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TALC DEPOSITS OF NORTH CAROLINA.

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ABSTRACT.

Talc deposits of lenticular shape and irregular size occur in association with the Murphy marble over a length of some 40 miles in the extreme southwestern corner of North Carolina. The marble is one of a series of sedimentary formations of Cambrian age and passes by gradations into the underlying and overlying formations. Along either side of the marble belt the rocks have been intruded by quartz-diorite dikes that are younger than the structures in the enclosing formations. Field and microscopic evidence indicate that the talc lenses were formed by hot solutions of magmatic origin. The quartz-diorite dikes seem to have been the source of the solutions that produced the mineralization.

INTRODUCTION.

TALC deposits of two distinct types have been known in North Carolina for many years. The more widely distributed type is associated with basic igneous rocks such as pyroxenite, dunite and soapstone. Deposits of this nature have not yielded talc in commercial amounts and have received little attention. In the second class of deposits the talc occurs as a series of irregular, lenticular masses associated with marble. These deposits contain important amounts of talc and have been extensively worked; the present study is restricted to them.

Deposits associated with marble are found in the extreme southwestern corner of the state (Fig. 1). Going southwest from Asheville, one finds talc first near Hewitt, in the Nantahala River Valley in Swain county. From this point the marble beds and associated talc lenses continue through the Red Marble Gap along the valleys of Valley and Nottely Rivers across Cherokee county into Georgia. The zone in North Carolina has a length of more than 40 miles and a width that ranges from a few hundred feet to more than one half mile.

Mining was begun in 1859 [1] when small amounts of talc were being used as furnace linings at Ducktown, Tennessee. At a later date it was hauled by wagon to Cleveland, Tennesee. With the

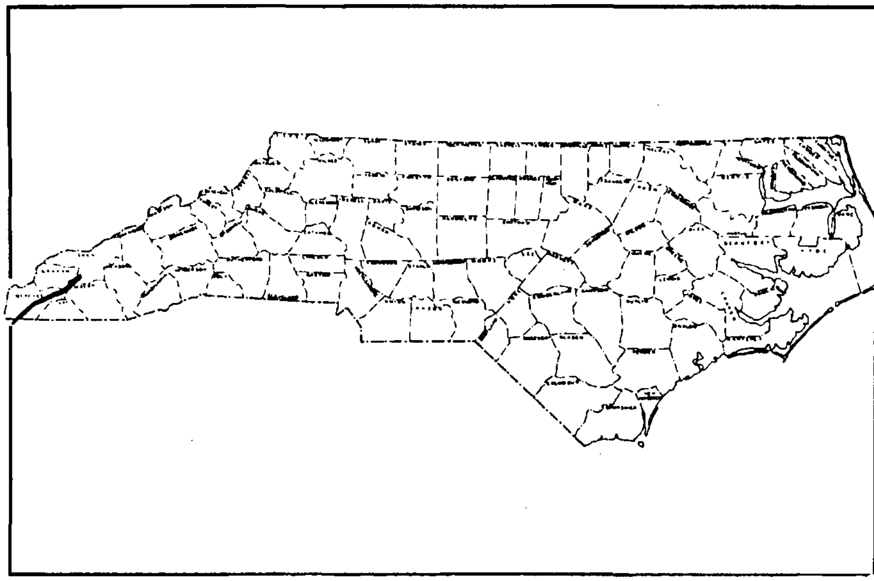

FIG. 1. Outline map of North Carolina showing distribution of marble (black) containing talc deposits.

building of the railroads into Murphy some 50 years ago, mining operations became very active and at one time or another production was made at some 25 localities. Many of these have been abandoned because of the limited size of the deposits or the poor locations with respect to the rivers. During recent years production has been carried on at Kinsey, near Murphy and at Hewitt.

GEOLOGY OF THE AREA.

The talc deposits are associated with the Murphy marble which is one of a series of sedimentary formations of Cambrian age [2] in the area. The marble is underlain by the Valleytown formation and overlain by the Andrews schist. It passes downward into the Valleytown formation by interbedding with the materials of the

1 Pratt, J. H.: Talc and pyrophyllite deposits of North Carolina. N. C. Geol. Surv. Econ. Paper no. 3, p. 8, 1900.

2 Keith, Arthur: U. S. Geol. Surv. Atlas, Nantahala Folio, no. 143, 1907.

latter, and grades upward into the Andrews schist through several feet of interbedded marble and schist.

The Murphy marble is a medium to fine grained rock that ranges in color from white to blue. Much of it is banded or mottled in blue and white colors. Small amounts with a beautiful rose-pink color are found in the Red Marble Gap. Analyses [3] from a number of localities indicate that the marble is a normal dolomite.

The underlying Valleytown formation consists mainly of mica-schist and fine-banded gneiss. In places the mica-schist gives way to mica-slate and argillaceous slate. In like manner the gneiss grades into graywacke and feldspathic sandstone. Portions of the mica-schist are rich in garnet and ottrelite crystals.

The Andrews schist overlies the Murphy marble throughout the area except in the northeastern portion, along the Nantahala River, where the Nottely quartzite comes in contact with the marble. The Andrews schist consists essentially of thin bedded calcareous schist. An interesting feature of the rock is that it contains large numbers of ottrelite crystals, which lie at right angles to the bedding planes. Considerable muscovite and biotite are present in the schist and lie parallel to the bedding planes.

The youngest rocks in the area consist of a series of quartz-diorite dikes of post-Cambrian age. They appear at close intervals along both sides of the marble belt along the valleys of Valley and Nantahala Rivers. To the northeast they continue 60 to 75 miles beyond the end of the marble belt and to the southwest for long distances into Georgia. The dikes vary in width from a few inches to 3 or 4 feet and generally lie parallel to the cleavages of the Cambrian rocks but in places cut across them. They are found in all the Cambrian formations except the Murphy marble and are conspicuous in the ottrelite-schist above and below the marble. Keith [4] states that the reason for their absence from the marble is probably due to its being more massive and less easily penetrated than the schists.

The quartz-diorite is composed essentially of quartz and feld-

[3] Pratt, J. H.: *Op. cit.*, p. 22.

[4] Keith, Arthur: *Op. cit.*, p. 5.

spar and has a distinct white appearance. In the groundmass are found well formed crystals of hornblende up to one half an inch long. The dikes are more coarsely crystalline in the center and pass by finer gradations into the schists so that in places it is almost impossible to tell where the diorite ends and the schist begins.

The Cambrian sediments have been altered by dynamic movements to such an extent that their original structure has been almost obliterated and their mineral content considerably changed. In their present condition they consist of marble, quartzite, gneiss, slate, and schist. Enough of their original characters have been preserved, however, to make it possible to work out the structure of the region. The Murphy marble with which the talc is associated occupies a synclinal position throughout its length in the State. The rocks have been subjected to such intense pressure that the limbs of the syncline have been intensely folded and crumpled. Faulting took place along the southeast side of the syncline and it was overturned and older formations thrust up over the Murphy marble throughout most of the area.

GEOLOGY AND MINERALOGY OF THE TALC

The Murphy marble outcrops over an area or belt 40 miles or more in length and from a few hundred feet to over one half mile in width. Some 25 or more talc deposits have been prospected or worked at one time or another in this area. These deposits are all lenticular bodies enclosed in the marble or lying in the marble near its contact with other formations. None have been found that are enclosed in the quartzites and schists either overlying or underlying the marble. The talc bodies are not confined to any portion or horizon of the marble, but are irregularly distributed through it, occurring generally along either side of the outcrop.

The lenses vary in size from a few inches in length and width to masses 50 feet thick or 200 feet long. Some of the lenses are not more than twice as long as they are thick and others are much drawn out and form thin sheets or tabular bodies. The bodies generally follow the structure of the marble beds in which they occur and lie in all positions from vertical to horizontal. Along the contacts they pass by gradations from pure talc to marble.

The minerals of the lenses in the order of their abundance are: talc, tremolite, carbonates (calcite or dolomite), quartz, hornblende, actinolite, chlorite, and small amounts of pyrite and magnetite. The last 5 of these occur in small amounts in different localities and are of no special importance.

Talc varies in color from bluish-white through pale greenish to white, and in structure from compact to foliated and fibrous. The fibrous structure is commonly pronounced, especially in the talc penetrating the marble. Even the massive talc, when crushed and examined under high magnification, has a fibrous structure.

Tremolite occurs as grains and crystals varying in size from mere specks and needles up to prisms with a diameter of half an inch and a length of 3 or 4 inches. The tremolite crystals may occur as individuals or in radiating bunches and groups. In the talc lenses and associated marble they occur with random orientation and show no relations to the metamorphic structures in the rocks.

Carbonates (calcite or dolomite) make up the marble that encloses the talc bodies. They also occur as irregular masses and lenses, commonly completely separated from the walls and surrounded by talc, within the talc bodies. Some of these masses occur as kidney-shaped lenses, from less than an inch in size to 5 or 6 inches in diameter, completely surrounded by talc or talc and tremolite.

Quartz occurs in the talc deposits in two forms; in the first and minor form it occurs as sand grains. These doubtless represent areas in the original limestone beds where sands were deposited along with the limey materials, which were later folded and metamorphosed into marble, although they may represent only partly replaced masses of silicified marble. In the second form it occurs as vein quartz and masses of silicified marble. On the dump at the Hayes mine, near Tomotla, are masses of vein quartz and silicified marble up to 18 inches in diameter.

A careful study of a number of thin sections cut from specimens taken from various portions of different talc deposits, shows definite relationships among the minerals present. All the minerals found in the area do not occur in every talc deposit, but careful study shows that for those present the same relations always exist.

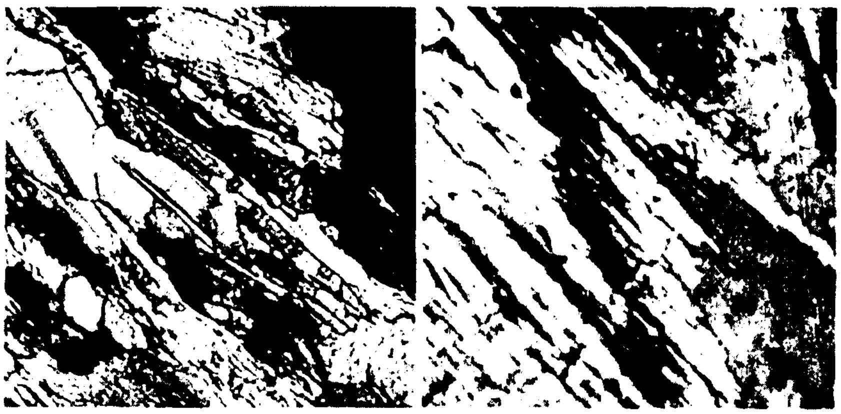

FIG. 2 (left). Talc replacing carbonates. Crossed nicols. × 70.
FIG. 3 (right). Tremolite replacing quartz. Crossed nicols. × 100.

Carbonates (calcite and dolomite) are the oldest minerals present since they form the enclosing marble. Where no quartz is present, carbonates have been replaced by tremolite, or tremolite and talc (Fig. 2). Where quartz is present, it is older than the tremolite and talc and appears to have replaced the marble, forming silicified areas, and to have been deposited as quartz veins. At the Hayes mine masses of cherty quartz contain included grains of carbonates. The masses of quartz, whether silicified marble or vein quartz have been replaced by tremolite (Fig. 3). The dark colored amphiboles, the chlorite, and the pyrite and magnetite appear to have been formed by the same agencies that produced the quartz, tremolite and talc. Talc was the last mineral formed and either replaced the tremolite or in its absence replaced the carbonates directly.

ORIGIN OF TALC.

Talc occurs widely distributed in crystalline rocks such as gneisses and schists and is especially common in dolomitic marbles. It is also found abundantly in metamorphosed basic igneous rocks such as gabbro, pyroxenite and peridotite. Various theories, too extensive to outline here, have been advanced to explain the origin of talc. Ries[5] has stated, however, that it seems safe to say at the present time that the majority of geologists believe that talc has been formed mostly by the action of solutions of magmatic origin.

Pratt's report was the first paper known to the writer in which the origin of the talc deposits associated with the Murphy marble was discussed. He[6] stated that the talc was an alteration product of the tremolite, and pointed out that in the marble walls along the talc bodies are many tremolite crystals entirely altered to talc. He recognized the fact that the tremolite crystals penetrate the marble in radiating fashion with random orientation but offered no suggestion as to their origin.

Keith[7] has discussed the origin of the same deposits in some detail and pointed out that the occurrence of the talc in amounts from mere scales up to bodies 50 feet thick or 200 feet long, many of which are barely twice as long as they are thick, was difficult to explain. He also recognized the fact that the tremolite is irregularly intergrown, in radiating bunches, in the talc and enclosing marble. He evidently considered the tremolite and talc to be due to dynamic metamorphism for he stated: "It is probable that the source of the magnesium carbonates and that of the hydrous silicates are the same, both being derived from the materials of an original sedimentary dolomite."

Gillson[8] has recently studied the Vermont talc deposits in de-

[5] Ries, H.: Economic Geology, 6th ed., p. 407, 1930.

[6] Pratt, J. H.: Talc and pyrophyllite deposits in North Carolina. N. C. Geol. Surv., Econ. Paper no. 3, pp. 12 and 13, 1900.

[7] Keith, Arthur: Talc deposits of North Carolina. U. S. Geol. Surv. Bull. no. 213, p. 434, 1903.

[8] Gillson, J. L.: Origin of the Vermont talc deposits. Econ. Geol., vol. 22, pp. 246–287, 1927.

tail, reviewed the literature and analyzed the conditions of all the more important talc deposits in the United States and some foreign deposits. At the end of his paper he set down a number of interesting conclusions chiefly as follows: 1. Talc deposits are commonly lens-shaped. 2. They are replacement deposits in limestone, schists, gneisses, and in altered basic intrusions. 3. The country rock of the talc was old and probably deeply buried at the time of the talc formation. Dynamic stress was not active in most cases during talc formation. 4. The solutions that formed the talc, whatever the original rock replaced, first formed amphibole, serpentine or chlorite. 5. In most cases the solutions were hot alkaline emanations from granite, diorite or from the acid differentiates of basic intrusions.

Burfoot,[9] in a recent detailed study of the talc and soapstone deposits of Virginia, stated that the talc and soapstone were formed by replacement through the agency of hot solutions of magmatic origin.

Careful studies of all the field and microscopic evidence obtained by the writer indicate that the talc and associated minerals, other than the enclosed carbonates, were formed by the replacement of the Murphy marble by hot solutions of magmatic origin. The evidence for this mode of formation may be stated as follows: (1) the occurrence of the talc in irregular lenses barely twice as long as they are wide; (2) gradational contacts between pure talc and the enclosing marble; (3) the silicification of the marble in some cases before the formation of the talc; (4) the presence of quartz veins at some localities both in the talc lenses and in the marble; (5) the presence of unsupported and completely surrounded lenses of marble in the talc; (6) the presence of radiating bunches and groups of tremolite in the talc and enclosing marble with random orientation; and (7) microscopic evidence of replacement (Figs. 2 and 3).

The sequence of events involved in the formation of the talc bodies is as follows: (1) formation of the Cambrian sediments; (2) metamorphism of the sediments into marbles, gneisses, and

[9] Burfoot, J. D.: Talc and soapstone deposits of Virginia. Econ. Geol., vol. 25, pp. 805–826, 1930.

schists during the Appalachian Revolution; (3) formation of large masses of igneous rocks in the Appalachian region and the intrusion of the quartz-diorite dikes into the gneisses and schists adjacent to the marble; (4) silicification of the marble; (5) development of the tremolite, hornblende, actinolite and chlorite by replacement of quartz and marble; (6) development of talc by replacement of tremolite and marble; and (7) development of pyrite and magnetite with or closely following talc.

The evidence outlined above seems conclusive that the talc was formed by hot solutions of magmatic origin. No large bodies of post-Cambrian igneous rocks are present in or near the area, but small quartz-diorite dikes from a few inches up to 3 or 4 feet wide are abundant in the gneisses, schists, and slates along both sides of the marble belt. As explained by Keith,[10] the dikes are probably present in the schists and slates because of their schistose character and absent from the marble because of its massiveness. The diorite dikes follow the cleavage in part, cut across it in part, and in places branch into layers or run out into thin edges and disappear. The enclosing schists have been strongly silicified and commonly contain veins of quartz younger than their cleavage in areas where the dikes are abundant. They also contain an abundance of garnet which is doubtless a contact mineral due to the effect of the diorite. Ottrelite crystals, which cut across the cleavage of the schists, are also abundant near the dikes, but absent in areas some distance away, indicating further the effect of the diorite on the enclosing rocks.

Nitze and Hanna [11] pointed out that gold bearing quartz veins in Archean rocks are not the only sources of gold in the region. They stated that gold associated with galena had been found in the marble at Section 6, one mile northeast of Murphy, at Axels shaft on Marble Creek, and near the village of Marble. The writer collected materials from the dump of an old shaft on the Section 6 property where it is reported that a gold bearing quartz vein 18 inches to 3 feet thick was worked. The specimens con-

[10] Keith, Arthur: U. S. Geol. Surv. Atlas, Nantahala Folio, no. 143, p. 5, 1907.

[11] Nitze, H. B. C., and Hanna, G. B.: Gold deposits of North Carolina. N. C. Geol. Surv., Bull 3, p. 193, 1896.

sisted of vein quartz attached to marble and contained sulphides in small amounts. Tremolite similar to that in the talc lenses and associated marble was present in the specimens.

The evidence indicates that the massive marbles blocked the rise of the intrusive diorite. Solutions from the dikes, however, reacted with the marble in the immediate vicinity and produced the small irregular talc lenses by replacement of the marble. No diorite has been found in the talc mines. This, however, is to be expected since the marble beds have a thickness of some 500 feet and the talc mines have reached a maximum depth of only about 100 feet.

OPERATIONS AND SUPPLY.

The irregular shape and size of the talc lenses make any attempt to estimate the amount of talc present in the area largely a guess. The soft talc seems to weather readily and many lenses have been found covered with residual mantle, in which only a few fragments of talc were present, or with alluvial soil. This makes it impossible to determine the size of a talc lens until it is largely worked out. It is also probable that many lenses of talc have escaped notice due to the surface covering.

Due to the shape and size of the deposits, mining has been carried on by open pits and shallow shafts from a few feet to 40 or 50 feet deep. Production varies widely from year to year but has been carried on almost continuously for nearly 50 years. The area will, doubtless, continue to produce talc in varying amounts for many years.

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