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INDUSTRIAL MINERALS IN EASTERN ONTARIO: OTTER CREEK SILLIMANITE OCCURRENCE

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1989

Energy, Mines and Resources Canada
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Inside Front Cover

Contribution to Canada-Ontario 1985 Mineral Development Subsidiary Agreement under the Economic and Regional Development Agreement. Project funded by the Geological Survey of Canada.

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Abstract

This study represents a synthesis of field and laboratory research centered on the Otter Creek sillimanite occurrence. The report has a detailed 1:5000 map of the study site.

The Otter Creek occurrence is confined to coarse-grained pelitic schists of the Clare River Synform, part of the middle Proterozoic, Central Metasedimentary Belt (Wynne-Edwards, 1972) of the Grenville Structural Province. The occurrence is about 3 kilometres long and 400 metres wide on the northern limb of the synform and about 3 kilometres long and 100 metres wide on the southern limb of the synform.

Approximately 40 to 50% of the detailed map area, presented in this report, contains greater than 20% sillimanite by volume.

INTRODUCTION

The Otter Creek sillimanite occurrence is located in Hungerford Township, adjacent to an abandoned CPR right-of-way situated about 2 kilometres east of the village of Sulfide and 10 kilometres east of the town of Tweed (Figure 1). Access to the occurrence is by Provincial highways (7, 37, 41) and Township roads that connect to a network of logging roads and the abandoned CPR right-of-way.

This report discusses the geology at the site, as determined by field and laboratory analysis as well as the regional geological setting. This report is accompanied by a detailed map (1:5000) of the occurrence site. The study site was chosen because of the high grade sillimanite that is present. This report plus a similar study in the Clarendon area (Black and Rencz, 1987) cover the most well known sillimanite occurrences in Eastern Ontario.

REGIONAL GEOLOGICAL SETTING

Stratigraphy

The Mellon Lake Complex lies to the southeast of the study area and consists of migmatitic metasedimentary rocks and tonolitic-granodioritic gneisses (Bright, 1985). Although the actual age relationship between the Mellon Lake Complex and the Grenville Supergroup is unknown, Bright (1985) suggests that the complex may form the basement of the Grenville Supergroup and thus becomes the oldest rocks in the region.

The Herman Group (Otter Creek, Todd Lake, and Shovel Lake Formations) forms the oldest strata of the Grenville Supergroup exposed in this portion of the Central Metasedimentary Belt. The Otter Creek Formation, the lowermost formation of the Herman Group consists of massive felsic metavolcanics, biotite-hornblende gneisses and schists, quartzofeldspathic psammite and pelite containing locally abundant sillimanite, rusty psammite, and calcareous marble. The overlying Todd Lake Formation consists of dolomitic marble, volcanic pebble metaconglomerate, metachert, para-amphibolite, and calc-silicate paragneiss. The Shovel Lake Formation, the uppermost formation of the Herman Group, consists of mafic intermediate, and felsic metavolcanics, and calc-silicate paragneisses. The Shovel Lake Formation contains part of the Otter Lake sillimanite occurrence.

Marbles of the Mayo Group unconformably overlie strata of the Herman Group (Moore and Thompson, 1980).

The Flinton Group (Beatty and Bogart Formations) unconformably overlies the Herman and Mayo Groups and, according to Moore and Thompson (1980), consists of the youngest known Precambrian stratified rock assemblage that post-dates the Grenville Supergroup. Strata of the Flinton Group outcrops in two localities within the region: 1) within the Clare River Synform, as narrow continuous to locally discontinuous bands that are tightly folded with rocks of the Hermon Group, and 2) as a fault bounded segment within the Elzevir Pluton.

The Beatty Formation, lower formation of the Flinton Group, consists of rusty psammite and allumina-rich pelitic gneiss that corresponds to the sillimanite rich gneiss of the Otter Lake occurrence. The overlying Bogart Formation consists of calcareous marble, dolomitic marble and calc-silicate paragneisses (Chappell, 1978).

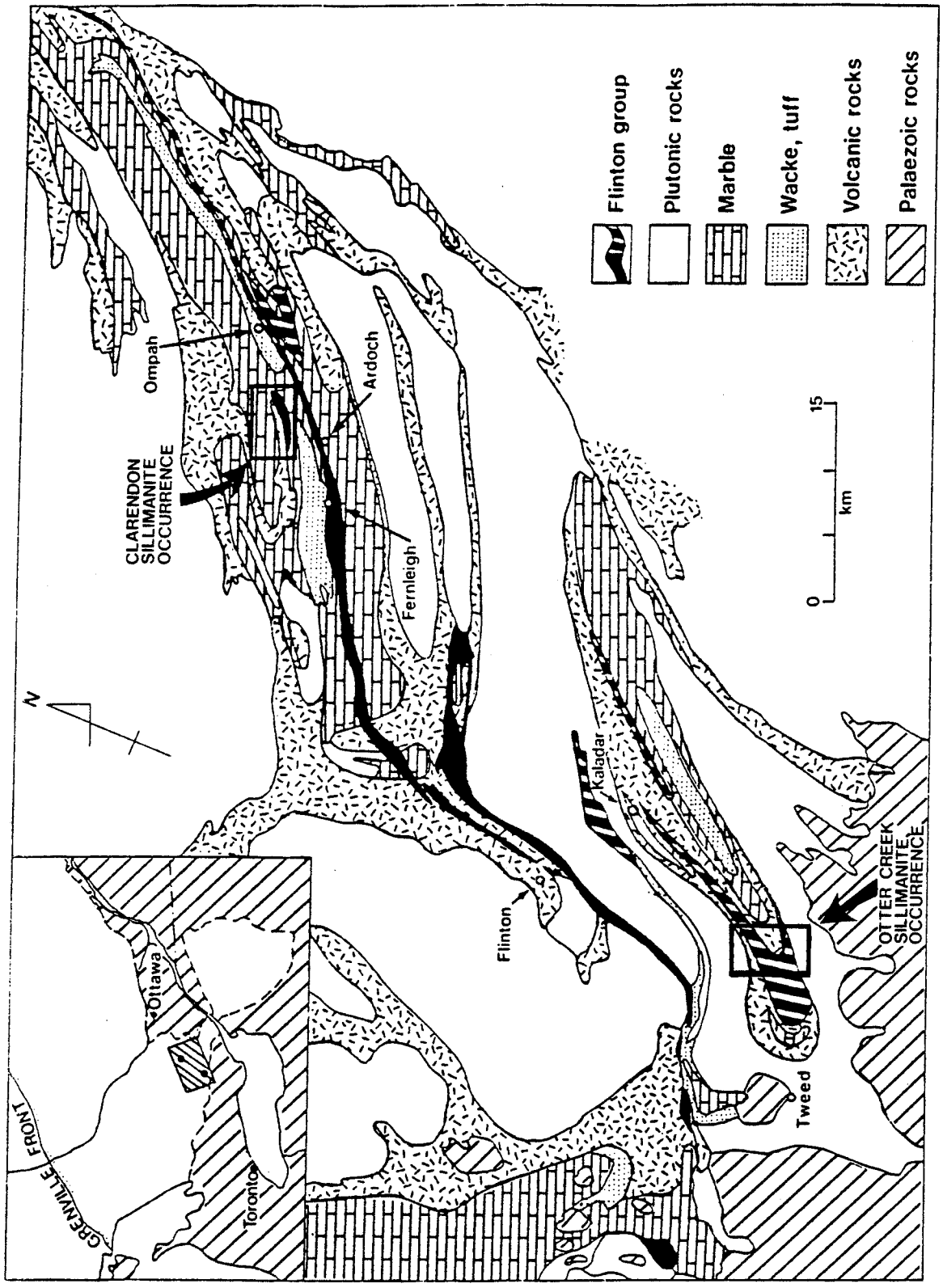

Figure 1. Regional geology of the Tweed-Ompah area. Modified from Moore and Thompson (1980).

Post Flinton Group rocks within the region consist of the Addington potassic granitic pluton to the northwest, and several small dikes. According to Bright (1985) the northeast trending granitic Mitten Dike appears to intrude the rocks of the Flinton Group at the eastern margin of the Clare River Synform.

Structure

Strata within the study area strikes north to northeast, except in the closure of the Clare River Synform, and has a moderate to steep southeasterly dip. The Hermon Group and Flinton Group rocks within the Clare River Synform have been subjected to at least two major periods of deformation producing a type III interface pattern. According to Chappell (1978), north-to-northeast trending reclined to recumbent folds have been refolded by a northeasterly trending set of tight to isoclinal folds to produce upright to northwesterly overturned, northeast- to southeast plunging folds. Bright (1985) interpreted the Clare River Synform to be an inverted anticline. In general, all rock types except the younger late tectonic granitic pegmatites, exhibit a penatrative LS-fabric with a northeasterly plunging lineation. The plunge of this lineation is shallow to moderate; however in places along the western margin of the synform, some lineations and folds plunge toward the southwest (Bright, 1985).

Metamorphism

Strata of the Mellon Lake Complex and the Grenville Supergroup have undergone two major thermal-tectonic events. During the first event, which probably coincided with the emplacement of the Elzevir Pluton, the Mellon Lake Complex and Grenville Supergroup rocks were subjected to upper amphibolite grade metamorphism. Subsequent upper greenschist to middle amphibolite facies metamorphism occurred after deposition of the Flinton Group and emplacement of the Addington Pluton.

The metamorphic grade in the Clare River Synform generally increases towards the southwest from upper greenschist to lower amphibolite facies (along highway 41) to middle amphibolite facies near the closure of the synform and the Otter Creek sillimanite occurrence (Bright, 1985). Chappell (1978) defined three mineral zones within the Clare River Synform: staurolite-kyanite, staurolite-sillimanite, and sillimanite (Figure 2). Peak metamorphism within the synform postdates the first thermal event in lower grade rocks, however, coincides with the final stages of the first thermal event in higher grade rocks (Chappell, 1978).

GEOLOGY OF THE OTTER CREEK SILLIMANITE OCCURRENCE

Lithology

The Otter Creek sillimanite occurrence is dominated by four rock types; 1) mafic to felsic metavolcanics, 2) calcareous mudstone and calcitic marble, 3) rusty pyritic quartzofeldspathic gneiss, and 4) mafic paragneiss and pelitic schist.

Mafic to felsic metavolcanics form part of the Shovel Lake Formation as defined by Chappell (1978). The leucocratic phase of the mafic to intermediate metavolcanic gneisses consists of plagioclase, quartz, and rarely microcline. The mafic phase consists of biotite with varying amounts of hornblende. Intermediate to felsic metavolcanics of the Shovel Lake Formation consist of 1) metamorhosed rhyolite flows, as defined by Chappell (1978), consisting of fine-grained to massive quartz, plagioclase, and microcline, and 2) well-layered felsic metavolcanics containg significant amounts of small pink feldspars and discontinuous streaky dark bands in a pink layered rock.

Chappell (1978) interpreted the intermediate to felsic metavolcanics of the Shovel Lake Formation to be characteristic of pyroclastic volcanic rocks.

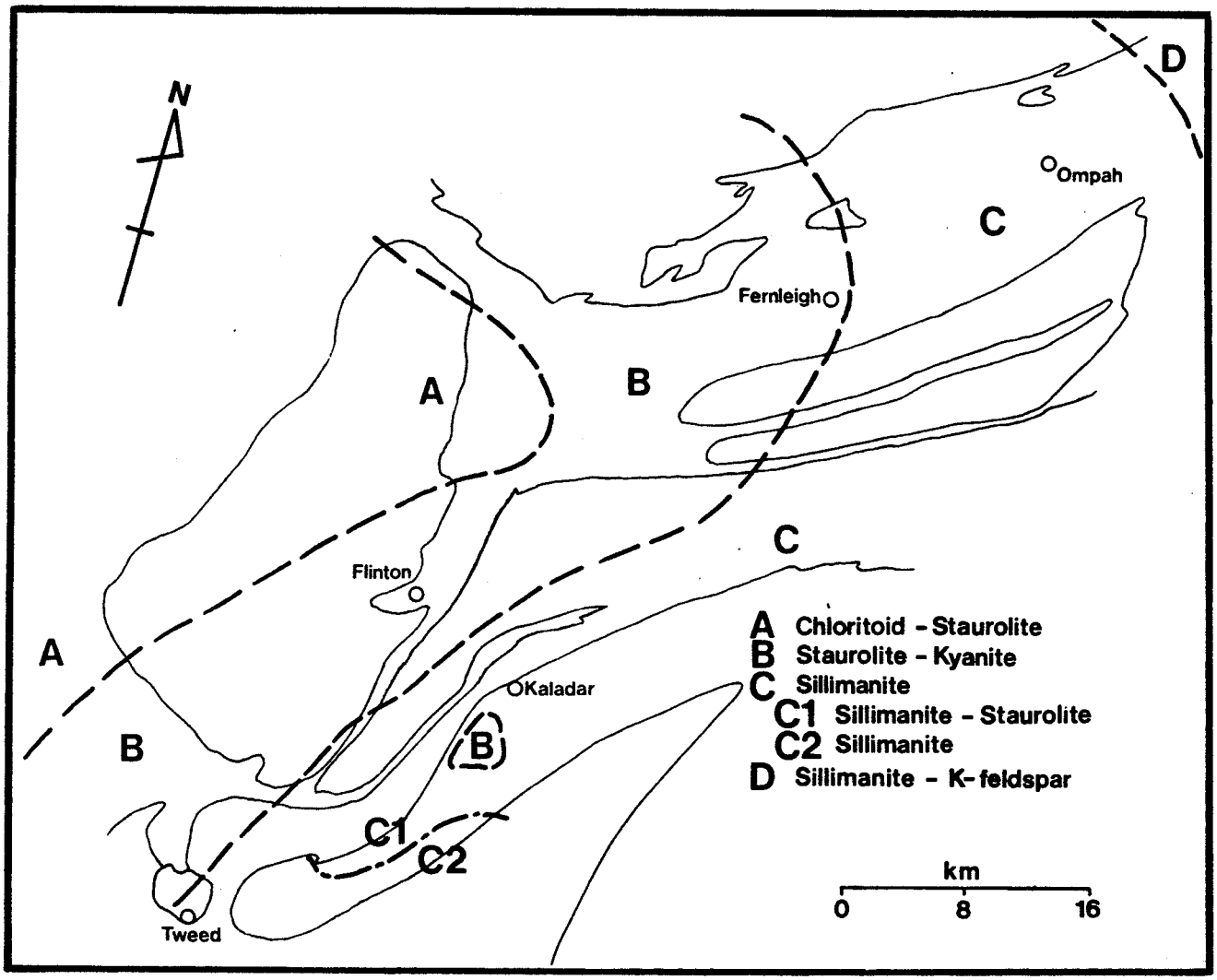

Figure 2. Distribution of mineral zones in the Tweed-Kaladar-Ompah area. Modified from Chappell (1978).

Marbles within the study area are predominantly massive, medium- to coarse-grained, white, buff, or grey-blue and contain varying amounts of quartz, diopside and sulphides. Within the marbles rare pods of interlayered clastic siliceous metasediments consisting of fine-grained biotite-quartz-feldspar gneisses, biotite schists, and fine- to medium-grained amphibolites are interpreted by Bright (1985) as calcareous meta-mudstones and meta-wackes. Recrystallization of the marbles during metamorphism and deformation resulted in a coarsening of the grain size and obliteration of the original texture.

Bright (1985) interpreted the rusty, pyritic quartzofeldspathic gneiss as a feldspathic meta-arenite. This unit also contains significant amounts of well foliated mafic paragneiss consisting of medium- to fine-grained hornblende and biotite.

The fourth rock type of the Otter Creek sillimanite occurrence consists of a spectacular porphyoblastic muscovite-biotite bearing pelitic schist. This unit is assigned to the Bishop Corners Formation of the Flinton Group by Moore and Thompson (1972), Chappell (1978) and Bright (1985). The matrix is dominated by muscovite although local concentrations of biotite are present. Quartz, plagioclase, and opaque oxides (primarily magnetite) also occur within the matrix. Porphyroblastic minerals include staurolite, garnet, sillimanite, and magnetite. At the Otter Creek occurrence the pelitic schist is characterized by two main sub-units that resemble pods formed roughly parallel to the foliation direction. The first sub-unit is of economic importance and is typified by a moderately high concentration (15-30%) of sillimanite in the form of fibrous clots. The clots form 1-2 cm long ellipsoids parallel to foliation, however several clots crosscutting foliation were noted. Sillimanite crystals within the clots are acicular with aspect ratios ranging from 20:1 to 30:1. Minor amounts of magnetite (1-2%) and quartz were noted in some clots. The matrix of high grade sillimanite zones within the sub-unit displays a high ratio of biotite to muscovite. Porphyroblasts within the sub-unit include garnet and staurolite. Staurolite is commonly surrounded by sillimanite needles and increases in abundance towards the northeast end of the synform. The staurolite probably formed as a retrograde metamorphic mineral. Ninety percent of the garnets within the first sub-unit are 1-2 cm in diameter, embayed, anhedral, and contain numerous inclusions (i.e. poikiolitic). The remaining 10% of the garnets are euhedral with well developed multiple facets, contain few or no inclusions, are only mildly fractured, and are commonly surrounded by sillimanite needles. The sillimanite needles are truncated by garnet boundaries suggesting a retrograde metamorphic origin for the garnet. These garnets would be suitable for good quality abrasive grade material, however distribution within the sub-unit is not uniform, and occasionally they occur with the poikiolitic garnets.

The second sub-unit is similar to the first although the sillimanite concentration is much lower, ranging from 0-15%. Garnet and staurolite porphyroblasts are less common than in the first sub-unit. The matrix consists of muscovite and lesser amounts of biotite.

Structural Geology

The closure of the Clare River Synform is outlined by the main pelitic schist unit of the Otter Creek occurrence. Limited exposure in the hinge area inhibits detailed mapping of the synform. Foliation directions on the northern limb trend 030-040 NE with a consistantly steep dip between 75°-80° SE. The southern limb of the synform trends 060 NE with a dip of 70° NW. The Clare River Synform is typical of the F2 folds in the area, while a reclined isoclinal fold just north of the hinge zone is typical of F1 folds in the area.

A down-plunge projection, constructed by Chappell (1978), indicates an estimated depth in the hinge area of less than 200-300 metres and a depth of almost 2 kilometres on the limbs. If this projection is correct it is possible to suggest that the sillimanite rich pelitic schist may be found at depth along the limbs of the synform.

CONCLUSIONS

The Otter Creek sillimanite occurrence is confined to coarse-grained pelitic schists that occur close to the southwest fold termination of the Clare River Synform. The occurrence contains about 20% sillimanite by volume in about 40-50% of the mapped area. Combining down-plunge projection and overall grade, results in a volume of material of economic importance.

ACKNOWLEDGMENTS

I wish to acknowledge the assistance of Dr. A.N. Rencz of the Geological Survey of Canada and Dr. P. Kingston of the Ontario Ministry of Northern Development and Mines.

In addition I wish to acknowledge Dr. B. Cumming for his review of the report.

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