorspar is the principal source of fluorine in nearly all fluorine compounds. These may be prepared directly from fluorspar or indirectly from hydrofluoric acid previously manufactured by treating fluorspar with sulphuric acid. These fluorine compounds include hydrofluoric acid, sodium fluoride, sodium and calcium fluor-silicates, barium fluoride, and potassium fluoride. For these purposes an especially high grade of fluorspar averaging 98 per cent CaF_2 and not more than 1 per cent of silica or calcium carbonate is required.

One of the chief uses of cryolite is as a solvent for alumina in the manufacture of aluminium by the electrolytic process. Artificial cryolite made from fluorspar is now being substituted in part for this purpose.[1]

Fluorspar possesses a very low refractive index and for this reason is used for correcting dispersion in microscopes, telescopes, spectroscopes, and in other optical apparatus. For these purposes pieces at least $\frac{1}{4}$ inch in diameter, free from flaws, clear, and practically colourless, are required. A considerable amount of fluorspar of this quality was produced from some of the mines of Madoc district. Especially large, beautiful, brilliant, clear crystals were found enclosed in celestite in the Keen vein. Optical fluorspar is said to be worth from $1 to $10 a pound according to quality.

[1]The importations of cryolite into Canada for the years 1915–1926 are given on page 96. All of this was used in the manufacture of aluminium at Arvida, Quebec.

CHAPTER II

GENERAL CHARACTER AND ORIGIN OF FLUORSPAR DEPOSITS

A large part of the most common mineral deposits occur in such geological relationships and include such an association of minerals as to indicate that they are intimately related in origin to intrusive masses of igneous rock. In contrast with these there are two other groups of deposits—those occurring as sediments and those (secondary deposits) formed by the mechanical or chemical alteration of older deposits—that obviously are not related in any way to igneous rocks. In addition to the deposits of these groups, however, there is a small class of deposits the origin of which is in doubt, some geologists regarding them as coming from a deep-seated igneous source and others regarding them as superficial concentrations made by meteoric waters. Mineral deposits of the first class are divided in turn into a series of types according to their proximity to the intrusive, or the temperature at which they were deposited. An approximate classification of mineral deposits according to origin as outlined above, with some of the characteristic minerals of each type, are included in the following table.

Types of Mineral Deposits

	Type of deposit	Some characteristic minerals
I	Associated with igneous rocks	
	(1) Magmatic	Chromite, magnetite, ilmenite, fluorspar
	(2) Pegmatitic	Orthoclase, muscovite, tourmaline, molybdenite, wolframite, rare earth minerals, cassiterite, fluorspar
	(3) Contact metamorphic	Garnet, tremolite, diopside, wallastonite, phlogopite, apatite, molybdenite, magnetite, pyrrhotite, fluorspar
	(4) Deep vein zone or hypothermal[1] deposits.	Gold, arsenopyrite, pyrite, pyrrhotite, chalcopyrite, fluorspar
	(5) Middle vein zone or mesothermal[1] deposits	Gold, native silver, argentiferous galena, sphalerite, pyrite, chalcopyrite, argentite, niccolite, fluorspar
	(6) Shallow vein zone or epithermal[1] deposits.	Mercury, cinnabar, pyrite, stibnite, fluorspar, kaolin
II	Sedimentary	
III	Deposits at moderate or shallow depths of doubtful origin	Galena, sphalerite, fluorspar
IV	Secondary deposits	

GENERAL CHARACTER

Fluorspar occurs in Canada in almost all the types of deposits included in the preceding table, but except for those of the low temperature classes (I (6), and III), either the total amount or the proportion of the mineral present is small. Descriptions of some of the most important of each type of deposit are as follows:

[1]Lindgren, W.: "Mineral Deposits", 1927.

Magmatic. There are at least two occurrences of fluorspar in Canada where the fluorspar appears to be either a normal constituent of an igneous rock or to have differentiated from the igneous rock in place as it consolidated. These are in the nepheline syenite dykes at St. Hilaire, Quebec[1], and in the molybdenite-bearing segregations in the Onslow quartz syenite near Quyon, Quebec[2]. The deposits in the Onslow quartz syenite are chiefly irregular aggregates of feldspar, quartz, deep green pyroxene (aegerine-augite), green amphibole, magnetite, pyrite, pyrrhotite, molybdenite, and purple fluorspar. Small aggregates of fluorspar and quartz a few inches or less in diameter also occur in the syenite in places. The largest deposit is 200 feet long and 50 feet wide. The amount of fluorspar present in either the St. Hilaire or the Onslow deposits is too small to be commercially valuable. It is possible that the fluorspar occurring in granite near Birch Island station, British Columbia, also belongs to the magmatic class, but there are some features of the deposit that suggest that it lies along a fracture zone and for that reason it is placed in the hypothermal class.

Pegmatitic. The occurrence of fluorspar in pegmatite in Canada has been noted in Cameron township, Nipissing district, Ontario, by Barlow; in two localities in Monteagle township, Hastings county, Ontario, by H. V. Ellsworth; in Preissac township, Abitibi district, by the writer; in Villeneuve township, Quebec, by H. S. Spence; and in two localities near New Ross, Lunenburg county, Nova Scotia, by Faribault. In all of these localities the fluorspar occurs here and there in the pegmatite and is not sufficiently abundant to be valuable even as a by-product in mining feldspar.

Contact Metamorphic. As masses of intruded igneous rock consolidate, emanations from the intrusive penetrate the adjacent rocks and where possible react with the invaded rock to form new minerals. Minerals formed in this way are called contact metamorphic and mineral aggregates composed wholly or in part of such minerals are called contact metamorphic deposits. There is much geological evidence to show that silica is one of the most abundant constituents of the emanations from intrusives and since the lime of limestone will readily combine with silica to form lime-silicates such as diopside, tremolite, wollastonite, and garnet these minerals are usually among the most common minerals of deposits of this type. The extensive masses of diopside (metamorphic pyroxenite) with which the amber mica (phlogopite) is associated in southeastern Ontario, and in Quebec to the northeast of Ottawa, are typical deposits of the contact metamorphic class. The occurrence of fluorspar has been noted in these deposits in numerous localities, especially in Hull and Papineau counties, Quebec, but the mineral is present in too small amounts to be of more than mineralogical interest. The so-called veins of calcite containing purple fluorspar, diopside, apatite, hornblende, and phlogopite, in Monmouth and Cardiff townships, Haliburton county, Ontario, although apparently veins are probably really contact metamorphic deposits, the

[1]O'Neill, J. J.: Geol. Surv., Canada, Mem. 43, p. 54 (1914).

[2]Geol. Surv., Canada, Mem. 136, pp. 66–72 (1924).

calcite being recrystallized limestone that escaped silicification. There is a considerable proportion of fluorspar in some of these deposits, but they are so irregular that it is doubtful whether any of them could be worked profitably under present conditions.

Hypothermal. Deposits of this class are formed at great depth and are usually found within, or in close proximity to, the intrusive from which they are derived. It is probable that the fluorspar found on the Atlantic and Pacific claims near Birch Island station on the Canadian National railway 81 miles north of Kamloops, British Columbia, is a deposit of this type[1]. This deposit occurs in quartz porphyry or porphyritic aplitic granite and can be traced in discontinuous, but, for the most part, not widely separated, outcrops for over 400 feet. The owner stated that outcrops of similar material occur along the strike of the deposit across both claims. The zone of fluorspar consists of a central concentrated band having an exposed width of 2 to 3 feet and an actual width at right angles to the dip of about 12 inches and on either side of this band a disseminated belt up to 30 feet wide in places. The only minerals present in addition to the constituents of the wall-rock are pyrite, celestite, and muscovite. Graham does not state that the fluorspar is associated with a fracture, but the linear character of the deposit and the presence of celestite suggest that the fluorspar may have replaced the granite along a fracture and that the deposit, therefore, belongs to the hypothermal rather than the magmatic class. Other fluorspar deposits in Canada of the hypothermal type are the vein on Porcupine creek, in Golden mining division, British Columbia, and the veinlets of fluorspar in granite on the John Bulger farm, in Bastard township, Leeds county, Ontario. With the possible exception of the fluorspar deposit near Birch Island station, the amount of fluorspar present in these deposits is small.

Mesothermal. Deposits of this class, as the name implies, are formed at intermediate temperatures and hence at points more remote from the intrusive or nearer the surface than the hydrothermal deposits. The most important deposits of this class in Canada that contain fluorspar are the silver-bearing veins near Cobalt in Timiskaming district and near Port Arthur and Fort William, Thunder Bay district, Ontario. In both of these districts the veins are associated with sills of diabase of late Precambrian (Keweenawan) age, have calcite as their principal gangue mineral, and contain about the same association of minerals. At Cobalt, however, fluorspar is rather uncommon, whereas in the Port Arthur-Fort William district it is fairly abundant and if some of the veins were worked for their silver content it possibly could be produced as a by-product. Other veins of the mesothermal class in Canada containing fluorspar are the galena-bearing veins of Slocan and Ainsworth mining divisions and the veins in the Sunday claim, in Golden mining division, British Columbia. The amount of fluorspar in all these veins is small, however.

Epithermal. Mineral deposits belonging to this class are believed to be related to igneous rocks in origin, but have been deposited at relatively low temperatures and hence at moderate depths. It is probable that the

[1]Graham, R. P. D.: Mineral Resources Commission, Final Report, 1920, pp. 49–52

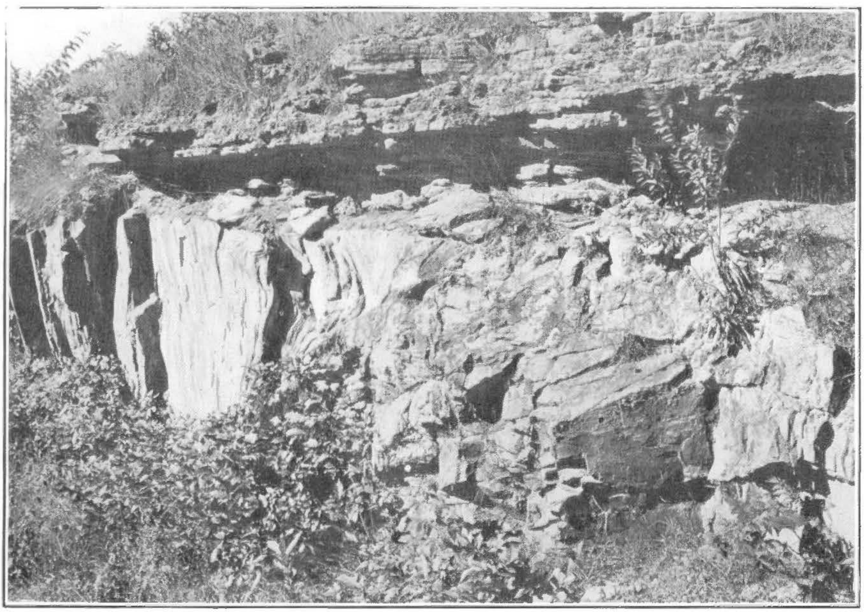
Rock Candy vein near Grand Forks, British Columbia, the most extensive deposit of fluorspar so far discovered in Canada, belongs to this class. It is described by Dolmage (page 22) as consisting of a network of closely spaced more or less parallel veins from a few inches to 30 feet wide, between which only a small proportion of altered wall-rock remains in narrow bands and horses. The outcrop of the deposit is about 500 feet long and up to 45 feet wide. It is exposed up the mountain slope vertically for 200 feet at the surface and has been developed for 250 feet vertically underground. It has been proved to a still greater depth by diamond drilling for a considerable distance beneath the drift towards the south, and a similar or the same parallel set of veins has been found in a series of widely spaced open-cuts along the bottom of a stream valley for over one-half mile towards the north. The wall-rock is syenite.

The vein material consists of fluorspar, barite, chert, quartz in crystals, calcite, pyrite, and kaolin. Galena and sphalerite are absent. Dolmage concludes that the solutions that replaced the syenite and deposited the fluorspar and associated minerals emanated from the syenite as a result of the differentiation processes that accompanied the cooling and consolidation of the magma. He makes no statement regarding the temperature at which the minerals were deposited, but the presence of chert, barite, and kaolin suggests that the deposit was formed at relatively low temperatures and hence at moderate depth. This implies, if the solutions that deposited the fluorspar, barite, and other vein minerals were derived from the syenite during its consolidation, that they ascended from the lower part of the mass after its upper part had cooled, thus permitting their temperature to fall before deposition occurred.

Deposits of Doubtful Origin. To this class belong those deposits that are not closely related to igneous rocks and, although possibly derived from a magmatic source, may have been formed superficially by the processes of surface weathering and groundwater circulation. The most important deposits in Canada belonging to this group are those of Madoc district, Hastings county, Ontario. These are veins occurring in two separate systems, the Moira Lake and the Lee-Miller groups. The veins of the Moira Lake group occur, for the most part, in the northern part of Huntingdon township and centre around a northwesterly trending fault fissure that has been traced for over 5 miles and along which most of the fluorspar deposits of the group are found. Other deposits occur nearby in parallel fissures that are evidently subsidiary fractures belonging to the same system. The veins intersect Palæozoic (Ordovician) limestone, and Precambrian granite, limestone, and greywacke (Plates II and III). The veins of the Lee-Miller group with one exception all lie in concession I, Madoc township. They trend northwesterly and are parallel. The total area occupied by the veins is about 6 miles from north to south and $\frac{3}{4}$ mile from east to west. The greater part of the veins are in Palæozoic limestone, but a single deposit at the extreme south end is in the blue limestone of the Hastings series and another at the extreme north intersects the granite of the Deloro batholith.

The vein material, for the most part, is concentrated along the fractures in lenses from a few feet to 200 feet long and from 2 feet to 17 feet wide.

A. Basal Palæozoic limestone, lot 2, con. IX, Madoc tp., Ont.



B. Basal Palæozoic limestone of Black River formation resting on the blue limestone of Hastings series, lot 11, con. VII, Marmora tp., Ont.

It consists chiefly of varying proportions of fluorspar, barite, and calcite. The only other common mineral is celestite. The uncommon minerals, named approximately in the order of their abundance, are pyrite, marcasite, chalcopyrite, quartz, tetrahedrite, elaterite, and malachite. On the Noyes property a peculiar, resinous-looking, brown, nodular variety of barite containing bituminous material occurs. So far as the writer observed, there is no definite order in which the fluorspar, barite, and calcite were deposited. They occur interbanded or intermingled in the partitions between cavities. Vacant spaces are exceedingly common in most of the veins, so that beautiful clear or delicately coloured crystals of fluorspar are abundant. In the Keen vein brilliant colourless or very pale blue crystals up to several inches in diameter were found enclosed in fibrous celestite. In some of the deposits of the Lee-Miller group the vein material has been disintegrated into "gravel spar" by weathering to depths of over 50 feet.

In several localities in Canada there are veins consisting chiefly of barite, but containing a small proportion of fluorspar, the mode of origin of which is at least in some cases doubtful. Since the amount of fluorspar in these deposits is not sufficient to be valuable even as a possible by-product, only the locality of each occurrence or group of occurrences will be mentioned here. They are described in greater detail in Chapter III. The principal deposits of this class are the Ravenna in Penhorwood township, near Tionaga station in Sudbury district; and the veins in Langmuir and Cairo townships, Timiskaming district; in Frontenac county, north of Kingston; in Carleton, Pontiac, Hull, and Papineau counties west and north of Ottawa; and in Lake Ainslie district, Inverness county, Nova Scotia.

Sedimentary. So far as known to the writer no attempt has been made to determine by chemical analysis whether fluorine is present as an original constituent in sedimentary rocks in Canada. Its occurrence has been recorded at two localities, however, in cavities in Devonian dolomite in the quarry of the Amherstburg Stone Company, at Amherstburg, Essex county, and in dolomite at Niagara Falls, Welland county, Ontario. It is practically certain that in both cases the fluorspar is an original constituent of the dolomite.

ORIGIN

General Statement

Fluorspar occurs in so many different geological relationships as to indicate that it can be formed under all or nearly all physical conditions and that it, therefore, as previously pointed out, belongs to the class of minerals known as "persistent."[1] It is a common constituent of igneous rocks,[2] and occurs in pegmatite dykes, in contact metamorphic deposits, and in all the other types of deposits believed to be related to igneous rocks whether deposited at great depth, intermediate depths, or near the surface.[3] It has also been noted in numerous localities in sedimentary rocks.[4] The

[1]Lindgren, W.: "The Relations of Ore Deposition to Physical Conditions"; Econ. Geol., vol. II, pp. 105-07 (1907).
[2]Clarke, F. W.: "Data of Geochemistry"; U.S. Geol. Surv., Bull. 695, p. 331 (1920).
[3]Emmons, W. H.: "A Genetic Classification of Minerals"; Econ. Geol., vol. III, pp. 611-627 (1908), and "Principles of Economic Geology", 1918.
[4]Andree, K.: "Uber einige Vorkommen von Fluszpat in Sedimenten"; Tsch. Min. und Pet., Mitt., vol. XXVIII, pp. 535-556 (1909).

A. Blue limestone and greywacke of the Hastings series, lot 7, con. XIV, Rawdon tp., Ont.

B. Openings along joint-planes, formed by weathering, in Palæozoic limestone, lot 10, con. V, Marmora tp., Ont.

important deposits of fluorspar from a commercial standpoint, however, are those that occur in such geological relationships and mineralogical associations as to indicate that they were formed at relatively low temperatures and, in some cases, that they are possibly not related in origin to igneous rocks.

The fluorspar deposits of Canada, from the standpoint of origin, may be classified into three groups: (1) those that are definitely associated with igneous rocks; (2) those that are definitely not related in origin to igneous rocks; and (3) those of which the origin is in doubt. In the first class is included the most important deposit of fluorspar so far discovered in Canada, the Rock Candy vein, near Grand Forks, British Columbia. There are two known occurrences of fluorspar in Canada belonging to the second class. These are very small aggregates in geodal cavities in the Niagara dolomite at Niagara Falls, and in the dolomite of the Detroit River series at Amherstburg, Ontario. Both of these are so remote from igneous rocks that they are almost certainly an original part of the sediments in which they occur. They are so unimportant, however, that further discussion of their origin is scarcely warranted. The third group includes the veins of Madoc district, Ontario, and probably some of the veins of barite containing fluorspar that occur in numerous localities in other parts of Canada.

Deposits Related to Igneous Rocks

With the exception of the Rock Candy vein and possibly the Birch Island deposit, the occurrences of fluorspar of this class so far discovered in Canada are unimportant. For this reason it is unnecessary to discuss in detail the origin of the group as a whole. The occurrences are believed to have originated in about the following manner: as masses of igneous rock intruded at depth within the earth's crust consolidate, certain minerals crystallize first and various elements including fluorine remain behind as a residue. During the early stages of consolidation, due either to deformation, differences in temperature, or other physical conditions, some of this residue may collect at one or more points in the magma, and magmatic segregations result. If a fracture occurs in the consolidated part of the igneous mass, or in the adjacent rocks, the residual material may fill the fracture, and a pegmatite dyke may be formed. At this, or a slightly later stage, the residual material may penetrate the rocks adjacent to the intrusive and, there, possibly react with them chemically to form new minerals. Mineral aggregates consisting wholly or in part of such minerals are known as contact metamorphic deposits. As the consolidation of the magma continues and differentiation becomes more complete, fractures may form either in the consolidated parts of the intrusive or in the intruded rock into which residual material of the intrusive may penetrate, forming veins, or by the solution of the wall-rock and the deposition of its own constituents in its place, replacement deposits, and these processes may occur either at great depth and at high temperatures or near the surface and at low temperatures.

The Rock Candy vein near Grand Forks, British Columbia, is believed by Dolmage to be of igneous origin. He concludes that the deposit has been formed by the replacement of the syenite along fractures and infers from the presence of barite in the syenite, wall-rock, the occurrence of fluorite in one of the closely related dykes, and the absence of any other probable source for the fluorspar, that it is "reasonably certain that the solutions that replaced the syenite and deposited the fluorite, barite, and other vein minerals originated in the syenite as a result of differentiation processes attendant on the cooling and recrystallization of the magma." Since the writer has not examined this deposit, he has no first hand information regarding its origin. It may be pointed out, however, that the principal minerals, other than fluorspar, composing the vein, are barite, chert, quartz in crystals, calcite, pyrite, and kaolin and that all of these minerals are found in, and three of them—barite, chert, and kaolin— are characteristic of, low temperature (epithermal) deposits. From this it follows that the vein material, if derived from the syenite, must have come from the lower part of the mass after its upper part had consolidated and completely cooled.

Deposits of Doubtful Origin

The deposits of this class include a large part of the most important fluorspar deposits of the world. They are usually found in relatively undisturbed sedimentary rocks and are not intimately associated with igneous rocks. They are typically exemplified by the veins of Durham and Derbyshire in England; Illinois and Kentucky, in United States, and Madoc district, Ontario, in Canada.

Summary Statement of Hypotheses

The hypotheses that have been suggested to explain the origin of the fluorspar deposits of the Madoc type, although somewhat varied in detail, fall into four main classes according to the assumed source of the material composing the deposits, or of the solutions depositing the material. The four main hypotheses, briefly stated, are as follows.

(1) That the vein material has been concentrated from the adjacent sedimentary rocks and redeposited in fissures through the agency of the ordinary groundwater circulation.

(2) That the vein material has been derived from the adjacent sedimentary rocks through the solvent action of ascending heated waters.

(3) That the lime contained in the fluorspar has been derived from the limestone wall-rock, but that the fluorine and other elements composing the vein material have been brought up in solution from a magmatic source.

(4) That both the vein material and the solutions from which the vein material has been deposited are of magmatic origin.

The first of these hypotheses is that proposed by Whitney to account for the origin of the lead and zinc deposits of Wisconsin[1] and subsequently applied by Norwood[2], Shaler[3], and Emmons[4] to the fluorspar-bearing veins of southern Illinois and western Kentucky.

[1]Whitney, J. D.: Geol. Surv., Wis., vol. I, pp. 388–406 (1862).

[2]Norwood, C. J.: "Report of a Reconnaissance in the Lead Region of Livingstone, Crittenden, and Caldwell Counties"; Geol. Surv., Kentucky, pt. 7, vol. I, 2nd ser., pp. 461–64 (1876).

[3]Shaler, N. S.: "On the Origin of the Galena Deposits of the Upper Cambrian Rocks of Kentucky"; Geol. Surv., Kentucky, pt. 8, vol. II, 2nd ser., pp. 277–330 (1877).

[4]Emmons, S. F.: Trans. Am. Inst. Min. Eng., vol. XXI, pp. 51–53 (1892–93).

The second was suggested by W. S. Tangier Smith in his report on the lead, zinc, and fluorspar deposits of western Kentucky[1]. In this publication the presence of mica peridotite dykes which have the same general trend as one of the systems of fissures and which have probably been introduced at the time of the general faulting of the region, is cited as evidence that the waters by which the fluorspar was concentrated were probably ascending and hot.

The hypothesis that the fluorspar has been formed by the interaction of fluorine compounds, contained in ascending magmatic waters, with the limestone composing the wall-rock of the veins, has been advanced by Fohs in a number of publications on the fluorspar deposits of Kentucky[2]. Fohs suggests, following Bain, that the fluorine was probably brought up in the form of fluosilicates of zinc, lead, copper, iron, barium, and calcium.

According to the fourth hypothesis the deposits are of magmatic origin and hence have been developed in a manner similar to that generally assumed to be the mode of origin of most other mineral deposits found in intimate association with igneous rocks. That the fluorspar veins of Kentucky might have originated in this manner was suggested as an alternative possibility by Tangier Smith; it was believed by Bain[3] to be the most probable mode of origin for the fluorspar deposits of southern Illinois, and has been adopted by Wedd and Drabble[4] as on the whole most in accord with geological conditions in the case of the fluorspar deposits of Derbyshire.

Madoc District

Since some of the largest deposits of fluorspar in Madoc district occur where the veins intersect batholithic masses of impermeable Precambrian granite or syenite, it is scarcely possible that the material composing the veins could have been concentrated from the adjacent wall-rock by ascending heated water or that the fluorspar could have been formed by the interaction of the lime in the wall-rock with fluorine in ascending magmatic waters. There are, therefore, only two theories that need be considered in endeavouring to ascertain the probable mode of origin of the Madoc fluorspar deposits, namely: that they have developed superficially by concentration from the Palæozoic limestone through the agency of the groundwater circulation, or that they have been brought up from a deep-seated magmatic source by ascending heated waters.

Superficial Origin. Field evidence that might be cited in support of the theory that the Madoc fluorspar deposits are superficial in origin, is as follows:

Throughout the region lying along the southern border of the Laurentian highlands of southeastern Ontario and the adjacent parts of Quebec, there are numerous veins that consist of varying proportions of galena, calcite, barite, sphalerite, and fluorspar and that occur either in the basal

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[1]Ulrich, E. O., and Smith, W. S. Tangier: Prof. Paper, U.S. Geol. Surv., No. 36, pp. 150–54 (1905).
[2]Fohs, F. Julius: "Fluorspar Deposits of Kentucky"; Geol. Surv., Kentucky, 1907, pp. 61–63; Econ. Geol., vol. V, pp. 377–386 (1910).
[3]Bain, J. Foster: "Fluorspar Deposits of Southern Illinois"; Bull. U.S. Geol. Surv., No. 255, pp. 66–67 (1905).
[4]Wedd, C. B., and Drabble, G. Cooper: "The Fluorspar Deposits of Derbyshire"; Trans. Inst. of Min. Eng., 1907–8, pp. 521–525.

Palæozoic formations that lie along the Precambrian border, or in the Precambrian in close proximity to the Palæozoic.[1] The occurrence of these deposits in these relationships and their apparent absence from the Precambrian remote from the Palæozoic border, and from the upper Palæozoic formations even where these have been much fractured and faulted supports the assumption that the material composing the deposits has been derived from the Palæozoic sediments and has been deposited in fractures or other openings at their base through the agency of meteoric waters[2].

The presence of numerous underground channels and caves in the Palæozoic limestone of Madoc district, and the chasm-like openings that occur along the numerous joint-planes intersecting the limestone (Plate III B) indicate that much of this rock has been dissolved away by the groundwater circulation and hence may have been the source from which the minerals composing the fluorspar-bearing veins have been concentrated. Furthermore, the enormous quantities of water pumped from the mines and the effect of this pumping on the neighbouring wells prove that the fissures in which the fluorspar deposits occur form important channels for the groundwater of the district.

The occurrence of stalagmites and stalactites composed of barite or of barite and fluorspar in a cave on the Bailey property indicates that at this point, at least, barite and fluorspar were probably deposited by meteoric water.

Igneous rocks of post-Ordovician age with which the deposits might be genetically connected are entirely absent from the district and are not known to occur within 200 miles of the region.

The banded (crustified) and cavernous character of the vein material and the small amount of metallic minerals that it contains suggest that the deposits have been deposited by meteoric rather than by magmatic waters.

The galena-calcite-barite-fluorite veins that occur in the Palæozoic border zone of southeastern Ontario and Quebec are in their character and relationships remarkably similar to the galena-sphalerite deposits occurring in Mississippi valley, United States, and which are believed by most geologists to be of meteoric origin. The Madoc deposits are similar in their character, and structural and age relationships to the other veins occurring in southeastern Ontario, in which galena predominates, and are almost certainly of similar origin.

The presence of a nodular, bituminous variety of barite and the mineral elaterite, in the fluorspar veins, can best be explained by the assumption that this material has been derived from the Palæozoic limestone, for these sediments are known to contain aggregates of oil.[3]

In places in Madoc district saline water is encountered in drilling wells at the contact of the Palæozoic and Precambrian. A sample of

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[1]Logan, W. E.: "Geology of Canada, 1863", pp. 516, 687–89.
Baker, M. B.: "The Geology of Kingston and Vicinity"; Ann. Rept. Ont. Bureau of Mines, vol. XXV, pt. 3, pp. 31–34.
Uglow, W. L.: "Lead and Zinc Deposits in Ontario and Eastern Canada"; Ann. Rept. Ont. Bureau of Mines, vol. XXV, pt. 2.

[2]Vennor, H. G.: Geol. Surv., Canada, Rept. of Prog. 1874–5, p. 163.

[3]Several gallons of oil are said to have been encountered in places in the limestone quarries at Crookston situated 6 miles south of Madoc.

such water from a well drilled in lot 8, concession 10, Huntingdon township, collected by the writer, was analysed in the chemical laboratories of the Department of Agriculture at the Experimental Farm, Ottawa, with the following results:

	Parts per million
Total saline matter at 212°F	23,832·00
Solids after ignition	18,424·00

From the detailed analysis of the saline matter the following approximate hypothetical composition was calculated.

	Parts per million
Magnesium sulphate (Epsom salts)	2,200·00
Calcium sulphate	1,305·00
" carbonate	4,031·00
Sodium chloride (common salt)	18,299·00
	25,835·00

This indicates that some at least of the elements contained in the fluorspar-bearing veins are present in the groundwater of the district.

Deep-seated Origin. Among the data that may be cited in support of the theory that the deposits are of magmatic origin are the following.

The principal deposits of the mineral occur in fault fissures, showing that the deposition of the vein material was preceded by crustal disturbances which might be related to magmatic movements at depth. Moreover, at least one of the faults is continuous for many miles and no doubt descends to a considerable depth. This would, therefore, afford a channel along which magmatic solutions might ascend.[1]

Although fluorspar is present in geodal cavities in the Palæozoic formations of later age at Niagara and elsewhere in southwestern Ontario, so far as known to the writer the mineral occurs only in fissures in the Palæozoic of southeastern Ontario, and it is scarcely conceivable that such large quantities of fluorspar could be concentrated from the Palæozoic formations (Black River and Trenton) of this district, without some evidence of its presence in these rocks being found.

The fluorspar-barite-calcite galena veins that occur along the Precambrian border in southeastern Ontario and the adjacent parts of Quebec are exceedingly variable in composition even in the same district. Thus, the vein on the property of the Kingdon Mining, Smelting, and Manufacturing Company at Galetta, Ontario, consists almost entirely of galena and calcite, whereas the vein occurring in a fault fissure at Quyon, Quebec, just 6 miles away, consists entirely of barite and fluorspar. Since the composition of the successive beds composing the various Palæozoic formations is approximately uniform, there is no apparent reason why the mineral composition of the vein material should be so different in the same district if the veins have been derived from Palæozoic sediments. On the other hand, this variability is not uncommon in mineral veins that are believed to be derived from a common magmatic source.

Discussion. It is obvious that in the summary of evidence presented in the preceding pages no data have been cited from which can be established any one of the hypotheses proposed to explain the mode of origin

[1]Pirsson, L. V.: "Economic Geology", vol. X, pp. 180–186 (1915).

of the fluorspar deposits of Madoc district, or of other deposits of the Madoc type. The principal objection to the meteoric origin is the inadequacy of the groundwater circulation to perform the concentration involved. It has long been known that fluorine is a constituent of sea water, that it has been noted to be present in both surface and underground waters, and that it is a constituent of calcareous corals and shells[1]. It has also been shown by Tangier Smith from analyses made by Steiger that the unaltered Palæozoic limestone of Kentucky contains small quantities (0·04-0·10 per cent) of fluorine. It is possible, therefore, that the Palæozoic limestone of Madoc district, especially since it contains an abundance of fossils, likewise contains a small proportion of fluorine. The objection to the concentration of the fluorspar by meteoric waters has not been based so much, therefore, on the inadequacy of the supply of fluorine in the Palæozoic sediments, as on the assumption that the concentration of the fluorine made it necessary that the fluorine be leached out of the Palæozoic in some way while the limestone in which the fluorine was present remained behind, an obviously impossible hypothesis. It has been previously pointed out, however, that the presence of chasm-like openings along the outcrops of the numerous joints that intersect the Palæozoic limestone (Plate III B) indicates that enormous quantities of limestone have been dissolved away by meteoric waters in Madoc district. Furthermore, since the fissures on which the fluorspar occurs were probably formed in Palæozoic time, and since southeastern Ontario has been a land area continuously or almost continuously since the Palæozoic, huge thicknesses of limestone must have been carried away in solution from this region during the long interval that has elapsed since the fissures in which the fluorspar occurs were developed. Thus, if the Palæozoic limestone of Madoc district contains the same proportion of fluorine as that present in the limestone of Kentucky (0·04 to 0·10 per cent) the fluorine that would go into solution due to the dissolving away of a mass of limestone 1 foot thick, over an area 100 feet square, would be sufficient to form at least one ton of fluorspar, and the fluorine that would go into solution as a result of the dissolving away of a similar thickness of limestone over an area of one square mile would be sufficient to form at least 5,000 tons of fluorspar. As regards the fluorspar deposits of Madoc district it is evident, therefore, that the groundwater circulation would be quite capable of effecting the concentration of the fluorspar from the Palæozoic limestone provided fluorine is present in the limestone in the same proportions as in the limestone of Kentucky.

The principal objection to the theory that the Madoc fluorspar veins are of magmatic origin is the absence of contemporaneous igneous intrusion. It has, however, been pointed out by Pirsson in this connexion that "magma in the pseudo-rigid, but potentially liquid form conceived by Iddings must everywhere underlie the outer rock zone", and any movement in the lithosphere, such as the faulting that occurred in Madoc district, might be attended by the liberation of volatile constituents, and that in

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[1]Clarke, F. W.: "Data of Geochemistry", U.S. Geol. Surv., Bull. 695, p. 118 (1920). Birschof, Gustav., Lehrbuch der Geologie, vol. II, pp. 78, 86–102 (1864).

Andree, K.: Ueber einige Vorkommen von Fluszpat in Sedimenten, Tsch. Min. Pet. Mitt., vol. XXVIII, pp. 536–556 (1909).

places no further action than this might happen. He suggests[1] further that in a large measure the peculiarities in the composition of many mineral springs and waters in otherwise apparently non-volcanic regions may be ascribed to activity of this type.

It has also been suggested by Uglow in discussing the origin of the fluorite contained in the lead and zinc deposits of southeastern Ontario that calcite-galena-barite veins occur in eastern Quebec where the Ordovician is cut by intrusives chronologically related to the Taconic revolution, and that it is possible that the presence of fluorine in the vein minerals has a genetic relation to the igneous activity of post-Ordovician age, which produced important results in the province of Quebec, but which as far as known did not affect Ontario.

Conclusion. The mode of origin of the fluorspar-bearing veins of Madoc district is obviously of considerable economic importance, because if the deposits are of meteoric origin it is probable that they will disappear at depth, whereas if they have been derived from a magmatic source they will probably continue to great depth or even become more extensive along their downward continuation. In view, however, of the conflicting character of the evidence bearing on these different theories and of the fact that the most important evidence related to the problem, namely the fluorine content of the Palæozoic limestone of the district, is unknown, the writer believes that a definite conclusion regarding the genesis of the fluorspar deposits of Madoc district is unwarranted at this stage of the investigation.

Veins of Barite Containing Fluorspar

In numerous localities in southeastern Ontario and the adjacent parts of Quebec veins of barite containing a small proportion of fluorspar occupy fault-fissures that cut the Palæozoic and older rocks. These deposits, except in the different proportions of the minerals they contain, are similar in every respect to the fluorspar-bearing veins of Madoc and their modes of origin are undoubtedly the same. In other parts of the Canadian Shield, however, there are veins of barite containing some fluorspar, as for example in Penhorwood township, Sudbury district, and in Cairo and Langmuir townships, Timiskaming district, Ontario, which occupy fractures in the Precambrian basal complex and lie many miles from the nearest remnant of Palæozoic strata. Since it is very probable that the region extending from lake Timiskaming to James bay was formerly completely covered by Palæozoic strata it is possible that the veins in Cairo and Langmuir townships originally extended upward into Palæozoic sediments that have since been removed by erosion, but it is doubtful whether the deposit in Penhorwood township could ever have occurred in such relationships.

Another group of barite veins containing fluorspar occur in the schists and felsite of the pre-Carboniferous complex of Lake Ainslie district, Inverness county, Nova Scotia. These deposits, although found in the pre-Carboniferous, occur in a region where remnants of relatively undis-

[1] "Economic Geology", vol. X, p. 184 (1915).

turbed Carboniferous strata are present, and hence in case they cut the Carboniferous, would have the same relationships as the barite veins of southeastern Ontario. H. S. Poole, who described the barite deposits of Lake Ainslie district in 1907, gives no positive information on this point. G. W. H. Norman, who has recently made a study of the Lake Ainslie deposits, states, however, that he has found evidence that the veins are of post-Carboniferous age.[1]

[1]Information given the writer by W. A. Bell. To all the barite deposits of this class cutting relatively undisturbed Palæozoic strata the discussion of the origin of the fluorspar deposits of Madoc district would apply.

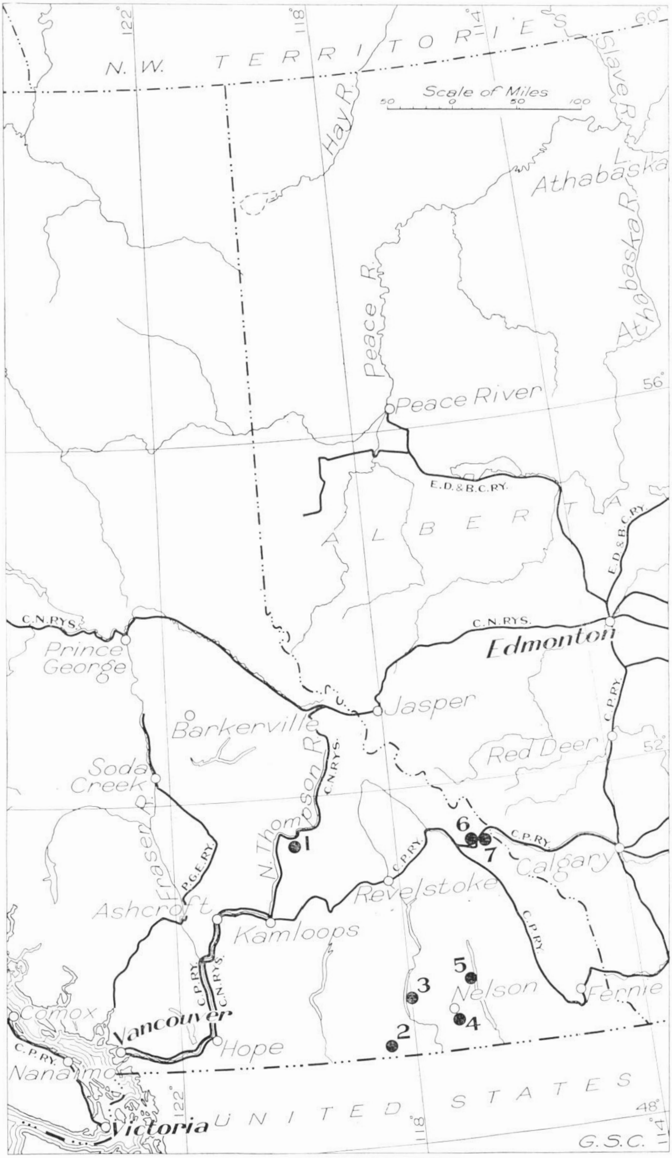


Figure 1. Index map showing location of fluorspar deposits in British Columbia. 1, Birch island; 2, Rock Candy; 3, Galena Farm; 4, Five Mile point; 5, Ainsworth; 6, Porcupine creek; 7, Sunday.

CHAPTER III

DESCRIPTION OF DEPOSITS

BRITISH COLUMBIA

KAMLOOPS MINING DIVISION

(1) Birch Island

Reference

Graham, R. P. D.: "Investigation of a Reported Occurrence of Fluorite near Birch Island, North Thompson River, B.C."; Munition Resources Commission, Final Report, 1920, pp. 49-52.

Two claims, the Atlantic and Pacific, were staked in July, 1918, on a fluorspar deposit outcropping on the summit of Red ridge, a prominent hill on the south side of Thompson river southeast of Birch Island station on the Canadian National railway, about 81 miles north of Kamloops, by A. G. McDonald, for J. F. Gardiner and E. H. Mansfield. No development work had been performed on the claims when they were examined by R. P. D. Graham in August of that year.

The rock with which the fluorspar is associated is a pale to nearly white, medium to fine-grained, quartz porphyry or porphyritic aplitic granite, through which colourless to white porphyritic crystals of orthoclase are commonly disseminated. Pyrite is everywhere present and by its decomposition imparts a rusty appearance to the weathered surface of the rock. Although the rock appears to be massive a foliation can be observed in places. This strikes north 5 degrees east and dips 18 degrees west. The rock outcrops are usually lenticular in form, with their longer axes running north and south.

The fluorspar is a deep-violet or purple-coloured variety and quite opaque in hand specimens. It occurs chiefly in a very fine-grained band that can be traced in discontinuous, but, in general, not widely separated exposures from the No. 1 post for about 180 feet along the strike to the south on the Pacific claim, and for 240 feet to the north on the Atlantic claim. Beyond these distances rock exposures are less common, but Mr. McDonald stated that outcrops of similar material occur along the line of the strike across both claims. The average width of the zone as exposed at the surface is from 2 to 3 feet or (assuming the dip to be 18 degrees) about 12 inches at right angles to the dip. Pyrite in crystals up to $\frac{1}{8}$ inch in diameter is distributed through the band.

On either side of this band is a zone in places 20 to 30 feet wide, consisting of more coarsely crystalline material of similar colour, but containing much pyrite (estimated to be as high as 10 per cent) in crystals up to one-quarter of an inch in diameter. The proportion of quartz, feldspar, and other gangue minerals also appears to be greater and more variable here than in the fine-grained band. Beyond these zones the purple material continues, but in very small quantity.

Another outcrop of somewhat different material, which proved to be a very pure fluorite, occurs about 50 feet east of the No. 1 post. This occupies an area of about 6 square feet. The fluorite is very fine-grained, compact, translucent, and mostly pure white in colour, but purple in places. "It contains little or no pyrite. A small outcrop of the same material was seen a little farther north along the strike and three or four others are reported to occur on the property."

The fine-grained, purple material when examined in thin section under the microscope was found to have a finely crystalline, even-grained structure and to consist largely of purple isotropic fluorite showing no crystal outlines, colourless minerals with low to medium birefringence interspersed through the fluorite, and a little muscovite. The colourless minerals are mainly celestite, but part appear to be feldspar and quartz. The results of two partial analyses of the material are as follows:

—	1	2
CaF_2	47·20	51·11
$SrSO_4$	32·30	26·29
$CaCO_3$	2·50	1·84
FeS_2	3·70	0·54
Fe_2O_3	....	1·18
Al_2O_3	3·00	2·19
SiO_2	6·50	not det'd
MgO	present	present
MnO_2	....	present
Undetermined	4·80	16·85
	100·00	100·00

1. Sample composed of typical average specimens taken at short intervals along the whole length of band. Analysis by Ore Dressing and Metallurgical Laboratories of Mines Branch, Department of Mines.

2. Same as 1 after removal of most of the pyrite by concentration. Analysis by R. P. D. Graham.

GRAND FORKS MINING DIVISION

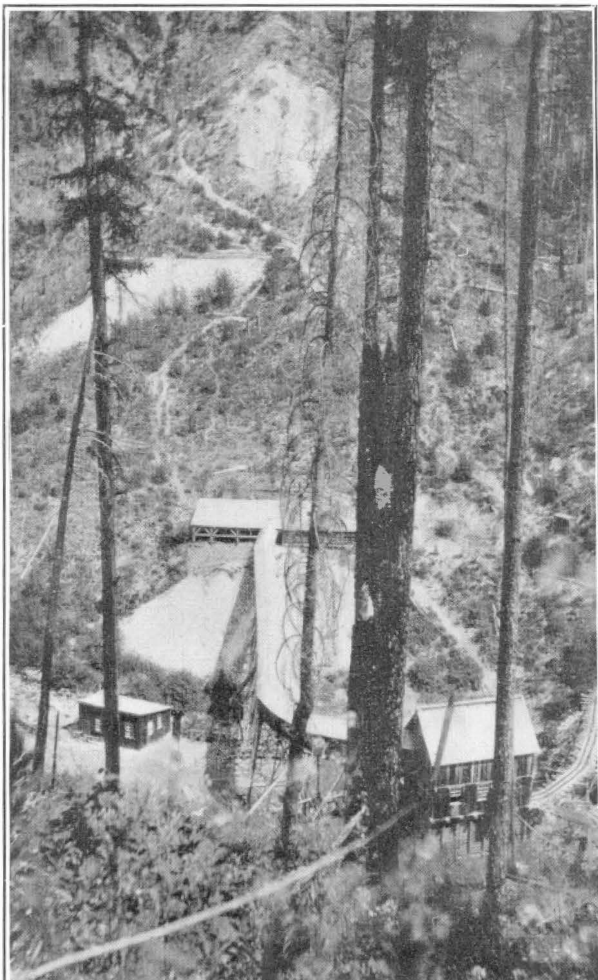
(2) Rock Candy

By Victor Dolmage

Previous Descriptions

Reports of the Minister of Mines, B.C., 1919-25, pp. 24, 25, and 26.
Freeland, P. B.: Report of the Minister of Mines, B.C., 1919, pp. 164-65.
Eardley-Wilmot, V. L.: Mines Branch, Dept. of Mines, Sum. Rept. 1922, p. 33.

The Rock Candy, the most important known fluorspar deposit in British Columbia, is situated on Kennedy creek, a small tributary entering Granby river from the west, about 15 miles north of Grand Forks. It is owned and operated by the Consolidated Mining and Smelting Company of Trail, B.C. The deposit is reached by a good motor road which branches at Pass creek from the main road running north from Grand Forks through the valley of Granby river. The ore is transported by an aerial tram which



A. Rock Candy mine, Grand Forks mining division, British Columbia.

B. Fluorspar vein, after stripping, Miller property, lot 4, con. I, Madoc tp.. Ont.

connects the mine with a branch of the Kettle Valley railway at a point in the valley of Granby river about 2½ miles east of the mine. The veins are at an elevation of about 2,600 feet and extend up the northern side of Kennedy Creek valley, which at this point is steep and narrow and about 400 feet deep. The lowest and main tunnel is about 40 feet above the creek and connected by a trestle with the ore bins, sorting tables, and aerial tram terminal (Plate IV A).

The equipment at the mine consists of a comfortable camp, blacksmith shop, and a small power plant for operating the aerial tram. At the junction of the tram with the railway a mill was built, designed to treat the ore by the decrepitation process, but, though good results were obtained, it was found that an adaptation of the flotation process gave still better results, and the ore is at present shipped to Trail where it is concentrated by this method.

The deposit was discovered in 1916 by two prospectors who believed the green-coloured fluorspar to be a copper-bearing mineral. When the true nature of the deposit was discovered the present owners bonded it, and after testing it by drilling, purchased it outright. In 1918 about 100 tons of ore was shipped by pack horses and sleighs. Before the end of the next year a new camp had been built, a motor road completed, and the aerial tramway put into operation. The first ore produced was sufficiently pure to permit of the direct shipment of hand-sorted material. Some of this was exported to the United States, but after a brief period this was terminated by the imposition of a duty of $6 per ton. The present production is used entirely at the Trail smelter.

The following table of production was compiled from the Annual Reports of the Minister of Mines, British Columbia.

Year	Tons fluorite produced	Year	Tons fluorite produced
1918	170	1922	5,044
1919	5,000	1923	
1920	7,500	1924	
1921	6,742	1925	3,874

GEOLOGY

Previous to the writer's examination the country immediately surrounding the deposit had not been mapped. However, a large area 2½ miles to the east, known as the West Kootenay area, was mapped by R. G. McConnell[1] and R. W. Brock, and another large area 2 miles to the south, known as the Boundary Creek mining area, was mapped by Brock[2] in 1901.

[1]McConnell, R. G., and Brock, R. W.: Geol. Surv., Canada, West Kootenay Sheet, No. 792.
Ann. Rept. 1898, pt. A.
Ann. Rept. 1899, pt. A.
Ann. Rept. 1900, pt. A.

[2]Brock, R. W.: Geol. Surv., Canada, "Boundary Creek Mining District", No. 826.
Ann. Rept. 1902–03, vol. XV, pt. A.

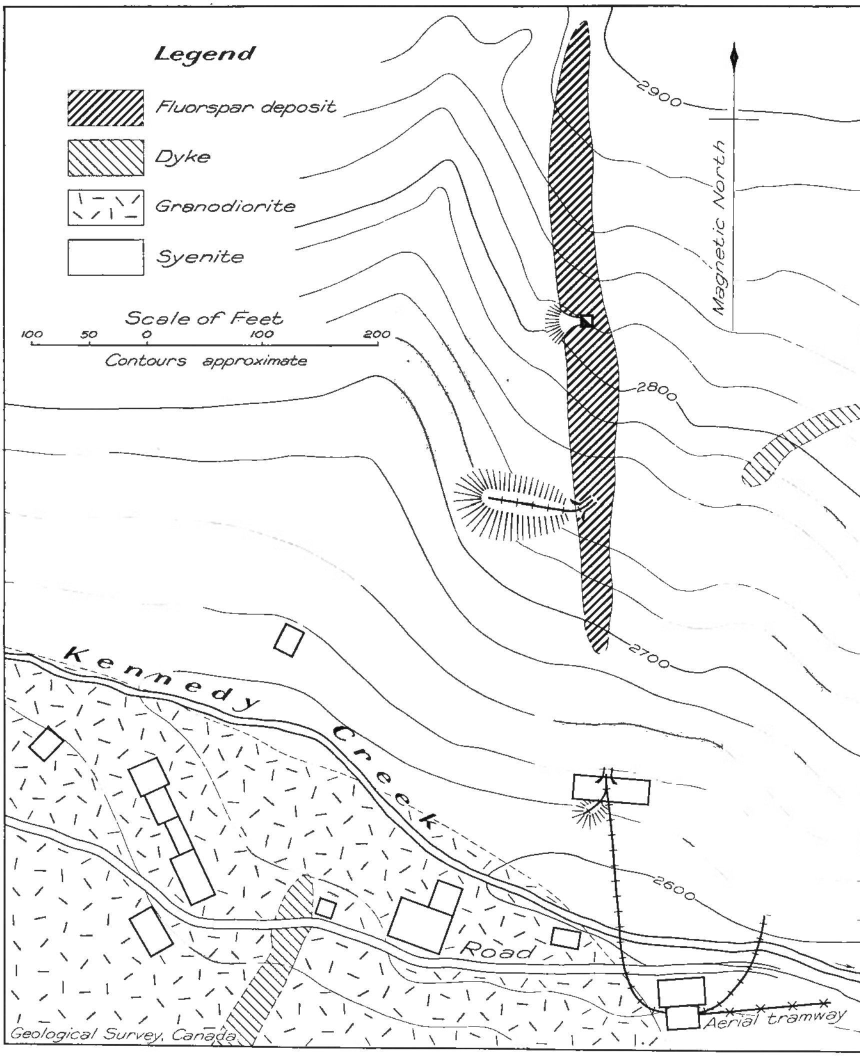


Figure 2. Rock Candy fluorspar deposit, Grand Forks mining division, British Columbia.

The accompanying figure shows that the fluorspar deposit lies completely within a body of syenite, which occupies all of the adjacent area except that occupied by a number of dykes and the body of granodiorite in the southwestern corner of the map-area.

The syenite extends over most of the surrounding country and occupies large portions of West Kootenay and Boundary Creek districts. It is a coarse-grained, plutonic rock decidedly pink in colour and appearing in the hand specimen to consist largely of orthoclase, with minute amounts of ferromagnesian minerals. Under the microscope it is seen to consist of about 70 per cent orthoclase with small amounts of plagioclase, biotite, hornblende, augite, and a very small amount of quartz, apatite, sphene, and zircon. The orthoclase occurs in large anhedral crystals rather densely clouded. The central parts of some of these crystals are white in colour and composed of aggregates of crystals which have optical properties very similar to those of hyalophene, the barium-bearing orthoclase. Owing to the variation of the optical properties with the barium content it was impossible to prove its identity by optical methods. The properties that were measured correspond closely to those of oligoclase, but the absence of twinning seemed to turn the balance of evidence to the side of hyalophene. The proximity of the fluorspar deposit, which carries much barite, and the fact that R. A. Daly found barium-feldspars in the rocks of Rock Creek district a few miles to the southwest, support the conclusion that the mineral in question is probably hyalophene. The plagioclase is fresh and has the composition of oligoclase-albite. Small quantities of apatite, sphene, and zircon were found. The age of the syenite was determined by Brock to be Tertiary.

The granodiorite which occupies the southwest corner of the area mapped is a coarse-grained plutonic rock of a pale greenish grey colour and composed principally of quartz, plagioclase, and orthoclase. The ferromagnesian minerals are largely altered to chlorite, quartz, and calcite. At no time did they form more than 10 per cent of the total volume of the rock. Quartz constitutes about 65 per cent, andesine-labradorite about 25 per cent, and orthoclase 8 per cent. The remainder consists of biotite, chlorite, magnetite, and sphene.

The contact of the granodiorite and syenite was not discovered, and, therefore, their relations were not determined.

Dykes of several closely related varieties were found cutting both the syenite and the granodiorite. The large dykes in the southern part of the map-area are very fine grained and have a dark greenish black colour. They consist of a felted mass of albite-oligoclase and actinolite needles, associated with much magnetite, less biotite, and a very small amount of quartz. Large amounts of chlorite and calcite are present. The dykes found in the syenite are coarser-grained, more porphyritic, and lighter in colour than those just described. The phenocrysts consist of orthoclase, andesine, and biotite which is partly altered to chlorite and epidote. Augite was found in only one of these dykes. The groundmasses of these dykes are made up of sheaves of radially branching, slender crystals of oligoclase-albite and actinolite, sprinkled with a quantity of minute grains of magnetite. In one dyke a few crystals of fluorite were identified.

THE DEPOSIT

The deposit as developed up to the present consists of one large ore-shoot made up of an intricate network of more or less parallel replacement veins varying from a few inches to 30 feet in width. The veins are so numerous and so closely spaced that they constitute much the greater proportion of the ore-shoot, leaving only narrow bands and isolated horses of altered country rock lying between them and forming so small a proportion of the whole that it can be mined with the ore without seriously lowering the average grade. The outcrop of the mineralized zone is about 500 feet in length and has a maximum width of 45 feet. It is exposed on the surface over a vertical distance of 200 feet and underground through a vertical distance of 250 feet. The lower or southern end passes under glacial drift and stream gravels, but diamond drilling has proved its extension for a considerable distance in this direction beyond the lowest workings. In a northern direction the extension of this or a similar set of veins has been traced by widely spaced open-cuts along the bottom of a small, shallow stream valley for a distance of half a mile. Although these open-cuts do not expose any important bodies of fluorspar they clearly indicate that the solutions of the same character as those that formed the main mass must have flowed in considerable quantities through this part of the veins, and it seems probable, therefore, that more extensive stripping in this direction might discover other valuable deposits of fluorspar.

Before purchasing the property the Consolidated Mining and Smelting Company tested the depth of the deposit by diamond drilling and though the results of this are not available it seems reasonable to believe that they were satisfactory to the company. The main vein zone dips vertically, but appears to plunge to the south.

A conspicuous feature of the deposit is the large number and great size of the open cavities or vugs. They are found in all parts of the vein and vary in size from a fraction of an inch up to 3 or 4 feet. They are lined with crystals of barite, quartz, calcite, and fluorite. They cause considerable difficulty in mining as it has been found impossible to break down much rock by firing drill-holes that penetrate the larger vugs.

The veins are composed of the following minerals, named in their order of abundance: fluorspar, barite, chert, quartz in the form of crystals, calcite, pyrite, and kaolin. The wall-rocks and the remnants of syenite scattered among the veins are intensely altered to sericite, kaolin, chert, calcite, and pyrite. The absence of galena and zinc blende is a remarkable feature of the deposit, as these minerals are more or less abundant in most known commercial deposits of fluorspar. There is a possibility that these minerals will be encountered if the deposit is developed to greater depths.

The fluorspar is mostly of a green colour, but purple and colourless varieties are present in small amounts. The barite forms large tabular crystals up to 4 inches in length. These are a pale yellow and are usually perfectly transparent. The chert is more abundant in some places than the barite. It has a cream colour and usually contains scattered crystals of fluorite and barite. Quartz is found most plentifully in the form of well-formed crystals lining the many cavities large and small. Calcite is one of the least abundant minerals, but wherever found it is in the form of large white or clear crystals. Pyrite is the only sulphide present and usually occurs as small, well-formed octahedrons clustered on the crystal faces of the other minerals. It is most plentiful in the altered country rock. Several small vugs were found containing a white plastic material which could be easily dug out with a pick. This was found under the microscope to consist chiefly of kaolin with some quartz in an extremely fine state of subdivision.

The presence of barite in the syenite, and of fluorspar in one of the closely related dykes, and the absence of any other likely source, make it seem reasonably certain that the solutions that replaced the syenite and deposited the fluorspar, barite, and other vein minerals originated in the syenite as the result of differentiation processes attendant on the cooling and crystallization of the magma.

SLOCAN MINING DIVISION

(3) Galena Farm

Fluorspar is a common gangue mineral, along with quartz and siderite, in the veins of the Galena Farm mine at Silverton in Slocan district. The quantity of the mineral is not sufficient to be of commercial importance, however.[1]

NELSON MINING DIVISION

(4) Fivemile Point

References

Robertson, W. F.: Report of the Minister of Mines, British Columbia, 1904, p. 134.
LeRoy, O. E.: Geol. Surv., Canada, Sum. Rept. 1911, p. 157.

This claim lies just above the Nelson and Fort Sheppard railway at Fivemile Point station. When visited by W. F. Robertson in 1904 it was owned by George Huston and associates of Sandon. The vein in which the fluorspar is found is exposed in the roof of an adit 75 feet long, and occupies

[1] Information from C. E. Cairnes.

a fissure cutting granite porphyry. It strikes north 60 degrees west, dips 55 to 90 degrees northeast, and is composed largely of zones of fluorspar and mingled fluorspar and broken rock. The maximum total width is 43 inches.

"A band of blue and purple fluorite, with a maximum thickness of 14 inches, occurs along and near the foot-wall, and smaller parallel streaks lie in the central and hanging-wall portions of the vein. Other streaks of a light grey, dense, siliceous material have a similar occurrence. An analysis of the latter by Mr. R. A. A. Johnston gave silica 91·28, alumina 6·16, and water 2·26. These streaks are apparently quartz containing a little kaolin from the crushed granite. Vugs up to a foot or more in diameter, with concentric banded borders, are common in the fluorite bands. Barite in minute crystals and aggregates is found in some of the vugs deposited on the fluorite."

A few tons of fluorspar were mined from the deposit for experimental purposes by the Hall Mining and Smelting Company in the autumn of 1904. It is said that the mineral contained "a higher amount of silica than was desirable".

AINSWORTH MINING DIVISION

(5) Ainsworth Camp

Reference

Schofield, S. J.: "Geology and Ore Deposits of Ainsworth Camp"; Geol. Surv., Canada, Mem. 117, pp. 34, 45, 46, and 47 (1920).

Fluorspar is one of the most common gangue minerals in the Ainsworth mining camp. It is most common in the Early Bird claim where pink and purple varieties are abundant as cubes and irregular masses associated with calcite. It is also the principal gangue mineral in the Silver Hoard mine, it is a common gangue mineral with ankerite in the Highland mine, and occurs here and there in the Number One mine.

GOLDEN MINING DIVISION

(6) Porcupine Creek

Reference

Allan, J. A.: "Geology of Field Map-area, Yoho Park, B.C."; Geol. Surv., Canada, Sum. Rept. 1911, p. 186.

About 3 miles up the valley of Porcupine creek and at an elevation of 4,300 feet, veins from 1 to 6 inches wide filling fractures in a dolomitic slate are exposed. The vein material consists of aggregates of galena and pyrite in a matrix of fluorspar ferruginous dolomite (ankerite), muscovite, and lepidomelane.

(7) Sunday Claim

Reference

Allan, J. A.: "Geology of the Field Map-area, Yoho Park, B.C."; Geol. Surv., Canada, Sum. Rept. 1911, pp. 185-6.

This claim lies on the south side of Ottertail river about ½ mile above the Canadian Pacific railway and 2 miles south of Emerald station. The workings consist of a shaft 100 feet deep and an adit about 75 feet long that cuts across soft, green, calcareous slates and argillites. The ore minerals are sphalerite, galena, pyrite, chalcopyrite, with a little tetrahedrite. The gangue minerals are fluorspar and calcite, occurring as veins along and across the bedding of the slate and in pockets up to 1 foot in diameter along fractures or small faults. The colour of the fluorspar varies from white to greenish blue. There is not enough of the mineral to give it economic value.

OTHER OCCURRENCES OF FLUORSPAR IN BRITISH COLUMBIA

In addition to the deposits already described, fluorspar has been observed by G. M. Dawson in British Columbia in veinlets on a point on Little Shuswap lake in Kamloops mining division; in melanite syenite in the Maple Leaf property at Franklin, in Similkameen mining division, by C. W. Drysdale; and in the Wigwam property in Lardeau mining division.[1] None of these occurrences is of commercial extent and the presence of the mineral in these localities is, therefore, merely of mineralogical interest.

NORTHWEST TERRITORIES

(1) Dubawnt River

Reference

Tyrrell, J. B.: Geol. Surv., Canada, Ann. Rept., vol. VII, pt. A, pp. 42-43 (1896).

On Dubawnt river, at the point where about 35 miles west of Baker lake it turns from a north to a southeast course, the sides of the valley are stated by Tyrrell to be composed "of light green Huronian schists, cut by dykes of dark green diabase, and veins of quartz, calcite, and fluorspar, associated with masses of pyrite." The proportions of fluorspar or the dimensions of the veins are not stated, but a deposit of fluorspar, even if extensive, in this remote locality has no immediate commercial value.

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[1]Information from J. F. Walker.

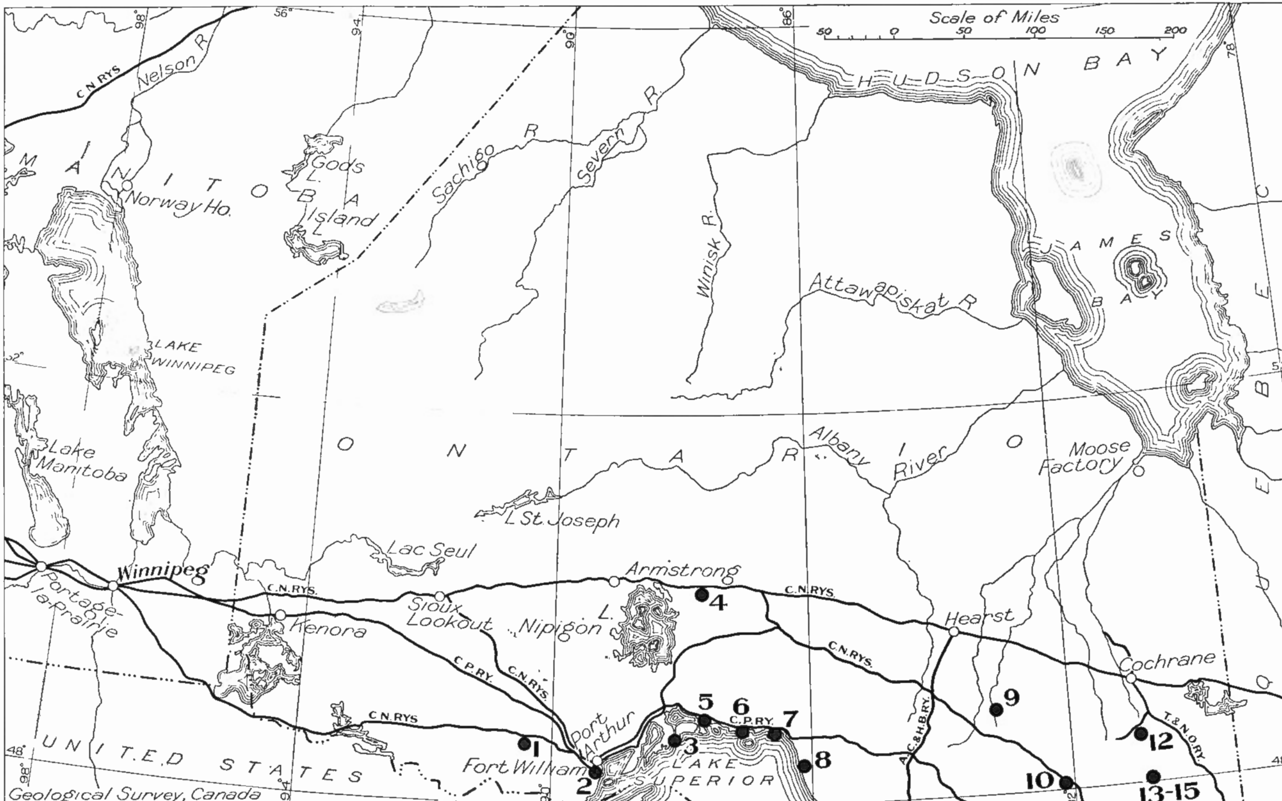

Figure 3 (West part). Index map showing location of fluorspar deposits in Ontario. For explanation of Figure *See* page 33.

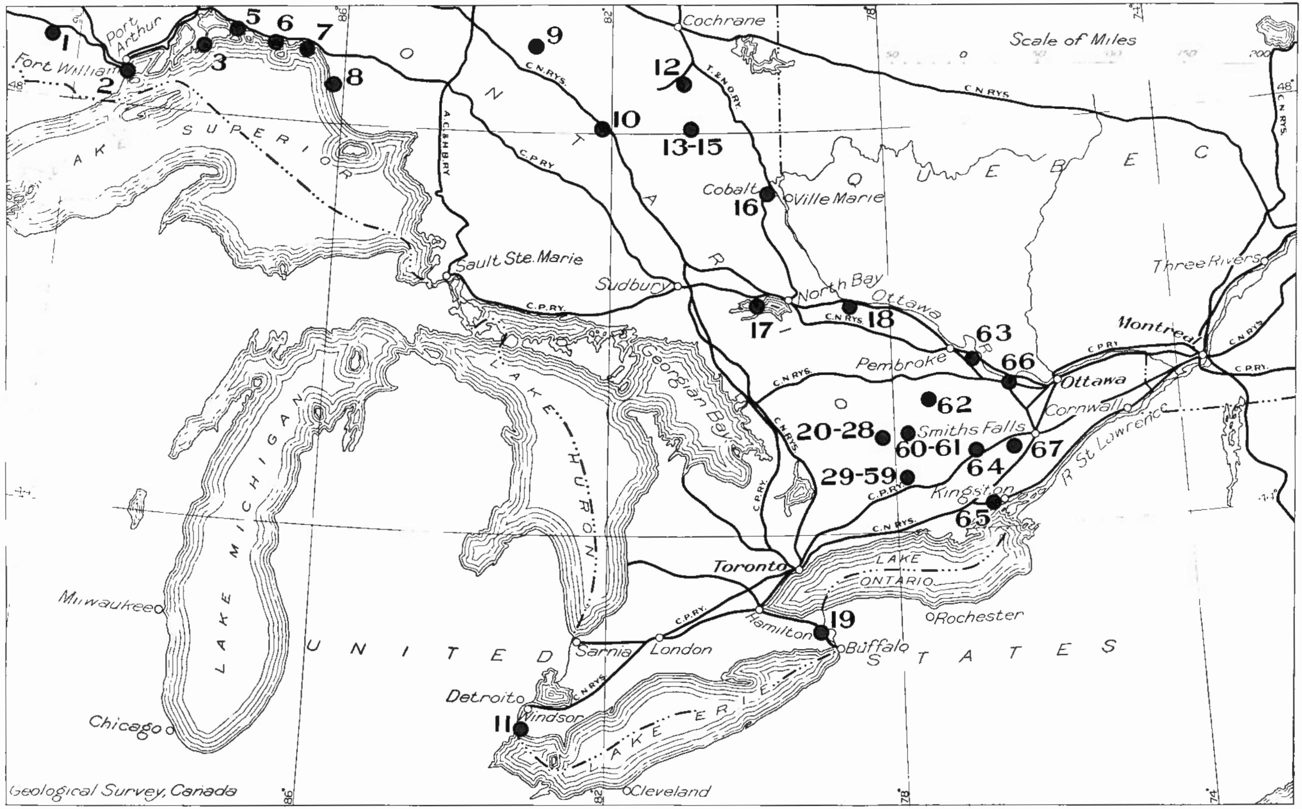

Figure 3 (East part). Index map showing location of fluorspar deposits in Ontario. For explanation of Figure *See* page 33.

Explanation of Figure 3 (Pages 31 and 32)

The localities indicated by numbers on Figure 3 are as follows:

1. Loch Erne
2. Port Arthur-Fort William
3. Fluor island
4. Tashota
5. Gravelly point
6. Schreiber
7. Pic island
8. Cape Gargantua
9. Trout lake
10. Ravenna
11. Amherstburg
12. Premier-Langmuir
13. Alma
14. Harvey
15. Biederman
16. Cobalt
17. Iron island
18. Cameron
19. Niagara
20. Monmouth
21. Earle
22. Richardson
23. Tripp
24. Cardiff tp., con. XXI, lot 9
25. Cardiff tp., con. XXI, lot 18
26. Dwyer
27. Cardiff tp., con. XXII, lot 9
28. Stoughton
29. Palmateer
30. Jones
31. Wright
32. Howard
33. Noyes
34. Blakely
35. Perry
36. Coe
37. South Reynolds
38. Rogers
39. Keen
40. North Reynolds
41. Huntingdon tp., con. XIV, lot 11
42. Bailey
43. Hill
44. McIlroy
45. Lee Jr.
46. McBeath
47. South Herrington
48. Lee Sr.
49. Wallbridge
50. North Herrington
51. Madoc tp., con. II, lot 1, W. half
52. Stewart
53. Madoc tp., con. II, lot 3
54. Ponton
55. Miller
56. William Reynolds
57. Rooks
58. Plain
59. Madoc tp., con. IV, lot 14
60. Woodcox
61. MacDonald
62. Renfrew
63. Ross
64. Oso
65. Kingston
66. Kingdon
67. Bulger

ONTARIO

THUNDER BAY DISTRICT

(1) Loch Erne

Occurrences of fluorspar in several localities on and near Loch Erne, about 7 miles southeast of Kashabowie station on the Canadian National railway, were observed by T. L. Tanton of the Geological Survey during the field season of 1928. The deposits in which the fluorspar occurs are breccia zones up to 20 feet wide, the interspaces of which are filled with quartz and, in places, a small proportion of purple fluorspar. The amount of fluorspar present in the observed occurrences is too small to be of commercial importance, but L. A. Anderson of Fort William states that a similar zone occurs nearby in which the proportion of fluorspar is much greater.

(2) Port Arthur-Fort William Area

References

Ingall, E. D.: "Mines and Mining on Lake Superior"; Geol. Surv., Canada, Ann. Rept., vol. III, pt. H (1889).

Parsons, A. L.: "Economic Deposits in Thunder Bay District"; Dept. of Mines, Ontario, Ann. Rept., vol. 30, pt. 4 (1921).

Fluorspar is a common mineral in the silver-bearing veins of the Port Arthur-Fort William area. These veins occupy vertical or steeply inclined fissures or fracture zones cutting the Animikie, Keweenawan, and older rocks, of that region, and are believed to be genetically related to the dykes and sills of Keweenawan diabase that occur extensively nearby. The vein filling material includes a great variety of metallic minerals, in a gangue composed chiefly of calcite, quartz, barite, and fluorspar. The fluorspar occurs in granular, crystalline, and mammillated forms, or in individual, or groups of cubic crystals. Its colour is mostly light green, less commonly pale amethyst. In places "detached, well-formed crystals occurring in vugs are pale yellow or colourless". Although present in most of the veins, fluorspar, except locally, is not the predominate gangue mineral, and is, therefore, not sufficiently abundant in any of the known veins to be of commercial importance. It is possible that, if some of the veins of the district were worked for their silver content, fluorspar could be produced as a by-product.

The properties in which fluorspar is reported to occur, and the geological reports in which its occurrence is noted, are included in the following table:

Fluorspar-Bearing Veins of Port Arthur-Fort William District

Township	Property or locality	Reference	Remarks
Strange	Gopher	G.S.C., Ann. Rept., vol. XIII, pt. A, p. 172 (1903)	Museum specimen
Lybster	Silver mountain	Ingall, E. D.: G.S.C., Ann. Rept., vol. III, pt. H, pp. 87–9 (1889)	Abundant in places, but generally in subordinate amount
"	Palisades	" pp. 92–3	Not abundant
"	Claim R 64	" p. 95	Interlaminated with quartz
"	Crown Point	" p. 92	Some green and purple fluorite in gangue
"	Claim R 111	" p. 96	A subordinate gangue mineral
"	Silver Hill	" pp. 93–4	A small amount of green fluorite
"	West end, Silver mountain	Parsons, A. L.: Dept. of Mines, Ont., Ann. Rept., vol. 30, pt. 4, pp. 31–32 (1921)	In tabular statement
Gillies	Porcupine	G.S.C., Ann. Rept., vol. XII, pt. A, p. 194 (1902)	Museum specimen
"	Badger	Parsons, A. L.: Dept. of Mines, Ont., Ann. Rept., vol. 30, pt. 4, pp. 31–32 (1921)	In tabular statement

Fluorspar-Bearing Veins of Port Arthur-Fort William District—Continued

Township	Property or locality	Reference	Remarks
O'Connor.........	Beaver.............	Ingall, E. D.: G.S.C., Ann. Rept., vol. III, pt. H, p. 72 (1889)	A little green or purple fluorite
"	West Beaver........	Ont. Bureau of Mines, Ann. Rept., vol. 24, p. 95 (1915)	Vein of interbanded calcite, quartz, fluorite, and sphalerite, with pockets of galena, pyrite, argentite, and native silver
Paipoonge.........	Elgin..............	Ingall, E. D.: G.S.C., Ann. Rept., vol. III, pt. H, p. 76 (1889)	Some dark purple, white, and light yellow fluorite
"	Rabbit mountain...	" pp. 68–69......	Gangue composed of quartz, calcite, and green and purple fluorite
"	Paresseux rapids....	" p. 66.........	Gangue of barite, calcite, quartz, and fluorite
"	Lots 4 and 5........	" p. 66.........	On the north bank of Kaministikwia river a vein 3 to 4 feet wide, having a gangue of barite, quartz, calcite, and fluorite
"	Woodside...........	" p. 96.........	Purple fluorite in joint fissures of enclosing granitic and gneissic rocks
"	Scripture's vein.....	" p. 93.........	2–4 inch zone of green fluorite on each wall of vein composed chiefly of barite
"	Federal.............	Parsons, A. L.: Dept. of Mines, Ont., Ann. Rept., vol. 30, pt. 4, pp. 31–32 (1921)	In tabular statement
Unsubdivided.....	Prince's mine.......	"Geology of Canada, 1863", pp. 463 and 707–8	In vein of calcite with quartz and barite
McGregor.........	Mackenzie river.....	Hoffmann, G. C.: G.S.C., Ann. Rept., vol. IV, pt. T, p. 33 (1891)	In vugs in irregular veins in syenite
"	Blende lake.........	Parsons, A. L.: Dept. of Mines, Ont., Ann. Rept., vol. 30, pt. 4, pp. 31–32 (1921)	In tabular statement
Unsubdivided.....	Silver islet..........	" "	" "
Dorion............	Dorion..............	" "	" "
Unsubdivided	Bishop's mine.......	" "	" "
"	Edward island......	" "	" "

(3) Fluor Island

Reference

"Geology of Canada, 1863", p. 707.

Fluor island consists of the same rocks as the adjoining country and is traversed by numerous veins, in which vitreous copper (chalcocite) has been found. It receives its name from the fluorspar which is said to abound in the veins.

(4) Tashota

Reference

Hopkins, P. E.: "The Kowkash Gold Area"; Ont. Bureau of Mines, Ann. Rept., vol. 26, p. 215 (1917).

Fluorspar occurs finely disseminated in a quartz vein exposed near the crossing of the Canadian National railway and Tashota creek northeast of lake Nipigon.

(5) Gravelly Point

Reference

Bigsby, John: "A List of the Minerals and Organic Remains Occurring in the Canadas"; Am. Jour. Sci., vol. 8, p. 72 (1824).

Fluorspar "is abundant lining fissures, together with sulphate of barites, in the porphyry of the large and lofty islands", on the north shore of lake Superior, "3 miles east of Gravelly point and 63 miles east of Fort William".

(6) Schreiber

References

Bigsby, John: "A List of Minerals and Organic Remains Occurring in the Canadas"; Am. Jour. Sci., vol. 8, p. 72 (1824).

Hopkins, P. E.: "Schreiber-Dick Lake Area"; Ont. Dept. of Mines, Ann. Rept., vol. 30, pt. 4, p. 7 (1921).

P. E. Hopkins states that fluorspar, specular hematite, and chalcedony, are found in quartz veins at mileage 111·6, 7 miles east of Schreiber, and with barite, in a narrow vein assaying 2 ounces of silver per ton, in a fault at the 90-foot falls near the mouth of Black river. The last vein is probably the deposit mentioned by Bigsby as being on the north shore of lake Superior 6 miles east of the Written rocks (about 4 miles southeast of Schreiber).

(7) Pic Island

Reference

Bigsby, John: "A List of Minerals and Organic Remains Occurring in the Canadas"; Am. Jour. Sci., vol. 8, p. 72 (1824).

Fluorspar occurs plentifully "in the syenite of the north mainland of lake Superior, opposite Pic island".

ALGOMA DISTRICT

(8) Cape Gargantua

Reference

Bigsby, John: "A List of Minerals and Organic Remains Occurring in the Canadas"; Am. Jour. Sci., vol. 8, p. 72 (1824).

Fluorspar is reported by Bigsby to occur with calcite in amygdaloidal trap 3 miles east of point Gargantua on the northeast shore of lake Superior.

SUDBURY DISTRICT

(9) Trout Lake

Reference

Bell, R.: "Report on the Geology of the Basin of the Moose River"; Geol. Surv., Canada, Rept. of Prog. 1880-82, pt. C, p. 6.

Crystalline, bright green fluorspar was observed by Bell on Trout lake, an expansion on Trout river, about 30 miles northeast of Chapleau. It occurs as crystals and masses in patches of amygdaloid enclosed in red granite exposed on the east shore of the lake at a point about 3 miles south of its outlet.

(10) Ravenna

References

Ont. Dept. of Mines, Ann. Rept., vol. 30, pt. I, pp. 21-22 (1921).

Spence, H. S.: "Barium and Strontium in Canada"; Mines Branch, Dept. of Mines, 1922, pp. 35-37.

Todd, E. W.: "Groundhog River Area"; Ont. Dept. of Mines, Ann. Rept., vol. 33, pt. 6, pp. 16-17 (1924).

In Penhorwood township, 3 miles west of Tionaga station on the Canadian National railway, there is a vein or vein-zone of barite from 1 to 16 feet wide, associated with a north-south trending pegmatite dyke. The rocks adjoining and cut by the pegmatite dyke belong to the early Precambrian basal volcanic complex. Purple fluorspar occurs along the wall of the vein-zone and in the pegmatite nearby, but the proportion of the mineral so far observed is not sufficiently great to be of commercial importance.

ESSEX COUNTY

(11) Amherstburg, Malden Township

Fluorspar occurs in cavities in Devonian dolomite in the quarry of the Amherstburg Stone Company at Amherstburg. The amount of the mineral is so small, however, that the occurrence is only of mineralogical interest.

TIMISKAMING AND NIPISSING DISTRICTS

Fluorspar is known to occur in several localities in Timiskaming district, but not in deposits of workable extent. The principal published information regarding each deposit and a reference to the report from which the information was obtained are included in the following table:

	Locality	Character of deposit	Associated rock	Reference
		Timiskaming District		
(12)	Langmuir tp. (Premier-Langmuir mine)	Excrustation along wall and around inclusions of wall-rock in veins of barite up to 6 ft. wide	Keewatin greenstone	Spence, H. S.: "Barium and Strontium in Canada"; Mines Branch, 1922, pp. 44–46.
(13)	Alma township	Quartz veins		Burrows, A. G.: Ont. Bureau of Mines, Ann. Rept., vol. 27, p. 235 (1918).
(14)	Cairo township Harvey	Vein of quartz 7 inches wide striking N. 75°E., and containing aggregates of fluorspar up to 2 inches in diameter	Syenite	Burrows, A. G.: Ont. Bureau of Mines, Ann. Rept., vol. 27, p. 235 (1918).
(15)	Biederman	Impurity in vein of barite up to 16 ft. wide	Red syenite	Spence, H. S.: "Barium and Strontium in Canada"; Mines Branch, 1922, pp. 38–39.
(16)	Cobalt district	In silver-bearing veins		Knight, C. W.: Ont. Dept. of Mines, Ann. Rept., vol. 31, 1922, pt. 2, p. 35.
		Nipissing District		
(17)	Iron island, lake Nipissing	Granular, and in small, cubic crystals with barite in fissures	Crystalline limestone	Logan, W. E.: Geology of Canada, 1863, p. 463.
(18)	Cameron township	In large cleavable masses in pegmatite	Biotite gneisses	Barlow, A. E.: Geol Surv., Canada, Ann. Rept., vol. X, pt. 1, p. 159.

(19) WELLAND COUNTY

References

"Geology of Canada, 1863", p. 463.
Coste, E.: Geol. Surv., Canada, Ann. Rept., vol. 3, pt. S, pp. 79-80.

Purple fluorspar associated with crystals of dolomite occurs in geodal cavities in the Niagara dolomite at Niagara falls and elsewhere. These occurrences are not extensive and are, therefore, only of mineralogical interest.

HALIBURTON COUNTY

(20-28) Monmouth and Cardiff Townships

Previous Description

Ellsworth, H. V.: Geol. Surv., Canada, Sum. Rept. 1923, pt. C I, p. 8.

Numerous veins of calcite containing fluorspar and other minerals have been discovered in recent years near Wilberforce on the Howland-Bancroft branch of the Canadian National railway. The veins occupy fractures cutting pegmatite, granite, syenite, and syenite-gneiss, diorite-gneiss, and other rocks. They trend for the most part northeasterly and range in width from a few inches to 10 feet. The vein material in addition to calcite includes: mica, apatite, pyroxene, hornblende, microcline, scapolite, titanite, molybdenite, and deep purple fluorspar. In the veins, so far discovered, the proportion of fluorspar present is not sufficient to be commercially important. Brief descriptions of these occurrences are included in the following table.

	Locality	Character of deposit	Wall-rock	Information from
(20)	Monmouth township, concession XVII, lot 29	Small masses of calcite and fluorite exposed in prospect pit	Granite	Ellsworth, H. V.
(21)	Cardiff township, concession XII, lot 9	Vein of calcite 5–6 feet wide, striking N. 25°E. mag., and dipping 45°W. The calcite contains apatite, mica, pyroxene, and a small proportion of fluorspar	Banded gneiss striking N. 40°W. mag., on west and coarse granite on east	Ellsworth, H. V.
(22)	Concession XXI, lot 4	Aggregates or masses of calcite, mica, feldspar, fluorspar, apatite, and other minerals up to 6 feet wide	Banded, biotite feldspar gneiss, syenite, and pegmatite	Goranson, R. W.
(23)	Lot 8 (Tripp)	A vertical, lenticular vein 120 feet long striking N. 50–60° E. mag., and having a maximum width of 4 feet. Vein material: calcite, brown apatite, black hornblende, mica, molybdenite, and fluorite	Syenite and hornblende gneiss	Ellsworth, H. V.
(24)	Lot 9	White calcite, purple fluorspar, black hornblende, and green apatite in pit 15 feet in diameter and 4 feet deep	Syenite	Ellsworth, H. V.
(25)	Lot 18	"Promising looking vein of deep purple fluorspar"	.... ?	Eardley-Wilmot, V.L.: Mines Branch, Sum. Rept., 1922, p. 33.

	Locality	Character of deposit	Wall-rock	Information from
(26)	Concession XXII, lot 8	Vein of white calcite, striking N. 50° E. mag., and dipping 45°SE. Minerals contained in vein: black pyroxene, red and green apatite, and deep purple fluorspar in masses up to 1 foot in diameter. Exposed in pit and adit on hill slope	Hornblende diorite gneiss, and massive granite	Wilson, M. E.
(27)	Lot 9	Vein about 4 feet wide striking N. 75°E. mag. Vein material: white calcite, purple fluorspar, and brown apatite, crystals of pyroxene and orthoclase along walls	Pegmatitic hornblende, granite, and syenite	Ellsworth, H. V.
(28)	Lot 13	Pit 10 feet by 10 feet and 3 feet deep in which an intermixture of microcline, pyroxene, scapolite, calcite, titanite, and purple fluorspar is exposed	Pegmatitic granite	Ellsworth, H. V.

HASTINGS COUNTY

Huntingdon and Madoc Townships

GENERAL DESCRIPTION

That fluorspar-bearing veins were present in Madoc district was known to some of the local inhabitants more than thirty years ago, but they were not then regarded as commercially important. The first attempt to mine the mineral was made by the late Stephen Wellington who in 1905 put down a prospect pit 14 feet deep on the Bailey property. During the years following this operation a small amount of prospecting work on the fluorspar deposits of the district was performed, but little interest was taken in the mineral until the year 1916 when owing to the world war the price of fluorspar advanced to as much as $30 per ton. As a consequence of this increased demand the production of fluorspar from Madoc district rose from nothing in 1915 to a maximum of 7,286 tons, valued at $153,190, in 1918. When the writer examined the fluorspar properties in 1920 there were six deposits on which mining operations were being carried on, but the greater part of the production of the mineral was being derived from the two principal mines of the district, the Noyes and the Perry. Now, however, both of these properties are idle and active mining of fluorspar in Madoc district has ceased.

Geographical Position and Distribution of Deposits

The village of Madoc, near which the deposits occur, is situated in the central part of southeastern Ontario about 25 miles north of the north shore of lake Ontario, and at the northern end of the Belleville-Madoc branch of

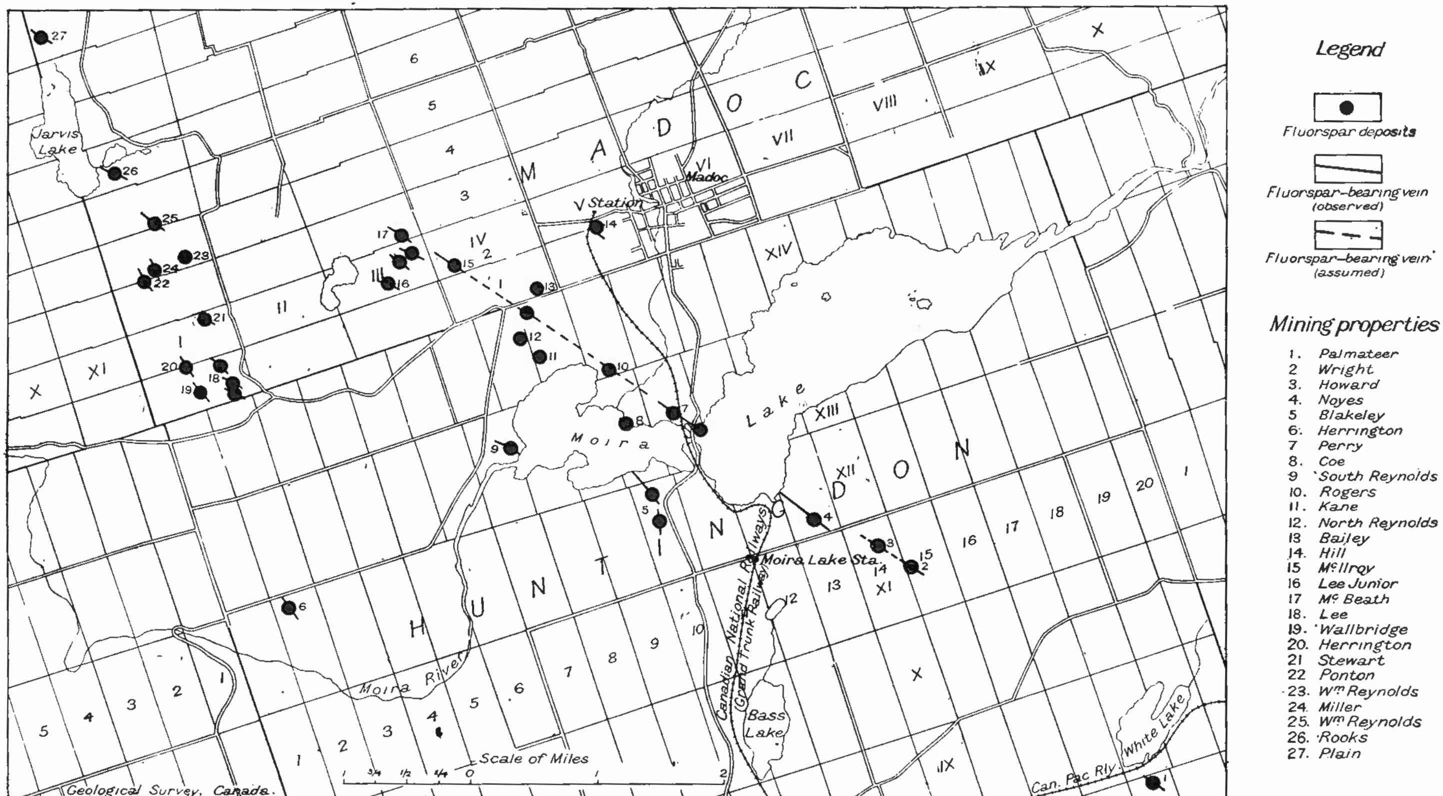

Figure 4. Diagram showing location of fluorspar deposits in the vicinity of Madoc, Hastings county, Ontario.

the Canadian National railway. It lies 7 miles north of Ivanhoe station on the main line of the Canadian Pacific railway between Toronto and Montreal via Peterborough.

The deposits outcrop mainly in two localities (*See* Figure 4): (1) the northern part of Huntingdon township; and (2) the southern part of concession I, Madoc township. Since nearly all the deposits in the first locality occur either in the vicinity of Moira lake or along the continuation of the Noyes-Perry fault which crosses Moira lake, they will be referred to collectively as the Moira Lake group. The deposits occurring in the southern part of concession I, Madoc township, on the other hand, will be designated the Lee-Miller group. The descriptions of the various properties composing these groups have been arranged in the order of their occurrence from south to north in the district and not in the order of their importance.

Geological Relationships

The geological formations with which the fluorspar deposits are associated belong to two principal groups: (1) a Precambrian basal complex; and (2) flat-lying or nearly flat-lying Palæozoic sediments which belong chiefly to the Black River formation and rest unconformably on the irregular surface of the Precambrian.

The Precambrian basal complex consists of three subdivisons: (1) grey, banded, crystalline limestone, buff-weathering dolomite, and other sediments belonging to the Grenville or Grenville and Hastings series; (2) masses of gabbro, diorite, and related intrusives; and (3) batholithic masses of red to pink (Moira) granite or syenite intruding the rocks of subdivisions 1 and 2.

The Palæozoic sediments that overlie the Precambrian complex consist in succession from the base upward of: (1) red and grey, calcareous arkose and sandstone alternating with thin, uniform beds of red to grey lithographic limestone; and (2) massive beds of coarsely crystallized, grey limestone. The total thickness of the formation is about 150 feet.

The fluorspar-bearing veins of the Lee-Miller group, with the exception of the outlying Herrington deposit on lot 2, concession XII, Huntingdon township, all occur in the Palæozoic. The veins of the Moira Lake group on the other hand intersect the Palæozoic only at the southeast and northwest extremities of the zone, the most important deposits, those on the Noyes, the Perry, the Rogers, and the Keen properties being in the Precambrian.

General Character of Deposits

All the fluorspar deposits of Madoc district are veins occupying fault fissures of post-Ordovician age. They consist chiefly of fluorspar and barite, or fluorspar, barite, and calcite intermingled or interbanded in varying proportions. The less common minerals present are celestite, quartz, pyrite, marcasite, chalcopyrite, tetrahedrite, malachite, and elaterite, but all of these with the exception of the celestite are quantitatively unimportant.

The most characteristic features exhibited by these veins are the presence of two parallel mineral zones separated by a zone of fractured or brecciated wall-rock, and of lenticular masses of vein material usually situated where two such mineral zones unite. Where two mineral zones are present, one is generally wide and the other relatively narrow. The width of the zone of fractured country rock intervening between the mineral zones ranges from a few inches to 10 feet or more in proportion to the average width of the main vein. The lenses that occur on the veins range from a few feet to 200 feet in length and from 2 feet to 17 feet in maximum width. The longer direction of each of the principal lenses that have so far been opened up on the Noyes-Perry vein, all appear to extend diagonally down the vein toward the southeast. The explanation of this structural feature was not determined by the writer.

The material composing the fluorspar deposits occurs chiefly in two ways: (1) as alternating bands; or (2) as an irregular network forming the partitions between caverns. In vein material of the first variety cavities are relatively uncommon, whereas in vein material of the second class cavities form a large part of the total volume. On this account the two varieties of vein material may be appropriately designated for the purpose of description the "banded" and "cavernous" types respectively.

Chemical Composition of Vein Material

It has been previously noted that the material composing the fluorspar-bearing veins consists chiefly of varying proportions of fluorspar, barite, and calcite. Furthermore, the relative abundance of these minerals varies so greatly, even in adjacent parts of the same vein, that the grade of fluorspar produced from different properties or from the same property at different times varies considerably. The analyses contained in the following table indicate approximately, however, the grade of some of the material produced from the Noyes mine which, from the standpoint of production at least, is the most important property so far developed in the district.

—	I	II	III	IV	V	VI	VII
CaF_2 (Fluorspar)	80·68	84·35	74·05	80·24	73·52	81·81	76·61
$BaSO_4$ (Barite)	5·10	5·34	9·34	7·54	11·88	5·30	8·13
$CaCO_3$ (Calcite)	10·04	6·75	10·76	7·16	10·31	7·85	9·11
R_2O_3 (Alumina, ferric oxide, etc.)	2·00	2·10	3·00	1·20	1·20	1·88	3·07
SiO_2 (Silica)	2·33	1·37	3·60	3·07	2·40	2·97	2·74
Total	100·15	99·91	100·75	99·21	99·31	99·91	99·66

Nos. I to VI, typical shipments; No. VII, average of sixteen shipments; analyses by Algoma Steel Corporation.

Mineralogy

The minerals comprising the fluorspar veins, named in the order of their abundance, are: fluorspar, barite, calcite, celestite, quartz, marcasite, pyrite, chalcopyrite, tetrahedrite, malachite, and elaterite. The character and mode of occurrence of each of these are briefly described in the following paragraphs.

Fluorspar (CaF_2, calcium 51·1 per cent, fluorine 49·9 per cent). This mineral occurs in the veins partly in the massive form and partly as crystals encrusting the walls of cavities.

The most common crystal forms of the fluorspar are the cube modified by the octahedron, but in some deposits the relative prominence of the two forms is reversed and the octahedron is modified by the cube. With the exception of the large, clear crystals that occur embedded in celestite in the Keen vein, the cubical crystals of the mineral generally have surfaces pitted with angular depressions, owing to the presence within the larger crystal of numerous, small cubes or cubes modified by the octahedron, intergrown in nearly parallel positions. In addition to the common forms the cube, a (100), and the octahedron, o (111), assumed by the mineral, the following have been observed by Dr. T. L. Walker on crystals from the Keen property: rhombic dodecahedron, d (110); tetrahexahedron, a (310); trisoctahedron, p (441); and icositetrahedron, n (322).[1]

The refractive index of the fluorspar according to a determination by C. W. Greenland is 1·4340[2].

The colour is most commonly white, grey, or green, but honey-yellow, blue, purple, rose, and red varieties are also common. Some of the large, brilliant, clear crystals embedded in celestite in the Keen vein, and the transparent, pale green crystals obtained from the deposit on the Perry property, are exceptionally beautiful.

Barite ($BaSO_4$, barium oxide 65·7 per cent, sulphur trioxide 34·3 per cent). Barite, the mineral next in abundance to fluorspar, occurs chiefly in the massive form or in crystals, but columnar, nodular, fibrous, and ochreous varieties are also represented. The crystals are commonly tabular in form and range in size from plates an inch or more in diameter to minute tabulæ. Most of them project edgewise from a solid mass of barite which may have the form of a dome, a column, or a flat sheet. Where the mass is dome-shaped, the tabulæ are distributed either concentrically around the dome or parallel one another across the dome; where the barite is columnar the tabulæ are distributed radially around the column with their longer axis roughly parallel to the axis of the column[3]; where they are developed on the surface of parallel sheets the tabulæ generally occur in groups of one to six crystals distributed heterogeneously. The faces observed on the barite crystals included the forms: a (100), c (001), m (110), c (011), and a series of macrodomes. The nodular type of barite occurs in several of the fluorspar deposits of the district and was especially common in the Noyes vein. It consists of nodular or concretionary-like masses of resinous material in which a concentric structure can usually be observed. A specimen of this nodular barite was submitted to R. A. A. Johnston, Mineralogical Division, Geological Survey, who found that it contained a considerable proportion of bituminous material. The fibrous and ochreous varieties of barite are evidently uncommon forms, for they were observed in only one locality, the fibrous in a mass of vein material lying adjacent to the east vein on the Miller property and the ochreous in the dump adjacent to the Bailey shaft. The colour of the barite

[1]Fluorite from Madoc, Ontario; Am. Min., vol. IV, p. 95 (1919).
[2]Am. Min., vol. V, p. 211 (1920).
[3]Walker, T. L.: Am. Min., vol. IV, p. 79 (1919).

is most commonly white, but red to yellow phases were observed in the vein on the Noyes property. The crystallized barite composing the deposit on the Bailey property ranges in colour from cream-white and snow-white to pale blue. A specimen of this barite analysed by Dr. T. L. Walker was found to have the following composition:

BaO	43·78
SiO_2	13·95
CaO	0·98
MgO	1·01
Al_2O_3	1·92
Fe_2O_3	0·48
SO_3	36·94
H_2O	0·26
	99·32

Calcite ($CaCO_3$, Lime 56·0 Per Cent, Carbon Dioxide 44·0 Per Cent). The calcite is generally white or grey and occurs both massive and in large, semi-translucent crystals up to 6 inches in diameter. In some of the veins that intersect the Palæozoic, nodular masses of calcite covered by a multitude of small, projecting hexagonal pyramids were present.

Celestite ($SrSO_4$, Strontia 56·4 Per Cent, Sulphur Trioxide 43·6 Per Cent). The celestite occurs partly as radial, fibrous aggregates up to several feet in diameter and partly as pale blue, transparent crystals projecting from the walls of cavities. The grey, fibrous variety of celestite has been found chiefly in the vein on the Keen property, where it contains numerous included crystals of brilliant, transparent fluorspar suitable for optical purposes. The pale blue crystals of transparent celestite were observed by the writer on the 250-foot level in the Noyes property. They are from ½ inch to 1 inch in diameter and like the barite are tabular in habit. The forms observed on the crystals were: c (001); d (102); o (011); and m (110).

Quartz (SiO_2, Silica). Quartz was observed in only three of the fluorspar deposits, in all of which it occurred as a zone of small, projecting crystals having the form of the hexagonal prism terminated by the hexagonal pyramid encrusted on the wall of the vein.

Pyrite (FeS_2, Iron 46·6 Per Cent, Sulphur 53·4 Per Cent). The sulphide of iron, pyrite, is not an abundant mineral in the fluorspar deposits, but occurs here and there in most of the veins either in small aggregates enclosed in the fluorspar or as a thin encrustation on the fluorspar crystals. Examples of the latter mode of occurrence were especially abundant in the vein on the Noyes property. Well-formed crystals of the mineral are uncommon.

Marcasite (Composition the same as that of pyrite). Marcasite occurs in the fluorspar deposits as small, flattened, and striated, five-sided crystals. It is not common in most of the veins and its presence is, therefore, merely of mineralogical interest.

Chalcopyrite ($CuFeS_2$, Copper 34·5 Per Cent, Iron 30·5 Per Cent, Sulphur 35 Per Cent). Copper pyrites, or chalcopyrite was noted to be present in a few of the veins, generally as a small aggregate enclosed in fluorspar. The largest mass of the mineral seen in the whole district occurred in association with barite in a small vein exposed in a prospect pit situated near the northeast corner of the east half of lot 2, concession 1, Madoc township.

Tetrahedrite ($Cu_8Sb_2S_7$, Copper 52·1 Per Cent, Antimony 24·8 Per Cent, Sulphur 23·1 Per Cent). Tetrahedrite or grey copper ore has been found in only one of the fluorspar deposits, that on the Bailey property. It occurs in small masses up to 3 inches or more in diameter, enclosed in pale green fluorspar[1].

Chalcocite (Cu_2S, Copper 79·8 Per Cent, Sulphur 20·2 Per Cent). Chalcocite was not seen by the writer in any of the fluorspar deposits, but has been found on the dump on the Bailey property by Mr. A. L. Parsons.[2]

Malachite ($CuCO_3$ $Cu(OH)_2$, Cupric Oxide 71·9 Per Cent, Carbon Dioxide 19·9 Per Cent, Water 8·2 Per Cent). Malachite was observed in only one locality, the northeast corner of lot 2, concession I, Madoc township, where it occurs as a bright green encrustation on chalcopyrite.

Elaterite (Carbon 86 Per Cent, Hydrogen 14 Per Cent). Elaterite or elastic bitumen was found by Mr. Bryden, in 1918, in small quantities in the underground workings on the Noyes property.[3] It is a dark brown, soft material and occupies caverns in the interior portions of the vein.

Faulting

That the fissures occupied by the fluorspar-bearing veins are related to faulting is indicated: (1) by the abundance of fractured and brecciated wall-rock associated with the fissures; (2) by the slickensided and striated character of the wall-rock on either side of the vein; and (3) by the displacement of contacts observed in underground workings. The first and second of these features can be observed almost anywhere in the workings along the veins, but the third feature was seen only in the underground workings on the Noyes and Perry properties.

The displacement that has occurred along the Noyes-Perry vein is shown at the extreme southeast end of the underground workings on the Noyes property, by the manner in which the contact between the Precambrian granite and the overlying Palæozoic limestone has been dislocated (Figure 7). Here the contact was encountered on the southwest side of the vein at a point approximately 40 feet lower than on the northeast side, indicating apparently that the southwest side had been downthrown 40 feet with respect to the northeast side. The striæ on the walls of the vein, however, are not vertical, but nearly horizontal, and indicate, therefore, that the faulting in reality was in a horizontal direction and consisted either of a movement of the rock on the southwest side of the vein towards the northwest, or of the rock on the northeast side towards the southeast. Since neither the slope of the Palæozoic-Precambrian contact at the point of dislocation, nor the direction of movement along the fault-plane, is definitely known, the exact amount of displacement resulting from the fault movement cannot be determined, but it probably was not less than 100 feet and may have been considerably greater than this amount.

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[1]Johnston, R. A. A.: Geol. Surv., Canada, Sum. Rept. 1909, p. 252.
[2]Personal communication.
[3]Knight, C. W.: Ann. Rept., Ont. Bureau of Mines, vol. XXVIII, pt. 1, pp. 90–93 (1919).

The evidence of displacement on the Perry property is the dislocation of the contact of the grey banded Precambrian limestone and an intruded mass of granite. The contact of this granite mass, which outcrops south of the vein and forms the wall-rock in the workings adjacent to No. 3 shaft (Figure 9), should under normal conditions cross the vein in a north-south direction, so that in drifting along the vein to the southeast the limestone would be met first on the northwest side of the vein. In reality, however, the relationships were reversed at the end of the drift driven to the southeast from No. 3 shaft at the 140-foot level, for the wall-rock on the southwest was limestone, and on the northeast granite. Furthermore, since the striæ on the walls of the vein in this locality also are approximately horizontal it is evident that at this point, as on the Noyes property, either the rock on the southwest side of the vein has moved towards the northwest or that on the northeast side of the vein has moved towards the southeast. When the writer last visited the Perry property in September, 1920, the limestone-granite contact was situated about 20 feet from the end of the drift on the southwest wall of the vein, but had not yet been intersected on the northeast wall, so that the amount of displacement along the vein was not determined, but it was at least greater than 20 feet.

Regional Structural Relationships of Veins

The fluorspar veins almost without exception trend in a northwesterly direction. The veins belonging to the Moira Lake group are distributed in a zone likewise trending northwesterly; the veins belonging to the Lee-Miller group, on the other hand, although individually trending in a northwesterly direction, lie in a zone trending only 15 degrees west of north (Figure 4).

The most striking structural feature exhibited by the fluorspar veins is the presence of horizontal or nearly horizontal striæ on the wall-rock of the veins belonging to the Moira Lake group. The well-developed character of these striæ, their presence on the wall-rock of every vein belonging to the group, and the absence of striæ in any other direction, seem to indicate that all the displacement along these fissures was in a horizontal direction. Owing to the secondary alteration along the outcrops of the veins of the Lee-Miller group and the shallow depth to which most of these veins have been followed, striæ were not seen on the wall-rock of many of these deposits, but wherever they were observed they were vertical or nearly vertical. The phenomena described indicate that the two groups of veins are not only geographically separate but have been formed by different movements of the earth's crust.

Secondary Alteration

The secondary alteration that has occurred along the outcrops of the fluorspar veins has been relatively small. It consists chiefly in the leaching away of the calcite of the vein material, with the resultant breaking down of the ore into small fragments, constituting what is known to the miners of the district as "gravel spar". In some properties this type of material has been found to extend to a depth of 40 feet. It is confined almost entirely to the veins that intersect the Palæozoic and especially to those of the Lee-Miller group. It may be noted in this connexion that the pits and shafts on the veins in which the disintegrated fluorspar occurs, become dry in late summer. It is probable, therefore, that the depth to which the "gravel spar" descends is controlled by the depth of the groundwater level during the summer season.

In the Bailey property, a cavern containing stalagmites and stalactites of barite and fluorspar was met in a drift driven from the bottom of a shaft 35 feet in depth. Since this cavern also becomes dry in the late summer these forms are possibly not original but have been formed by the solution and redeposition of the vein material secondarily.

With the exception of a small amount of malachite formed on the, surface of chalcopyrite in a vein situated at the northeast corner of lot 2, concession I, Madoc township, no minerals formed by secondary alteration were seen in any of the deposits and any change of this character that has occurred has been unimportant.

Age

The age of the fluorspar-bearing veins cannot be definitely fixed except within wide limits. It is known, of course, since the veins intersect Ordovician strata, that they have been formed since the Ordovician. It is probable also that the fault fissures occupied by the veins were formed either during the period of igneous activity that occurred during the late Devonian in eastern Canada, or at the time of the Appalachian revolution that took place at the close of the Palæozoic era. The time at which the fluorspar was deposited, however, whether immediately after the fissuring occurred, or more recently, is dependent on the way in which the deposits were formed.

DESCRIPTION OF PROPERTIES

Moira Lake Group

(29) Palmateer

The fluorspar deposits situated farthest to the south in the district are those outcropping at the north end of lot 18, concession VIII, Huntingdon township, the property of Mr. George Palmateer (1 in Figure 4). In this locality the Palæozoic limestone, which underlies nearly the whole of the southern part of Madoc district, is cut by several, small, fluorspar-bearing veins, the principal data regarding which are included in the following table.

No. of pit or trench	Width of vein	Trend of vein	Excavation
1	Two parallel veins 15 feet apart. North vein 1 foot wide. South vein ½ inch wide.	North 60 degrees west (magnetic)	Trench 16 feet long
2	6 inches to 2 feet	North 40 degrees west (magnetic)	Pit 35 feet long, 4 feet wide, and 3 feet deep
3	6 inches wide	North 25 degrees west (magnetic)	Pit 15 feet long, 10 feet wide, and 5 feet deep
4	6 inches wide	North 35 degrees west (magnetic)	Pit 3 feet long, 8 feet wide, and 5 feet deep
5	Two parallel veins 9 feet apart; north vein 1 to 2 inches wide, south vein 6 inches wide	North 70 degrees west (magnetic)	Pit 10 feet long, 10 feet wide, and 8 feet deep

The material composing these veins consists mainly of fluorspar, barite, and calcite. The fluorspar is chiefly a colourless, massive, white or green variety, but in the pile of the mineral near No. 2 pit some crystallized, red-looking fluorspar was observed which consists of colourless fluorspar in which red particles (probably hematite) were distributed in zones parallel to the crystal faces.

Although these veins are relatively small their presence in this property is important because they all trend in a northwesterly direction and lie directly on the continuation of the Noyes-Perry vein, thus indicating that the Moira Lake fracture system continues at least as far south as this locality (Figure 4).

(30) Jones, Huntingdon Township, Concession IX, Lot 15

A shaft was sunk in this lot during the summer of 1917 by Quinlan and Robertson, on an occurrence of fluorspar that Mr. A. Jones, owner of the lot, had discovered while digging a well. The shaft was full of water when the property was visited by the writer, so that, except for an examination of the material in the dump, no first hand information regarding the deposit could be obtained. It is said to consist of breccia-matrix and veinlets forming a fracture zone. This zone is 3 feet wide, and trends north 60 degrees west, magnetic. A small pile of vein material consisting of white calcite and white to honey-yellow fluorspar lies near the shaft. The rock in the dump is fine, dark grey, Ordovician limestone; the limestone at the end of the dump is cherty, indicating that cherty limestone was encountered in the bottom of the shaft.

(31) Wright

Wellington and Munro of Madoc have excavated a series of ten prospect pits in the gravel which overlies the Palæozoic bedrock in this property, (2 in Figure 4) to discover the continuation of the vein exposed on the Howard property which adjoins this lot on the west. In one of these pits situated near the middle of the series—an excavation about 50 feet long, from 20 to 55 feet wide, and 10 feet deep—a vein of fluorspar was discovered. When the writer examined the pit the walls had caved in and the only evidence of the presence of fluorspar that could be observed was the fragments of vein material that had been piled nearby.

(32) Howard

Several carloads of fluorspar have been shipped from a deposit situated near the north end of lot 14, concession XI, Huntingdon township (3 in Figure 4). The discovery of fluorspar in this locality was made by Stephen Wellington who, with Mr. Munro, worked the deposit during January and February, 1918, and then sold the property along with the Noyes mine, which adjoins the Howard on the northwest, to Canadian Industrial Minerals, Limited. The operations commenced by Wellington and Munro were not continued by the new owners, however, and the property lay idle until August, 1920, when Wellington and Munro obtained an option on the lot from Canadian Industrial Minerals, Limited, and resumed operations.

A number of scattered prospect pits have been excavated in this property, but the only openings in which a vein has been found are two northwesterly-trending pits situated about 300 feet east of the Howard farmhouse. The northern of these pits is about 70 feet long, 10 to 15 feet wide, and 2 to 15 feet deep. The other pit which is situated about 50 feet to the south is about 60 feet long, 10 to 20 feet wide, and 10 feet deep. A shaft now filled with water, but said to be 25 feet deep, has been sunk from the bottom of the north pit close to its southeast end. In September, 1920, a new shaft about 25 feet deep was sunk from the bottom of the south pit near its northwest end. The walls of the pits consist of grey, flat-bedded Palæozoic limestone overlain by gravel and boulder clay. The latter material has slumped down from the pit faces covering the bottoms of the pits, so that the vein was not seen by the writer except in the south-east face of the north pit and in the faces of the new shaft. At the first of these points the vein was 2 feet wide, but was said to be 5 feet wide in the old shaft only a few feet away. In a new shaft it was from 5 to 7 feet wide, but included a considerable proportion of limestone fragments in places. The vein material is mainly white to grey, massive fluorspar, but includes some barite and calcite.

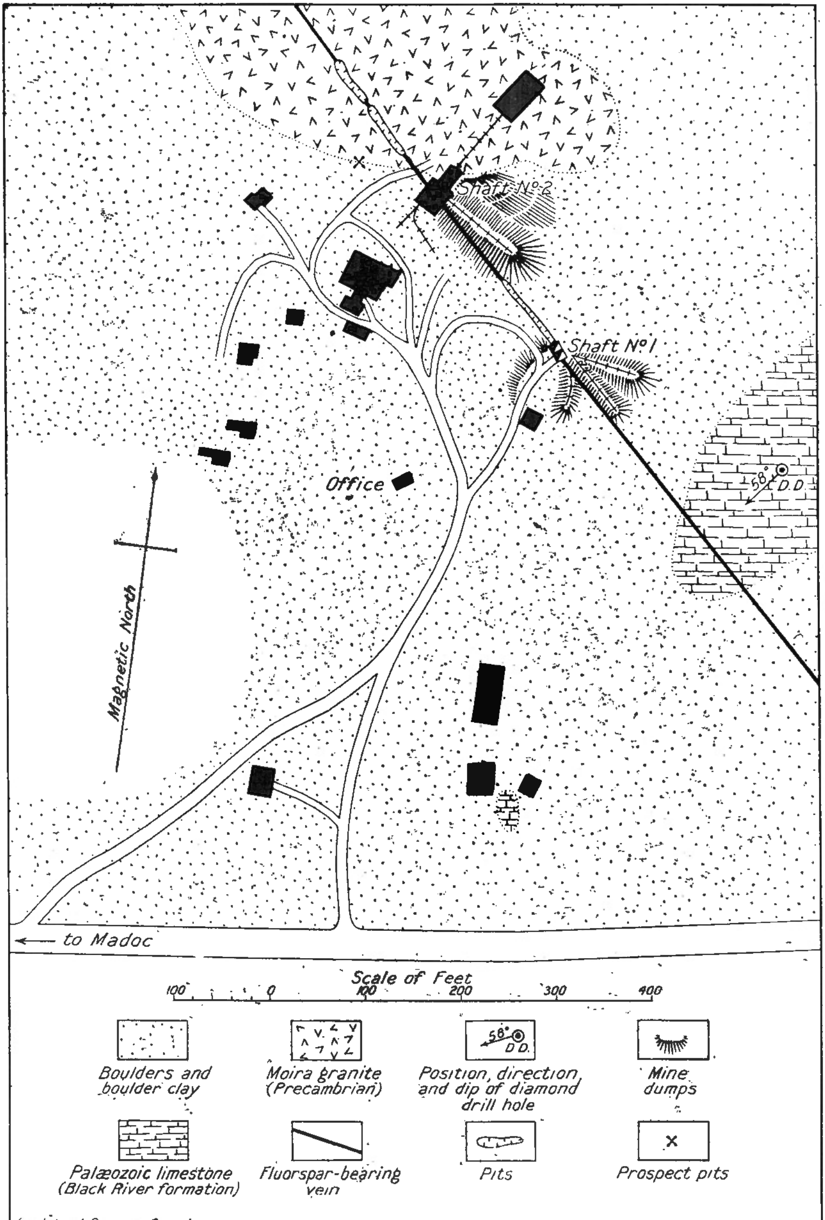
A diamond drill hole was put down on this property at an angle of 61 degrees towards the northeast, from a point about 60 feet to the south of the old shaft, the record of which is as follows:

Depth of diamond-drill hole	Equivalent vertical depth	Material cut by drill
Feet	Feet	
0·0 to 84·5	0·0 to 73·9	Palæozoic limestone
84·5 to 85·0	73·9 to 74·3	Fluorspar
85·0 to 146·0	74·3 to 127·7	Palæozoic limestone
146·0 to 150·0	127·7 to 131·2	Red granite
150·0 to 171·0	131·2 to 149·5	Palæozoic limestone

The mass of red granite penetrated at a vertical depth of 131·2 feet was presumably a boulder and indicates that the drilling was discontinued close to the Precambrian-Palæozoic contact. The Palæozoic in this locality is, therefore, about 150 feet thick. The vein of fluorspar was cut in the drill hole about 10 feet to the southwest of the outcrop of the vein at the surface. It has, therefore, an average dip of 80 degrees.

(33) Noyes

Location and History. The Noyes mine (4 in Figure 4), formerly the property of Canadian Industrial Minerals, Limited, now owned by the Noyes Mining Company, Limited, is situated on the top of the high area



5. Fluorspar-bearing vein, lot 13, con. XII, Huntingdon tp., Hastings co., Ont.

of granite that outcrops to the south of the eastern and lower part of Moira lake. It lies about one-half mile east of Moira Lake station on the Madoc branch of the Canadian National railway, where a siding has been constructed by the company.

The discovery of fluorspar in this property was made by Donald Henderson of Madoc, in 1916. In that year Henderson, in company with Chesley Pitt, purchased an option on the mining rights of 20 acres in the southeast corner of lot 13, concession XII, Huntingdon township, and after sinking prospect pits along the outcrop of the vein they sold their option in the early part of 1917 to Wellington and Munro who had previously acquired an option on the remainder of the property. Wellington and Munro then commenced mining operations and continued to work the property until March, 1918, when they sold their options on lot 13, with the mining rights to some adjacent lots, to Canadian Industrial Minerals, Limited. This company continued mining operations until the autumn of 1920 when the mine was closed down. Over 15,000 tons of fluorspar were produced from the mine during the period of its operation.

Geology. The belt of Palæozoic limestone that underlies the southern part of central Ontario is delimited on the north in places by steep, northward-facing escarpments that rise abruptly to a height of 150 feet above the Precambrian complex exposed at their bases. An escarpment of this type lying along the south shore of Moira lake is interrupted directly east of the narrows where the Canadian National railway crosses the lake by an embayment three-quarters of a mile in width, on either side of which the escarpment turns southward and gradually disappears on the slope of a knob of Precambrian granite. The principal workings on the Noyes property are situated close to the eastern edge of this granite mass, but the vein from which the ore has been mined has been traced almost continuously in a northwesterly direction to the shore of Moira lake and in a southeasterly direction into the Palæozoic limestone.

The granite is a pink to red variety which is intersected by numerous joint-planes, but is not foliated. When examined under the microscope, it was found to consist of a fine, granular mosaic of quartz, microcline, and orthoclase, in which grains of microperthite up to 3 mm. in diameter are included. The less common constituents are biotite, apatite, magnetite, and hematite. The biotite is a brown to pale yellow variety occurring only here and there throughout the rock. The hematite lies along the contacts of the quartz and feldspar grains in aggregates or zones.

The Palæozoic limestone is a fine-grained, grey rock occurring in flat-lying or nearly flat-lying beds from a few inches to several feet in thickness and exhibiting a rubbly appearance on the surface of its exposures. It belongs to the Black River formation. The contact of the limestone with the underlying granite was not observed to be exposed at the surface on the property, but was seen underground at the extreme southeast end of the workings.

General Character of Deposits. The fluorspar produced from the Noyes mine has been obtained chiefly from lenticular enlargements on a vertical or nearly vertical vein which extends in a northwesterly direction diagonally across the property. These lenses range from a few feet to over 200 feet in length and from a few inches to 17 feet in width. They consist mainly of fluorspar and barite in varying proportions, fluorspar being predominant in some lenses and barite in others. In practice only that part of the vein in which fluorspar predominates is mined.

For the purpose of detailed description the deposits may be divided into two groups: (1) those exposed in openings at the surface; and (2) those seen in the underground workings.

Deposits in Surface Openings. The openings along the outcrop of the vein to the southeast of the No. 2 shaft (Figure 5) are now either covered by waste dumps or filled with debris, so that the vein cannot be seen at the surface in this part of the property. Northwest of the No. 2 shaft a number of lenses are exposed in pits and trenches that have been excavated along the outcrop of the vein, but on the whole, the deposits so far discovered in this locality are small and relatively unimportant. The principal data regarding these occurrences are included in the following table:

Distance northwest of No. 2 shaft	Vein	Excavation
0 feet to 35 feet	Not exposed	
35 feet to 185 feet	Vein material 1 to 4½ feet wide	No. 1 open-cut, 2 to 8 feet wide, 5 to 25 feet deep
185 feet to 465 feet	Granite fractured, but little or no vein material present	
465 feet to 520 feet	Vein 6 inches to 2 feet wide	No. 2 open-cut, 2 to 5 feet wide, to 20 feet deep
520 feet to 625 feet	Not exposed	
625 feet to 675 feet	Vein 1 inch to 2 feet wide	Trench 3 to 5 feet deep
675 feet to 775 feet	Not exposed	
775 feet to 1,000 feet	Vein 3 to 10 inches wide	A series of eight prospect pits in drift
1,000 feet to 1,750 feet	Not exposed	
1,750 feet to 1,815 feet	Vein 3 inches to 8 inches wide	Three prospect pits in drift
1,815 feet to 2,050 feet, Moira lake	Not exposed	

At the time the writer examined the openings in the northwest part of the Noyes property, the bottoms of the pits were hidden by debris, so that the vein could be seen only at the ends of the openings, or in the case of No. 1 open-cut, in the faces of the mass that remains in the centre of the cut. In open-cut No. 1, the vein material occurs chiefly in two parallel banded zones separated partly by horses of broken granite, and partly by vein material of the cavernous type. The banded vein material consists of bands of pink to white barite from ½ to 4 inches wide, alternating with bands of honey-yellow fluorspar from ½ to ⅛ inch wide. The cavernous type of vein material has the same composition as the banded type, except that it contains a small proportion of calcite. The zones of banded ore range from 6 inches to 1½ feet, and the cavernous masses up to 2½ feet in width. The total maximum width of vein material observed was 4½ feet. Some barite was shipped from this pit in 1918 by Wellington and Munro.

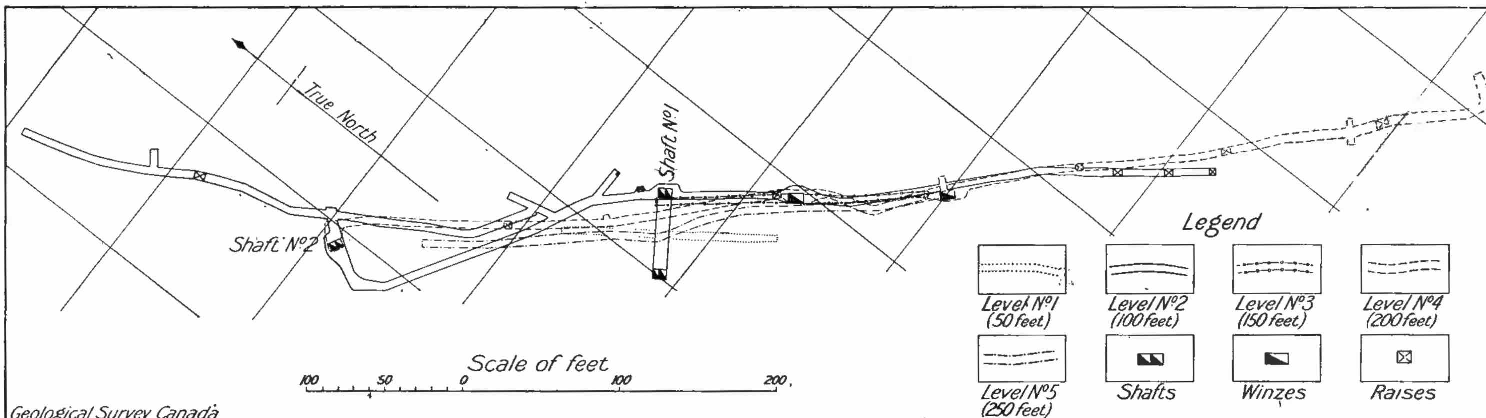


Figure 6. Plan of underground workings, Noyes mine, lot 13, con. XII, Huntingdon tp., Hastings co., Ont.

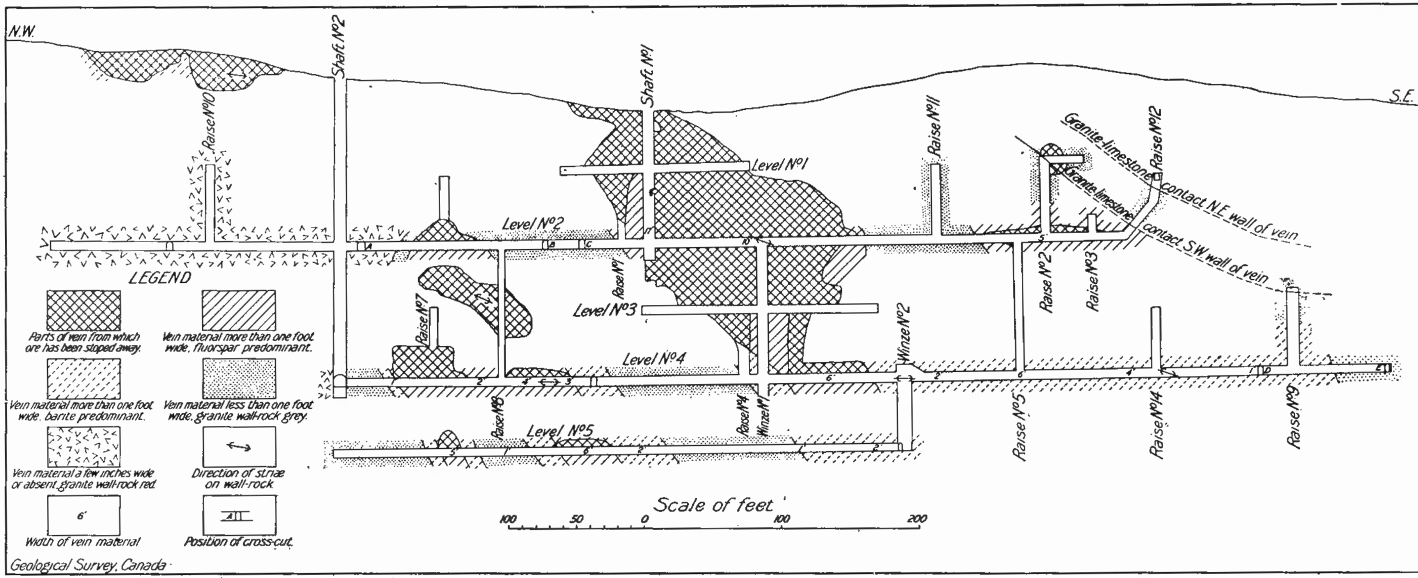


Figure 7. Longitudinal section through underground workings, Noyes mine, lot 13, con. XII, Huntingdon tp., Hastings co., Ont.

In open-cut No. 2, also, there are two parallel zones of banded vein material, but wherever these are exposed they are separated by unbroken red granite. The zones range from 6 inches to 1 foot in width and have a total maximum width of 2 feet. In places the vein material occurs in peculiar dome-like forms within which the barite and fluorspar bands exhibit a concentric structure. The maximum diameter of the domes was 3 inches.

Deposits in Underground Workings. The principal data regarding these deposits are indicated in Figures 6 and 7. In Figure 7 the extent and grade of the vein material encountered on the various levels have been indicated.

The areas represented as "parts of vein from which fluorspar has been stoped away" include those parts in which the vein material was sufficiently extensive and high enough in grade to be mined. Three separate lenses or groups of lenses belonging to this class were present: *(a)* a large lens lying mainly to the southeast of shaft No. 1, from which about 10,000 tons of fluorspar was obtained; *(b)* a group of five small lenses situated on the 100, 200, and 250-foot levels to the southeast of shaft No. 2; *(c)* a small lens situated at the southeast end of the 100-foot level.

The area represented as "vein material more than 1 foot wide, fluorspar predominant," includes all those parts of the vein in which a width of at least 1 foot of vein material of marketable grade is present, but which either because it is too much intermingled with wall-rock, or too limited in extent, was not mined. It may be observed that these parts of the vein all lie adjacent to the openings from which the vein material has been stoped away.

The area represented as "vein material over 1 foot wide, barite predominant," includes the parts of the vein in which the vein material is over 1 foot in width but contains too great a proportion of barite to be mined for fluorspar. Vein material of this type is found chiefly in the lower workings and most extensively at the southeast end of the 200-foot level.

The area represented as "vein material less than 1 foot wide, granite wall-rock grey," includes the parts of the vein where the width of vein material is less than 1 foot, and where the circulation of the depositing solutions has been sufficient to alter the colour of the granite wall-rock from red to grey.

The area represented as "vein material a few inches wide or absent, granite wall-rock red," includes the parts of the vein where the vein material is only a few inches wide or is absent, and where there has not been sufficient circulation of the solutions depositing the vein material to change the colour of the granite wall-rock. They occur mainly in the vicinity of shaft No. 2 and along workings to the northwest of shaft No. 2.

Diamond Drilling. Two diamond-drill holes were put down on the Noyes property by Canadian Industrial Minerals, Limited, the principal data regarding which are included in the following table:

No.	Position of drill hole	Direction of dip	Angle of dip	Depth in Palæozoic Feet	Equivalent vertical depth in Palæozoic Feet	Depth in granite	Total depth
1	250 feet east of shaft No. 1, and 105 feet northeast of vein (Figure 7)	SW.	58	49	43	117¼	166¼
2	632 feet north of southeast corner and 57 feet west of east boundary of property	SW.	55	134	110	9	145

Hole No. 1 was drilled for the purpose of cutting the Noyes vein at depth, but was discontinued approximately 30 feet above the necessary depth. Drill hole No. 2 was put down to intersect the continuation of the Howard vein on the Noyes property, but was probably placed too far north for this purpose (Figure 4).

(34) Blakeley

The Blakeley property (5 in Figure 4) is situated west of the Madoc-Belleville road, where it ascends the Palæozoic escarpment that adjoins the south shore of Moira lake. The discovery of fluorspar on this lot was made by James O'Reilly in 1916, but most of the development work was performed by the late Stephen Wellington and his associates. Several carloads of fluorspar were shipped from pit No. 1 and shaft No. 1 by Wellington during the summer of 1920.

Character of Deposits. There are at least three fluorspar deposits present in this lot, which for the purpose of description may be referred to as the north vein, the south vein, and vein in pit No. 1.

North Vein. The north vein as shown in Figure 8 trends approximately north 40 degrees west (magnetic) and has been traced at intervals for over 500 feet. The principal data regarding the character of the vein as exposed in the various openings that have been excavated along the vein are included in the following table.

Excavation (Figure 8)	Character of vein	Width of vein material	Dimensions of excavation
Pit No. 2...........	Well-defined, mainly honey-yellow fluorspar	1 to 2½ feet........	15 feet by 15 feet 12 to 15 feet deep
Shaft No. 1.........	A well-defined vein along east wall, remainder of wall-rock traversed by numerous veinlets	1 to 3 feet.........	10 feet long, 8 feet wide, 25 feet deep
Pit No. 3...........	Two veins separated by horse 2 feet wide on northwest face, vein material adhering to southwest wall	2 feet.............	60 feet long, 10 feet wide, 10 feet deep
Adit No. 1..........	Lenticular enlargement on vein, 30 feet long	6 inches to 2 feet..	30 feet long
Adit No. 2..........	Vein crossing end of adit...........	6 inches...........	60 feet long
Trenches along outcrop of vein northwest of adit No. 1	Not exposed........................	1 foot or less......	1 to 3 feet deep

South Vein. The south vein on the Blakeley property (Figure 8) trends north 4 degrees west (magnetic). It can be observed in pit No. 4, in shaft No. 2, and in a trench situated about 80 feet north of pit No. 4. Pit No. 3 is an excavation 40 feet long, 10 feet wide, and 6 feet deep, from the bottom of which, at a point about 10 feet from its south end, shaft No. 2

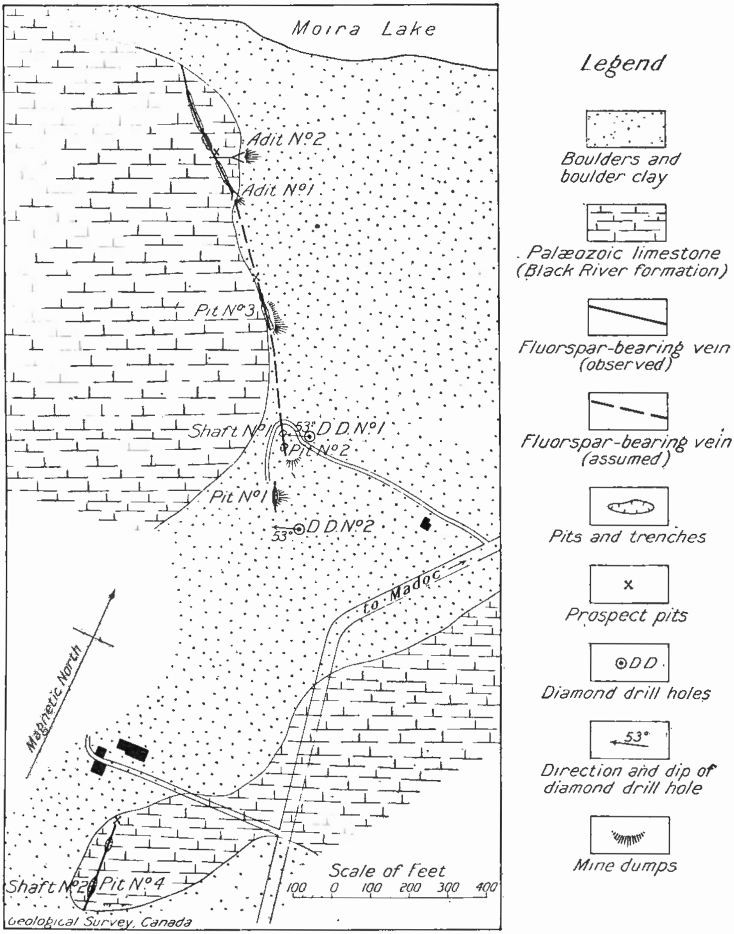


Figure 8. Fluorspar-bearing veins, lot 10, con. XII, Huntingdon tp., Hastings co., Ont.

has been sunk to a depth of 25 feet. The vein material exposed in these openings consists mainly of alternating bands or zones of white barite and colourless to honey-yellow fluorspar. The proportion of barite and fluorspar varies greatly from point to point, but on the whole the barite predominates. The width of vein material exposed in shaft No. 2 ranges from

2 to 6 feet. The vein material observed in the trench that has been excavated along the outcrop of the vein farther to the north, ranges from 6 inches to 1 foot in width and is similar in character to that seen in pit No. 4.

Vein in Pit No. 1. Pit No. 1 is an excavation 50 feet long, 6 feet wide, and 30 feet deep that was opened up by Stephen Wellington during the summer of 1920. The vein material exposed in the pit consists mainly of fluorspar and occurs in two zones separated by a much fractured mass of the limestone wall-rock. The total width of the vein material ranges from 1 to 3 feet. Since this vein trends north 35 degrees west (magnetic) and is situated 30 feet to the southwest of the continuation of the north vein (Figure 8), it might be assumed that it is a separate parallel vein having no connexion with the north vein, but the results from diamond-drill hole No. 1 have shown that the north vein dips to the southwest, so that at depth it lies almost directly on the continuation of the vein in pit No. 1. It is possible, therefore, that this vein is a branch from the north vein. The walls of the pit are polished and striated, indicating that the fracture in which the vein occurs is also the locus of a fault. Since the striæ trend almost horizontally the direction of movement along the fault was presumably nearly horizontal.

Diamond Drilling. Two diamond-drill holes were put down on the Blakeley property in 1918 by Canadian Industrial Minerals, Limited. The positions, and the directions and angles of dip of these are shown in Figure 8. The depths were 172 and 235 feet respectively. In hole No. 2 no fluorspar was found, but in hole No. 1, 7 feet of vein material was cut at a depth of 142 feet. From these data it can be calculated that the vein was crossed by the diamond drill at a vertical depth of 114 feet and at a point situated about 25 feet to the southwest of shaft No. 1.

(35) Perry

The Perry mine (7 in Figure 4) is situated about 2 miles south of the village of Madoc and close to the north shore of the narrows that divides Moira lake into upper and lower divisions. The principal workings on the property lie only a few hundred feet to the west of the Belleville-Madoc branch of the Grand Trunk railway, with which the mine is connected by a siding.

History. The outcrop of the vein on the Perry property is said to have been laid bare at the time the Belleville-Madoc branch of the Grand Trunk (now Canadian National) railway was being built, but no attention was paid to the discovery until the year 1912, when Messrs. Cross and Wellington purchased an option to prospect the property. Actual mining operations were first undertaken in the autumn of 1915 and except for an interval of about 11 months between December 1, 1917, and November 1, 1918, were carried on continuously from that time to the autumn of 1920.

Geology. The rocks occurring adjacent to the Perry mine (*See* Figure 9), so far as observed, are all of Precambrian age and fall into two principal groups: (1) a number of sedimentary types belonging to the Grenville series; and (2) masses of quartz syenite and granite similar in character to the Moira granite that outcrops in extensive areas south and east of Moira lake.

The rocks of the first class are chiefly rusty-weathering, cream-coloured dolomite and finely banded, light and dark grey, impure limestone. The rusty-weathering dolomite outcrops adjacent to No. 2 shaft and in the area adjoining the north shore of Moira lake to the southwest of the No. 2 shaft. The finely laminated grey limestone is exposed near No. 1 shaft and in the northeastern part of the property. About 200 feet to the north of the No. 3 shaft a small outcrop of a dark brown, dense rock occurs which when examined under the microscope was found to consist of dark brown mica, sericite, and fine, granular quartz and feldspar. Since this rock occurs in an outcrop only 20 feet in diameter and is not in contact with any of the other rocks exposed in the area, it is not possible to determine definitely its age relationships or origin. It, however, resembles a banded argillite or tuff seen elsewhere in the region, and is probably either a metamorphosed argillaceous sediment or pyroclastic rock contemporaneous in age with the Grenville limestone and dolomite.

The quartz syenite and granite exposed near the Perry mine occur in scattered, irregular masses, the largest of which forms the ridge that lies directly south of No. 1 and No. 3 shafts. Since this ridge, except where it adjoins No. 1 shaft, is surrounded by swamp or glacial drift, the extent of the granite-quartz syenite mass is not known, but at its west end it evidently extends for some distance to the north beneath the drift cover, for it forms the wall-rock in No. 3 shaft and in the adjacent underground workings. At these points, just as in the case of the Noyes mine, the colour of the granite changes from its normal red or pink to pale grey in the vicinity of the vein. A thin section of a specimen of this grey phase of the rock taken from the dump adjoining shaft No. 3, when examined under the microscope, was found to consist of fine, granular orthoclase partly altered to sericite, plagioclase, quartz, muscovite, and scattered grains of pyrite, tourmaline, and calcite.

Character of the Deposit. The fluorspar found on the Perry property occurs in a northwesterly-trending vein that outcrops in two rock-areas that protrude through the swamp adjoining the north shore of Moira lake. Since this vein trends in the same direction as, and lies directly on the continuation of, the vein on the Noyes property to the south of Moira lake, it is evident that the veins on the two properties belong to the same fracture system and are probably parts of the same vein. One of the two rock areas in which the vein is exposed adjoins the north shore of Moira lake, whereas the other area is situated across the swamp about 700 feet to the northwest.

The principal data regarding the superficial workings on the property are included in the following table.

Excavation (Figure 9)	Character of vein	Width of vein material	Dimensions of excavation
Southeast area			
Pit adjoining shaft No. 2 on southeast	Honey-yellow to pale green fluorspar	5 feet...........	25 feet long, 6 feet wide, and 7 feet deep
Shaft No. 2...............	Vein not seen (shaft filled with water)	Said to be 5 feet wide to bottom of shaft	35 feet deep
Pit 60 feet northwest of shaft No. 2	Vein not seen (pit filled with water and debris)	....	20 feet long, 4 feet wide, and 6 feet deep
Northwest area			
Pit between shaft No. 1 and railway	Vein well defined...................	1 foot to 18 inches	25 feet long, 1 to 4 feet wide, 10 to 12 feet deep
Shaft No. 1...............	Not observed......................	Not observed ..	75 feet deep
Pit adjoining shaft No. 1 on the west	Two veins 6 inches to 2½ feet wide enclosing a mass of broken limestone	1 to 3 feet......	30 feet long, 10 feet wide, 20 to 40 feet deep

With the exception of a small stope said to be 20 feet long to the southeast of shaft No. 1, all the underground mining on the Perry property has been carried on from No. 3 shaft. This shaft, which is 140 feet deep, has been sunk close to the west end of a lenticular mass of granite 50 feet long and 10 feet wide that lies between northeast and southwest branches of the vein. Between the surface and the 90-foot level, to the southeast of the shaft, the northeast branch of the vein is only a few inches wide, whereas the south branch widens at a depth of 50 feet to a lens having a maximum width of 4 feet; to the northwest of the shaft both branches of the vein unite, forming a single lens 100 feet long and 6 feet wide. Between the 90-foot and the 140-foot levels, to the southeast of the shaft, the southwest branch is only a few inches wide, whereas the north branch widens into a lens 80 feet long and 5 feet wide at its maximum point; to the northwest the lens terminates at about 50 feet from the shaft. In reality, therefore, most of the fluorspar found in the vicinity of No. 3 shaft occurs in a lens having a horizontal length of 100 to 130 feet and extending diagonally down the vein to the southeast at an angle of about 65 degrees. From this lens a branch lens extends southeast for about 50 feet at the 50-foot level. Since the main lens has a width of 5 feet at the 140-foot level and no vein material has been removed below that depth the total length of this lens is not known, but its length from its northwest termination down to the 140-foot level is 150 feet. The height of the lens measured parallel to the shaft is about 200 feet, but measured at right angles to its longer direction only 100 feet. Its maximum width is 6 feet. All the fluorspar in this lens has been removed down to the 140-foot level. During the latter part of the summer of 1920 a drift was driven along the continuation of the vein for 75 feet from the southeast end of the 140-foot level, that is, to a point 160 feet from shaft No. 3 and hence almost directly beneath shaft No. 1. In this distance the vein had an average width of 2 feet.

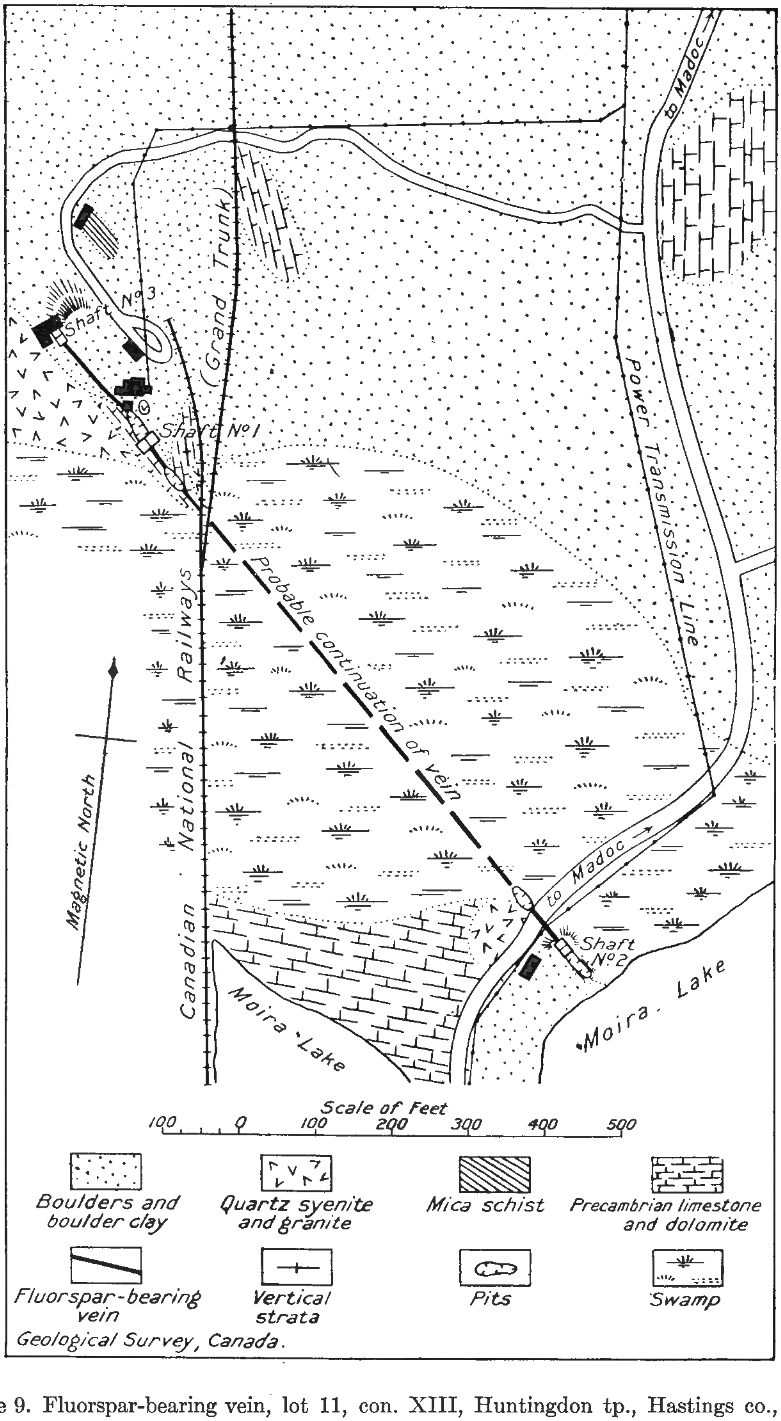


Figure 9. Fluorspar-bearing vein, lot 11, con. XIII, Huntingdon tp., Hastings co., Ont.

The vein material on the Perry property is mainly the banded type and consists chiefly of fluorspar, barite, and calcite. The fluorspar greatly predominates and practically all the vein material is sufficiently high grade to be mined. The fluorspar is a honey-yellow, colourless to pale green variety, and for the most part occurs in well-developed crystals. The less common constituents are fibrous celestite and pyrite.

(36) Coe

Two parallel northwesterly-trending veins are exposed in some shallow pits that have been excavated close to the north shore of Moira lake on lot 10, concession XIII, Huntingdon township, the property of Mrs. Arthur Coe of Madoc (8 in Figure 4). The principal data regarding these deposits are included in the following table.

Vein	Character of vein	Width of vein material	Dimension of excavation	Trend of vein	Country rock
East vein....	Fluorspar and barite, fluorspar predominant	6 to 18 inches.	90 feet long, 3 to 5 feet wide, 1 to 18 feet deep	North 40 degrees west (magnetic)	Buff-coloured dolomite Precambrian
West vein....	Fluorspar, calcite, and barite, calcite abundant	4 to 18 inches.	40 feet long, 3 feet wide, 5 feet deep	North 40 degrees west (magnetic)	Buff-coloured dolomite Precambrian

(37) South Reynolds

A fluorspar-bearing vein trending north 45 degrees west (magnetic) occurs on the South Reynolds property (9 in Figure 4), lot 7, concession XIII, Huntingdon township, directly north of the outlet of Moira river into Moira lake. The vein can be seen along the bottom and faces of an open-cut, 200 feet long, 2 to 6 feet wide, and 20 feet deep, that has been excavated at right angles to the slope of the ledge of Palæozoic limestone that parallels the west shore of Moira lake in this locality. Throughout a considerable part of the length of the open-cut the deposit consists of two parallel veins ranging from a few inches to 18 inches in width and separated by lenses of limestone up to a foot or more in width. In places along the northeast face of the pit subsidiary veins branch from the main vein, and fade out towards the north, a feature that was also observed along the north side of the Noyes-Perry vein on the Noyes property. The material composing the vein on the South Reynolds property, as in the case of most other deposits, consists chiefly of fluorspar with barite and calcite as less abundant constituents. The walls of the open-cut are slickensided and striated in places and as in the case of the other deposits of the Moira Lake group, the striæ are almost horizontal. Two carloads of fluorspar were shipped from this property in 1917.[1]

[1]Ann. Rept., Ont. Bureau of Mines, vol. XXVII, p. 138 (1918).

(38) Rogers

The occurrence of a northwesterly-trending fluorspar-bearing vein at the south end of lot 10, concession XIV, Huntingdon township, is of considerable interest because the vein at this point lies directly on the continuation of the Noyes-Perry vein and hence affords evidence of the continuity of the Noyes-Perry vein from the Perry mine on the east across the Rogers' property (10 in Figure 4) to the Keen mine on the west (11 in Figure 4). The discovery of the vein at this point was made by Donald Henderson and Chesley Pitt of Madoc about the year 1909, but actual mining was first undertaken by Messrs. Gillespie, Cross, and Wellington, in 1910. In the following year Gillespie, Cross, and Wellington sold the property to Mr. L. L. Battle, from whom it was afterwards purchased by the present owner, Mr. C. M. Bowman. Mining operations have been attempted on the Rogers' property at frequent intervals during the twelve years that have elapsed since the vein was discovered, but the greater part of the work on the deposit was performed during 1910, 1911, and 1914.

The principal excavation on the property, an open-cut about 100 feet long and from 5 to 10 feet wide, was partly filled with water at the time the writer examined the property in the summer of 1920, so that neither the depth of the pit nor the character or extent of the vein present in the bottom of the pit could be determined. The form of the opening indicated, however, that the vein material originally present occurred as a lens about 80 feet long and 8 feet wide at its middle. The only vein material seen on the property was a mass that stood above the surface of the water at the northwest end of the pit. This had a width of about 5 feet, and consisted mainly of green to honey-yellow fluorspar. The striæ on the walls of the pit are almost horizontal. At a point about 40 feet northwest of the pit a vertical shaft said to be 65 feet deep has been sunk, from the bottom of which a crosscut has been driven to intersect the vein. It was reported to the writer, however, that no fluorspar was mined by way of this crosscut. The country rock exposed near the vein and the rock composing the dump from the shaft are mainly the buff-coloured Precambrian dolomite that outcrops extensively elsewhere in the vicinity of the north shore of Moira lake.

(39) Keen

The fluorspar deposits occurring on the Keen property (11 in Figure 4), lot 9, concession XIV, Huntingdon township, are especially interesting because the principal vein contains a considerable proportion of brilliant transparent crystals of fluorspar up to 4 or 5 inches in diameter.[1] The discovery of the main vein on the property was made by Mr. Keen, owner of the lot, in the latter part of the summer of 1917, when deepening the outlet of a spring. In the autumn of 1917 Mr. Rinaldo McConnell purchased a lease of the lot from Keen, and the following spring after sinking a pit 10 feet deep on the vein, sold his lease to a company known as Canadian Fluorite, Limited, that had been organized in Toronto for the purpose of purchasing and developing the property. The new company continued operations until April, 1919, when the mine was closed down, and all equipment, with the exception of the shaft house, was removed.

[1]Walker, T. L.: "Fluorspar from Madoc, Ontario"; Am. Min., vol. IV, pp. 95–96 (1919).

Two occurrences of fluorspar are known to be present in the territory included in the Keen property: (1) the main vein which is situated near the north end of the lot, and lies directly on the continuation of the Noyes-Perry-Rogers vein (Figure 4); and (2) a group of veinlets exposed in a small prospect pit situated near the southwest corner of the lot.

Main Vein. Since the main vein on the Keen property is not exposed at the surface and all the mining operations performed on the vein were carried on underground from a single vertical shaft, which is now inaccessible, the following description of the deposit is based for the most part on an examination of the material exposed on the dumps adjoining the shaft. The rock fragments observed on the dumps indicate that the wall-rock of the vein consists partly of dark grey, banded, impure Grenville limestone, and partly of a dark, fine-grained, metamorphosed, igneous intrusive of Precambrian age. The limestone in places contains dark phenocryst-like inclusions which on microscopic examination were found to be crystals of microcline. The bands in the limestone range from $\frac{1}{32}$ inch to 1 inch in width. The igneous rock when examined under the microscope was found to consist almost entirely of blue green to pale yellow amphibole and plagioclase having the optical properties of andesine, and has, therefore, the mineralogical composition of a diorite. The vein material is said to have a width of 8 to 9 feet in the shaft and as in the case of the other deposits in the district consists chiefly of fluorspar, barite, and calcite, but unlike any other known deposit, contains on the whole more calcite than fluorspar or barite. The fluorspar is either white, pale green, honey-yellow, or rose-red, and is commonly transparent. The brilliant crystals of transparent fluorspar suitable for optical purposes occur as inclusions in a grey, fibrous celestite which is evidently present in the vein in masses of considerable size, since the broken fragments of the mineral in the dumps were a foot or more in diameter. The barite occurs partly in separate tabular crystals and partly in dome-like aggregates of concentrically arranged tabulæ. These domes generally range from $\frac{1}{2}$ inch to 1 inch in diameter. The underground workings on the main vein consist of a vertical shaft said to be 65 feet deep and drifts along the vein at a depth of 50 feet for 100 feet to the southeast, and for 160 feet towards the northwest. At a point on the 50-foot level, 150 feet northwest of the shaft, a winze was started, and had been sunk to a depth of 16 feet on March 15, 1919[1]. No stoping was done on the vein, but several carloads of fluorspar obtained in the course of development work were shipped from the property in 1918.

Southwest Vein. Near the southwest corner of the Keen lot, there is a shallow prospect pit about 12 feet long and from 2 to 6 feet wide and 3 feet deep, in which three fluorspar-bearing veinlets 6 inches in width are exposed. Two of the veinlets lie along the north wall of the pit and strike north 80 degrees west (magnetic) parallel to the structural trend of the Precambrian limestone wall-rock. The third veinlet, which is possibly a branch from the other two veinlets, outcrops about 3 feet farther to the south and trends in a northeast-southwest direction. The material composing the veinlets consists mainly of zones of minute crystals of

[1]Ann. Rept., Ont. Bureau of Mines, vol. XXVIII, pt. I, p. 156 (1919).

quartz overlain by pale green crystals of fluorspar ranging from $\frac{1}{16}$ inch to over 1 inch in diameter. The common crystal forms assumed by the fluorspar in this locality, as elsewhere in the district, are the cube and the octahedron, but in this occurrence the octahedron is the dominant form.

(40) North Reynolds

Near the southeast corner of the north half of lot 8, concession XIV, Huntingdon township, and hence almost directly south of the shaft house on the adjacent lot to the east (Keen property) an area of impure, grey, banded Precambrian limestone is exposed, in which two small deposits of fluorspar have been found (12 in Figure 4). The larger of the two deposits is exposed in an east-west trending pit 12 feet long, 2 to 6 feet wide, and 2 to 12 feet deep, and is a mass of the cavernous type about 10 feet long and ranging in width from 6 inches at its extremities to 5 feet at its middle. The solid parts of the mass consist of white, massive fluorspar and calcite in which fragments of the grey limestone wall-rock are enclosed. The crystallized parts of the mass occur as a lining on the walls of the cavities and consist of honey-yellow crystals of fluorspar on which tabular crystals of barite projecting edgewise from the cavity-wall are present in places. The crystals of fluorspar have the form of the cube modified by the octahedron, and have a maximum diameter of about three-quarters of an inch.

The smaller of the two deposits is exposed in the bottom of a shallow trench situated about 75 feet to the northeast of the larger mass. It consists of a vein or mass of material similar to that in the larger deposit, has a width of 1 to 2 feet, and an exposed length of 3 feet. At the time the writer visited the property a few tons of fluorspar had been piled on a platform near the main pit.

(41) Huntingdon Township, Concession 14, Lot 11

Aggregates of calcite up to 5 feet in diameter, in which a small proportion of pale green fluorspar is included, are exposed in some shallow prospect pits in grey crystalline limestone at the north end of this lot. The amount of fluorspar present is scarcely sufficient to warrant further development work on the deposit.

(42) Bailey

The discovery of fluorspar on the Bailey property (13 in Figure 4) is said to have been made about thirty-five years ago by Nicholas Fleming, owner of the lot, while excavating the cellar for a house, but no attention was paid to the discovery at that time, and it was not until 1905, when Stephen Wellington purchased an option on the property, that mining operations were undertaken. In that year Wellington sunk the shaft to a depth of 14 feet, and took out a carload of fluorspar in the course of this operation, but the following year allowed the option to expire. In 1907 Wellington renewed the option from William Bailey, who meanwhile had purchased the lot from Fleming,[1] but after taking out a half carload of ore

[1]Ann. Rept., Ont. Bureau of Mines, vol. XIV, pt. I, p. 106 (1905).

again dropped the option. During the years following the operations of Stephen Wellington, numerous options were taken on the property, but actual mining was not resumed until late in 1916, when Mr. H. Hungerford took an option on behalf of the Hungerford Syndicate. This syndicate, after taking out one carload of ore during the early part of 1917, in 1918 purchased the mining rights to the lot outright. When the writer examined the property in the summer of 1920 there was a shaft on the deposit 45 feet deep, from the bottom of which a drift had been driven 35 feet towards the southwest. A stope had also been excavated for about 20 feet to the north-east of the shaft.

The only outcrop of rock occurring near the Bailey mine is a mass of fine, dense, green andesite or dacite 50 feet in diameter, situated about 100 feet east of the shaft, but the presence of fragments of grey Precambrian limestone on the dump adjoining the shaft indicates that limestone occurs in the underground workings. The outcrop of andesite or dacite had been fractured and broken along its southern margin and the fractures and the interspaces between the fragments filled with quartz and barite. Fragments of the andesite or dacite were also observed in masses of breccia in the dump, but the matrix in this case included red fluorspar, calcite, and minute flakes of biotite, as well as barite and quartz.

The fluorspar-bearing mass occurring on the Bailey property trends approximately north 55 degrees east (magnetic) and dips steeply to the south. The foot-wall of the deposit is fairly well defined, but the hanging-wall is most irregular and poorly defined. The deposit as seen underground consists of a zone of banded fluorspar and barite from 6 inches to 2 feet in width adjacent to the foot-wall, and of caverns separated by fragments of wall-rock enclosed in barite or fluorspar and barite elsewhere. The width of the mass ranges from 3 to 8 feet, but the maximum width of vein material actually present—owing to the presence of numerous caverns—is considerably less than 8 feet. In the drift southwest of the shaft beneath the Bailey farmhouse, a large, open cavern was met in which stalactites and stalagmites of barite and fluorspar are said to have been present. The fluorspar contained in the deposit is mainly a pale green, or honey-yellow variety, but a few specimens were observed on the dump which were red; the principal forms of the mineral are the cube and the octahedron, but unlike the fluorspar in most other deposits, the octahedron is generally dominant. The barite contained in the ore mass occurs partly in a white, massive form, partly as a yellow powder, but chiefly in well-developed, white, or pale blue, tabular crystals arranged either irregularly, or in the form of domes or columns. Other minerals composing this deposit in addition to the barite and fluorspar are calcite, quartz, and tetrahedrite.

(43) Hill

A number of pits and trenches have been excavated along the outcrops of two small veins or vein-zones of fluorspar (14 in Figure 4) exposed on the north slope of a ridge of Precambrian limestone situated a few hundred feet south of the Canadian National Railway station in Madoc village. The fluorspar occurs in the excavations on the south deposit as a zone of two or more parallel veinlets, which range from ½ inch to 2 inches in width, and lie from 1 to 2 feet apart. The trend of the veinlets is approximately north 35 degrees west (magnetic); the length of the zone exposed is about 75 feet.

The other fluorspar deposit is exposed in a series of openings lying about 75 feet to the northeast of the south group of pits and consists of one principal vein having a maximum width of 2 feet and an average width of approximately 9 inches. The outcrop of this vein exhibits a peculiar structural feature in that it consists of a number of sections from 25 to 50 feet in length having an echelon distribution, but connected obliquely at their extremities. The echelon sections of the vein all trend 75 degrees east of north (magnetic), and lie parallel to the bedding of the grey-banded Grenville limestone which forms the country rock and which in this locality stands nearly vertical. The parts of the vein connecting the echelon sections obliquely trend in a southeasterly direction so that the average trend of the vein as a whole is approximately east-west (magnetic). The zigzag trend of this vein evidently owes its origin to the structure of the Grenville limestone, the bedding in which afforded a plane of easy parting at an angle of only a few degrees from that of the plane along which the fracture occupied by the vein would have developed had the structure of the country rock been uniform.

The material composing the veins consists mainly of fluorspar, but includes a considerable proportion of calcite and some barite. A few small aggregates of pyrite are also present. These occur partly included in the fluorspar and partly resting on the faces of the fluorspar crystals. The fluorspar is an opaque, white to honey-yellow variety, and occurs mainly in well-crystallized zones, encrusting the walls of cavities. The crystals are all similar in form, consisting of cubes modified by octahedra. The largest observed had a diameter of about 1¼ inches. When the writer examined the property several tons of fluorspar had been placed in piles adjacent to the openings along the outcrop of the veins. Most of the fluorspar crystals in these piles were covered with an encrustation of iron oxide, indicating that a certain amount of superficial oxidation had occurred in the veins.

(44) McIlroy

The McIlroy property (15 in Figure 4) comprises part of the west half of lot 2, concession IV, Madoc township. Mining operations were commenced in this locality in 1916 by Mr. C. R. Ross and were continued at intervals during 1917 and the early part of 1918 by Mr. Ross as manager, for a company known as Mineral Products, Limited, which in the meantime had been organized to take over the property. Since 1918 the mine has been idle. Several hundred tons of fluorspar are said to have been shipped from the property during the period of its operation.

The deposit from which the fluorspar produced from the McIlroy property has been obtained consists of a northwesterly-trending vein that, as is shown in Figure 4, lies directly on the continuation of the Noyes-Perry-Keen vein. The vein (*See* Figure 10) is exposed almost continuously in pits and trenches across the southwest corner of the lot, but throughout the greater part of this distance the vein material is only a few inches wide, so that the most of the fluorspar has been obtained from a single lens approximately 70 feet in length. The fluorspar was removed from this lens partly by means of an open-cut and partly by means of a vertical shaft 60 feet deep. When the writer examined the property in July, 1920, the shaft was inaccessible, but the vein is said to have a width of 2 feet in its bottom. The principal data regarding the character of the deposit and the amount of development work performed along its outcrop are indicated in the following table.

Excavation	Character of vein	Width of vein	Dimensions of excavation
Adit No. 1........	Merely a fracture, no vein material observed	....	40 feet long
200 to 100 feet southeast of shaft No. 1	Chiefly fluorite, some barite............	2 to 6 inches......	2 to 6 feet wide, 1 to 8 feet deep
100 to 80 feet southeast of shaft No. 1	All ore removed, but apparently a short lens originally present	Not observed.....	1 to 4 feet wide, and 25 feet deep
80 to 40 feet southeast of shaft	West wall well defined, vein material fluorspar	6 inches...........	Trench 4 feet deep
40 feet southeast of shaft No. 1 to 20 feet northwest of shaft No. 1	Lens of fluorspar with horse of wall-rock in centre	Total width of vein material 3 feet	2 to 10 feet wide
20 to 215 feet northeast of shaft No. 1	A series of pits, west wall of vein well defined	Nowhere more than 6 inches wide	Pits 2 to 25 feet deep and 1 to 6 feet wide
Shaft No. 2......	Not observed...........................	Not observed.....	20 feet deep

(45) Lee Junior

Three fluorspar-bearing veins, from one of which three carloads of fluorspar are said to have been shipped by Mineral Products, Limited, in 1917, occur on lot 2, concession III, Madoc township (16 in Figure 4), the property of Mr. George Lee, jun. The principal data regarding these deposits are included in the following table.

No. of vein[1]	Character of vein	Width of vein material	Trend of vein	Dimensions of excavation
1	Barite and fluorspar, barite predominant	6 inches.............	North 50 degrees west (magnetic)	3 feet long, 2 feet wide, 2 feet deep
2	Interlaminated barite and fluorite	6 to 18 inches.......	North 45 degrees west (magnetic)	40 feet long, 1 to 3 feet wide, 1 to 3 feet deep
3	White to pale green, massive fluorspar	Not observed, said to be 1 to 2 feet wide	North 50 degrees west (magnetic)	155 feet long, 2 to 5 feet wide, 5 to 15 feet deep

[1]Veins numbered in order of their occurrence from east to west.

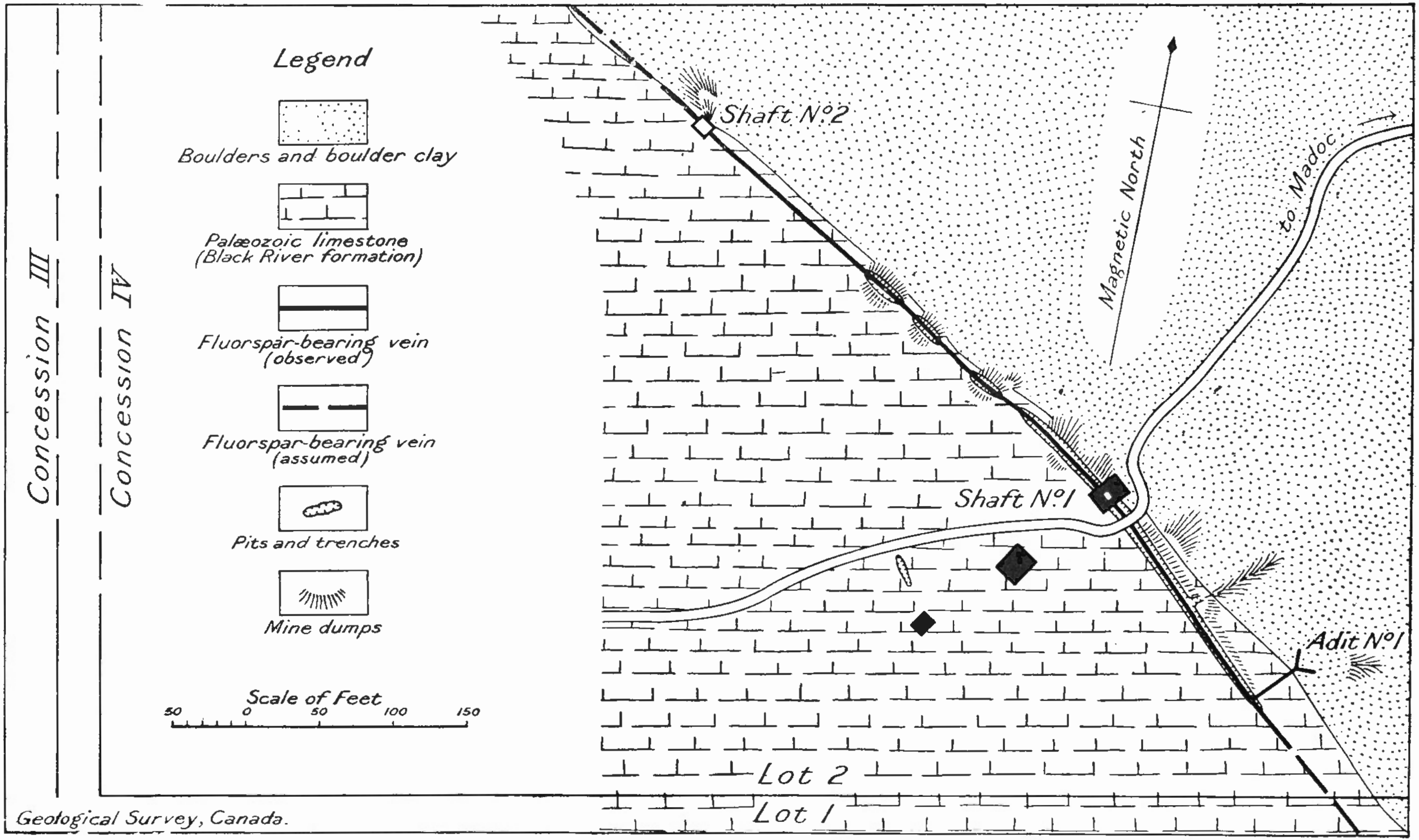


Figure 10. Fluorspar-bearing vein, lot 2, con. IV, Madoc tp., Hastings co., Ont.

(46) McBeath

A northwesterly-trending vein of fluorspar and barite about 1 foot in width is exposed in a trench near the south boundary of the east half of lot 3, concession III, Madoc township, the property of Mr. D. McBeath (17 in Figure 4). No fluorspar has been mined from this deposit, however, and it is of interest chiefly because it lies almost directly on the continuation of the McIlroy vein and is the most northern known occurrence of fluorspar belonging to the Moira Lake group.

Lee-Miller Group

(47) Herrington, Huntingdon Township, Concession XII, Lot 2

A narrow vein having an average trend of north 30 degrees west (magnetic) is exposed on this property (20 in Figure 4). The principal feature of interest with regard to the deposit is the manner in which the vein is offset at intervals towards the left, so that the various parts have an echelon distribution. This peculiar feature appears to be related in its origin to the fact that the average trend of the vein is almost but not quite at right angles to the strike of the grey, banded, Precambrian limestone that forms the wall-rock of the deposit; and that this rock fractures more readily at right angles to, rather than obliquely to, its strike; consequently, parts of the vein trend at right angles to the strike of the limestone, whereas the intervening parts trend obliquely. The most important data regarding the deposit are included in the following table.

Excavations numbered from north to south	Character of vein	Width of vein	Dimensions of excavation
1	Calcite chiefly.............	6 to 10 inches.............	5 feet long, 3 feet wide, 3 feet deep
2	Calcite and fluorite, calcite predominant	1 to 18 inches.............	100 feet long, 2 to 4 feet wide, 1 to 10 feet deep
3	Calcite and fluorite, calcite predominant	1 to 2 feet wide...........	50 feet long, 3 to 6 feet wide, 2 to 10 feet deep
4	Calcite and fluorite, calcite predominant	6 inches to 2½ feet.........	120 feet long, 2 to 6 feet wide, 1 to 4 feet deep

(48) Lee Senior

A number of fluorspar-bearing veins have been discovered on the east half of lot 1, concession I, Madoc township (18 in Figure 4), by Mr. George Lee, sen., to whom the property belongs. The most important of these occurrences is the No. 5 vein that outcrops close to the west boundary of the property and extends diagonally across the half lot line into the territory belonging to the Wallbridge estate (*See* Figure 11). About 800 tons of fluorspar are said to have been mined from this deposit in 1918 by H. L. Osborne who worked the vein under lease during the greater part of that year. The deposit consisted of a lenticular mass of fragmental or "gravel" fluorspar, 90 feet in length and 8 feet wide at its middle. The fluorspar was mined from the lens chiefly by way of a vertical shaft 60 feet deep, from the bottom of which drifts were driven along the vein for 30 feet towards the north and 60 feet towards the south. These workings were inaccessible when the writer examined the property in 1920, but the vein is said to have a width of 2 feet on the bottom of the shaft. The principal data regarding the various veins on the Lee Senior property are included in the following table.

No. of vein[1]	Character of vein	Width of vein material	Trend of vein	Dimensions of excavation
1	Massive fluorspar...	2 to 12 inches.......	North 50 degrees west (magnetic)	80 feet long, 2 to 6 feet wide, 2 to 10 feet deep
2	Fluorite and barite, chiefly fluorite. Two parallel veins in places	3 to 12 inches.......	Variable, north 40 to north 65 degrees west (magnetic)	A series of pits extending 250 feet along vein, 2 to 6 feet wide, 1 to 8 feet deep
3	Massive fluorspar...	6 inches to 2 feet....	North 35 degrees west (magnetic)	350 feet long, 6 inches to 10 feet wide, and 10 feet deep
4	Chiefly barite and calcite	4 to 12 inches.......	North 30 degrees west (magnetic)	70 feet long, 3 to 8 feet wide, 20 to 25 feet deep
5	White to honey-yellow fluorspar, barite, and calcite, chiefly gravel fluorspar	2½ to 8 feet..........	North 40 degrees west (magnetic)	Open pit 50 feet long and 10 feet wide, shaft said to be 60 feet deep near south end; drifts 30 feet to south and 60 feet to north at bottom of shaft

(49) Wallbridge

There are two fluorspar-bearing veins known to be present on the Wallbridge property (19 in Figure 4) which for the purpose of description may be designated the north and south veins, respectively (*See* Figure 11). Of these, the south vein is the continuation of the No. 5 vein on the Lee property and the north vein the continuation of the vein on the adjacent (Herrington) lot to the north. These deposits were discovered by Mr. C. M. Wallbridge during the summers of 1918 and 1919 while prospecting

[1]Veins numbered in order of their occurrence from east to west.

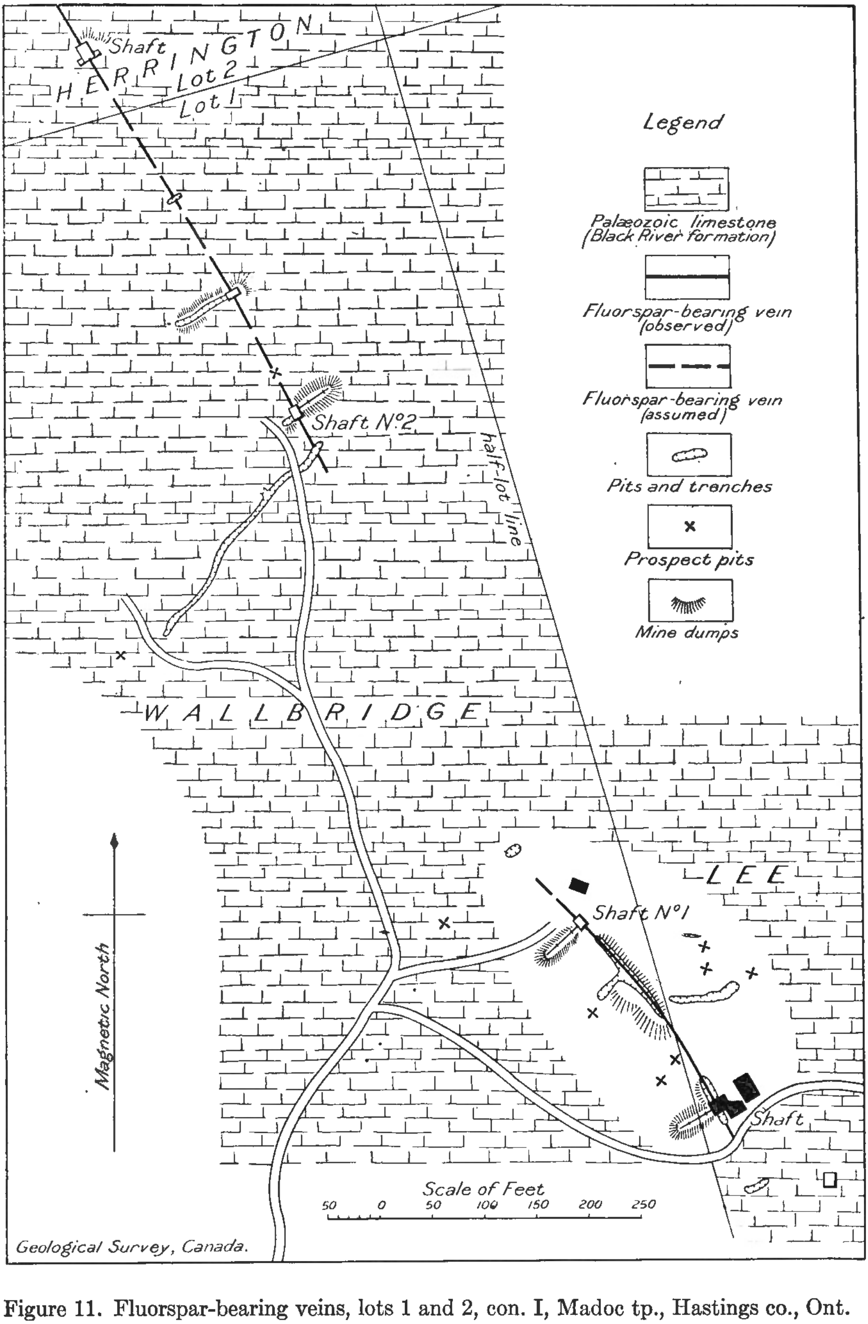


Figure 11. Fluorspar-bearing veins, lots 1 and 2, con. I, Madoc tp., Hastings co., Ont.

for the continuation of the Lee vein. Three hundred and eighty tons of fluorspar were shipped from the property in 1918[1]. The principal data regarding the deposits are included in the following table.

Excavation	Character of vein	Width of vein material	Trend of vein	Dimensions of excavation
South Vein:				
Trench between No. 1 shaft and half lot line	Fluorspar and barite	6 to 18 inches...	North 40 degrees west (magnetic)	125 feet long, 2 to 6 feet wide, 4 to 10 feet deep
Prospect pit adjoining half lot line to south of main vein.	Fluorspar and barite	2 veinlets 6 inches wide		5 feet long, 4 feet wide, 3 feet deep
No. 1 shaft..............	"Gravel" fluorspar forming matrix around fragments of Palæozoic limestone	6 feet..........	North 40 degrees west (magnetic)	55 feet deep
North Vein:				
Trench 40 feet south of No. 2 shaft	2 veins: one on the continuation of the main vein and one 75 feet west of main vein	Width of main vein not determined, width of vein to west of main vein 6 inches	....	1 to 3 feet wide, 2 to 5 feet deep
No. 2 shaft..............	Fluorspar, barite, and calcite	5 to 6 feet of breccia on west, 1 to 2 feet of ore on east. Total width 7 feet	North 30 degrees west (magnetic)	25 feet deep
Opening on parallel vein 5 feet west of No. 2 shaft	Fluorspar, barite, and calcite, forming matrix of breccia in part	5 feet of breccia on west, 2 feet of cavernous ore on east. Total width 7 feet	....	12 feet deep
Pit and trench 130 feet north of shaft No. 2	Gravel, fluorspar, and breccia	4½ feet wide in pit, veinlet 4 inches wide in trench 30 feet from pit	North 30 degrees west (magnetic)	Pit, 15 feet long, 4 feet wide, 15 feet deep. Trench 55 feet long
Pit 240 feet north of shaft No. 2	Chiefly breccia.	Veinlets 1 to 6 inches wide, breccia 5 feet wide	North 30 degrees west (magnetic)	20 feet long, 2 feet wide, 10 feet deep

(50) Herrington, Madoc Township, Concession I, West Half Lot 2

The fluorspar-bearing vein occurring in this locality is the northern continuation of the north vein on the Wallbridge property (*See* Figure 11). The outcrop of the vein at the point where a pit has been sunk was overlain by a solid mass of limestone 5 feet thick and at least 25 feet in diameter, which appeared at the surface to be in place, but which, on examination of the pit faces, can be seen to be underlain by 2 to 3 feet of glacial drift, and has, therefore, been transported into its present position by glacial action. When the writer last visited the property in September, 1920, a vein of "gravel" fluorspar 6 feet wide was exposed in the bottom of the pit which at that time was 12 feet long, 8 feet wide, and 20 feet deep.

(51) Madoc Township, Concession II, Lot 1, West Half

Veinlets of fluorspar and barite a few inches wide are said to occur in this lot. They were not seen by the writer.

[1]Ann. Rept., Ont. Bureau of Mines, vol. XXVII, pt. 1 (1918).

(52) Stewart

A northwesterly-trending vein of barite and fluorspar 4 inches in width is exposed in a trench and prospect pit in Palæozoic limestone near the northeast corner of lot 2, concession I, Madoc township (21 in Figure 4), the mining rights to which belong to Mr. D. E. K. Stewart of Madoc. The principal point of interest with regard to this deposit is the presence of a small proportion of the minerals chalcopyrite and malachite in the vein.

(53) Madoc Township, Concession II, Lot 3

Veinlets of fluorspar and its associated minerals up to 5 inches are reported to occur in the west half of this lot. They were not examined by the writer.

(54) Ponton

The discovery of fluorspar in this locality (22 in Figure 4) was made by Mr. G. M. Ponton, in 1917. The deposit (*See* Figure 12) consists of a northwesterly-trending vein from 1 inch to 2½ feet in width, which is exposed for over 400 feet in the bottoms of a series of pits up to 160 feet long and 20 feet deep. Four carloads of fluorspar were shipped from the property in 1919.

(55) Miller

The veins occurring in this property (24 in Figure 4) were discovered by Mr. C. M. Wallbridge in the spring of 1917 and were worked by him during the summer of 1917 and the winter of 1917-1918. In the spring of 1918 Wallbridge sold the property to Mr. H. L. Osborne who continued operations during the following summer and for a short period during the spring of 1919. Since 1919 the property has been idle.

There are two fluorspar veins on the property (Figure 12 and Plate IV B) which for the purpose of reference may be designated the east and west veins respectively. The principal data regarding these deposits are included in the following table.

Excavation	Character of vein	Width of vein material	Trend of vein	Dimensions of excavations
East Vein				
Pit south of shaft.....	Fluorspar, barite, and calcite	10 inches to 3 feet.	North 25 degrees west (magnetic)	300 feet long, 1 to 5 feet wide, 3 to 10 feet deep
Shaft................	Fluorspar, barite, and calcite	3 feet at surface to 6 inches at bottom	....	75 feet deep
Pit north of shaft.....	Fluorspar, barite, and calcite (barite fibrous in part)	18 inches to 4 feet.	....	130 feet long, 1 to 5 feet wide, 3 to 10 feet deep
West Vein				
	Honey-yellow fluorspar	2 parallel veins 1 to 2 feet apart. Total width 3 inches to 9 inches	North 40 degrees west (magnetic)	75 feet long, 1 to 5 feet wide, 2 to 20 feet deep

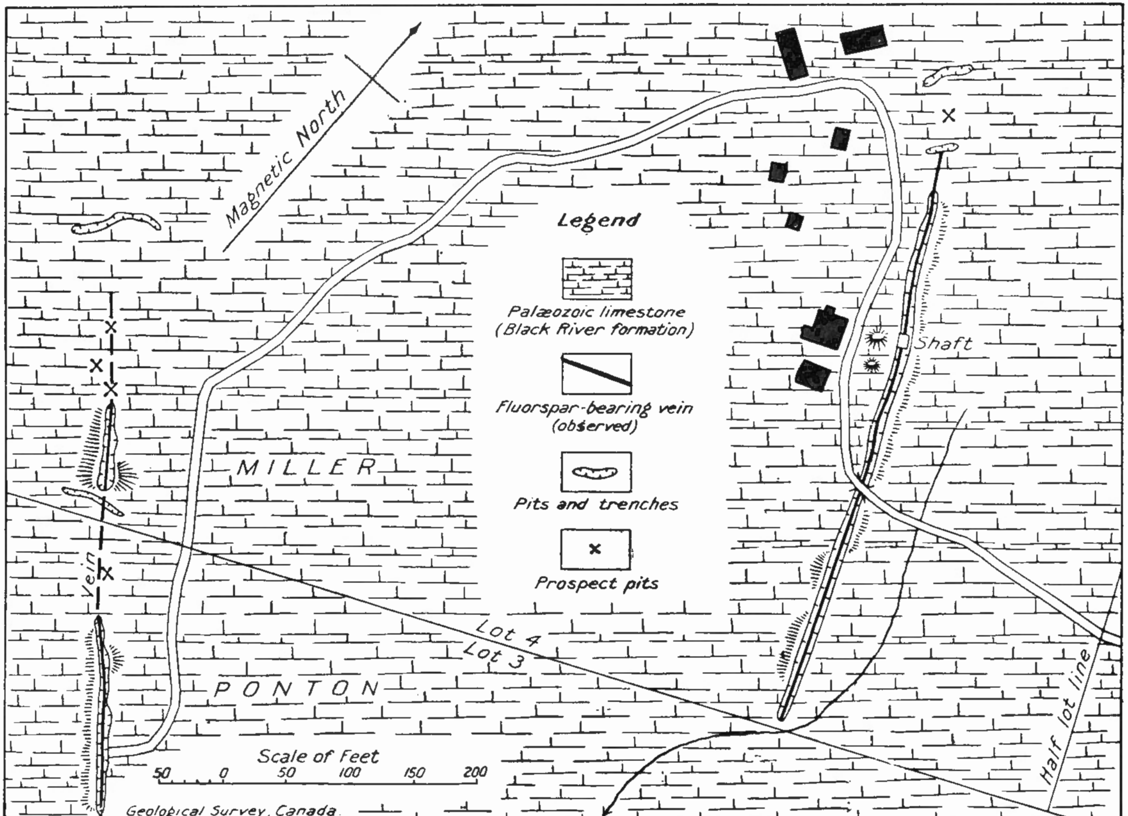


Figure 12. Fluorspar-bearing veins, lots 3 and 4, con. I, Madoc tp., Hastings co., Ont.

(56) William Reynolds (Madoc Township, Concession I, Lot 5)

A northwesterly-trending vein consisting of grey to green fluorspar and calcite was discovered on this property (23 in Figure 4) by Donald Henderson and James O'Reilly during the summer of 1920. A shaft 20 feet deep and two pits situated 70 and 140 feet respectively to the northwest of the shaft have been excavated on the vein. The total width of vein material exposed in these openings ranges from 18 inches to 2 feet.

(57) Rooks

The fluorspar-bearing vein occurring on this property (26 in Figure 4) was opened up by James O'Reilly during the summers of 1916 and 1917. Several carloads of ore were shipped from the property by O'Reilly as a result of these operations.

The vein outcrops close to a northward-facing escarpment and like the other fluorspar-bearing veins of the Lee-Miller group trends in a northwesterly direction (north 45 degrees west magnetic). When the writer visited the property in August, 1920, the vein had been mined away to a depth of 2 to 20 feet for over 300 feet along its outcrop. The bottom of the excavation was hidden by debris, but judging from the width of the excavation from which the vein material had been removed, the vein had a width ranging from 6 inches to $2\frac{1}{2}$ feet.

(58) Plain

Near the north end of Jarvis lake on lot 9, concession I, Madoc township (27 in Figure 4), prospect pits have been sunk along the outcrop of a veinlet of fluorspar and barite that intersects the red granite exposed in this part of Madoc district. This veinlet, so far as known, is the most northerly occurrence of fluorspar belonging to the Lee-Miller group.

(59) Madoc Township, Concession IV, Lot 14

A pit 8 feet long, 3 feet wide, and 3 feet deep has been excavated in granite at a point about 150 feet north of the road that crosses this lot longitudinally. Basal Palæozoic sandy limestone outcrops about 50 feet away. Near the north end of the pit there is a lens of granular white fluorspar about 3 feet long and 1 foot wide, trending north 15 degrees west magnetic. Beyond the lens there is a faintly marked fracture in the granite continuing for a few feet. Some irregular aggregates of fluorspar occur at the north end of the pit about 1 foot from the lens. A pile of about 200 pounds of fluorspar lay near the pit at the time it was examined by the writer in June, 1925. Except for its elongated form and the poorly defined fracture on its continuation the occurrence of this deposit as a local mass in the granite directly below its contact with the overlying Palæozoic suggests that the fluorspar may be an aggregate deposited from the Palæozoic limestone without continuation at depth.

(60-61) Monteagle Township

Reference

Ellsworth, H. V.: Geol. Surv., Canada, Sum. Rept. 1923, pt. C I, p. 18.

The occurrence of dark purple fluorspar in pegmatite dykes at the Woodcox feldspar property, lot 17, concession VIII, and at the MacDonald feldspar mine, lots 18 and 19, concession VII, Monteagle township, Hastings county, is recorded by H. V. Ellsworth. The proportion of the mineral present is too small to be valuable even as a by-product in mining the feldspar.

RENFREW, FRONTENAC, AND CARLETON COUNTIES

Fluorspar is reported to occur in one or more localities in these counties, but not in deposits of commercial extent. The principal information regarding each deposit is included in the following table.

—	Locality	Character of deposit	Associated rock	Reference
	RENFREW COUNTY			
(62)	.........?.........	In purple grains as accessory mineral in corundum deposits	Syenite pegmatite..	Barlow, A. E.: "Corundum"; Geol. Surv., Canada, Mem. 57, p. 114 (1915)
(63)	Ross township......	Purple, disseminated grains associated with green apatite	Crystalline limestone	"Geology of Canada, 1863", p. 463
	FRONTENAC COUNTY			
(64)	Oso township, concession I, lot 25	Green crystals on barite in parallel veins of barite and calcite	Brown dolomitic limestone	Spence, H. S.: "Barium and Strontium in Canada"; Mines Branch, 1922, p. 21
(65)	Kingston township, concession IV, lot 17	Along wall of northwesterly trending vein of barite 2 to 4 feet wide	Flat-lying Ordovician limestone	Baker, M.B.; "The Geology of Kingston and Vicinity"; Ont. Bureau of Mines, Ann. Rept., vol. 25, pt. 3, pp. 33-34 (1916)
	CARLETON COUNTY			
(66)	Fitzroy township, concession VI, lot 22, Kingdon mine	In vein of calcite carrying galena, not abundant	Crystalline limestone, granite, and diorite	Wilson, M. E.: "Arnprior-Quyon Area"; Geol.Surv., Canada, Mem. 136, p. 96 (1924)
	LEEDS COUNTY			
(67)	Bastard township, concession I, lot 28, J. Bulger	Veinlets up to $1\frac{1}{2}$ inches wide and a few feet long	Granite............	Wilson, M. E.: unpublished notes

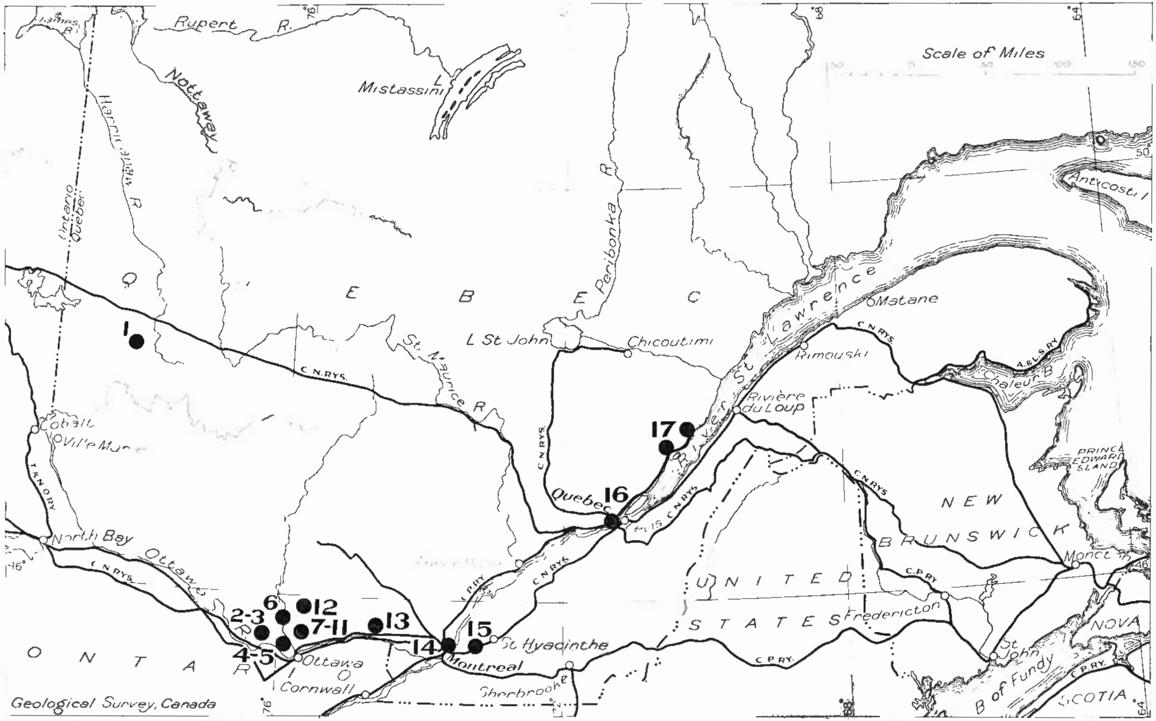


Figure 13. Index map showing location of fluorspar deposits in Quebec. 1, Height of Land; 2, Onslow tp., range III, lot 13; 3, Onslow tp., range VII, lot 9; 4, Hull tp., range X, lot 14; 5, Hull tp., range X, lot 7; 6, Leduc; 7, Templeton tp., range I, lot 15; 8, Haycock; 9, Trusty; 10, North Star; 11, Derry tp., range IX, lot 1; 12, Villeneuve; 13, Grenville augmentation; 14, Mount Royal; 15, St. Hilaire; 16, Quebec city; 17, Baie St. Paul and Murray Bay.

QUEBEC

Numerous occurrences of fluorspar in Quebec are mentioned in the reports of the Geological Survey, but so far as known these are merely mineral localities and not deposits of commercial importance. The principal information given regarding each occurrence is included in the following table.

	Locality	Character of deposit	Associated rock	Reference
	ABITIBI COUNTY			
(1)	Preissac tp. Range X, Height of Land property	Associated with molybdenite, native bismuth, bismuthinite, beryl, garnet, and muscovite in pegmatite	Granite dyke......	Wilson, M. E.: Geol. Surv., Canada, Sum. Rept. 1920, p. 207
	PONTIAC COUNTY			
	Onslow tp.			
(2)	Range III, lot 13 .	Parallel veins of barite and a small proportion of fluorspar, total width 5 feet	Beekmantown dolomite on south. Syenite on north	Wilson, M. E.: "Arnprior-Quyon Area"; Geol. Surv., Canada, Mem.136, p. 115
(3)	Range VII, lot 9..	Purple fluorspar associated with molybdenite, pyrite, pyrrhotite, etc.	Quartz syenite.....	Wilson, M. E.: "Arnprior-Quyon Area"; Geol.Surv., Canada, Mem.136, p. 66
	HULL COUNTY			
	Hull tp.			
(4)	Range X, lot 14..	In apatite deposit..........	Metamorphic pyroxenite	Harrington, B. J.: Geol. Surv., Canada, Rept. of Prog. 1877–78, p. 16
(5)	Range X, lot 7...	Green fluorspar in northwesterly trending vein of barite up to 3 feet wide	Crystalline limestone	"Geology of Canada, 1863", p. 20; Vennor, H. G.: Geol. Surv., Canada, Rept. of Prog. 1873–4, p. 145
	Wakefield tp.			
(6)	Range VII, lot 25, Leduc	Associated with feldspar, tourmaline, and large dolite	Pegmatite dyke....	de Schmid, H. S.: "Mica"; Mines Branch, Dept. of Mines, 1912, p. 199
	PAPINEAU COUNTY			
	Templeton tp.			
(7)	Range I, lot 15....	Specimen.................	....	Hoffmann, G. C.: Geol. Surv., Canada, Ann. Rept., vol. IV, pt. A, p. 49 (1891)

—	Locality	Character of deposit	Associated rock	Reference
	PAPINEAU COUNTY-Con. Templeton tp.–*Con.*			
(8)	Range 5, lot 1, Haycock mine	Sea-green fluorspar associated with hematite	Crystalline limestone	Vennor, H.G.: Geol. Surv., Canada, Rept. of Prog. 1873–74, p. 145
(9)	Range XII, lot 12, Trusty pit	In apatite deposit..........	Metamorphic pyroxenite	Harrington, B. J.: Geol. Surv., Canada, Ann. Rept. 1877–78, pt. G, p. 16
	East Portland tp.			
(10)	Range VII, lot 22, North Star mine	In apatite deposit..........	Metamorphic pyroxenite	Osann, A.: Geol. Surv., Canada, Ann. Rept., vol. XII, pt. O, p. 38 (1902)
	Derry tp.			
(11)	Range IX, lot 1 ..	Specimen..................	....	Hoffmann, G. C.: Geol. Surv., Canada, Ann. Rept., vol. XV, pt. A, p. 436 (1907)
	Villeneuve tp.			
(12)	Range 1, lot 31....	In pegmatite dyke.........	Garnet gneiss.......	de Schmid, H. S.: "Mica"; Mines Branch, Dept. of Mines, 1912, p. 187
	ARGENTEUIL COUNTY			
	Grenville tp.			
(13)	Augmentation ..	Purple and wine-coloured fluorspar associated with pyroxene, apatite, sphene, orthoclase, tourmaline, and calcite	Metamorphic pyroxenite	Harrington, B. J.. Geol. Surv., Canada, Rept. of Prog. 1877–78, pt. G, p. 16
	JACQUES CARTIER COUNTY			
(14)	Mount Royal. Montreal	Small vein of purple fluorspar	Grey fossilferous limestone	"Geology of Canada, 1863", p. 463
	ROUVILLE COUNTY			
(15)	St. Hilaire..........	In coarser parts of aegerite-augite dykes	....	O'Neill, J. J.: Geol. Surv., Canada, Mem. 43, p. 54
	QUEBEC COUNTY			
(16)	Quebec city, near citadel	Deep purple fluorspar with calcite in veins cutting black slates near citadel	Black slate.........	"Geology of Canada, 1863", p. 463
(17)	Baie St. Paul and Murray Bay	Green fluorspar in veins of calcite and galena	Potsdam sandstone.	"Geology of Canada, 1863", p. 463

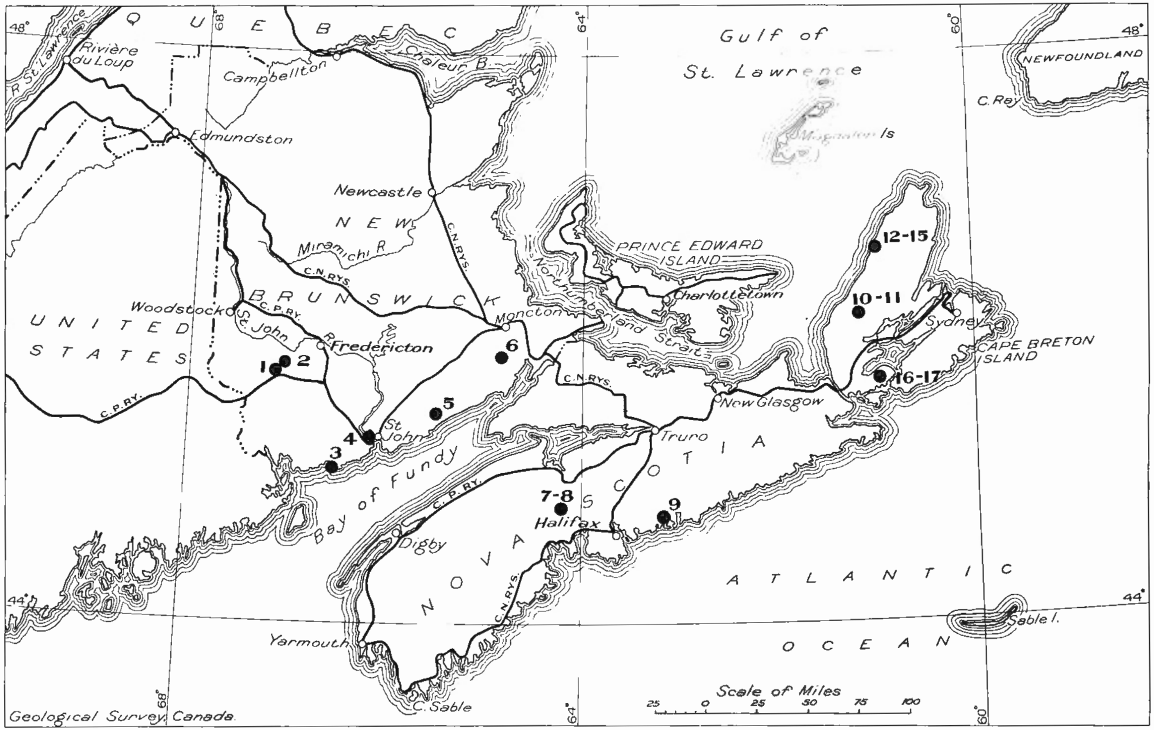


Figure 14. Index map showing location of fluorspar deposits in New Brunswick and Nova Scotia. 1, Harvey station; 2, Lister's mills; 3, Frye island; 4, Indiantown; 5, Upham; 6, Beech hill; 7, Larder river; 8, Reeves; 9, Musquodoboit harbour; 10, McDougall, McMillan, and Campbell; 11, Johnston; 12, Poirier; 13, Trout brook; 14, Comus; 15, Cap Rouge; 16, McNab cove; 17, Plaster cove.

NEW BRUNSWICK AND NOVA SCOTIA

Fluorspar is reported to occur in pegmatite and in veins of barite, calcite, and other minerals in numerous localities in these provinces, but so far as known the proportion of the mineral present in the deposits is too small to be important even as a by-product. The most important information regarding each occurrence is included in the following table.

NEW BRUNSWICK

—	Locality	Character of deposit	Associated rock	Reference
	YORK COUNTY			
	Sutton parish			
(1)	Harvey station...	In small veins..............	Feldspathic rocks at the summit of the Lower Carboniferous series	Bailey, L. W., and Matthew, G. F.: Geol. Surv., Canada, Rept. of Prog. 1872–73, p. 229
(2)	Lister's mills.....	Deep purple and emerald green in veins with quartz and calcite	" "	" "
	CHARLOTTE COUNTY			
	St. George parish			
(3)	Frye island.......	"With calc-spar and barytes also in compact white masses in veins mingled with quartz"	Not stated.........	Bailey, L. W., and Matthew, G. F.: Geol. Surv., Canada, Rept. of Prog. 1870–71, p. 237
	ST. JOHN COUNTY			
	Simonds parish			
(4)	Indiantown.......	"A small specimen of fluorite with calcite was found in the limestone quarry of Stetson and Cutler"	Crystalline limestone	Hayes, A. O.: Geol. Surv., Canada, Sum. Rept. 1913, p. 243
	KINGS COUNTY			
	Upham parish			
(5)	Upham...........	Some purple crystal.........	Lower Carboniferous limestone	Bailey, L. W., and Matthew, G. F.: Geol. Surv., Canada, Rept. of Prog. 1870–71, p. 237
	ALBERT COUNTY			
	Hillsborough parish			
(6)	Beach hill, Belleveaux mill	Green fluorspar with amethystine quartz and copper ore	Not stated.........	Bailey, L. W., and Matthew, G. F.: Geol. Surv., Canada, Rept. of Prog. 1870–71, p. 237

—	Locality	Character of deposit	Associated rock	Reference
	LUNENBURG COUNTY			
(7)	New Ross, Larder river, 1 mile south Dalhousie road	Trifling quantities of fluorspar with chlorite, molybdenite, and scapolite in an association of quartz, feldspar, and mica	Granite............	Faribault, E. R.: Geol. Surv., Canada, Ann. Rept., vol. XVI, pt. A, p. 344
(8)	New Ross, Reeves..	A pegmatitic segregation composed of feldspar, quartz, a little mica, fluorite, cassiterite, and other minerals	Grey granite........	Faribault, E. R.: Geol. Surv., Canada, Sum. Rept. 1907, p. 81
	HALIFAX COUNTY			
(9)	Musquodoboit harbour	Associated with galena......	.... ?	Johnston, R. A. A.: Geol. Surv., Canada, Mem. 74, p. 97 (1915)
	INVERNESS COUNTY			
	Lake Ainslie			
(10)	McDougall, McMillan, and Campbell	A gangue material in vein of barite. Strike of vein NW., dip 60° SW.	Felsite.............	Spence, H. S.: "Barium and Strontium in Canada"; Mines Branch, 1922, pp. 25–27
(11)	Johnston..........	Pale green fluorite in veins of barite up to 10 feet wide. Strike of veins almost due east-west, dip steep to north	Reddish brown felsite	Spence, H. S.: "Barium and Strontium in Canada"; Mines Branch, 1922, pp. 24–25
	North Cheticamp			
(12)	Poirier...........	An east-west trending vein of barite, quartz, calcite, and fluorite 3 to 6 feet wide	Schists derived from shales and argillaceous sandstone	Poole, H. S.: "The Barytes Deposits of Lake Ainslie and N.Cheticamp, N.S.";Geol.Surv., Canada, 1907, pp. 26–27
(13)	Trout brook......	In lens of barite trending N. 10° W.	Sericite schist.......	" "
(14)	Comus............	In vein of barite 10 inches to 8 feet wide	Schist.............	" "
(15)	Cap Rouge........	Specimen.................	....	Piers, H.: "Economic Minerals of Nova Scotia"; Rept. Dept. of Mines, N.S., 1906, p. 41
	RICHMOND COUNTY			
(16)	McNab cove........	Associated with "traces of coaly matter"	In limestone........	Fletcher, H.: Geol. Surv., Canada. Rept. of Prog. 1877–78, pt. F, p.28
(17)	Plaster cove........	"Fluorspar of a beautiful blue colour"	.... ?	Coste, E.: Geol. Surv., Canada, Ann. Rept., vol. III, pt. S, p. 79

CHAPTER IV

FLUORSPAR IN OTHER COUNTRIES

Fluorspar being a persistent mineral and hence having a wide range of occurrence is found in practically every country of the world, but, as explained in Chapter II, the deposits in which it occurs abundantly are restricted to the low temperature types, so that the principal part of the production of the world comes from countries where deposits of this class are present. Fluorspar from deposits of the other classes, if mined at all, is obtained largely as a by-product in the mining of other minerals. The countries of the world may be grouped according to their production of fluorspar into three classes: (1) those from which the principal production of the world is obtained; (2) those from which there has been a production of several thousand tons without interruption for several years; and (3) those from which a small amount of fluorspar is being produced or has been produced at some time in the past. To the first class belong United States, Great Britain, Germany, and France; to the second the Union of South Africa, Italy, and Australia; to the third, Canada, Mexico, Spain, Norway, China, Russia, and Japan.

UNITED STATES

Fluorspar is very common in the United States, but in many of its occurrences it is merely a gangue material associated with other minerals of more value. It has been mined at some time, if not recently, in ten different states, but by far the greater part of the production is obtained from Illinois and Kentucky. The remaining states, the total annual production from which has never exceeded a few thousand tons, named in the order of their importance, are: Colorado, New Mexico, New Hampshire, Arizona, Tennessee, Nevada, Utah, and Washington. With the exception of Colorado and New Mexico there has been no production from any of these states since 1924.

Illinois[1]

The fluorspar deposits of Illinois that are being worked are all in Pope and Hardin counties, near the extreme south end of the state, and directly across Ohio river from the fluorspar deposits of western Kentucky. The bedrock formations of the district consist chiefly of flat-lying or gently dipping beds of limestone, chert, shale, sandstone, and conglomerate of Devonian and Carboniferous (chiefly Mississippian) age. These are cut by numerous intersecting normal faults along which the strata have been downthrown for various distances up to 1,200 feet. They are also cut by several small dykes and sills of mica peridotite and lamprophyre ranging in width from a few inches to 5 feet and outcropping in some cases for several hundred feet.

[1]Bain, H. Foster: "The Fluorspar Deposits of Southern Illinois"; U.S. Geol. Surv., Bull. 255 (1905).
Blayney, J. M., jun.: "The Mining and Milling of Fluorspar"; Eng. Min. Jour., vol. III, pp. 222–223 (1921).
Currier, L. W.: "The Geology of Hardin County"; Chap. 12, Econ. Geol., Ill. State Geol. Surv., Bull. 41, pp. 247–304 (1920).

The fluorspar occurs for the most part in vertical or nearly vertical veins occupying fault fissures, but a few, flat, tabular deposits believed to have been formed by replacement are found in the limestone adjoining the faults. It is thought that the veins have been widened in places by replacement of the limestone wall-rock. The veins have an average width ranging from 5 to 15 feet and maximum widths of 25 to 40 feet. The most abundant minerals other than fluorspar, composing the veins, are calcite, quartz, galena, sphalerite, chalcopyrite, and a black, flaky, bituminous hydrocarbon. The less common minerals are barite, pyrite, and stibnite. The proportions of fluorspar and calcite vary in different parts of the vein, practically pure fluorspar occurring at some points and solid calcite at others. Blayney states that the fluorspar as a rule decreases in quantity with depth, the fault either pinching or the vein matter being replaced by calcite. The concentration of the fluorspar and the associated metallic minerals is effected by coarse breaking, washing, hand sorting, crushing, and jigging. Only the fluorspar and galena are shipped, but the zinc concentrate is being saved.

Kentucky[1]

Fluorspar occurs in Kentucky chiefly in two districts, known respectively as the western and central Kentucky fields. The western Kentucky field is at the extreme western end of the state and adjoins the fluorspar mining district of southern Illinois. The bedrock formations of the region are horizontal or gently folded, interstratified beds of limestone, shale, and sandstone of Carboniferous (chiefly Mississippian) age, cut by dykes of mica, peridotite, and pyroxene lamprophyre up to 12 feet wide. The beds are intersected by numerous normal faults and zones of fissuring in which the fluorspar and associated minerals have been deposited as veins. The minerals composing the veins include, in addition to fluorspar, calcite, galena, sphalerite, barite, quartz, greenockite, pyrite, chalcopyrite, and various oxides and carbonates formed where the veins have been superficially altered. The proportion of fluorspar and calcite in the veins is variable, ranging from pure fluorspar in some places to solid calcite in others. The veins pinch and swell and vary in width from a few inches up to 26 feet. The milling processes employed, like those of Illinois, consist in washing, hand sorting, crushing and concentration by jigs and tables. The products produced are a fluorspar and a lead or zinc concentrate.

The principal fluorspar deposits of central Kentucky are confined to the bluffs of Kentucky river, in Mercer and Woodford counties, about 20 miles southwest of Lexington. The bedrock formation underlying the region is limestones belonging to the Ordovician, and unlike the strata of the western Kentucky and southern Illinois fields, is not, so far as known, cut by igneous intrusives. The fluorspar occurs in veins associated with calcite and barite and subordinate amounts of galena, sphalerite, and marcasite.

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[1]Ulrich, E. O., and Smith, W. S. Tangier: "The Lead, Zinc, and Fluorspar Deposits of Western Kentucky"; U.S. Geol. Surv., Prof. Paper, No. 36, 1905.

Fohs, F. Julius: "Fluorspar Deposits of Kentucky"; Ky. Geol. Surv., Bull. No. 9 (1907). "The Fluorspar, Lead, and Zinc Deposits of Western Kentucky"; Econ. Geol., vol. 5, pp. 377-86 (1910).

Currier, L. W.: "Fluorspar Deposits of Kentucky"; Ky. Geol. Surv., ser. 6, vol. 13 (1923).

Miller, A. M.: "The Lead and Zinc-bearing Rocks of Central Kentucky"; Ky. Geol. Surv., Bull. No. 2 (1905).

Colorado[1]

Fluorspar occurs widely distributed in the mountainous parts of Colorado, but in many of its occurrences it is merely gangue material associated with metalliferous minerals of more value. The most extensive deposits are in two districts, a central belt extending from Jackson to Custer counties and a southwestern area confined largely to Mineral, Ouray, and San Juan counties. In the central district, with the possible exception of a recently discovered deposit near Cowdrey, in Jackson county, the geology of which has not been described, the fluorspar occurs in veins cutting Precambrian granite. They range in width from a few inches to 7 feet and have an average width of 2 to 5 feet. They consist either of solid fluorspar, fluorspar mingled with quartz, clay, and fragments of granite, or fluorspar, galena, pyrite, chalcopyrite, chalcocite, bornite, and other metalliferous minerals. The most important deposits in this district are in Boulder county. In southwestern Colorado district, the fluorspar is associated with Tertiary volcanics. The deposit found on Goose creek near Mineral Gap, in Mineral county, is typical of the group. It is a vein cutting rhyolite, latite, tuffs, and breccia. It has a width up to 14 feet, of which 3 to 4 feet is solid fluorite. The remainder consists of fluorite, barite, altered country rock and gouge. The wall-rock is highly altered and contains disseminated pyrite.

New Mexico[2]

A few thousand tons of fluorspar have been produced annually from New Mexico in recent years. The deposits from which most of this production has been derived are in Grant, Luna, and Donna Ana counties, in the southwestern part of the state. The principal known deposits are those on the Tortuga property near Mesilla Park in Donna Ana county, the Great Eagle property in Grant county, and a property 10 miles northeast of Deming in Luna county. The Deming deposits have been described by E. F. Burchard. They are veins occupying fractures and fault fissures in an altered monzonite porphyry that has intruded limestone, sandstone, quartzite, and conglomerate of Palæozoic and Mesozoic age. The veins consist of fluorspar mingled with a small proportion of quartz and have a normal width of 2 to 5 feet with local maximum widths up to 12 feet.

Arizona[3]

The principal known deposits in Arizona are those in Castle Dome district north of Yuma, northeast of Duncan on the Arizona-New Mexico line, and that of the Neptune mine in Serrita mountains, southwest of Tucson. In the Castle Dome district the fluorspar is obtained as a by-product in mining silver-lead bearing veins. Near Duncan it forms the

[1]Emmons, W. H., and Larsen, E. S.: "The Hot Springs and the Mineral Deposits of Wagon Wheel Gap, Colorado"; Econ. Geol., vol. 8, pp. 235–246 (1913).
Lunt, H. F.: "A Fluorspar Mine in Colorado"; Min. and Sci. Press, vol. III, pp. 925–926 (1915).
Hibbs, G. G.: "Boulder County Fluorspar"; Eng. Min. Jour., vol. 109, pp. 494–495 (1920).
Aurand, H. A.: "Fluorspar Deposits of Colorado"; Col. Geol. Surv., Bull. 18 (1920).
Davis, H. W.: "Fluorspar and Cryolite"; Min. Res. of United States, U.S. Bureau of Mines, pt. 2, pp. 22 (1926).

[2]Burchard, E. F.: "Fluorspar in New Mexico"; Min. and Sci. Press, vol. 103, pp. 74–76 (1911).
Eng. and Min. Jour., vol. 115, p. 200 (1923).

[3]Allen, M. A., and Butler, G. M.: "Fluorspar"; Univ. of Ariz., Bull. Ariz. Bur Mines, 1921

gouge in veins of a fracture zone 50 feet wide cutting andesite porphyry. At the Neptune mine it occurs in a vein from a few inches to 2 feet wide cutting mica schist intruded by dykes of porphyry. The total production of fluorspar from Arizona up to the present has been less than 2,000 tons.

GREAT BRITAIN[1]

The fluorspar deposits of Great Britain that are being worked or are of possible commercial importance are confined to four districts: (1) Derbyshire; (2) the north of England (Durham); (3) Cornwall and Devon; and (4) north Wales (Flintshire); of these the first and second are by far the most important.

Derbyshire

The fluorspar deposits of Derbyshire occur in the upper part of the Carboniferous Limestone, a great mass of strata consisting almost entirely of limestone lying at the base of the Carboniferous system. Although neither the continuation of the limestone downward nor the floor upon which it was deposited is exposed in Derbyshire, it is known that it constitutes only the upper part of the formation as found elsewhere in England and on the mainland of Europe. The limestone has an exposed thickness of over 1,500 feet and has been folded into a broad, unsymmetrical anticline. There are some basic igneous rocks associated with the limestone, partly lava flows, ash and tuff beds contemporaneous with the limestone, and partly sills, dykes, or volcanic necks of dolerite, agglomerate, and basalt.

The fluorspar deposits occupy fissures or other cavities in the limestone and are known according to their form as: (1) rakes or rake-veins; (2) pockets; (3) pipes; and (4) flats. The "rakes or rake-veins" are defined as deposits in enlarged joints, faults, fissures, or cracks, the last variety being known as "scrins". Pockets are described as deposits in chambers on the side of a "rake"; "pipes" as the combination of joint fissure cavities, with one or more horizontal cavities formed along the bedding, the whole being more or less completely filled with mineral matter; and "flats" as deposits in horizontal cavities formed along the bedding and regarded independently of "pipes".

The "rake-veins" are the most common type of deposit and occur in the limestone everywhere, but most abundantly in its eastern part. The veins belong chiefly to two groups, one of which trends approximately west and the other northwest. They range in width from a fraction of an inch to 30 or 40 feet. They have an average width of about 6 feet. The longest deposit has a length of 7 miles. Fluorspar is confined almost entirely to the uppermost 600 feet of the limestone and largely to the uppermost 300 or 400 feet. In consequence of this restriction the fluorspar is found only along the margin of the limestone mass, and is replaced by barite and calcite, both towards the interior of the mass and at depth.

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[1]Carruthers, R. G., and Pocock, R. W., with contributions by others: Mems. Geol. Surv., Spec. Repts. on Min. Res. of Gr. Brit., vol. 4, "Fluorspar", 3rd Ed. (1922).
Wedd, C. B., and Drabble, G. Cooper: "The Fluorspar Deposits of Derbyshire"; Trans. Inst. Min. Eng., vol. 36, pp. 501–535 (1907–08).

The most common minerals associated with the fluorspar include barite, calcite, galena, zinc blende, and, locally, copper ores. Less common vein constituents are selenite and bitumen. Quartz is almost unknown. In most deposits the metallic minerals are concentrated in the middle of the vein. The fluorspar, barite, and calcite are variously distributed in the deposits occurring interbanded in some places and separately in other places. The massive commercial fluorspar is usually opaque, white or faintly tinted; the crystal phases range from amber yellow to deep violet. A variety of fluorspar in which the mineral occurs in concentric layers of different tints and having a radial structure is known as "Blue John."

Derbyshire fluorspar is marketed chiefly either as it comes directly from the mine, in the form of "lump spar," or as screened tailings from old mines known as "gravel spar." A third grade of "spar" described as "fine ground spar" is now produced from high-grade lump spar in some localities. The "lump spar" averages from 90 to 95 per cent calcium fluoride, whereas the "gravel spar" contains from 55 to 75 per cent calcium fluoride. The mines from which the fluorspar is obtained were worked originally for lead, the fluorspar being a waste product of no commercial value. Now, owing to the demand for fluorspar, some of the mines have been reopened. The supply of fluorspar from waste heaps, which has been the principal source of fluorspar in Derbyshire in the past, is about exhausted.

North of England

Fluorspar is common in the metalliferous veins of the north of England, but the productive area is restricted almost entirely to Weardale district in Durham. The rocks exposed in this region belong to the Yoredale division of the Carboniferous Limestone series and consist of alternating, gently dipping beds of sandstone, shale, and limestone up to 100 feet thick. As in Derbyshire, the district was originally a lead mining centre, the mining of fluorspar being a development of recent years.

The veins are numerous and of the normal fissure type, occurring chiefly in two groups, one trending northeast and the other between west and northwest. They have a maximum length of several miles and a maximum width of 20 feet. Fluorspar is the principal constituent of both veins and "flats" in the district. Other minerals present named in their order of abundance are: quartz, calcite, galena, and pyrite. Barite is entirely absent. The galena although disseminated through the fluorspar is usually concentrated in the middle of the veins. The fluorspar is colourless or pale coloured for the most part, an amethyst-tinted variety being most common. It is shipped either as "lump" or "gravel spar."

Cornwall and Devon

Fluorspar is not now being mined in Cornwall and Devon, but the mineral is common in association with the lead and copper ores of the district. The copper-bearing minerals give place to ores of tin and wolfram at depth and the fluorspar usually dies out at depth in a similar manner. The copper lodes are not now being worked, but fluorspar may be found in many of the dumps adjoining the abandoned workings. In recent years fluorspar has been found in quantity at only two properties, on the summit of Hingston Down near Gunnis lake, where in 1906 in working a lode of tin and wolfram in granite a level was driven for 23 feet in a mass of fluorspar averaging 20 feet wide, and in the lodes at South Crofty from which several tons of fluorspar a week have been produced in recent years.

North Wales

Fluorspar occurs in places in the lead and zinc-bearing veins that cut the Carboniferous Limestone and Millstone Grit of Flintshire in north Wales, but it is not sufficiently abundant or pure to be commercially valuable. There is sufficient fluorspar present in some veins in this region for fluorspar to be produced as a by-product, provided it could be easily separated in the concentration of the galena and zinc blende.

GERMANY[1]

The commercially important fluorspar deposits of Germany are found in the southeastern part of Harz mountains, the Upper Palatinate of Bavaria, the Black Forest of Baden, and the Thuringian Forest of Thuringia, and Saxony. The most extensive deposits are those in Harz mountains. These are veins occupying fault fissures that parallel the southern border of the mountains. The principal mine of the district and the largest fluorspar mine in Germany, the Fluszschlacht, lies north of Stolberg. The veins are large, attaining widths of over 32 feet (10 metres) in places. The chief minerals associated with the fluorspar are barite and quartz; the other minerals present named in the order of their abundance are chalcopyrite, galena, and siderite. The fluorspar is a coarsely crystalline violet or green variety and was formerly used by the Mansfield copper smelters. It is now shipped largely to iron furnaces. Definite statistics regarding the production of fluorspar from the district are not available.

The best known deposits of fluorspar in Germany are those occurring near Wölsendorf between Nabburg and Schwarzenfeld in the Upper Palatinate of Bavaria. These are veins that were originally [illegible] for silver-bearing galena, but are now being worked chiefly for fluorspar. Although many of the veins trend in different directions their dominant strike is northwesterly. The vein filling in addition to fluorspar consists of barite, quartz, argentiferous galena and its decomposition products, and uranium mica. The fluorspar is usually coarsely crystalline and massive, well-developed crystals being uncommon. Its colour ranges from very dark violet, through grey, yellowish green, light blue, and light green, to yellow. Of the associated minerals barite is the most important being sufficiently abundant to be produced as a by-product. The rock in which the veins occur is a micaceous granite. It has been bleached and kaolinized adjacent to the deposits.

The fluorspar deposits in the Black Forest of Baden, like those at Wölsendorf, are veins that were originally opened in mining silver-bearing

[1]Dammer, B., and Tietze, O.: Die Nutzbaren Mineralien, vol. 2, pp. 318–321 (1913).

lead ores, but are now being worked for fluorspar. They consist chiefly of fluorspar, barite, galena, and the secondary lead-bearing minerals pyromorphite and cerussite. The fluorspar is produced in the form of "gravel spar" having an average content of calcium fluoride ranging from 72·1 to 82·9 per cent. Bleached zones in the gneissic wall-rock are well developed on both sides of the veins.

In the fourth district in Germany in which fluorspar is mined, the Thuringian Forest, the fluorspar is intimately associated with barite. Thus in the veins occupying faults, along the southern border of this district near Herges-Voigtei, although the principal part of the barite is older than the fluorspar, the latter occupying the middle of the vein, in other places numerous interlaminations with barite may be observed.

FRANCE[1]

Fluorspar occurs in France in the Department of Var near the Riviera; at St.-Laurent-les-Bains in Ardêche; near Langeac, Paulhaguet, and Brioude in Haute-Loire; at Vaux Renard in Rhône; in Auvergne and Vosges mountains; near Autun, in Saône-and-Loire; and in Morihan to the northwest of St. Nazaire in Brittany. The most important mines are those in the Department of Var, most of the output from which is shipped from Toulon to United States. There are three mines with a total output of about 100 tons a day being worked in this district, the Font Sant and Les Adrets mines in the upper valley of the Reyran about 10 to 15 miles north of Fréjus, and the Garot mine on the right bank of the Reyran, 9 miles north of Fréjus. There are also deposits of fluorspar in Maures mountains to the west of Fréjus, but the fluorspar is said to be so mingled with other minerals that it is difficult to mine profitably. At St.-Laurent-les-Bains a mine is being worked from which about 1½ tons of fluorspar a day is being produced and exported to England. In Auvergne mountains a mine said to have an annual production of 1,500 tons of fluorspar is being worked to supply an electro-metallurgical company. In Vosges mountains a small deposit of fluorspar is being worked for use in steel plants. The fluorsp[illegible]ine of La Petite Vérriere northwest of Autun in Saône-and-Loir[illegible]n described by A. C. Lane. The fluorspar occurs in a vein consisting of very light green fluorspar, chalcedonic silica in thin seams, barite, quartz, and limonite. The strike of the vein is north-northeast and it dips 66 degrees east. The country rock is granite porphyry. The output of the mine is used in the manufacture of steel in the Schneider works at Le Creusot.

UNION OF SOUTH AFRICA[2]

The most important deposits of fluorspar so far discovered in South Africa occur in the dolomite of the Transvaal system near Ottoshoop in Zeerust district of the Transvaal. One of these on the farm, Malmani Oog, No. 101, has the form of a large pipe said to be 120 feet in diameter.

[1]The mineral industry of the British Empire and foreign countries, "Fluorspar"; 1913-19, Imp. Min. Res. Bur.
Lane, A. C.: "A Mineralogical Trip in France"; Am. Min., vol. 4, pp. 140-1 (1919).
Davis, H. W.: "Fluorspar and Cryolite"; Min. Res. of U.S., U.S. Bur. Mines, 1925, pt. 2, pp. 22-3.

[2]Wagner, Percy A.: "Fluorspar"; S. Afr. Jour. of Ind., vol. 1, pp. 1516-1520 (1918).

The fluorspar in this deposit is colourless and exceptionally pure. Other deposits in this district are found on farms Nauuwpoort, No. 102, Witkop, No. 228, and Buffelshoek, No. 284. In the last two occurrences the fluorspar is associated with sphalerite, galena, pyrite, and calcite. Here, also, the deposit has a pipe or chimney-like form.

Fluorspar is also found in the tin deposit of the Waterberg and Olifants River tin fields. In the former district its presence has been recorded from the Zaaiplaats, Groenfontein, Groenvlei, and Appingadam Rooiberg, and Leeuwpoort mines. According to H. Martin a persistent vein of coloured fluorspar, ranging in width from 18 inches to 3 feet, was opened some years ago on the farm Vlakfontein, No. 2235, about 4 miles northeast of the Leeuwpoort mine. In the Olifants River field fluorspar is found in the Stavoren and Mutue Fides mines. At the former mine it is sufficiently abundant to be recovered as a by-product. Fluorspar is also found in Olifants district at the Houtenbeck mine, No. 392, in association with monazite and molybdenite in pegmatite.

Other occurrences of fluorspar in South Africa are as a common accessory mineral in the elaeolite syenites and allied alkali rocks of the Bushveld complex, in the alkali felsites of Pilandsberg, in veins and dykes of pegmatite intersecting the basement complex in Southern Rhodesia, and near the farm, Stinkdoorn, in Great Kharas mountains of southwest Africa.

A small part of the output is consumed at home and the remainder exported to the United States and Australia.

ITALY[1]

Fluorspar deposits occur in Italy near Bolzano in the Trentino and near Brescia in Lombardy. The mine from which the greatest production has been obtained lies 13 kilometres (8·7 miles) north of Serentino, and 34 kilometres (21·1 miles) from Bolzano. This deposit is a vein of the pinch and swell type and consists of a succession of pitching shoots from 3 to 4 metres wide and 20 to 60 metres long. The vein material consists of about three-fourths fluorite and the remainder chiefly schist fragments, galena, and sphalerite. Some quartz and calcite are also present. It has been estimated that there are reserves of 200,000 to 300,000 tons of fluorspar proved in the workings on this vein.

AUSTRALIA[2]

Fluorspar occurs in numerous localities in Australia in association with silver-bearing galena, wolframite, chalcopyrite, and other ore minerals. In recent years there has been a production from these deposits ranging from several hundred to several thousand tons, most of which has come from New South Wales and Queensland.

[1]Ladoo, R. B.: "Fluorspar"; U.S. Bur. of Mines., Bull. 244, pp. 163-4 (1927).

[2]Raggatt, H. G.: "The Mineral Industry of New South Wales, N.S. Wales"; Dept. of Mines, pp. 292-294 (1928). Geol. Surv. of Queensland, Pubs. 248 and 261.

Fluorspar occurs in New South Wales near Holbrook railway station in Goulburn county, near Deepwater and Tingha in Gough county, near Woolgarlo and Sapling Point in Murray county, and near Dalgety in Wallace county. The most important of these deposits, the Carboona, in Goulburn county, lies 39 miles by road east-southeasterly from Holbrook station. It is a northeasterly-trending vein having an average width of 5 feet and consists of silver-bearing galena and pyrite in a gangue of fluorite. The galena is produced as concentrates and the fluorspar as tailings. The property is owned by the Broken Hill Proprietary Company which uses the fluorspar in its steel works at Newcastle. The principal deposits in Gough county are situated northwest of The Gulf about 30 miles west-northwest of Deepwater. The fluorspar occurs in association with quartz and wolframite and small quantities of arsenical and copper pyrites in pipes and vugs in granite. Two hundred tons of fluorspar were produced from the district in 1919. The deposit at Woolgarlo on Yass river, in Murray county, is a poorly defined lode in beds of Silurian age and like the Carboona consists of silver-bearing galena and fluorspar. About 3,000 tons of fluorspar were produced from Woolgarlo during 1915-18.

In Queensland fluorspar is found associated with wolframite, molybdenite, and bismuth in mines at Bamford, and with wolframite, chalcopyrite, arsenopyrite, magnetite, etc., in the copper-bearing lodes at Cardross. In Victoria it is reported to occur at Beechworth and Woolshed.

MEXICO[1]

Practically the entire production of Mexico has been obtained from one mine situated near Guadalcazar in San Luis Potosi. Here it occurs associated with quartz, pyrite, and antimony, in masses or irregular veins lying along a contact between granite and limestone. The output is used in iron and steel works at Monterey and in the manufacture of hydrofluoric acid.

SPAIN[2]

Fluorspar occurs in numerous localities in Spain, but it has been mined in only a few localities and in these chiefly as a by-product in mining lead. Prior to 1923 production was confined to the San Maximiliano and Brillante mines near Irun in the province of Guipûzcoa. In recent years fluorspar has been produced from a quarry known as La Collada, near Siero, in the province of Oviedo, from the Berta mine at Papiol in the province of Barcelona, originally developed for lead but reopened in 1925 for fluorspar, and the Jorna mine, at Murelaga, in the province of Vizcaya, from which a small quantity of fluorspar is said to have been produced in 1926. Other occurrences of fluorspar in Spain that have not been worked are reported to be present in the provinces Huesca, Ciudad Real, and Cordoba.

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[1]Wittich, Ernesto: La fluorita en los criadores de contacto y de cinabuo de Guadalcazar, San Luis Potosí, Bol. Petrol., vol. 13, p. 10 (1920).

[2]Davis, H. W.: "Fluorspar and Cryolite"; Min. Res. of United States, U.S. Bureau of Mines, pt. 2, pp. 45-48 (1928).

NORWAY[1]

The principal deposits of fluorspar in Norway are near Kongsberg in Buskerud county, and near Dalen in Telemarken county. The Kongsberg deposit is stated to contain 65 per cent of fluorspar and the veins at Dalen are said to be 3 to 3·5 metres (9·8 to 11·4 feet) wide and to contain 75 to 80 per cent of fluorspar. During the World War the annual production of fluorspar in Norway attained a maximum of over 1,035 metric tons, now the production is small. The total annual consumption of fluorspar in Norway is only about 500 tons.

CHINA[2]

Little is known regarding the fluorspar deposits of China. Fluorspar is reported to occur in a lead mine about 23 miles south of Kiaoshen in Shantung, near Poshan in Heinshan, and in several localities along the South Manchuria railway in Manchuria; some of the last deposits are worked in a small way by Chinese.

AUSTRIA[3]

Prior to the World War Austria-Hungary had a production of 6,000 to 8,000 tons of fluorspar annually. No statistics regarding production from Austria or the countries formerly composing Austria-Hungary are available.

GREENLAND (CRYOLITE)[4]

The only mine in the world where cryolite is found in a deposit of workable extent is at Ivigtut on the southwest coast of Greenland. It occurs in a northeasterly-trending, elongated mass of pegmatite and granite that has intruded Precambrian granite-gneiss parallel its foliation. The deposit is worked from an open pit now 500 feet long, 60 to 147 feet wide, and 150 feet deep. Except for a single mass of granite at one point the whole northwest face of the pit is cryolite. This continues in a northwesterly direction. Diamond drilling has proved the deposit to continue to a depth of at least 312 feet. The cryolite is partly white and partly brownish grey, the two phases occurring intermingled with one another. The impurities in the cryolite are light brown siderite, white quartz, sphalerite, galena, chalcopyrite, and pyrite. These form about 10 per cent of the whole material mined. The granite adjoining the deposit has been sericitized and mineralized with minerals of the pegmatitic association such as microcline, quartz, tantalite, cassiterite, fluorspar, wolframite, molybdenite, pyrite, and columbite. The total annual product of cryolite is about 24,000 tons, of which about one-third is shipped to United States and the remainder to Copenhagen.

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[1]Davis, H. W.: "Fluorspar and Cryolite in 1923"; U.S. Geol. Surv., Min. Res. of United States, pt. 2, p. 38 (1923).

[2]Ladoo, R. B.: "Fluorspar"; U.S. Bur. Mines, Bull. 244, pp. 1C8–9 (1927).

[3]"Fluorspar, the Mineral Industry of the British Empire and Foreign Countries, 1913–19"; Imp. Min. Res. Bur., 1921, p. 13.

[4]Ball, S. H.: "The Mineral Resources of Greenland"; Meddelelser on Greenland, vol. 63, pp. 17–31 (1923).
Gordon, S. G.: "Mining Cryolite in Greenland"; Eng. Min. Jour.-Press, vol. 121, pp. 236–240 (1926).

CHAPTER V

STATISTICS

The entire production of fluorspar in Canada up to the present has been derived from the Rock Candy mine near Grand Forks, British Columbia, and from veins near Madoc, Ontario. The Rock Candy mine, owned by the Consolidated Mining and Smelting Company, was operated from 1918 to 1923 and again in 1925. The Madoc mines were operated chiefly during and following the World War when the price of fluorspar rose to a maximum of $30 a ton. At present all the fluorspar used in Canada is being imported. Importations during the past five years ranged from 4,355 tons, valued at $50,158, in 1924, to 14,362 tons, valued at $153,046, in 1928. Owing to the distance of the Rock Candy mine from the consuming centres of eastern Canada, all the production from this property during the years of its operation, with the exception of fluorspar used by the Consolidated Mining and Smelting Company in its own refinery at Trail, was exported to United States, but in September, 1922, the United States Government imposed an import duty of $5.40 a ton on fluorspar, which was further increased in November, 1928, to $7.90 a ton, an impost that practically prohibits the export of fluorspar from Canada.

The principal statistical data of interest to owners of fluorspar properties in Canada are included in the following tables.

Production of Fluorspar in Canada[1]

Year	Ontario		British Columbia		Canada	
	Short tons	Value	Short tons	Value	Short tons	Value
1905	30	$ 150	....	....	30	$ 150
1907	15	75	....	....	15	75
1910[1]	2	15	....	....	2	15
1911	34	238	....	....	34	238
1912	40	240	....	....	40	240
1916	1,284	10,238	....	....	1,284	10,238
1917	4,249	68,756	....	....	4,249	68,756
1918	7,187	150,779	175	$ 5,250	7,362	156,029
1919	3,425	59,281	1,638	38,556	5,063	97,837
1920	3,758	68,756	7,477	171,971	11,235	240,446
1921	116	1,744	5,403	134,523	5,539	136,267
1922	284	3,905	4,219	98,233	4,503	102,138
1923	64	597	75	1,135	139	1,732
1924	76	1,343	....	....	....	....
1925	12	200	3,874	19,034	3,886	19,234

[1]1910–26, Ann. Rept. on the Mineral Production of Canada, Dom. Bur. Stat., Dept. Trade and Com., 1926.

Exports of Fluorspar from Canada

Year	Tons	Value	Year	Tons	Value
1919 (9 mos.)	697	$ 9,616	1922	2,944	$ 32,914
1920	7,477	171,971	1923–8	....	....
1921	5,403	134,523			

Imports of Fluorspar into Canada

Year	Tons	Value	Year	Tons	Value
1919 (9 mos.)	8,273	$ 84,702	1924	4,355	$ 50,158
1920	6,812	113,818	1925	5,111	60,458
1921	3,867	43,752	1926	9,968	97,482
1922	4,980	73,343	1927	4,561	58,701
1923	17,235	199,595	1928	14,362	153,046

The imports of cryolite into Canada for the fiscal years ending March 31 are as follows:

Year	Short tons	Value	Value per ton	Year	Short tons	Value	Value per ton
1915	1,765	$ 72,024	$ 40 81	1921	107	$ 22,196	$ 205 52
1916	860	87,146	101 33	1922	692	91,506	132 24
1917	685	131,236	191 49	1923	789	118,027	149 59
1918	732	137,258	187 43	1924	642	79,369	123 63
1919	839	137,702	164 12	1925	670	87,852	131 12
1920	865	153,500	177 45	1926	3,917	473,523	120 89

Sources of Fluorspar Imported into Canada in 1927 and 1928[1]

—	1927		1928	
	Tons	Value	Tons	Value
From				
United Kingdom	2,405·1	$ 19,222	9,389·0	$ 72,966
United States	2,085·8	38,989	4,891·2	79,046
Other countries	70·3	490	81·4	1,034
Total	4,561·2	58,701	14,361·6	153,046

[1]Information given the writer by Mining, Metallurgical, and Chemical Branch, Dominion Bureau of Statistics.

Consumption of Fluorspar in Canada, 1926-28

—	1926	1927	1928
	Tons	Tons	Tons
As flux in steel furnaces	6,009	7,123	9,201
In the manufacture of chemical products	2,826	2,476	2,948
In the enamelware industry	125	125	125
	8,960	9,724	12,274

World Production of Fluorspar (Short Tons)[1]

Country	1923	1924	1925	1926	1927	1928
Australia	280	2,614	4,734	2,588	1,157	....
Canada	139	76	3,886	....	....	....
China	179	....	....	....	....	....
France	14,230	25,424	26,914	45,933	....	....
Germany	27,074	45,659	79,016	87,783	....	....
Great Britain	54,915	55,431	43,768	40,189	44,491	....
Italy	3,705	7,518	8,555	6,966	6,048	....
Mexico	560[2]	560[2]	560[2]	224	1,033	....
Russia	....	....	1,335	4,151	926	....
Spain	....	699[3]	920[3]	380[3]	....	....
Union of South Africa (shipments)	12,098	11,235	5,377	9,264	8,357	....
United States	121,188	124,979	113,669	128,657	112,546	140,631

[1]"The Mineral Industry of the British Empire and Foreign Countries", Imp. Inst., 1923–25, 1925–27; "Fluorspar and Cryolite", Min. Res. of United States, pt. 2, U.S. Bur. of Mines, 1925–27.
[2]Estimated.
[3]1,600, 650, and 5,612 cubic yards additional produced from quarries in 1924, 1925, and 1926 respectively.

UNITED STATES[1]

Fluorspar in United States, 1925-28, by States

State	1925		1926		1927		1928	
	Short tons	Value	Short tons	Value	Short tons	Value	Short tons	Value
Colorado	11,776	$ 153,707	10,440	$ 161,269	6,432	$ 130,481	5,000	$ 76,800
Illinois	54,428	1,024,516	53,734	1,012,879	46,006	863,909	65,884	1,154,983
Kentucky	44,826	833,794	62,494	1,167,129	57,495	1,040,338	69,747	1,426,766
New Mexico	2,639	40,325	1,989	x	2,613	x	x	x
Nevada	....	....	....	....	....	....	x	x
Total	113,669	2,052,342	128,657	2,234,277	112,546	2,034,728	140,631	2,658,549

[1]U.S. Bur. Mines, Min. Res., 1925–28.
xIncluded with Colorado.

Fluorspar Shipped from Mines in the United States, 1927-28, by Uses[1]

Use	1927			1928		
	Short tons	Value		Short tons	Value	
		Total	Average		Total	Average
Steel	93,196	$1,523,915	$ 16 35	108,205	$1,643,185	$ 15 19
Foundry	4,533	84,724	18 69	3,694	66,215	17 93
Glass	5,968	184,450	30 91	6,499	195,885	30 14
Enamel and vitrolite	3,813	119,888	31 44	4,713	142,495	30 23
Hydrofluoric and derivatives	3,748	98,364	26 24	15,946	585,092	36 69
Miscellaneous	903	15,880	17 59	1,176	19,091	16 23
Exported	385	7,507	19 50	398	6,586	16 55
	112,546	2,034,728	18 08	140,631	2,658,549	18 90

[1]U.S. Bur. Mines., Min. Res., 1928.