# CHLORITOID FROM THE DEEP RIVER REGION, NORTH CAROLINA

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## Introduction

In 1923, while studying the pyrophyllite deposits in the Deep River region of North Carolina, the writer found, at the old Womble Mine, in Moore County, a dark green mineral in such abundance as to readily attract attention. Specimens collected and examined proved to be chloritoid. The pyrophyllite deposits have been described by both Emmons[2] and Pratt[3] but neither mentioned the chloritoid. Genth[4] mentioned chloritoid associated with pyrophyllite schist from Chatham County, North Carolina, but gave no details. The recent study indicates that the occurrence at the Womble Mine is different from that ordinarily described for chloritoid.

## Geologic Occurrence

The deposits lie along the eastern edge of the "Carolina Slate Belt" which is made up of volcanic rocks of pre-Cambrian age. In the Deep River region the rocks consist of slate, tuff, breccia, and flows of rhyolite and dacite; and tuff, breccia, and flows of andesite, all highly metamorphosed. Some of the coarse acid breccia contains considerable iron in the form of grains of hematite and magnetite and has been called "iron breccia."

Over an area some 20 miles long by 5 miles wide deposits of pyrophyllite are found in lenses from 500 to 2000 feet in length and 200 to 500 feet wide. The pyrophyllite bodies are always found associated with the tuff, breccia, and flows of rhyolite and dacite. The only variation from this is at the Womble Mine where the foot wall of the mineral body is a well developed iron breccia.

Chloritoid occurs in small amounts in practically every pyrophyllite body in the district, but it is found in important amounts only in the Womble Mine on the foot wall side near the iron

[1]State Geologist, Department of Conservation and Development, Raleigh, N. C.

[2]Emmons, E.; Geological Report of the Midland Counties of North Carolina, Raleigh, (**1856**).

[3]Pratt, J. H.; Talc and Pyrophyllite in North Carolina, *N. C. Geol. Surv. Econ. Paper* **3** (1900).

[4]Genth, F. A.; Contributions from the Mineralogical Laboratory, University of Pennyslvania. *Amer. Phil. Soc.*, **13**, 399, (1873).

breccia. This old mine was the first pyrophyllite mine opened in the United States and has been worked at intervals since 1856. During that time a large number of pits and shafts have been sunk on the mineral body. A large amount of chloritoid was found on the dumps on the foot wall side.

## Description of the Chloritoid

The typical chloritoid rock is a schist which varies from gray to greenish gray in color. The chloritoid is scattered through the rock in tiny crystals that vary from light to dark green in color and have a pearly luster.

In thin sections, the mineral varies from brown to dark green in color, the latter being much more abundant. The individual crystals are tabular and vary in size from 1 mm. in diameter to 0.3 mm. thick. It usually occurs, however, as sheaf-like patches made up of bladed crystals which are often twinned and without well defined crystal ends. The chloritoid often constitutes 30 percent of the rock. In some of the more schistose specimens it was observed altering to chlorite[5].

The chief minerals associated with the chloritoid are quartz, pyrophyllite, chlorite, iron oxides (hematite and magnetite) and occasionally small particles of epidote.

For chemical analyses a specimen containing approximately 30 percent of chloritoid was selected. The rock was powdered and screened through a 70-mesh silk screen. The chloritoid was separated from the other minerals by Thoulet solution. Microscopic examination showed that the mineral used for analyses did not contain over 1 percent of impurities. This consisted of bits of quartz and pyrophyllite adhering to the chloritoid. The concentrated mineral had a specific gravity of 3.45 and analyzed as follows[6]:

| | |
|---|---|
| $SiO_2$ | 29.28 |
| $Al_2O_3$ | 37.98 |
| $Fe_2O_3$ | 2.32 |
| FeO | 21.97 |
| MgO | 1.28 |
| CaO | Trace |
| $H_2O$ | 6.04 |
| $TiO_2$ | 0.86 |
| MnO | 0.29 |
| Total | 100.02 |

[5]Whittle, C. L.; *Amer. Jour. Sci., Ser.* 3, 44, 270, (1892).

[6]Stuckey, J. L. Analyst.

The optical properties are as follows:[7] Biaxial (+), elongation (−), inclined extinction 12° or more with marked dispersion of the bisectrices. The refractive indices all lie between 1.723 and 1.732. $\beta = 1.728 \pm .005$. Birefringence = .007.

Z makes an angle of about 15° with the normal to the base. No cleavage or crystal faces are present from which the positions of X and Y can be determined.

Z is colorless in thinner fragments and light yellow in somewhat thicker ones. Y is bluish green and X is yellowish green. Pleochroism is strongest in sections at steep angles with the basal cleavage.

### Origin of the Chloritoid

Chloritoid is generally considered as characteristic of sedimentary rocks which have suffered the earlier stages of dynamic metamorphism, such as argillites. The occurrence described here is interesting because the chloritoid was not found in the region except in close association with the pyrophyllite and was best developed in the Womble Mine on the foot wall side in close association with the iron breccia.

The pyrophyllite has been formed by replacement under conditions of intermediate temperature and pressure by hot solutions coming up from below[8]. The pyrophyllite and chloritoid are closely associated. In most thin sections from the foot wall of the Womble Mine both pyrophyllite and chloritoid were present, replacing quartz. In a few sections chloritoid was found without pyrophyllite in which case it was replacing the silicified rock. The marked concentration of the chloritoid in the Womble Mine near the iron breccia wall would seem to indicate that its formation was in some way influenced by that rock, while its close association with the pyrophyllite and its replacement of quartz would seem to indicate that it was formed by the same agencies and under approximately the same conditions as the pyrophyllite.

[7]The writer is greatly indebted to Mr. J. H. C. Martens of Cornell University for carefully checking all the optical properties of the mineral and determining the optical orientation, refractive indices and pleochroism.

[8]Stuckey, J. L. The Pyrophyllite Deposits of the Deep River Region of North Carolina. *Econ. Geol.* **20,** 442–463, (1925).