# BRUCITE, A NEW OCCURRENCE AT MEAT COVE, NOVA SCOTIA

WILLIAM M. TUPPER
*Carleton University, Ottawa, Canada*

## Abstract

A new occurrence of brucite at the Meat Cove zinc deposit in Northern Cape Breton, Nova Scotia, is briefly described. The Meat Cove deposit zinc is a contact metasomatic replacement of marble which has been altered and metasomatized by an intrusion of syenite. The marble occurs as large inclusions in the syenite. Brucite has been identified by petrographic and *x*-ray studies. It occurs with serpentine as spheroids 0.1–3 mm. in diameter in a coarse mosaic of calcite (marble). Between crossed polaroids the spheroids show a complex partly radial, partly concentric onion skin arrangement of minute flakes. The brucite is derived from the breakdown of dolomite in the presence of water. The necessary conditions of temperature, pressure, and $pH_2O$ are readily developed within the contact metamorphic aureole. Some of the material examined contains up to thirty per cent brucite.

## Introduction

In August, 1960, the writer visited the Meat Cove zinc deposit in Northern Cape Breton. The geology in the immediate area of the deposit, the drill core, the entrance to the adit, and the mine dump were examined. Hydromagnesite, an alteration product of brucite was noted on the weathered surface of material on the mine dump. A suite of samples collected from the drill core and mine dump was subsequently examined at Carleton University.

The local geology is described only in sufficient detail to outline the geological environment in the immediate vicinity of the zinc deposit.

## Location and General Geology

The Meat Cove zinc deposit is located on the headwaters of French Brook, two miles southwest of the settlement of Meat Cove (Fig. 1). Meat Cove is situated on the very northern tip of Cape Breton Island. It can be reached over secondary roads from Cape North on the Cabot Trail.

The principal zinc mineral at Meat Cove is sphalerite, which, with pyrite, pyrrhotite, and silicates, form a contact metasomatic replacement of marble (Neale 1956). The mineralized zone is part of a sedimentary series which has been highly altered and metasomatized by an intrusion of syenite. The marble occurs as large inclusions in the syenite. The inclusions vary up to one third of a mile in length.

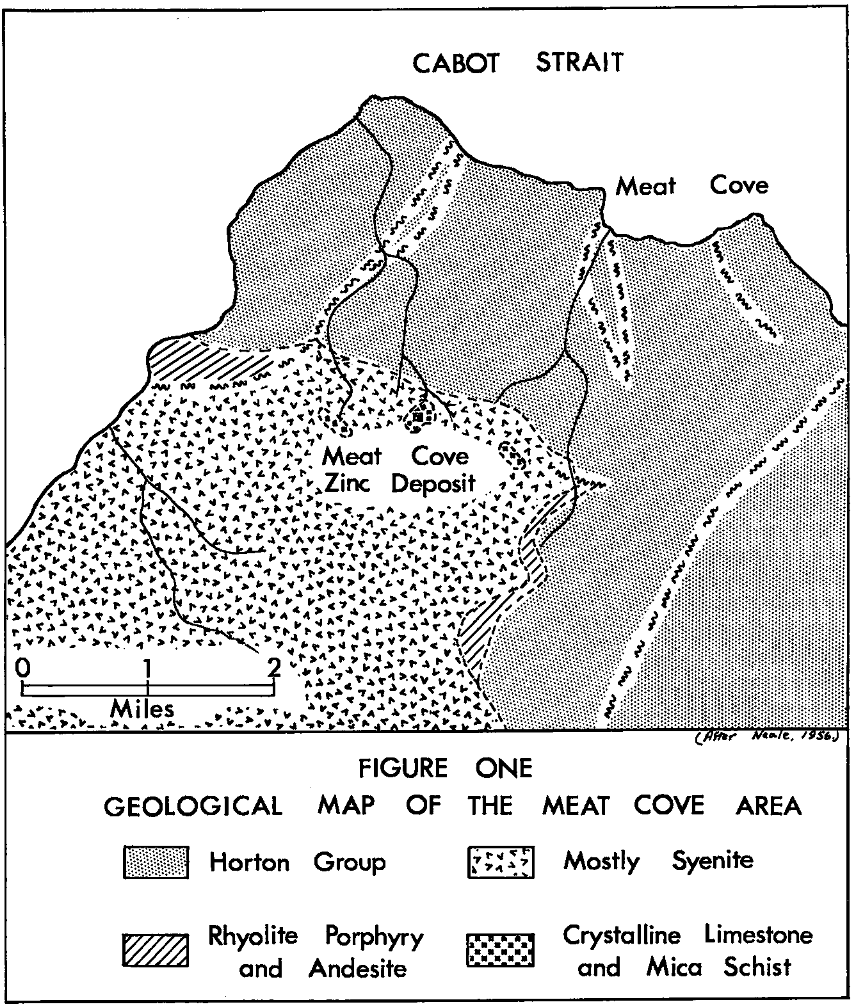



FIGURE ONE
GEOLOGICAL MAP OF THE MEAT COVE AREA

The marble is a medium to coarse grained white to grey-green rock. It consists of calcite, dolomite, serpentine, and minor pyroxene. Thin bands of micaceous limy quartzite and mica schist overlie and are intercalated with the marble.

The syenite is a reddish-grey, medium to coarse-grained rock. It consists of orthoclase, microcline, and highly chloritized hornblende. The clots of hornblende and chlorite are stretched out and aligned in a parallel direction, resulting in a strong lineation. Immediately to the north the crystalline limestone and syenite are unconformably overlain by the Lower Mississippian Horton group (Neale 1956).

The crystalline limestone and syenite have been considered for some time to be Precambrian in age. Recent age determination studies on Cape Breton rocks have thrown some doubt on this conclusion (Fairbairn *et al.* 1960). This problem is currently under consideration by the Geological Survey of Canada.

At the Meat Cove deposit, sphalerite occurs throughout the altered zone as stringers, massive aggregates, and disseminated grains. No galena occurs with the sphalerite, but a varying content of germanium, cadmium, and silver have been reported.

## Brucite at Meat Cove

While examining the mine dump, it was noted that much of the marble contained circular blotches up to one-eighth of an inch in diameter of a white powdery mineral. When specimens were broken open the white mineral was found only on the outer, weathered skin.

On a fresh surface, the powdery mineral was found to be the weathered product of a semi-transparent, grey mineral. The white mineral was thought to be hydromagnesite ($Mg_4(OH)_2(CO_3)_3.3H_2O$) formed by the alteration of brucite ($Mg(OH)_2$).

A suite of samples was collected from the mine dump and drill core for the Petrology Collection at Carleton University. This material represented mainly the zone of zinc mineralization and is not a truly representative suite of the entire area. In the course of cataloguing the specimens at Carleton, thin sections were cut of the material suspected of containing brucite. The presence of brucite was confirmed by both microscopic examination of thin sections and by *x*-ray diffraction analysis.

*Hand specimen description.* The brucite occurs within the marble as rounded blebs or spheroids 0.1–3 mm. in diameter. The spheroids are semi-transparent to opaque. They vary from grey to almost grey-black in colour. The brucite can easily be mistaken for serpentine which occurs in some abundance in the rocks. The habits of serpentine and brucite in the altered marble are almost identical.

*Thin section description.* The brucite is colourless in plain light, and first order yellow between crossed polaroids. Relief is moderate. The interference figure is uniaxial positive. The brucite occurs as ragged, semi-rounded spheroids 0.1–3 mm. in diameter (Fig. 2). The spheroids are embedded in a coarse mosaic of calcite. The spheroids show a complex, partly radial, partly concentric onion skin arrangement of minute flakes between crossed polaroids (Fig. 3). Brucite and serpentine occur together in the same section. Frequently this association is intimate, with small blebs of serpentine enclosed in the brucite, and vice versa (Figs. 4–7).

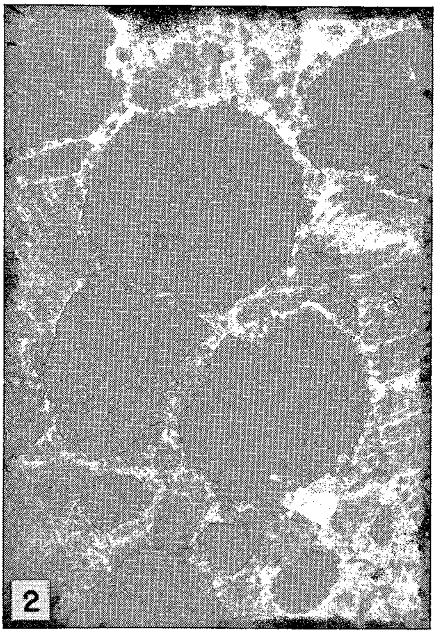


FIG. 2. Semi-rounded spheroids of brucite in a coarse mosaic of calcite. Small grains of calcite mantle the brucite. Ordinary light 20×.

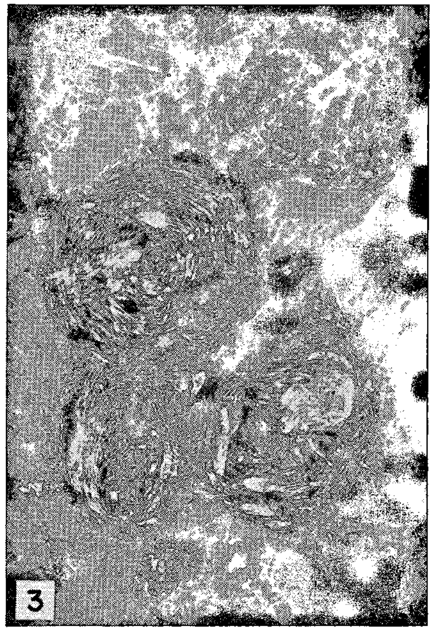
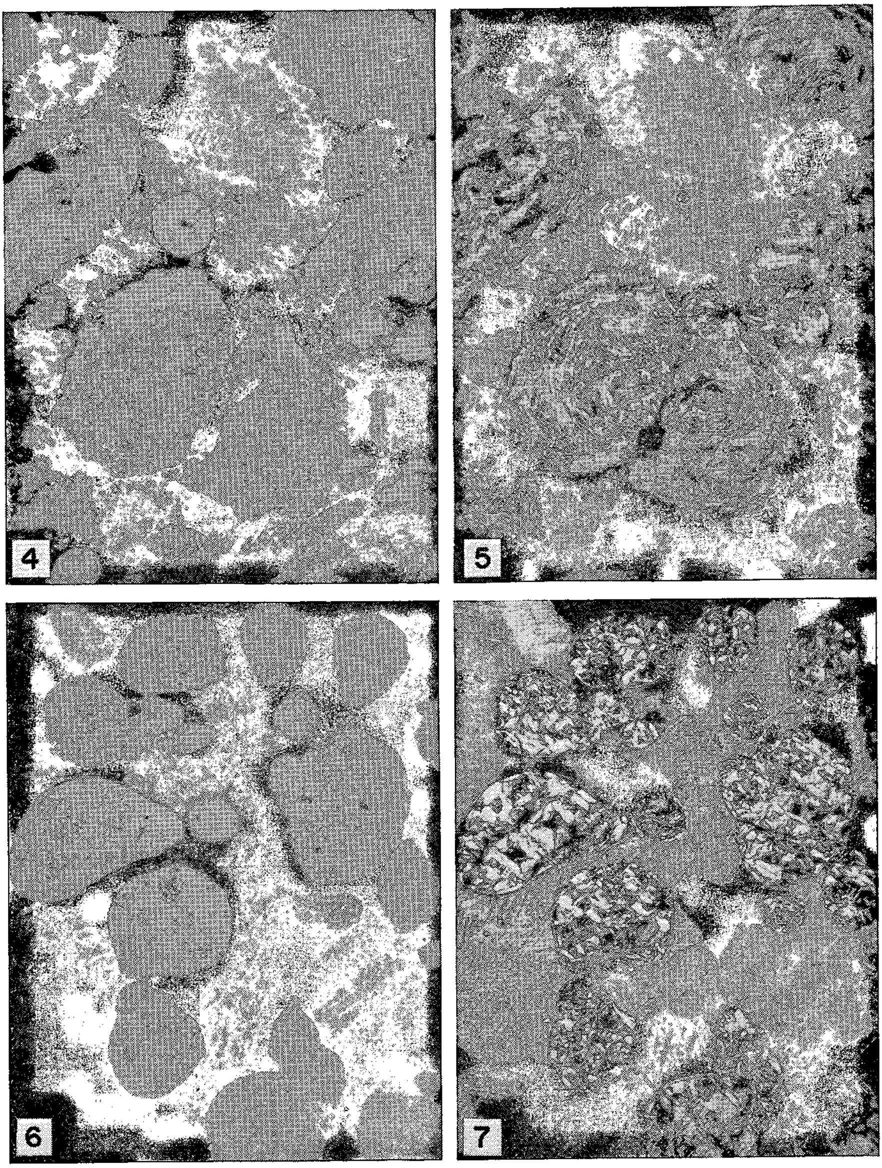


FIG. 3. Semi-rounded spheroids of brucite in calcite. The spheroids show a complex, partly radial, partly concentric onion skin arrangement of minute flakes. Crossed polaroids, 20×.

The serpentine displays strong first order grey interference colours, which are easily distinguished from the yellowish interference colour of brucite. No thin sections were cut to show the alteration to hydromagnesite.

*X-ray description.* The *x*-ray diffraction data, obtained on a Siemens Crystalloflex IV diffraction unit, are recorded in Table 1. Comparison of this data with the A.S.T.M. powder data file (Card No. 7–239) confirmed the presence of brucite. The relative intensities of the lines did not agree exactly with the A.S.T.M. data. The preferred orientation of brucite can account for the small discrepancies.

*Amount of brucite present.* The samples examined were taken from the zone of zinc mineralization. Thus, they are not representative of a very extensive area. It is also possible that the brucite and zinc mineralization are genetically related, and that little or no brucite is found outside the area of zinc mineralization. For these reasons an extensive discourse on the amount of brucite present is hardly in order. However, the following data were collected during the course of the study. It is hoped that these data will be viewed in their proper perspective.




FIGS. 4, 5. Spheroids of brucite and serpentine in calcite. The brucite encloses smaller spheroids of serpentine. 4—ordinary light—25×. 5—crossed polaroids—20×.

FIGS. 6, 7. Spheroids of serpentine in calcite. 6—ordinary light, 20×. 7—crossed polaroids, 20×.

TABLE 1. COMPARISON OF *d* VALUES FOR BRUCITE FROM MEAT COVE WITH A.S.T.M. VALUES

| Observed *d* Meat Cove sample | | *d* values for brucite from A.S.T.M. Card 7–239 | | | |
|---|---|---|---|---|---|
| $I/I_1$ | *d* | $I/I_1$ | *d* | *hkl* | Remarks |
| 8 | 4.765 | 90 | 4.77 | 001 | |
| 1 | 2.721 | 6 | 2.725 | 100 | |
| 10 | 2.360 | 100 | 2.365 | 101 | |
| 8 | 1.791 | 56 | 1.794 | 102 | |
| 5 | 1.571 | 36 | 1.573 | 110 | |
| 3 | 1.492 | 18 | 1.494 | 111 | |
| 4 | 1.370 | 16 | 1.373 | 103 | |
| 2 | 1.308 | 11 | 1.310 | 201 | |
| 2 | 1.182 | 9 | 1.183 | 202 | |
| 1 | 1.091 | 3 | 1.092 | 104 | |
| 2 | 1.034 | 5 | 1.034 | 203 | Broad and diffuse |
| 2 | 1.006 | 7 | 1.0067 | 211 | |
| 2 | 0.945 | 8 | 0.9455 | 212 | Broad and diffuse |
| 1 | 0.908 | 3 | 0.9085 | 300 | |
| <1 | 0.892 | 2 | 0.8923 | 301 | Very faint and diffuse |
| 2 | 0.864 | 5 | 0.8643 | 213 | Broad and diffuse |
| 2 | 0.816 | 3 | 0.8156 | 115 | Broad and diffuse |
| 1 | 0.787 | 3 | 0.7865 | 220 | Broad and diffuse |

(*X*-ray diffraction analysis by *X*-ray Laboratory, Carleton University. Copper radiation, 35 kv, 22 ma.)

The amount of brucite in each sample was determined by quantitative *x*-ray diffraction analysis. A portion of each sample collected was reduced to minus 200 mesh. A set of standards were prepared which contained varying amounts by weight of brucite in calcite. Using copper radiation, two-minute counts were made on the two theta peak at 50.8°. The working curve is shown in Fig. 8. Results are recorded in Table 2.

Visual estimates were made of the amount of brucite present in the thin sections (Table 2). Reasonable agreement is noted. The brucite content varies over a large range. Many samples contain no brucite. A few samples contain at least thirty per cent brucite.

## ORIGIN OF BRUCITE WITHIN CONTACT AUREOLES

The metamorphism of a pure limestone is a relatively simple process. If the pressure is sufficiently high to prevent the dissociation of calcite, the limestone recrystallizes, yielding an even-grained marble. If the carbonate rock is dolomitic, it may recrystallize like calcite or, with lower pressures, it may dissociate. Only the magnesium portion breaks down. At a pressure of one atmosphere the dissociation temperature of calcium carbonate is 898° C., for magnesium carbonate 402° C.

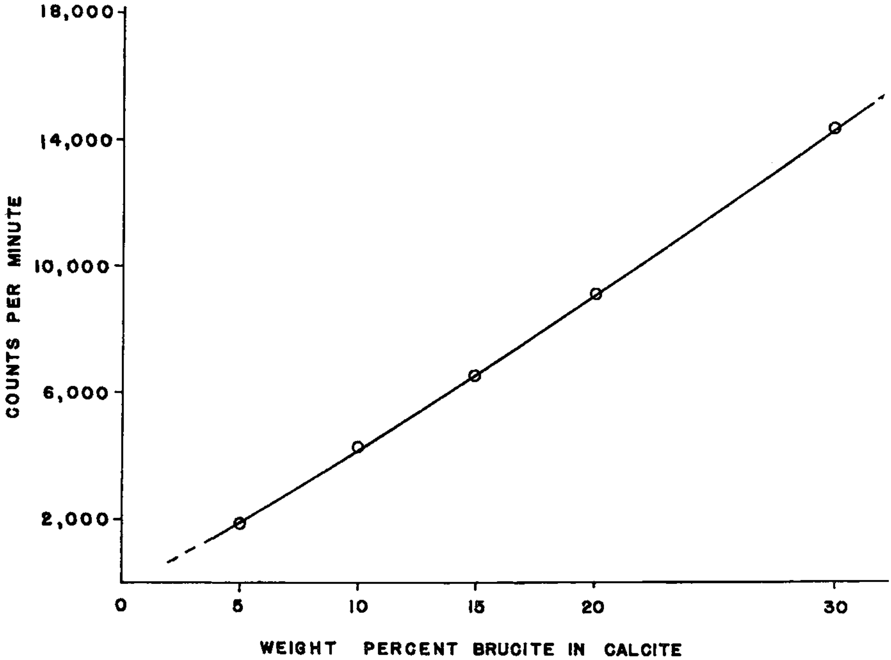



FIG. 8. Working curve—$x$-ray diffraction analysis.

TABLE 2. QUANTITATIVE $X$-RAY DIFFRACTION ANALYSIS OF BRUCITE

| Sample No. | Location | C.P.M. corrected for background | Percent Brucite by weight ± 5% | Percent Brucite by volume. Estimated from thin sections |
|---|---|---|---|---|
| 1 | Meat Cove | 12,518 | 26 | 30 |
| 2 | Meat Cove | 21,051 | >30 | 35 |
| 3 | Meat Cove | 10,357 | 22 | 20 |
| 4 | Meat Cove | 13,010 | 27 | 25 |
| 5 | Meat Cove | Not detected | — | Not detected |
| 6 | Meat Cove | 290 | Trace | Not detected |
| 7 | Meat Cove | Not detected | — | Not detected |
| 8 | Meat Cove | 19,320 | >30 | 35 |
| 9 | Meat Cove | 15,545 | >30 | 25 |
| 10 | Meat Cove | 7,254 | 16 | 15 |
| 11 | Meat Cove | Not detected | — | Not detected |
| 12 | Meat Cove | Not detected | — | Not detected |
| 13 | Meat Cove | Not detected | — | Not detected |
| 14 | Meat Cove | 9,314 | 20 | 25 |
| 15 | Lime Hill | Not detected | — | Not detected |
| 16 | Lime Hill | Not detected | — | Not detected |
| 17 | Lime Hill | Not detected | — | Not detected |
| 18 | Lime Hill | Not detected | — | Not detected |

(Quantitative $X$-ray diffraction analysis by $X$-ray Laboratory, Carleton University. Two-minute counts at $2\theta = 50.8°$ Copper radiation 35 kv, 22 ma.)

Dedolomitization is generally considered to take place in two stages with the formation of calcite and brucite:

(1) $$\underset{\text{dolomite}}{CaMg\,(CO_3)_2} \rightarrow \underset{\text{calcite}}{CaCO_3} + \underset{\text{periclase}}{MgO} + CO_2$$

(2) $$\underset{\text{periclase}}{MgO} + H_2O \rightarrow \underset{\text{brucite}}{Mg\,(OH)_2}$$

Periclase is known to be stable in contact with water vapour only at temperatures approaching 900° C. with pressures in the range of 5,000–30,000 lb./sq. in. (Bowen & Tuttle, 1949). Water at sufficient pressure to convert periclase to brucite will usually be present at some stage of metamorphism when the temperature is lower than 900° C. Thus periclase marbles with no brucite are rare. It is also possible that dolomite may be converted directly to brucite and calcite.

(3) $$\underset{\text{dolomite}}{CaMg\,(CO_3)_2} + H_2O \rightarrow \underset{\text{brucite}}{Mg\,(OH)_2} + \underset{\text{calcite}}{CaCO_3} + CO_2$$

The brucite-bearing mineral assemblages form within the amphibolite facies. The necessary conditions of temperature, pressure, and $pH_2O$ are readily developed within contact metamorphic aureoles. If a pure dolomite (Mg = Ca by vol.) is converted into brucite and calcite, the brucite-calcite mixture may contain up to 37 per cent by weight of brucite.

## Other Occurrences of Brucite in Cape Breton

It is interesting to speculate on the possibility of other occurrences of brucite in Cape Breton. The relationship between the magnesium content of dolomitic limestones and brucite was noted earlier. The stratigraphy of the marbles in Cape Breton is not sufficiently well known to outline the more dolomitic magnesium rich horizons. Until the stratigraphy is better known, it is almost impossible to predict favourable localities for the development of brucite. The contact between intrusive rocks and marble are the only known targets. Such relationships are not uncommon in Cape Breton.

An occurrence of sphalerite in marble similar to that at Meat Cove is found at Lime Hill in central Cape Breton. No brucite was noted at Lime Hill (Table 2).

## Acknowledgments

The field work was supported by Vi–Nor Explorations Ltd., Dr. George Chao, Seimens Post-Doctoral Fellow at Carleton University assisted with the $x$-ray analysis. The author is indebted to J. M. Moore Jr., and R. M. Buchanan for their helpful advice and criticism during the preparation of the manuscript.

## Summary

Brucite is present in an alteration zone at Meat Cove in northern Cape Breton. The brucite is found with serpentine in a coarse grained marble which has been intruded by syenite. Zinc mineralization is found within the same zone. The presence of brucite was confirmed by microscopic and $x$-ray analysis.

The stratigraphy of the marbles in Cape Breton is not sufficiently well known to outline the dolomitic horizons which are favourable for the development of brucite. Until this information is available, the contact between intrusive rocks and marble are the only available targets. Such relationships are not uncommon in Cape Breton.

## References

Bowen, N. L., & Tuttle, O. F. (1949): The system $MgO\text{-}SiO_2\text{-}H_2O$, *Geol. Soc. Am. Bull.*, **60**, 439–460.

Fairbairn, H. W., Hurley, P. M., Pinson, W. H. Jr., Cormier, R. F. (1960): Age of the granite rocks of Nova Scotia, *Geol. Soc. Am. Bull.*, **71**, 399–414.

Neale, E. R. W. (1956): Cape St. Lawrence, *Geol. Surv. Canada, Paper* **55–22**.

*Manuscript received February 20, 1963*