DAWSONITE-FLUORITE RELATIONSHIPS AT MONTREAL-AREA LOCALITIES

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ABSTRACT
Dawsonite and fluorite, crystallized together, have been collected recently from three localities in the Montreal area, where they were found in particular dykes or sills which were only briefly exposed by quarrying and excavation. The intergrowth of the dawsonite and fluorite crystals and their frequent association with vein quartz gave evidence of hydrothermal origin. The fine-needle dawsonite in the assemblages is similar to dawsonite which occurs in fluid inclusions in gold-quartz veins. Field relationships support the conclusion that the Montreal-area dawsonite and fluorite are low-temperature hydrothermal minerals related in origin to the alkaline rocks of the area.

SOMMAIRE
On a récolté récemment de la dawsonite et de la fluorite, cristallisées ensemble, dans trois localités de la région de Montréal. Ces minéraux ont été trouvés dans des dykes et des sills exposés temporairement, au cours des travaux, dans des carrières et des excavations. L’intercroissance de cristaux de dawsonite et de fluorite et leur fréquente association avec du quartz filonien indiquent une origine hydrothermale. La dawsonite aciculaire de ces associations ressemble à la dawsonite que l’on trouve dans les inclusions fluides des filons de quartz aurifère. Les observations faites sur le terrain étayent la conclusion que la dawsonite et la fluorite de la région de Montréal sont des minéraux formés à basse température, par voie hydrothermale, dont l’origine est liée à celle des roches alcalines de cette région.

INTRODUCTION
Although both dawsonite and fluorite have been collected separately from several localities in the Montreal area, occurrences are few where these two minerals have crystallized together and where their petrogenetic relationships may be studied. Our interest in this relationship first began with the collection of excellent specimens of well-crystallized dawsonite and fluorite from rock near University Street in Montreal which was being excavated for an underground portion of the Trans-Canada Highway. Later, good specimens were obtained from the Francon Quarry, St-Michel, Montreal, and from the De-Mix quarry, Mount St. Hilaire, Quebec (Fig. 1).

In a recent publication Clark (1972, p. 128-129) stated: “Dawsonite, first described from Montreal, may be the result of hydrothermal changes more nearly akin to weathering than to metamorphism.” We believed a study of this new material might contribute further evidence in support of a truly hydrothermal origin for the Montreal dawsonite.

DAWSONITE-FLUORITE LOCALITIES
The Montreal Trans-Canada Highway dawsonite-fluorite was found in April, 1973, near the University Street entrance. This mineralization appeared to occur in a continuation of the feldspathic dyke associated with nepheline syenite (feldspathoidal monzonite of Gélinas 1972) of the McGill University type locality (Stevenson & Stevenson 1965), although dawsonite and fluorite crystallized together had not been found at the type locality. Construction work has made further collecting at the Trans-Canada site impossible.

In 1974-75 several specimens of dawsonite and fluorite were collected from sills in the Francon quarry, St-Michel, Montreal. This quarry has gained prominence as the type locality for weloganite and as a source of other rare minerals, including dresserite (Sabina et al. 1968;
Jambor et al. 1976; Sabina 1976), although the specimens we studied did not contain these rare minerals.

Dawsonite-fluorite material was collected from the De-Mix quarry, Mount St. Hilaire, 48 km east of Montreal, in 1974 and 1975. These specimens were associated with syenite breccia (Chao et al. 1967; Perrault & Mandarino 1972).

At all three localities, the dawsonite-fluorite is concentrated in relatively small areas of particular sills or dykes, as Sabina (1976) has noted at the Francon quarry.

PETROGENETIC STUDIES

In the syenite breccia at Mount St. Hilaire, dawsonite-fluorite lines the walls of vugs which range from about 1 cm to 2 m in diameter. Vugs at other localities are generally smaller, 1 cm to 2 cm in diameter, and seem to represent filled or partly filled vesicles or amygdules, with flowage of groundmass plagioclase of the dyke rock around the vesicles (Fig. 2). Most dawsonite occurs as closely packed blades, some as large as 1 cm long by 1 mm wide, ranging down to 2.4 mm long and 0.04 mm wide, frequently intimately intergrown with fluorite in cubes or parts of cubes up to 2 mm on the edge (Fig. 3).

Although dawsonite usually occurs as closely packed blades, some of it occurs as needles, associated with the blades, up to 0.8 mm long and 0.09 mm wide; the smallest needles range down to a size so small that the individual crystals are barely detectable with the electron microscope.

That the dawsonite and fluorite were crystallized together is suggested by the intergrowths illustrated in Figure 4, where delicate needles of dawsonite bridge space between fluorite crystals. These photographs show interesting similarities to the SEM photographs of the Chihuahua geode minerals studied by Finkelman et al. (1972), in which delicate euhedral and subhedral crystals were interpreted as having precipitated simultaneously.

Both the dawsonite and fluorite are intergrown in places with minor amounts of coarse calcite crystals and coarse-grained hypidiomorphic quartz characteristic of vein quartz.

Another common occurrence of the assemblage dawsonite-fluorite-quartz-calcite is as gash veins from 0.025 mm to 2 mm wide within the grey feldspathic dykes (Fig. 5). Much of the dawsonite-fluorite material was collected from the De-Mix quarry, Mount St. Hilaire, 48 km east of Montreal, in 1974 and 1975. These specimens were associated with syenite breccia (Chao et al. 1967; Perrault & Mandarino 1972).

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veinlets have all the characteristics of filled, sonite exposed in broken dump material repre-
sonite fragments of the wall rock. In places the frag-
frequently contain very jagged and irregular walls, approximating a comb texture, and the
Where breccia fragments are absent, both the
cut sharply across the feld-
spar phenocrysts and flow-aligFed groundmass
dawsonite-fluorite veinlets are almost sufficiently numerous to con-
In the Berry Formation of the Sydney Basin, New
occurrence of fluorite with the alkaline intru-
sions of Cripple Creek, Colorado, a famous gold
camp. There we have extensive replacements of

ted with hair-like stringers of dawsonite and
It is apparent from thin-section study that the
The veinlets extend into vugs, join vugs to amyg-
ded veins in the rocks, accompanied by widespread metasomatic re-
accompanied by widespread metasomatic re-
and that the right pH and pressure be main-
tained, but these requirements can be satisfied

**DAWSONITE-FLUORITE RELATIONSHIPS**

Sonite exposed in broken dump material repre-
sents the coatings of these vein walls. These
dawsonite phenocrysts by fluorite and quartz
(Lindgren 1900, Fig. 10). The Cripple Creek oc-
currences are similar to the replacements in the
Montreal-area dawsonite-fluorite. At Cripple
Creek the fluorite is considered to be a low-
temperature hydrothermal mineral of magmatic origin. Likewise, the Montreal-area dawson-
ite, by virtue of its close association with fluorite, is viewed as a low-temperature hydrothermal mineral related in origin to the alkaline rocks of the area.

For dawsonite to form, it is necessary that
the requisite chemical constituents be present
and that the right pH and pressure be main-
tained, but these requirements can be satisfied
by a variety of geological environments. For
example, in the Montreal and similar occur-
rences, an alkaline environment relatively rich
in soda and alumina and deficient in the strong
acidic radicals such as Cl and SO₄ would be
natural in an area of nepheline syenite. Further
alumina may also be contributed from the de-
struction of the feldspars.

On the other hand, a completely different but
proper environment for the formation of daw-
sonite is in the saline soils of Olduvai Gorge, Tanzania (Hay 1963), in the marine strata of the Berry Formation of the Sydney Basin, New
South Wales (Goldbery & Loughnan 1970), and
also in the oil shales of the Green River Forma-
tion, Colorado (Smith & Milton 1966; Milton
1976). Another type of occurrence has been de-
scribed by Aikawa et al. (1972) from the Izumi
Group in southwest Japan, where mudstones
with marine fossils are associated with layers of
uff and with mineral springs abnormally rich
in NaHCO₃.

Dawsonite in fluid inclusions in gold-quartz
veins of the Alleghany district, California (Cove-
ney & Kelly 1971) is similar in habit to the
Montreal-area fine-needle dawsonite. Coveney
& Kelly suggest that the general rarity of daw-
sonite as a vein mineral may be due to its high
solubility under normal hydrothermal conditions,
but that the formation of dawsonite in low-
temperature hydrothermal deposits would be
favored by loss of dissolved CO₂ due to fluid
cooling or boiling, sharp reduction in fluid activ-
due to wall-rock reaction, and high dis-
solved sodium and aluminum concentration.

Certainly the special conditions mentioned
above are met in the Montreal occurrences of
dawsonite and fluorite. Extensive wall-rock
alteration of rocks rich in alkali and alumina re-
duced the acidity and increased the alkali and
alumina content of the hydrothermal fluids. The
near-surface nature of the occurrences, as at-
tested by the breccia and gash veins, provided

**ORIGIN OF DAWSONITE AND FLUORITE**

Fluorite has always been thought of as a
typical hydrothermal mineral, and the consti-
tuent fluorine generally accepted as a magmatic
product (Lindgren 1933; Deer et al. 1966).
Buddington (1933, p. 380) has noted: "Fluorine
is considered . . . a characteristic and perhaps
the most distinctive volatile element of alkalic
maggas." The association of fluorine with alk-
aline rocks, such as alkaline syenite and ne-
pheline syenite, is indeed widespread. Perhaps
the most striking association is the extensive
occurrence of fluorite with the alkaline intru-
sions of Cripple Creek, Colorado, a famous gold

inged the acidity and increased the alkali and
alumina content of the hydrothermal fluids. The
near-surface nature of the occurrences, as at-
tested by the breccia and gash veins, provided
opportunity for rapid loss of pressure, loss of CO₂, and consequent precipitation of the dawsonite.

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REFERENCES


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