Publications of the Division of the Geological Sciences
California Institute of Technology
Pasadena, California
Contribution No. 479

New York Talcs, Their Geological Features, Mining, Milling, and Uses

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Introduction

The New York talc deposits of commercial importance are in St. Lawrence and Lewis counties, in the northwest Adirondack Mountains (Fig 1). All of the deposits are of pre-Cambrian age and occur within highly deformed and recrystallized marble of the Grenville series.

The deposits in St. Lawrence County, near Gouverneur, are the largest and most productive of their type known in the Western Hemisphere. In 1948 the seven mines which are in operation will produce about 130,000 tons of ground talc.

All talc production in Lewis County is from one mine. There the annual production ranges from 15,000 to 30,000 tons.

These so called talcs of New York State include earth materials of different chemical and mineral compositions. In general the mineral talc is subordinate in amount to other minerals in both the Gouverneur and Natural Bridge deposits.

In the Gouverneur district the mineral talc comprises less than 25 pct of the mined and ground rock. Most of the rock mined is a tremolite- or tremolite-anthophyllite schist somewhat altered to serpentine and talc.

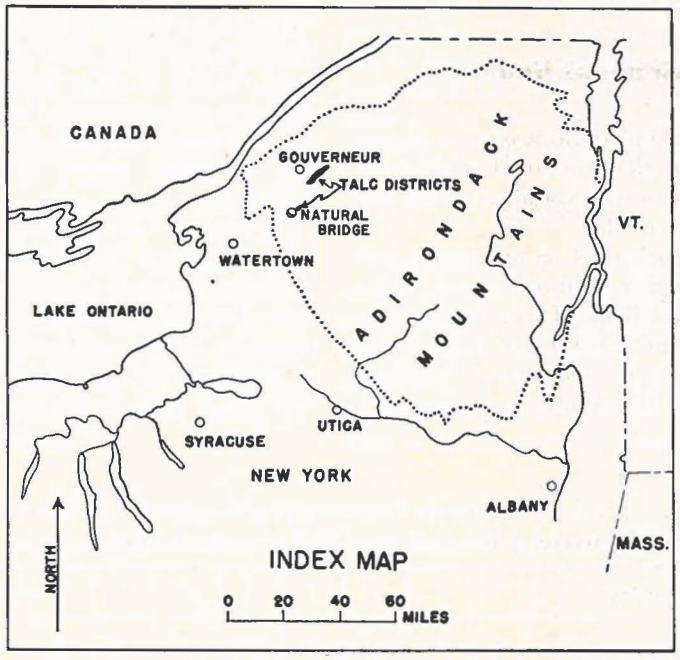

FIG 1—Map of New York talc deposits in the Adirondack Mountains.

Los Angeles Meeting, October 1948. TP 2653 H. Discussion of this paper (2 copies) may be sent to *Transactions* AIME before Oct. 30, 1949. Manuscript received Dec. 7, 1948.

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This characteristic in no way devaluates the "talc" for certain markets, and in some instances makes the material more desirable.

The Natural Bridge talcs include types high in serpentine, as well as complex aggregates of serpentine, talc, carbonates, and diopside.

Usage of the term talc, however, for

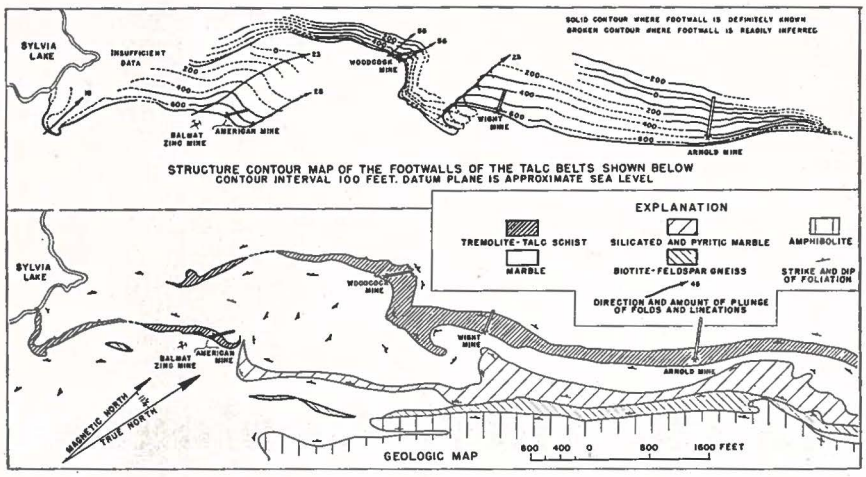

FIG 2—Geological features of the area north of Balmat, N.Y.

these industrial mineral aggregates is widespread and deeply rooted. Accordingly, this usage is followed in this paper. The phrase "the mineral talc" is used herein wherever reference is made to the specific mineral talc, $H_2Mg_3(SiO_3)_4$ or in terms of oxides $H_2O{\cdot}3MgO{\cdot}4SiO_2$.

General Geology

The talc of the Gouverneur district occurs in elongate zones interlayered within a northeastward-trending belt of impure marble.

The marble belt is apparently part of a highly deformed and metamorphosed flank of a northeastward-trending anticline. Cross folds, plunging north to northwest, foliations, shears, and lineations constitute important structural features of the talc zones (Fig 2 and 3).

The zones of commercial talc pinch, swell, and curve in sinuous to complexly folded patterns, Fig 2, but are rudely conformable with adjoining marble layers. The talc zones have a composite strike length of more than six miles, a probable extent down dip in excess of 2000 ft, and widths of as much as 400 ft. Dips along the talc belts are quite variable, ranging from the horizontal through the vertical, but averaging about 45° to the northwest.

Variations in thickness of the talc belts or of any included zone may be either abrupt or gradual. The belt near Talcville, which contains two producing mines, varies up to 300 ft or more in thickness, averaging perhaps 135 ft thick in the mines, Fig 3. Much of this thickness is commercial talc. A talc belt north of Balmat and southeast and east of Fowler, along which are 4 active mines, varies up to at least 425 ft in thickness, and averages possibly 125 ft thick, Fig 2. In this belt, however, one or several zones of commercial talc 6 to 25 ft thick or rarely as much as 75 ft thick are interlayered with impure or discolored noncommercial zones within the belt. Within these two belts are talc reserves sufficient to last several generations, at the present rate of production, under resourceful mining methods.

The approximate percentages of constituent minerals in various types of commercial talcs from the Gouverneur district are shown in Table 1.

A wide variation in proportions of tremolite, anthophyllite, serpentine, and talc are apparent. Other minerals which occur in and along the talc belts include quartz, calcite, dolomite, hexagonite (a manganese-bearing tremolite), iron and manganese oxides, diopside, chlorite, pyrite, mica, feldspars, titanite, magnesian- and manganese-bearing tourmalines, and apatite. Most of these last-named minerals constitute obvious adulterants or impurities and are avoided in mining.

The chemical compositions of some of the more important types of talc are indicated in Table 2. The range of variations in SiO_2 and MgO are readily apparent. Iron and manganese oxides, SO_3, and CO_2 when present in excess of the amounts shown constitute serious impurities for some markets. In general the companies in the Gouverneur district attempt to keep the CaO content between 3 and 7 pct, and the MgO content between 25 and 30 pct. The relatively high CaO content is largely a reflection of the lime present in tremolite and anthophyllite, Table 3.

Much of the tremolite probably formed by reactions between, and replacement of, favorable beds of quartzite and dolomite. This initial stratigraphic control of talc distribution was partly obscured, and to some extent superseded, by prominent secondary structures, especially shear zones that developed during metamorphism.

The talc-forming constituents doubtless were derived largely from the quartzite and dolomite beds, but water, silica, magnesia, and other elements were introduced into the present talc belts, and calcite removed by hydrothermal solutions.

Table 1 . . . The Approximate Percentages of Constituent Minerals in Layers of Commercial Talc and the Oil Absorption of These Layers

Specimen Number[a]	1	2	3	4	5	6	7	8	9	10
Tremolite	68	98	17		78	38	29	15	88	46
Anthophyllite			20				45	78	4	39
Talc, fibrous		1	63					5		
Talc, foliate					{>4}			1		5
Talc, shredded aggregate								1	1	{>4
Serpentine, massive		1		80	18	54	21		4	
Serpentine, fibrous							5			
Quartz	31	trace							2	4
Carbonates	1			2	trace	4				1
Hexagonite, iron and manganese oxides, mica, other impurities	trace			trace						1
Diopside				18		4			1	
Oil absorption 97.5 particles through 325 screen	29	33	58	56	45	50	55	52	35	48

[a] 1. Pale-pink, tremolite schist, hanging-wall side of talc belt, Talcville, N. Y.
2. Lustrous, white, stubby-bladed tremolite rock interlayered with Specimen No. 1.
3. Pale-gray to white, fibrous "talc," Talcville, N. Y.
4. Watery-green, serpentinized diopside rock along footwall talc belt, Talcville, N. Y.
5. Serpentinous tremolite, "10A ore," Talcville, N. Y.
6. Streaked, buff to chalky-tan, serpentinous tremolite, "regular ore," Talcville, N. Y.
7. Watery-gray, fibrous to bladed, tremolitic talc, Ontario mine, Fowler, N. Y.
8. "Arnold fiber," Arnold mine, Fowler, N. Y.
9. Medium-grained, serpentinous, splotched tremolite, "Arnold heavy stock," Arnold mine, Fowler, N. Y.
10. Pale buff, highly schistose "talc," hanging-wall zone, Woodcock mine, Balmat, N. Y.

Talc Mining

In general, methods used in mining New York talcs are less progressive than those used in the zinc mines of the same region.[1,2] Until recently, less than 30 pct of the commercial talc in the larger deposits was recovered. The amount of talc recovered from smaller, complex zones and ore bodies was considerably smaller. In general, however, and especially at Natural Bridge, N. Y., numerous natural obstacles in the way of efficient operations are presented by complexities of form, structure and composition of these talc deposits. At present, capable operators, who have introduced modern equipment, are in charge in most of the New York mines, and the projected plans of the several companies, if effected, will result in a more ideal exploitation of the important talc deposits.

Both the tabular deposits of the Gouverneur district and the brecciated talcose marble at Natural Bridge have a moderate to steep dip. In these deposits it is common practice to sink a shaft in the talc, on the footwall side of the desired rock. Since the commercial talc is followed by most of the shafts, changes in dip and plunge of the talc body are reflected in corresponding irregularities of the shafts.

One straight, inclined shaft was sunk in 1934 in the Gouverneur district, and another vertical, concrete-lined shaft is being sunk at present to an adjacent talc body.

In most of the New York mines, drifts and crosscuts driven from shafts are used to explore and outline the body of minable rock, as well as for tramways and subsequent mining needs. Since many deposits are of irregular, folded forms, many drifts are quite crooked. Almost no timbering is done in the Gouverneur district. At Natural Bridge, steel and concrete are employed in the shaft where it cuts a major fault zone, but the drifts are not timbered. Caving and bad ground constitute serious problems, however, in both districts.

In the Gouverneur district it is common practice in mining the talc bodies to drive raises at frequent intervals, often 30 to 50 ft, in whatever minable talc is encountered, as far as the overlying levels, or as far as safety or the upper limit of the talc body permits. Wet drilling is employed exclusively in the New York mines to reduce the hazard of silicosis and fibrosis.[3]

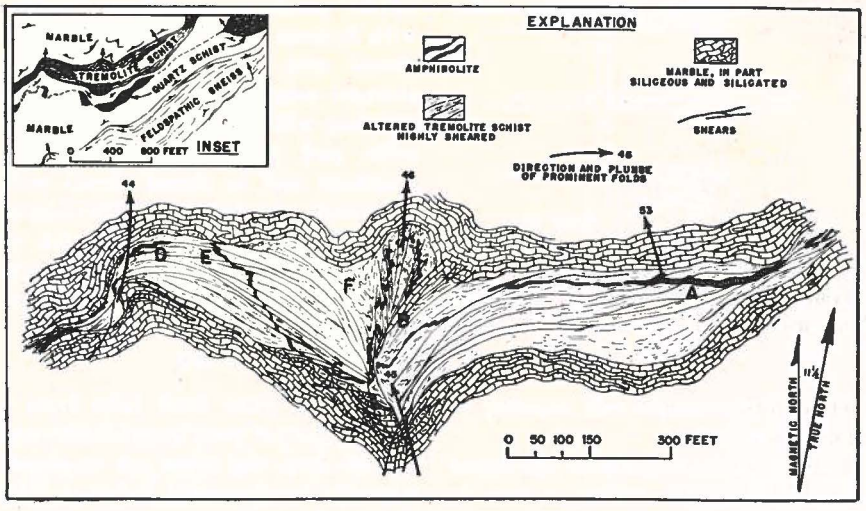

FIG 3—Simplified geological map of the seventh level of the International Talc Co. mine, Talcville, N.Y.

The raises are enlarged into stopes, with the broken rock falling to the drift floor to be mucked by hand or mechanically. A few old stopes in a number of New York mines "work themselves."

Recent practice in the Gouverneur district tends toward the development of conventional sublevel stopes wherever possible, with grizzlies and chutes. A valuable addition is a waterway with a fine-spaced grizzly placed in the intersection of appropriate raises and sublevels to drain off water which would otherwise soak the muck and impede milling (Fig 4). The underhand stoping (benching) method of mining commonly is employed where possible. In several mines in the Gouverneur district, blocks of ore are mined by long hole drilling.

Conventional practice in all the mines involves the use of air and electrically operated mucking machines, commonly rocker shovels, for mucking crosscuts and drifts. Small battery locomotives have supplanted hand tramming in all the mines. One company in the Gouverneur district sorts talc at the mine on steel plates in the head house. Under the steel plates is a series of bins into which talc is sorted according to color and impurities.

Milling

Talc milling in New York, as elsewhere, is largely a grinding operation, accompanied by air separation. Seven talc mills are in operation in New York, six of them in the Gouverneur district. Driers are employed in three of these mills in the Gouverneur district since

Table 2 . . . Chemical Analyses of Industrial Talcs Mined in New York State

Specimen Number[a]	1	2	3	4	5	6	7
SiO_2	59.80	66.23	67.0	56.50	59.40	57.26	47.0
Al_2O_3	0.57	1.05	} 1.40	1.0	0.74	1.14	1.71
Fe_2O_3	0.05	0.13		0.10	0.02	0.24	
FeO	0.15	0.22			0.12	0.05	
MnO	0.39	0.16	0.80		0.20	0.51	
CaO	6.80	2.26	2.30	6.20	4.94	6.50	6.61
MgO	27.45	25.71	24.80	30.40	30.09	29.08	33.5
TiO_2						0.04	
SO_3	0.07	0.01	0.07		0.01	0.14	
Ignition loss	4.75	3.86	3.10	4.80	4.09	3.98	7.74
Water (105°C)	0.45	0.25	0.30	0.77	0.47	0.34	1.96
CO_2	1.18	0.56	1.30	0.20	0.31	0.29	2.61
Total	101.66	100.44	101.07	99.97	100.39	99.57	101.13

[a] 1. Analysis of average sample of mined talc zone, Talcville, Gouverneur district, N. Y. Analyst Glen Edgington, U. S. Department of Agriculture.
2. Analysis of average sample of footwall talc zone, Fowler, Gouverneur district, N. Y. Analyst Glen Edgington, U. S. Department of Agriculture.
3. Analysis of hanging-wall talc zone, Woodcock mine, Balmat, N. Y. Analyst Orton Smalley, courtesy Loomis Talc Corp.
4. Analysis of footwall zone, American mine, Balmat, N. Y., courtesy St. Joseph Lead Co.
5. Analysis of "middle zone," Woodcock mine, Balmat, N. Y. Analyst Charles O'Brien, courtesy Loomis Talc Corp.
6. Analysis of average sample across commercial talc zone, Balmat, N. Y. Analyst F. A. Gonyer, Harvard University, courtesy R. T. Vanderbilt Co.
7. Analysis of "Micro Velva Talc," Natural Bridge, N. Y., courtesy Carbola Chemical Co.

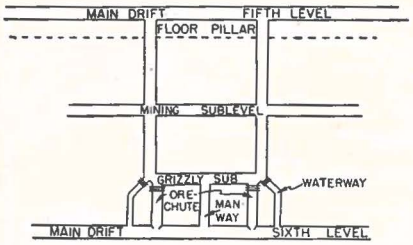

FIG 4—Diagrammatic sketch showing development of an inclined tabular or lenticular talc body by sublevel stopes.

wet material reduces mill capacity as much as 30 pct.

Talc taken from some of the mines may include blocks a foot or more in their largest dimensions. This rock goes directly from the mines to crushing plants at the mills, where primary and secondary crushers are used to reduce the talc to ½, 5/16, 3/16 or ⅛ in. products. Finer grinding is achieved in tube mills. Raymond mills, and Hardinge mills, in closed circuits with Sturtevant, Raymond or other type air separators.

Much New York talc is ground to one of the following general size groups: 97.5 pct particles through a 325 mesh screen, or 99.5 pct particles through a 325 mesh screen. Actually, in achieving either of these specifications, some talc is "overground" with a resulting large spread in particle dimensions. Many fines 15 to 35 microns in size commonly result.

Extremely fine grinding with fluid energy mills is done in several New York mills. A number of Micronizers and Wheeler mills are now in operation. Standard particle sizes ranging between one-half and 20 microns, as measured by air permeation methods, are attained in this fine grinding.

The following mill procedure is contemplated for a mill just erected in the Gouverneur district: primary crushing with gyratory crusher at shaft head house; conveyor to plant 500 ft away; wet storage; drying of minus ⅝ in. product; secondary crushing with Symons shorthead cone in closed circuit with ⅛ in. screen; dry ore storage; weightometer; extremely fine grinding with C. H. Wheeler Co. air mills and standard grinding with Hardinge mill in closed circuit with Raymond separator; Fuller-Kinyon conveying to bulk storage bins to packing house; Bates valve packers; power and gravity conveyors to cars.

Uses

Although New York talcs have a wide variety of uses, some 75,000 tons of talc from the state are employed annually by the paint industry. The fibrous form of the minerals anthophyllite and talc especially seems to hold heavier paint pigments in suspension longer, and to prevent caking and settling. The fibrous and blade-like mineral forms also are believed to serve as locking or bonding agents in the paint film. Better grades of Gouverneur talc have values of 90 or better in the standard industry whiteness scale.

A conventional standard for classifying New York talcs prepared for paints is the Gardner-Coleman oil absorption test.[4] In general, fine grinding increases the quantity of a given oil required to wet thoroughly all the absolute particle surface of the talc. For approximately uniform particle sizes, the talcs composed largely of the mineral talc, or serpentine, have a higher oil absorption than talcs rich in tremolite, quartz, or carbonates. Highly fibrous or flaky grains have greater oil absorption than equant grains of roughly the same size groups as indicated by conventional screening.

New York talcs range from 30 to 60 in the scale of oil absorption. The slightly serpentinous or talcose tremolite schist so common in the mines of the Gouverneur district tests between 40 and 45 when ground so 97.5 particles will pass through a 325 mesh screen. Essentially unaltered tremolite, ground to about the same size averages between 30 to 34 in oil absorption, Table 1. This same tremolite rock, ground to grain sizes of 1 to 25 microns, tests about 40 to 42 in oil absorption. Obviously the extent of surface area in relation to the mass of the grain is an important factor in determining oil absorption.

The ceramic industry used about 25,000 tons of New York talc in 1947, and probably will use a larger tonnage in 1948. In the manufacture of whiteware bodies, the CaO content of 4.5 to 6.5 which characterizes much Gouverneur talc is not at all objectionable, and in fact, may be desirable.[5]

Besides the consumption of New York talc in the paint and ceramic industries, appreciable tonnages are used in the insecticide, rubber, and textile industries.

In general, consumer demand has and continues to be for a talc of uniform chemical and physical properties. Accordingly, present philosophies in the two New York districts are to establish practical and efficient means of blending and averaging out the variations along and across the strike and down dip inherent in the talc deposits.

Table 3 . . . Approximate Composition by Oxides of the Common Minerals in, and Associated with, Industrial Talcs of New York

Mineral	CaO	MgO	Al_2O_3	SiO_2	CO_2	H_2O	MnO
Talc		32		63		3–7	
Serpentine		43		44		7–13	
Chlorite		36	18	33		5–14	
Tremolite	13	27		57		2	
Anthophyllite	3.5	31	0.5	59		2.5	3
Diopside	26	18		56			
Dolomite	30	22			48		
Calcite	56				44		
Quartz				100			

Acknowledgments

The writer's studies of New York talcs were undertaken for the U. S. Geological Survey, and welcomed and enlivened by the staffs of mining companies in the New York districts.

I also wish to acknowledge the inestimable contributions to my efforts made by H. M. Bannerman, C. N. Bozion, A. F. Buddington, James Page and many other members of the U. S. Geological Survey.

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