

REPORT  
OF THE  
STATE GEOLOGIST  
ON THE  
MINERAL INDUSTRIES  
OF  
VERMONT  
1933-1934

NINETEENTH OF THIS SERIES

ELBRIDGE C. JACOBS  
*State Geologist*

2673

REPORT OF THE VERMONT STATE GEOLOGIST  
1933-1934

CORRECTION SHEET

Page 12

WELLS-LAMSON QUARRY COMPANY, INCORPORATED

Main office, Barre.

Officers: President, Marshall J. England; treasurer, H. Brandom Jones.

Quarries at Websterville.

Product: Light Barre granite, Medium Barre granite.

WETMORE & MORSE GRANITE COMPANY

(This is an independent company)

Main office, Montpelier.

Officers: President, Frank M. Corry; vice-president, William F. Corry; treasurer, Edward H. Deavitt.

Quarries at Websterville.

Product, Rough Barre granite, light and medium.

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STATE OF VERMONT  
OFFICE OF STATE GEOLOGIST  
BURLINGTON

*To His Excellency,*

*Stanley C. Wilson, Governor of Vermont,*

*Sir:* In accordance with Act 405 of the General Laws of Vermont, I present herewith my Report as State Geologist.

Owing to the cutting off of printing appropriations by the last Legislature, with the resulting throwing back upon departmental budgets of printing expenses, and owing, furthermore, to the 40 percent reduction in the amount of the geology appropriation, the size of the present Report has been greatly reduced and several important articles on the geology of the State furnished gratis by eminent geologists, have been lost to the Survey by this drastic legislative retrenchment.

It is earnestly to be hoped that the next Legislature will provide funds for the resumption of full-sized reports, since there can be no doubt of the value of these publications, the demands for which, by the layman as well as by the scientist, exceed those of any other State publication.

In addition to this Report on the Mineral Industries of the State, the Geologist has attended to the large correspondence connected with his office and has advised with various people on their geological problems.

Respectfully submitted,

ELBRIDGE C. JACOBS,  
*State Geologist.*

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## The Mineral Resources and Industries of Vermont

The State of Vermont continues to be a great reservoir of mineral wealth. Her non-metallic resources are unimpaired; her monumental and structural marbles are world famous; her granite is nationally known and is unexcelled in quality; she has vast resources of slate and talc; she possesses one of the largest deposits of fine China clay in the country; Belvidere is practically a mountain of short fiber asbestos, by far the most extensive in the United States; along the western length of the State are stores of high-grade limestone; while the deposits of brick-clay are great and could supply bricks for the nation.

As regards metallic minerals, copper, gold, etc., time was when Vermont possessed at South Strafford, Vershire, and Corinth,<sup>1</sup> very important deposits of copper ore; while vein deposits of gold were worked years ago in Plymouth<sup>2</sup> and placer deposits have been washed in Stowe and other places.

There is probably a good deal of copper ore left in the mines at the three localities cited, but it is doubtful if it could be economically mined, while the great admixture of pyrrhotite (sulphide of iron) would render concentration and smelting difficult.

During the Great War, when copper was selling at 35 cents a pound, attempts were made at these three places to concentrate the ore by flotation methods, but costs were very high. The writer was told that copper could not be "made" for less than 21 cents a pound. Naturally the post-war slump in copper prices has rendered any further attempts at copper mining out of the question and, with the tremendous over-production of copper in the world, it is doubtful if the Vermont mines will ever be reopened.

The recent great increase of the price of gold, from the old standard of \$20.67 per Troy ounce to \$35, has led to a good many inquiries as to the occurrence of the yellow metal in this State. The article cited above, by Professor Perry, gives a good account of gold occurrence and extraction at Plymouth, which is the only place in this commonwealth where serious attention has been given to gold recovery. But the mineral history of this region, as well as that of the whole northeastern part of the continent, has failed to show profitable gold mining operations. The Geologist

<sup>1</sup> Copper Mining in Vermont; E. C. Jacobs, 10th Rpt. Vt. State Geol.

<sup>2</sup> The Geology of Bridgewater and Plymouth; E. L. Perry, 16th Rpt. Vt. State Geol.

feels sure that only financial disaster would result from considerable attempts at gold winning in Vermont.

### *The Non-Metallic Mineral Industries*

Like all of the great industries of the United States the Vermont mineral industries have been, and still are, much depressed. Probably the monument trade has felt the depression less acutely than the others, but even here the statistics of production show marked recessions from the "brave days" before 1929. Quite a number of the granite, slate and limestone quarries are shut down. Aside from these the mineral industries of the State are active, but on a much reduced scale.

In the following pages the Geologist has endeavored to set forth the present condition of each of the non-metallic industries, sometimes with an historical note, to present statistics of production during the last five and one-half years, to give the names and organizations, and products of the companies engaged in the various industries, and so to document the Report, geologically, that persons interested can study the scientific articles that have been written about the mineral deposits of Vermont.

## Marble

The marble industry throughout the country has severely felt the effects of the depression. Stagnation in building construction and the tendency to substitute less expensive materials have contributed to the present low ebb. Vermont plants have, however, been maintained in a high state of efficiency and it is to be expected that, with the ultimate return to normal times, Vermont marble will again come into its own.

### *Occurrence*

The belt of typical Vermont marble is found in the western central to southern part of the State, from Middlebury and Brandon down the Vermont Valley to about Manchester. The so-called "black marble" is quarried from the semimetamorphosed limestone of Isle la Motte, while the varicolored Champlain marbles are now obtained at Swanton and St. Albans. Verd antique, although considered commercially a marble, is really a metamorphosed igneous rock. Deposits of it are or have been quarried at Moretown, Roxbury, Rochester, Proctorsville, and Windsor.

### *Geology*

A great deal of geological work has been done on the marble belt, beginning perhaps with the work of Augustus Wing,<sup>1</sup> about 1875, and including investigations of J. E. Wolff,<sup>2</sup> T. N. Dale,<sup>3</sup> and others. G. W. Bain<sup>4</sup> has shown that "The marble belt lies in the Taconic synclinorium, between the Champlain overthrust and the Green Mountain arch. The southward pitch of numerous folds along the east side gives this boundary an irregular form. Lower Cambrian quartzite and pre-Cambrian schists are thrust over phyllites of possible Ordovician age and cut across the strike of folded Cambrian and Ordovician limestones on Pine Hill, between Proctor and Center Rutland. The outcrop of the thrust begins east of Brandon, follows the west crest of Pine Hill, and continues south with an irregular course to the vicinity of Wallingford, where it crosses to the east side of the valley, but it cannot be recognized east of Danby. The largest overfolds and

<sup>1</sup> Am. Jour. Science, 3rd Series, Vol. XIII.

<sup>2</sup> On the Lower Cambrian Age of the Stockbridge Limestone; Bul. Geol. Soc. of America, 1891.

<sup>3</sup> The Commercial Marbles of Vermont; 9th Rpt. Vt. State Geol. (1913-14).

<sup>4</sup> International Geological Congress, Guidebook No. 1, 1933.

flowage folds, which cause abnormal thickening of the beds and the formation of the marble deposits of commercial value, occur at the ends of this great thrust."

### *Chemical and Physical Properties*

Chemically, Vermont marble is one of the purest of rocks. The marbles recommended for use in buildings and memorials test about 99 percent calcium carbonate, the remainder consisting of silicates of iron, aluminum, and magnesium.

The "absorption" of Vermont marbles is only about one-tenth of one percent by weight. It thus has a lower absorption than any of the masonry products with which it comes into contact—granite, limestone, sandstone, slate, terra cotta, concrete, or mortar.

The crushing strength of Vermont marble can possibly be best expressed by saying that a tower could be built of it to a height of two and one-half miles before failure of the bottom course from compression would result.

### *Production*

Vermont is the greatest producer of marble in the United States (and probably in the world), exceeding her nearest competitor, Tennessee, by a small margin as regards tonnage, and to a much greater extent if dollar values be considered.

The latest figures available from the Bureau of Mines bulletin for 1932 are as follows:

State	Building and monumental		Other uses		Total	
	Cubic feet	Value	Short tons	Value	Short tons	Value
Alabama .....	96,790	\$ 380,158	35,310	\$ 34,391	43,540	\$ 414,549
Arkansas .....	16,750	36,996	2,850	3,226	4,280	40,222
California .....	10,910	35,905	4,510	12,004	5,440	47,909
Georgia .....	322,940	1,524,253	16,870	27,490	44,310	1,551,752
Missouri .....	189,340	384,661	39,580	18,278	55,330	402,939
New York .....	20,300	70,083	10,520	44,419	12,260	114,502
Tennessee .....	424,430	1,900,700	44,210	26,508	80,010	1,927,208
Vermont .....	937,300	2,611,246	640	7,965	80,300	2,619,211
Other States .....	95,680	353,289	9,210	60,728	17,360	414,017
	2,114,440	\$7,297,291	163,700	\$235,018	342,830	\$7,532,309

From these figures it is calculated that of the total dollar value of building and monumental marble produced, Vermont companies accounted for 35.8 percent; while of the total dollar value of all grades of marble, Vermont companies showed 34.8 percent.

### *Vermont Production*

The following figures, compiled from reports of the marble-producing companies of the State to the State Geologist, show very interestingly the trend of the industry from the boom days of 1929 to the present depression which, in this case, seems not to have reached its lowest depth.

	Production of building and monumental marble, in cu. ft.	Value
1929 .....	1,120,571	\$4,291,383
1930 .....	1,085,521	4,175,554
1931 .....	925,301	3,135,612
1932 .....	1,183,481	2,614,753
1933 .....	814,231	2,619,219
1934 (6 months) .....	163,351	499,865

### *Marble Companies*

#### THE VERMONT MARBLE COMPANY

Main office, Proctor.

Branch offices in the larger cities of the country.

Officers: President, Frank C. Partridge; vice-president, S. A. Howard; vice-president, Redfield Proctor; executive vice-president and treasurer, A. W. Edson; secretary, Benjamin Williams.

Quarries at Brandon, Danby, Dorset, Florence, Isle la Motte, Proctor, Rochester, West Rutland, Roxbury, St. Albans, Swanton; also in Alaska, Colorado, and Montana.

Fabricating plants at Florence, Middlebury, Proctor, Center Rutland, West Rutland, and Swanton.

Products: Memorials, mausoleums, exterior building stone, interior finish, garden furniture, gifts in marble, scale tops, imposing stones, electric switch boards, etc.

By-products: Fluxing material, road "metal," whitening substitutes, "Ver-marco" products,<sup>1</sup> chicken feed, etc.

#### RESEARCH DEPARTMENT

For the past twelve years the Vermont Marble Company has maintained a Research Department, studying the technical and scientific aspects of the marble business. This study has covered a wide range of subjects, such as: Cement for use with marble, physical and chemical tests of marble, use of bronze and other metals in conjunction with marble, care and cleaning of marble, development of stain removers, the dyeing of marble, weatherproofing methods for stone, new uses for marble and marble waste.

#### MARBLE EXHIBIT

The Vermont Marble Company has recently installed a beautiful exhibit of their products at Proctor.

In the exhibit there are fifty-five varieties of marble, each arranged in the shape of a three-sided booth. The booths vary from eight to sixteen feet in length and are uniformly six feet, seven inches high. The colors of the marbles run from pure white, "Secondary Statuary," through the "Westland Dark Cream," "Northern Pearl," "Neshobe Gray," "Pink

<sup>1</sup>See under Lime, p. 30.

Lepanto," "Variegated Champlain," "Royal Red," Verd Antique, "Champlain Black," and many other varieties. Besides the panels, there are displays of gifts in marble: Carved fireplaces, garden seats, baptismal fonts, bird baths, flower pots, etc., while the masterpiece is undoubtedly a carving, in white statuary marble, of Leonardo da Vinci's "Last Supper."

#### THE GREEN MOUNTAIN MARBLE COMPANY

Main office, Clarendon Springs.

Officers: President, P. F. McCormack; secretary-treasurer, E. B. Fleming.

Quarries at Clarendon Springs and West Rutland.

Fabricating plants at Clarendon Springs and West Rutland.

Products: Building and monumental marble—white, light variegated, blue.

*Note.*—This company succeeded the old Clarendon Marble Company in 1907.

#### THE VENETIAN MARBLE COMPANY

Main office, Rutland.

Officers: President, Frederick S. Chaffee; treasurer, Newman K. Chaffee.

Quarries at Pittsford.

Product: Blue, monumental marble.

Product goes to the Marble Manufacturing Company at Brandon.

#### THE COLONIAL MARBLE COMPANY

Head office, West Rutland.

Officer: President, R. V. Reynolds.

Quarries at West Rutland.

Products: Building and monumental marble.

#### *Marble Fabricators*

#### TEMPLE BROTHERS, INCORPORATED

Main office, Rutland.

Officers: President, J. R. Temple; treasurer, W. N. Temple.

Products: Monuments made from Vermont and other marbles.

#### THE RUTLAND MARBLE MANUFACTURING COMPANY

Office and fabricating plant at Brandon.

Officers: President, M. R. Brown; manager, E. A. Bellmore.

Business: Wholesale manufacturers of monuments which are sold to jobbers and retailers. Practically all Vermont marbles are used.

## Granite

Of the three mineral industries—granite, marble, and slate—granite seems to have suffered least by the depression. The Vermont granite industry is, however, practically confined to monumental rough and finished stone. The demand for structural granite has gradually declined until today the former great works at Woodbury are being dismantled, while the Bethel monzonite granite plant ("Bethel white") is closed.

The granite N.R.A. code was approved March 26, 1934, and the dealers here seem unanimous in believing that it will be helpful in enabling them more successfully to compete with those states in which cheaper labor has been employed.

#### *Occurrence*

The granite deposits of the State occur as intrusions into the Green Mountain metamorphic rocks. With the single exception of a small mass in Pleasant Valley, Underhill, these deposits lie east of the main range of the mountains and extend pretty much throughout the length of the State, from Derby on the north, to Dummerston on the south.

#### *Geology*

The geology and/or petrography of the granites has been described by Finlay,<sup>1</sup> Dale<sup>2</sup> and, more recently, by Balk.<sup>3</sup> It is not thought necessary to recapitulate their findings in this report, except as follows:

In 1907 Dale classified the granites of Vermont in three divisions: (1) Biotite granite, (2) quartz-monzonite, (3) hornblend-augite granite. The last named is not really granite but syenite, a rock having the texture and general properties of granite, but lacking the quartz component. Of these, the first is characterized by its large content of black mica (biotite) which, with the light minerals, give the "pepper and salt" effect; the second by its lack of biotite and its considerable content of oligoclase feldspar, giving the light gray, clouded appearance; while the third is not really granite at all, but a dark green variety of

<sup>1</sup>The Granite Area of Barre, Vt.; George I. Finlay, 3rd Rpt. Vt. State Geol. (1901-02).

<sup>2</sup>The Granites of Vermont; T. Nelson Dale, 6th Rpt. Vt. State Geol. (1907-08).

<sup>3</sup>Structural Relations of the Granites of Bethel, Barre and Woodbury; 15th Rpt. Vt. State Geol. (1925-26).



syenite, called nordmarkite, which is sold under the trade-name of "green granite."

The principal granite-producing centers of the State, grouped under Dale's classification, are (or have been) as follows:

Biotite granite	Quartz-monzonite	Hornblend-syenite
Barre	Bethel	Mount Ascutney <sup>1</sup>
Newark	Calais	(There are also large deposits of syenite at
Ryegate	Derby	Cuttingsville <sup>2</sup> and Mt.
Woodbury	Dummerston	Monadnock, Vt. <sup>3</sup> )
	Groton	
	Hardwick	
	Kirby	
	Randolph	
	Rochester	
	Ryegate	

### Petrography

Dale<sup>4</sup> has studied the petrography of the Vermont granites. For the Barre stone he shows that the mineral constituents, in descending order of abundance are: (1) Clear, colorless or bluish to translucent potash feldspar (microcline) with or without a little orthoclase, rarely minutely intergrown with a little soda-lime feldspar; (2) light smoky quartz, showing optical effects of strain, rarely with hair-like crystals of rutile, etc.; (3) bluish translucent to milk-white soda-lime feldspar (albite to oligoclase-albite, in some sections with flexed twinning lamellae), considerably kaolinized and micacized, and with plates of calcite; (4) biotite, some of it chloritized and associated with a little muscovite; (5) accessory minerals: pyrite, magnetite, titanite, allanite, apatite, zircon, rutile; (6) secondary minerals: kaolin, a white mica, calcite, epidote, chlorite. Exceptionally there are minute veins of quartz, calcite and epidote.

The Bethel quartz-monzonite is well described by Dale as "of slightly bluish milk-white color, with grayish spots up to 0.3 inches and 0.5 inches, and mica up to 0.3 inches." Its constituents, in descending order of abundance, are (1) bluish, milk-white, soda-lime feldspar (oligoclase), slightly kaolinized and micacized; (2) clear, colorless, rarely bluish quartz with hair-like crystals of rutile, and with fluidal or other cavities in sheets with cracks parallel to them; (3) very little clear, potash feldspar (microcline); (4) muscovite; (5) very little biotite; (6) accessory min-

<sup>1</sup> The Geology of Ascutney Mt.; R. A. Daly, Bul. U. S. G. S., No. 209, p. 51

<sup>2</sup> Eruptive Rocks of Cuttingsville, Vt.; J. W. Eggleston, 11th Rpt. Vt. State Geol. (1917-18).

<sup>3</sup> Mt. Monadnock, Vt., a Syenite Hill; J. E. Wolff, 17th Rpt. Vt. State Geol. (1929-30).

<sup>4</sup> *Op. cit.*

erals: apatite, titanite, zircon, rutile (no magnetite or pyrite detected); (7) secondary minerals: kaolin, a white mica, epidote and zoisite in some abundance, and very little calcite.

The nordmarkite has been described by Daly<sup>1</sup> as "a handsome dark green syenite, in this place (quarry on the flank of Mt. Ascutney, Windsor) characterized by medium to coarse grain." \* \* \* "It is a syenite with variable amounts of free quartz and a low percentage of colored constituents." \* \* \* "In addition to the feldspars and accessory quartz, the list of minerals includes, in order of their abundance, a hornblend, biotite, a pyroxene, allanite, titaniferous magnetite, apatite, pyrite, zircon, monazite, and a lime-iron garnet."

It may be interpolated that this "green granite" has not found much favor with the public. The great columns of the Columbia University Library, New York City, are the outstanding representatives of Ascutney syenite. At Ausable Forks, New York, a similar stone has been quarried to some extent and is to be seen as monuments in the local cemetery.

### Chemical Analyses

Only a few of the Vermont granites have been chemically analyzed. Two analyses of the Barre granite are available: The E. L. Smith stone (it is not stated whether the rock selected was "light Barre" or "dark Barre") which was analyzed in the U. S. Geological Survey laboratories, with the following results:

	Percent
Silica (SiO <sub>2</sub> ) .....	69.56
Alumina (Al <sub>2</sub> O <sub>3</sub> ) .....	15.38
Iron oxide (Fe <sub>2</sub> O <sub>3</sub> ) .....	2.65
Magnesia (MgO) .....	trace
Lime (CaO) .....	1.76
Soda (Na <sub>2</sub> O) .....	5.38
Potash (K <sub>2</sub> O) .....	4.31
Manganese (MnO) .....	trace
CO <sub>2</sub> and moisture .....	1.02
	100.06

The Pirie "dark Barre" shows (analyst not given):

	Percent
Silica .....	70.87
Alumina .....	15.96
Iron oxide (Fe <sub>2</sub> O <sub>3</sub> ) .....	2.63
Magnesia .....	1.13
Lime .....	1.56
Alkalies .....	5.78
CO <sub>2</sub> and moisture .....	1.08

<sup>1</sup> *Op. cit.*

99.01

The chemical composition of the nordmarkite is much more complex and, as the stone is no longer used, it is not given here. It may be found in Professor Daly's article cited above.

### Physical Tests

A good many requests for the physical properties of Vermont granites have been received by the Geologist. The following data, obtained by the Pittsburgh Testing Laboratory on the E. L. Smith Barre granite are, as far as the writer is aware, the only ones at present available:

*Crushing strength:* 22,750 pounds per square inch.

*Hardness:* Coefficient of 18.66 (name of test not stated).

*Toughness test:* An average toughness of 15 (made in accordance with American Association of Testing Materials method, using a Page impact machine).

*Absorption test:* Samples of Smith Barre granite were dried to constant weight at 210 degrees Fahrenheit and then immersed in water at a room temperature of 72 degrees Fahrenheit. The percentage of absorption after 24 hours was 0.265; after 48 hours, 0.330. There was no increase in absorption at the 72 and 96 hour periods.

*Specific gravity:* Tests made years ago by Whitman Cross, U. S. Geological Survey, on Jones' Brothers' Barre granite showed for the "Dark Barre," 2.672; for the "Medium Barre," 2.662.

### Production

Vermont's granite production is practically wholly confined to monumental stone. According to the figures of the U. S. Bureau of Mines, in 1929 Vermont produced 62 percent of the total cubic footage of monumental granite of the country; in 1930, 65 percent; in 1931, 84 percent; and in 1932, 54 percent.

Vermont production, by years, according to the same source was as follows:

	Rough		Dressed	
	Cubic feet	Value	Cubic feet	Value
1929 .....	1,305,110	\$3,755,177	45,840	\$339,070
1930 .....	1,168,400	3,348,938	included under "rough"	
1931 .....	867,060	2,351,918	29,930	124,434
1932 .....	650,460	1,610,197	5,280	42,410
1933, total cubic feet, estimated at 596,104.				
1934, six months, cubic feet, estimated at 423,457.*				

\* The greater part of the year's production, however, is quarried during the first six months.

### Production in the Barre District

The "Barre District"<sup>1</sup> produces about 90 percent of the total Vermont granite. The following interesting figures were furnished by the Barre Granite Dealers Association.

ESTIMATED OUTPUT, ETC., OF MONUMENTAL GRANITE IN BARRE DISTRICT, 1933

Total quarry output, rough stock, cu. ft. ....	575,046
Shipped out of Barre district, in rough, cu. ft. ....	115,009.2
Manufactured in Barre district, cu. ft. ....	460,036.8
Light stock consumed in district, cu. ft. ....	287,523
Dark stock consumed in district, cu. ft. ....	172,513.8
Number of cutters (approximately) .....	900
Average daily wage .....	\$8.00
Number of days worked .....	200
<hr/>	
Total payroll for year .....	\$1,440,000.00
Estimated overhead .....	720,000.00
Estimated value of light stock .....	898,508.65
Estimated value of dark stock .....	862,568.40
Estimated polishing cost .....	363,831.60
Output from saws .....	121,277.20
<hr/>	
Total value of granite .....	\$4,406,185.85

First six months, 1934

Total quarry output, rough stock, cu. ft. ....	412,128
Shipped out of Barre district in rough, cu. ft. ....	82,425.6
Manufactured in Barre district, cu. ft. ....	329,702.4
Light stock consumed in district, cu. ft. ....	206,064
Dark stock consumed in district, cu. ft. ....	123,638.4
Number of cutter (approximately) .....	900
Average daily wage .....	\$8.00
Number of days worked .....	100
<hr/>	
Total pay roll for one-half year .....	\$ 720,000.00
Estimated overhead .....	360,000.00
Estimated value of light stock .....	643,950.00
Estimated value of dark stock .....	618,192.00
Estimated polishing cost .....	260,753.40
Output from saws .....	86,917.80
<hr/>	
Total value of granite .....	\$2,689,813.20

### Active Granite Companies—Barre District

The active granite companies in the Barre district at the present time are Jones Brothers, J. K. Pirie Estate, the Rock of Ages

<sup>1</sup>In order to stop pirating, the Federal Trade Commission has defined the "Barre District for the Quarrying of Granite" as beginning at the southerly part of the city of Barre, Washington County, State of Vermont, and extending westerly about two and one-half miles, then southerly about four miles to and including Williamstown, in Orange County. All granite quarried elsewhere may not legally be named and advertised as "Barre granite" hereafter. The location indicated comprises the whole of the eminence south of Barre City locally known as Millstone Hill.

Corporation, E. L. Smith & Company, Wells & Lamson, and Wetmore & Morse, the last named being owned by Jones Brothers.

#### JONES BROTHERS COMPANY, INCORPORATED

Main office, 10 High Street, Boston, Massachusetts.  
 Branch office, 700 Main Street, Barre, Vermont.  
 Officers: President, M. Walker Jones; vice-president, Marshall J. England; treasurer, Seward W. Jones.  
 Quarries at Graniteville, East Barre.  
 Fabricating plant, 700 Main Street, Barre.  
 Products: Monuments and mausoleums, granite machinery, rolls for paper companies and chocolate grinding, ornamental sundials, garden seats, etc.

#### J. K. PIRIE ESTATE

Main office, Barre.  
 Trustees and managers, James G. and Fred F. Pirie.  
 Quarries in South Barre and Williamstown.  
 Cutting plant, none. This company simply quarries granite.  
 Products: Mostly dark Barre granite, some light Barre.

#### ROCK OF AGES CORPORATION

*Note.*—This corporation is a consolidation of the following old companies: Boutwell, Milne & Varnum, Barclay Brothers, Canton Brothers, E. A. Chase Granite Company, Eureka Granite Company, Gearson & Lane, Lawrence Granite Company, William Milne Company, Perry Granite Corporation, Phillips & Slack, and George Stratton Granite Company.

Main office, 206 Bank Street, Burlington.  
 Officers: President, Roy L. Patrick; vice-president, Harry A. Way; treasurer, Joseph T. Smith; clerk, Warren R. Austin.  
 Quarries at Graniteville, East Barre.  
 Fabricating plants at Barre, Montpelier, Northfield, Waterbury.  
 Products: Monuments and mausoleums.

#### E. L. SMITH & COMPANY

Main office, Barre.  
 Officers: President, Frank M. Corry; vice-president, Donald W. Smith; treasurer, William L. Wheaton.  
 Quarries at Graniteville.  
 Fabricating plant, none. The company simply quarries granite.  
 Products: Light and dark Barre granite.

#### WELLS & LAMSON QUARRY COMPANY

Main office, Barre.  
 Officers: President, Marshall J. England; treasurer, H. Brandon Jones.  
 Quarries at Websterville, East Barre.  
 Fabricating plant, 700 North Main Street, Barre.  
 Product: Light Barre granite.

#### WETMORE & MORSE GRANITE COMPANY

Main office, Montpelier.  
 Officers: President, Frank N. Corry; vice-president, William F. Corry; treasurer, Edward H. Deavitt.  
 Quarries at Websterville.  
 Product: Rough Barre granite, light and medium.

#### Other Active Granite Companies

##### FLETCHER QUARRY

Office, Woodbury.  
 Proprietor, E. R. Fletcher.  
 Quarries at Hardwick.  
 Cutting and finishing done at the quarry.  
 Product: Woodbury granite.

##### PRESBREY-LELAND QUARRIES, INCORPORATED

Main office, 681 Fifth Avenue, New York City.  
 Manufacturing office, Brattleboro.  
 Officers: President, C. H. Presbrey; treasurer, F. C. Presbrey; manager of fabricating plant, W. S. Martin.  
 Quarries at West Dummerston.  
 Fabricating plant, Brattleboro.  
 Product: Dimension stone for monuments and mausoleums.

##### ADAMANT QUARRY COMPANY

Main office, Montpelier.  
 Officers: President, Henry Daniels; vice-president, W. E. Patch; secretary-treasurer, R. B. Daniels.  
 Quarry at Adamant, East Montpelier.  
 Fabricating plant, none.  
 Products: Light and medium granite.

#### Granite Cutters

Besides the firms quarrying and cutting granite there are over a hundred concerns engaged in cutting operations. Those forming the members of the Barre Granite Association, Incorporated, are given in the following list:

##### BARRE

Abbiati & Fontana  
 Acme Granite Company  
 Adams Granite Company  
 Aja Memorial Works  
 American Granite Company  
 Anderson-Friberg Company, Inc.  
 Anderson & Johnson  
 Barre Hickey Mill  
 Barre Memorial Company  
 Batchelder Company, E. J.  
 Beck & Beck  
 Bergeron & Son, Louis  
 Bianchi & Sons, Charles  
 Bilodeau & Company, J. O.  
 Brusa Brothers  
 Burke Brothers  
 Buttura & Sons  
 Caccavo Granite Company  
 Carroll Brothers  
 Celente & Bianchi

Cerasoli & Cerasoli  
 Chioldi Granite Company  
 Comolli & Company  
 Cook, Watkins & Patch  
 Dessureau & Company  
 Gerrard-Barclay Granite Company  
 Giudici Brothers & Company  
 Granite Memorial Shop  
 Gearson & Lane Company  
 Harrison Granite Company  
 Hebert & Ladrie  
 Herrera & Reales Granite Company  
 Hinman Company, H. P.  
 Hoyt & Milne, Inc.  
 Imperial Granite Company  
 Industrial Granite Company  
 Initial Granite Company  
 Johnson & Gustafson  
 Johnson, E. F.  
 Jones Brothers Company  
 Jones Brothers Dark Quarry Company

Lawson Granite Company  
 Letter Granite Company  
 Liberty Granite Company  
 Littlejohn, Odgers & Milne  
 Macetti, Paul  
 McDonnell & Sons  
 Malo Granite Company  
 Marr & Gordon, Inc.  
 Milne Granite Co., Alex.  
 Modern Granite Company  
 Morlote Granite Co., S.  
 Nativi Granite Company  
 North Barre Granite Company  
 Novelli & Calcagni  
 Olliver & Company  
 Orlandi Granite Company  
 Parnigoni Brothers  
 Peerless Granite Company  
 Pena Granite Company  
 Pirie Estate, J. K.  
 Puente Granite Company  
 Revilla Granite Co., J.  
 Robins Brothers  
 Rock & Sons, E. N.  
 Roux Granite Company  
 Saporiti, Wm.  
 Shield, Waldron Company  
 Sierra Granite Co., R.  
 Smith & Co., E. L.  
 South Barre Granite Company  
 Steele Granite Company  
 Stewart Turning Works, R. J.  
 Union Granite Company  
 Usle & Perojo Granite Company  
 Usle & Revilla  
 Valz Granite Company  
 Wells-Lamson Quarry Company  
 White Granite Company  
 Zampieri & Buttura

#### MONTPELIER

Arioli Granite Company, G.  
 Bonazzi & Bonazzi

Capitol Granite Company  
 Columbian-Artistic Granite Com-  
 pany  
 Desilets Granite Company  
 Doucette Brothers  
 Everlasting Memorial Works  
 Excelsior Granite Company  
 Gill & Company, C. P.  
 Green Mountain Granite Company  
 Johnson Granite Company  
 Jurras Granite Company  
 Mills & Company  
 Montpelier Granite Company  
 National Granite Company  
 Sheridan & Poole  
 Wetmore & Morse Granite Com-  
 pany  
 United Granite Company

#### NORTHFIELD

Cross Brothers Company  
 Pando Granite Company

#### WATERBURY

O'Clair Granite Works  
 Union Granite Company

#### RIVERTON

Davis Brothers Company  
 Provost Granite Company

#### WILLIAMSTOWN

Williamstown Granite Company

#### EAST BARRE

World Memorial Granite Company

## Slate

Of all the Vermont mineral industries, slate has undoubtedly suffered the most severely during the business depression. The stagnation in building construction throughout the country and the competition of slate substitutes for roofing, electrical switchboards, etc., have been accountable for idle quarries and closed mills, with their accompanying extreme unemployment. Many quarries are full of water and the fabricating plants are leading a hand-to-mouth existence. It is to be hoped that the worst is over and that Federal home loans and other agencies will aid in the revival of this very important Vermont industry.

### *Occurrence*

There are four slate belts in Vermont: One along the Connecticut River from Barnet to Guilford, the second from Lake Memphremagog to Northfield, the third, an area of black slate in the town of Benson, and the fourth and most important, extending from Sudbury to Rupert. Of these only the last named is of present commercial importance. Here slate quarries are found from Lake Bomoseen, on the north, to West Pawlet, on the south. In this belt Castleton, Hydeville, Fair Haven, Poultney, Wells, and West Pawlet are the "slate towns," while in the adjacent New York slate district, Granville is the center of the industry.

### *Geology*

Dale and others<sup>1</sup> have shown that the commercial slate belt of Vermont, which lies between the Taconic Mountains and the Lake Champlain lowland, is of lower Cambrian and Ordovician age and is associated with calcareous quartzite and beds of limestone conglomerate. In this bulletin Dale has gone very fully into the structure, mineralogical and chemical composition of the various kinds of slate. Bulletin 586 is the standard reference work on the subject.

### *Varieties of Slate*

Vermont is famous, if not unique, in the possession of colored slates: Sea-green, unfading green, purple, mottled, variegated, etc. The area of black slate in Benson appears not to have been

<sup>1</sup> Slate in the United States; T. Nelson Dale and others, Bul. 586, U. S. Geological Survey.

a commercial success. Of these slates, those occurring north of Poultney are known as "unfading," from the permanency of their colors; those south, as "fading"; while in Poultney itself both unfading and fading slates occur. The cause of these colors, and of their fast or fading qualities, is an interesting one which Dale discusses in his bulletin.

### Production

Vermont stand second only to Pennsylvania, in the United States, in the production of slate.

Year	Dollar value in United States	Pennsylvania	Vermont
		Percent	Percent
1928 .....	\$11,472,291	41.7	34.7
1929 .....	11,245,178	42.6	32.0
1930 .....	7,911,618	45.9	31.1
1931 .....	5,498,336	50.8	27.4
1932 .....	3,104,300	43.6	28.4
1933 .....	2,731,000	...	...

The figures show very impressively the great decrease in slate production during the depression.

### "N.R.A."

Some of the large producers claim that the slate industry is being ruined by an increasing number of small jobbers of inferior slate, and that codes of fair competition, whether N.R.A. or otherwise, honestly lived up to, are absolutely essential to the future of the slate business.

### Slate Companies

*Note.*—On his recent visit to the slate district the writer found the following companies to be organized for business and more or less active. It is possible that some of the many organizations have been omitted, but the list is reasonably complete.

#### Castleton

The large quarries and mill of the Staso Milling Company are located in Castleton, just south of the village. The headquarters are at Poultney.

### Hydeville

#### THE HINCHEY CONSOLIDATED SLATE COMPANY

This company is a consolidation of the P. F. Hinchey Slate Company, the G. R. and J. F. Hinchey Slate Company, and the General Slate Company.

Main office, Hydeville.

Officers: President, James Hinchey; treasurer, M. H. Fain.

Quarries at North Poultney and Fair Haven.

Fabricating plants at Hydeville, North Poultney, Fair Haven.

Products: Unfading green, unfading mottled purple and green slate, sold as roofing slate and mill stock (electrical panels, billiard slabs, flooring, flagging, etc.)

#### THE HYDEVILLE SLATE WORKS

This partnership has succeeded the old McDougal & O'Day Company.

Partners: J. O'Day and F. D. O'Day.

Quarry at Castleton (north of the village).

Plant at Hydeville.

Products: Panels for switchboards, flagging, etc.

### Fair Haven

#### S. ALLEN'S SONS

This partnership purchased the old Eureka Slate Company many years ago.

Main office, Fair Haven.

Partners: George H. V. Allen, A. Vail Allen.

Quarries and cutting mills in Fair Haven.

Products: Roofing slate, unfading green, purple, mottles, etc.

#### HARVEY BUSH SLATE COMPANY

Main office, Fair Haven.

Partners: Joel Griffith, Mrs. Joel Griffith, John R. Griffith.

Quarries at Scotch Hill, Fair Haven.

Products: Unfading green, mottled, purple, gray, sold as roofing slate, and flagging.

#### DURICK KEENAN & COMPANY

Main office, Fair Haven.

Officers: President, J. R. Durick; secretary-treasurer, Josephine E. Durick.

Quarries at Scotch Hill.

Business: Quarriers, manufacturers and jobbers of "everything in slate."

#### THE CARBODY WILLIAMS SLATE COMPANY

Office, Fair Haven.

President, Owen Roberts.

Quarry in Fair Haven.

Products: Unfading green slate and flagging.

THE FAIR HAVEN MARBLEIZED SLATE AND VERMONT  
STRUCTURAL SLATE COMPANY

Main office, Fair Haven.

Officers: President, Frank E. Allen; treasurer, M. A. Owens; manager, A. L. Carpenter.

Quarries at Castleton, Fair Haven, and Poultney.

Products: All unfading colors, except red, made into roofing and structural slate (flooring, electrical slate, etc.) Also marbleized slate.

This company recently celebrated its seventy-fifth birthday and is the oldest slate company in Vermont—and perhaps in the United States.

LINCOLN SLATE COMPANY

Office in Fair Haven.

President, Daniel Flaherty.

Quarry at North Poultney.

Business: Sells mill stock and makes flagging.

MAHAR BROTHERS SLATE COMPANY, INCORPORATED

Main office, Fair Haven.

Officers: President, George M. Mahar; vice-president, and general manager, Thomas Mahar; secretary-treasurer, Edward F. Mahar.

Quarries in Poultney and Castleton.

Fabricating plants: Roofing slate mill in Poultney; electrical and structural mill in Hydeville.

Products: Unfading purple, unfading mottled green and purple slate, sold mostly as roofing slate, but also for electrical and structural purposes.

This company also leases the Minogue Brothers & Quinn mill at Hydeville.

OLD ENGLISH SLATE COMPANY

This company has been bought out by the Hydeville Slate Works.

PEDRO BROTHERS PARTNERSHIP

Office, Fair Haven.

Partners: Joseph Pedro, Rivese Pedro, Tony Pedro, John Foote, Domick Sbardella.

Quarry at Scotch Hill.

Products: Unfading green, mottled green and purple, gray slate sold as roofing slate and flagging.

W. H. PELKEY SLATE COMPANY

The proprietor has died and the estate is being settled.

THE SCOTCH HILL SLATE COMPANY

Proprietor, Richard Griffith.

Product: Roofing slates.

VARIEGATED SLATE COMPANY

Office at Fair Haven.

President, Connie Hayes.

Quarry at Fair Haven.

Products: Green and variegated structural slate and flagging.

*Poultney*

THE AULD & CONGER SLATE COMPANY

This company has been sold to C. R. Beach of Fair Haven.

THE CAMBRIAN SLATE COMPANY

Main office, Granville, N. Y.

Officers: President, David O. Roberts; secretary-treasurer, Iola San. Quarry at Poultney.

Products: Sea-green and variegated roofing slate.

LANDSCAPE SLATE AND ROOFING COMPANY

Office at Poultney.

Officers: President, D. O'Brien Owen; vice-president, W. Harry Williams; treasurer, Russell I. Williams; sales manager, Geo. W. Sutter.

Quarries at Poultney.

Products: Roofing and flagging.

H. A. MATOT

Office at Poultney.

Quarries at Poultney, and in New York.

Products: All colors of Vermont slate, sold as roofing and flagging.

MONTVERT SLATE COMPANY, INCORPORATED

Office at Poultney.

Officers: President, George Ebel; vice-president, W. Harry Williams; treasurer, Russell I. Williams.

Quarries at Poultney and in New York.

Products: Roofing and flagging.

NEW ENGLAND SLATE COMPANY

Main office, Poultney.

Officers: President, Thomas J. Hughes; treasurer, E. Evans.

Quarries at Poultney.

Products: Roofing and flagging.

THE STASO MILLING COMPANY

Home office, Chicago.

Vermont office, Poultney.

General manager, Charles T. Kett.

Quarries at Castleton and in New York.

Fabricating plant at Castleton.

Product: Slate roofing granules.

Capacity of plant, 150 tons a day.

The company also has quarries and mills in Maryland, Georgia, and Michigan.

*Wells*

NORTON BROTHERS

Main office, Granville, N. Y.

Proprietor, E. R. Norton.

Quarries at Wells and at Pawlet.

Products: Roofing slate and flagging.

## OWEN L. WILLIAMS &amp; SON

Office at Granville, N. Y.  
 Quarry at Wells.  
 Product: Roofing slate.  
 Dealers in all slate products.

*Pawlet*

## OWEN W. OWENS SONS, INCORPORATED

Main office, Granville, N. Y.  
 Officers: President, D. O. Owens; vice-president, W. R. Owens; secretary, D. O. Owens, Jr.  
 Quarries and mill at Pawlet.  
 Products: Roofing slates.  
*Note.*—The Progressive Slate Company, of Granville, has been merged with the above corporation.

## THE O'BRIEN SLATE COMPANY, INCORPORATED

Main office at Granville, N. Y.  
 Officers: President and secretary-treasurer, James O'Brien.  
 Quarries at Pawlet.  
 Product: Roofing slate.

*West Pawlet*

## RISING &amp; NELSON SLATE COMPANY

Main office, West Pawlet.  
 Partners: S. M. Rising, T. S. Nelson, A. H. Morrill.  
 Quarries and mills at West Pawlet, Poultney, Fair Haven, and in Maine.  
 Products: Roofing, flagging, flooring, etc.

## Talc

For many years Vermont has been one of the largest producers of ground talc in the Union, in one or two years exceeding New York in tonnage; in others, standing second only to that state.

Many uses have been found for Vermont talc; for example, in the paper, rubber, foundry, and roofing trades, in bleacheries, in wire and cable insulation, in soap, polish, and cosmetic manufacture, as wall plaster, etc., etc.

In the northern part of the State, the consolidation of several former companies, with the resulting closing of unprofitable mines and mills, has placed the industry in a position to profit by the return to normal business conditions; while, in southern Vermont, three independent companies are well established and capable of largely increasing their outputs as a larger demand for their products arises.

*Occurrence*

Vermont possesses very numerous and very extensive deposits of talc. The writer<sup>1</sup> has shown that these take the form of irregular lenses, or pods, which lie in two broken chains within the folds of the Green Mountains. There are not less than thirty-five known occurrences of talc in the State.

The western chain possesses the greater number of lenses and stretches from Canada to Massachusetts, including those in the townships of Berkshire, Enosburg, Montgomery, Waterville, Johnson, Cambridge, Duxbury, Stowe,<sup>2</sup> Moretown, Fayston, Warren, Rochester, Plymouth, Ludlow, Andover, Dover, and Marlboro. The eastern chain is shorter. It includes the deposits at East Granville, Braintree, Reading, Cavendish, Chester, and Windham. The old soapstone deposits of Chester, Grafton, and Athens, now pretty well exhausted, belong on this chain.

*Geology*

The geology of the talc deposits has been studied by E. C. Jacobs,<sup>3</sup> J. L. Gillson,<sup>4</sup> and more recently by H. H. Hess.<sup>5</sup> The

<sup>1</sup> The Talc and Serpentine Deposits of Vermont; 10th Rpt. Vt. State Geol., 1915-16.

<sup>2</sup> There is a very extensive deposit of talc on the west shore of Sterling Pond. It extends for a mile or more northeasterly towards the summit of Mount Madonna and has also been noted on the Hell Brook trail of Mount Mansfield.

<sup>3</sup> Talc and the Talc Deposits of Vermont; 9th Rpt. Vt. State Geol., 1913-14.

<sup>4</sup> The Talc and Serpentine Deposits of Vermont; 10th Rpt. Vt. State Geol., 1915-16.

<sup>5</sup> Origin of Vermont Talc; Economic Geology, Vol. 22, 1927.

<sup>6</sup> Origin of Certain Asbestos and Talc Deposits; Economic Geology, Vol. 27, 1933.

theories of these writers as to the origin of the talc are quite at variance. Whichever theory is the correct one, it is undoubtedly true that the talc is closely associated with the belt of basic intrusives which extends southward from the serpentine deposits of southern Quebec throughout the length of the State. There is clear, petrographic proof that the talc in some of the deposits, at least, was derived from serpentine which, in turn, was a metamorphic product of pyroxenite, peridotite or dunite.

### Production

From the latest report on the Talc and Soapstone industry by the United States Bureau of Mines (August 7, 1934), the following interesting information has been taken:

"The talc-bearing states in 1933 were California, Georgia, Maryland, Michigan, New Jersey, New York, North Carolina, Pennsylvania, Vermont, Virginia, and Washington.

"In 1933 the talc and soapstone industry made substantial gains in commercial output. Compared with 1932, total shipments by 29 producers registered increases of 30.3 percent in quantity and 23.5 percent in value. The 1933 figures reveal decreases of about 30 percent in quantity and 36 percent in value from the high output of 1929."

"Compared with 1932, average prices as reported by producers showed little change. Ground talc and soapstone, which comprise more than 95 percent of the total shipments, ranged from \$2.50 a short ton for low-grade material to \$30.00 a ton for the highest grade of ground talc.

"The total quantity of talc and ground soapstone sold by producers in the United States in 1933 was 160,000 short tons, valued at \$1,681,324, according to individual reports furnished by producers. Corresponding figures for 1932 were 123,221 short tons, valued at \$1,361,633."

*Note.*—As far as the writer is informed, no soapstone is being produced in Vermont today. The old quarries at Grafton and Athens are apparently exhausted.

### Vermont Production

At present the talc-producing companies in the State are The American Soapstone Finish Company, The Eastern-Magnesia Talc Company, The Vermont Mineral Products Company, and The Vermont Talc Company. Their combined production and average selling price, reported directly to the Geologist, are shown as follows:

	1929	1930	1931	1932	1933	Six months, 1934
Short tons....	60,397	45,825	38,396	30,696	36,225	17,743
Average selling price .....	\$8.17	\$7.92	\$7.82	\$7.76	\$7.38	\$8.26

### Uses of Talc

Again quoting from the Bureau of Mines bulletin, one notes that domestic talc and ground soapstone have been used as follows:

"In 1931 and 1933 about 96 percent of the total talc and soapstone output was ground to a powder, and found application in many industries. The following table shows the approximate percentage of talc and ground soapstone that entered the industries listed.

Industry	1931 Percent of total	1933 Percent of total
Paint .....	48	42
Paper .....	16	15
Roofing .....	11	10
Rubber .....	11	9
Toilet preparations .....	3	1
Foundry facings .....	1	7
Ceramics .....	1	7
Miscellaneous <sup>2</sup> .....	9	17
	100	100

### Prospects

Among the talc producers there is undoubtedly a feeling of encouragement and a hopeful view of the future. The industry has not suffered as severely as have the slate, granite and marble, as regards tonnage production, while prices have been better maintained.

### N.R.A.

The organization of the National Association of Talc and Soapstone Producers was effected on August 3, 1933, and it has, according to Mr. John B. Aikman of The Vermont Talc Company, been of decided benefit in bringing the members of the talc fraternity into close contact. The Talc Code was made effective on April 1, 1934. Price cutting has been the bane of the talc business for many years, and it is believed that the provisions of the code are capable of rectifying this condition.

<sup>1</sup> Bureau of Mines not at liberty to publish figures.

<sup>2</sup>1931: Includes talc or ground soapstone for waterproofing concrete, in pharmaceutical products, plastic cement, wall plaster, electric insulation, textiles, stove linings, lubricants, cleansing preparations, cork, and other goods; 1933: Includes in addition to uses enumerated for 1932, talc or ground soapstone used in toilet preparations, for foundry facings, as a backfiller for bleacheries, for rice polishing, wax fillers, mine dusting, asphalt filler, and other purposes."



*The Talc Producing Companies*THE AMERICAN SOAPSTONE FINISH COMPANY,  
INCORPORATED

Main office, Chester Depot.

Officers: President, W. N. Holt; treasurer, E. E. Holt.

Quarry, 4½ miles from Chester Depot.

Product: A "mongrel" soapstone and talc, used largely by roofing manufacturers.

## THE EASTERN-MAGNESIA TALC COMPANY, INCORPORATED

This corporation is a consolidation of the former American Mineral Company of Johnson, Eastern Talc Company of Rochester, and Magnesia Talc Company of Moretown. Consolidation was effected January 1, 1924.

Main office, Burlington.

Officers: President, John S. Patrick; vice-president, Joseph T. Smith; treasurer, Roy L. Patrick.

Mines at Johnson and Moretown.

Grinding plants at Johnson and Moretown.

Products: Ground talc at Johnson; ground talc and pencil stock at Moretown.

THE VERMONT MINERAL PRODUCTS COMPANY,  
INCORPORATED

Main office, Chester.

Officers: President, Harry F. Douglas; secretary, Walter H. Austin; treasurer-manager, Forrest H. Guild.

Quarry at Chester.

Products: Micaceous soapstone and talc.

## THE VERMONT TALC COMPANY

Main office, Chester Depot.

Officers: President, Nathan P. Avery, Holyoke, Mass.; secretary, Giles Blague, Springfield, Mass.; treasurer, John B. Aikman, Chester, Vt.

Quarries at Windham, Vt.

Grinding mill at Chester Depot.

Product: Finely ground talc.

## Asbestos

The great belt of serpentine rock of southern Quebec, made famous by the asbestos mines of Thetford, Black Lake, etc., extends as a broken chain throughout the length of Vermont.

In the northern part of the State the belt is wide, and in it chrysotile asbestos is found developed to varying degrees from Lowell and Eden to Moretown. Farther south the metamorphism of the serpentine has been to talc.

In Lowell, Belvidere Mountain is largely made up of asbestos-bearing serpentine which, however, is abruptly faulted against a great mass of amphibolite.

The geology of the Vermont serpentine and its associated asbestos has been studied and written about by J. F. Kemp,<sup>1</sup> V. F. Marsters,<sup>2</sup> C. H. Richardson,<sup>3</sup> E. C. Jacobs,<sup>4</sup> Edw. Wigglesworth,<sup>5</sup> and S. B. Keith and G. W. Bain<sup>6</sup>.

Asbestos mining and milling on Belvidere Mountain have been carried on, intermittently, for over thirty years.

The deposit was first opened up,<sup>7</sup> on the south side of the mountain, in 1900 when the New England Asbestos Corporation was active. Since the demand of the asbestos industry at that time was for long, spinning fiber and since the mountain yields only short fiber, the venture failed within a year.

Another attempt was made some ten years later, but after four or five years of intermittent work, operations were suspended. The property was in litigation till 1919 when the Asbestos Corporation of America was formed to take over the New England property, together with the so-called Brown lot on the west, and the Gospel lot on the east.

Owing to the depression of 1921 and perhaps to other causes this corporation was also unsuccessful in its efforts. Further litigation followed till about 1929 when the Vermont Asbestos Corporation was formed and has been in operation ever since.

On the southeast side of Mount Belvidere the old Gallagher property, comprising about a thousand acres of mineral lands, was opened up by the Lowell Asbestos and Lumber Company in 1910

<sup>1</sup> Notes on the Occurrence of Asbestos in Lamoille County; Mineral Resources of the United States (1901-02).

<sup>2</sup> The Serpentine Belt of Lamoille and Orleans Counties; 4th Rpt. Vt. State Geol. (1903-04).

<sup>3</sup> Asbestos in Vermont; 7th Rpt. Vt. State Geol. (1909-10).

<sup>4</sup> The Talc and Serpentine Deposits of Vermont; 10th Rpt. Vt. State Geol. (1915-16).

<sup>5</sup> The Serpentine of Vermont; *Ibid* (1915-16).

<sup>6</sup> Chrysotile Asbestos; Economic Geology, Vol. 27, No. 2.

<sup>7</sup> Report by Chester G. Gilbert.

and a mill was built capable of treating about 150 tons of rock a day. This was an ambitious venture and a small mining community, known as Chrysotile, sprang up. Due to one cause or another mining and milling operations on this property have never been successful.

In recent years new uses have been found for asbestos, such as pipe covering, insulation, asbestos cement, fireproof paint, road surfacing, asbestos shingles (about 15 percent asbestos and 85 percent Portland cement), asbestos paper, millboard, and brake linings. For these purposes the short fibered mineral is adequate and, therefore, the possibility of a successful asbestos industry in Vermont is increased. The only other known deposits of asbestos in this country are in Alaska, Arizona, and Washington. Domestic production is so small that in 1933 it filled only about 3.8 percent of the demand, the balance being imported, mostly from Canada.

In the Ural Mountains district Russia possesses enormous quantities of high-grade asbestos with which, following the lifting of the embargo by the present Administration in the spring of 1933, she could probably destroy competition in United States markets. This threat has not been carried out and the explanation seems to be that the Soviet is developing an asbestos industry of its own which at present, at any rate, is absorbing Russian production.

#### *Production*

According to bulletins of the U. S. Bureau of Mines the production of asbestos mined in the United States in 1933 showed a considerable increase compared with that of 1932. The total domestic production in 1933 was 4,745 short tons, valued at \$130,677, compared with 3,559 short tons, valued at \$105,292 in 1932. The production, therefore, increased 33⅓ percent in tonnage and 24 percent in value. The product was practically all chrysotile asbestos and came almost entirely from Vermont. That this country produces only about 3.8 percent of its requirements is shown by the fact that the total imports in 1933 were 119,494 short tons.

The following figures, again taken from the Bureau of Mines bulletins, show how the domestic marketed production and prices have varied during the past six years.

Year	Short tons	Dollar value
1928 .....	2,239	\$351,178
1929 .....	3,155	351,004
1930 .....	4,242	289,284
1931 .....	3,228	118,967
1932 .....	3,559	105,292
1933 .....	4,745	130,677

#### *Uses and Prices of Asbestos*

PRICES PER SHORT TON OF ASBESTOS, F.O.B., QUEBEC, CANADA, MINES<sup>1</sup>  
(Tax and bags included)

	1932	1933	
		January-November	December
Crude No. 1 .....	\$400.00-\$450.00	\$400.00-\$450.00	\$450.00
Crude No. 2 .....	200.00	200.00- 225.00	\$200.00- 225.00
Spinning fibers .....	75.00- 125.00	80.00- 125.00	90.00- 135.00
Magnesia and compressed sheet fibers .....	70.00- 125.00	80.00- 90.00	90.00- 100.00
Shingle stock .....	45.00- 65.00	45.00- 60.00	45.00- 65.00
Paper stock .....	27.50- 35.00	30.00- 35.00	32.50- 37.50
Cement stock .....	15.00- 20.00	18.00- 20.00	19.00- 23.00
Floats .....	10.00- 15.00	15.00- 18.50	16.00- 18.50
Short fibers .....	10.00- 14.00	10.00- 12.50	11.00- 14.50

#### PRICES OF ASBESTOS MINED IN VERMONT

Shingle stock .....	\$ 40.00-\$ 45.00	\$ 40.00-\$ 45.00	\$ 50.00-\$ 60.00
Paper stock .....	30.00- 35.00	30.00- 35.00	35.00
Cement stock .....	18.00- 22.00	18.00- 22.00	23.00

#### *Asbestos-Producing Company*

#### THE VERMONT ASBESTOS CORPORATION

Main office, Hyde Park, Vt.  
Officers: President, T. E. Byrnes; vice-president, F. E. Byrnes; treasurer, Caleb Loring; secretary, B. W. McFarland.  
Mine and mill at Belvidere Mountain, Eden.  
Product: Asbestos fiber.

#### *Production*

The corporation began the production of fiber in 1929. Since then the annual tonnage, reported directly to the Geologist, has been:

<sup>1</sup>Quotations from the *Engineering and Mining Journal*, Metal and Mineral Market Reports.

	Short tons		Short tons
1929 .....	1,170.3	1932 .....	3,558.75
1930 .....	3,530.25	1933 .....	4,964.8
1931 .....	2,980.4	1934 (to September 1) .....	4,265.1

Comparing these figures with those of the Bureau of Mines, given above, one sees that in 1930 the Vermont corporation produced 83 percent of the total domestic tonnage; in 1931, 92 percent; and in 1932, practically 100 percent. There is a discrepancy between the Vermont corporation's figures for 1933 and those of the Bureau of Mines.

### Notes

The corporation possesses a modern mill capable of treating 7,500 short tons of fiber annually.

In 1933 the yield of fiber was 8.75 percent of the rock milled.

The corporation has extended the open cut of its predecessors some 300 feet into the mountain and has found increasingly rich asbestos-bearing serpentine.

A three months' sample of the finished product showed the following analysis:

	Percent
SiO <sub>2</sub> .....	36.27
Al <sub>2</sub> O <sub>3</sub> .....	2.51
Total Fe as Fe <sub>2</sub> O <sub>3</sub> .....	5.43
CaO .....	2.18
MgO .....	38.12
H <sub>2</sub> O .....	15.21
Alkalies (by difference) .....	.28
	100.00

### Exploration on the Gallagher Property

During the spring and summer of 1934 the Johns-Manville Asbestos Corporation employed the Sullivan Machine Company of Claremont, New Hampshire, and Pennsylvania, to explore the old Gallagher property for asbestos by means of diamond drilling. It was planned thoroughly to investigate the asbestos content of the serpentine to depths as great as 300 feet. Presumably, if the drill cores indicate sufficiently rich rock, important developments will follow.

## Lime

In many parts of Vermont one sees the remains of small, abandoned limekilns which bear silent testimony to the activity of lime burners in the old days of small business and individual initiative.

On a larger scale Vermont lime, whose high degree of purity is generally recognized by the trade, has been burned for nearly a century and has been used by farmers for "sweetening" their acid soils, in the building, paper, and leather trades, in the manufacture of pharmaceutical preparations, etc.

The lime industry in Vermont, as well as in other parts of the country, has suffered from the introduction of gypsum, cement, and "ready-mixed" plasters as substitutes, while, of course, the prevailing business depression has accentuated the whole situation.

Within the last twenty years hydrated lime (calcium hydroxide) has made its appearance as a commercial product and has found much favor with lime users for certain purposes.

### Occurrence

In the State, both east and west of the mountains, there are roughly aligned series of outcrops of metamorphosed limestones and dolomites. The late Mr. T. Nelson Dale<sup>1</sup> described those east of the mountains where, of late years, only one lime-burning company has been active, the Amsden Lime Company at Weathersfield.

But west of the mountains, among the Cambro-Ordovician terranes of the Champlain Valley, there are beds of very pure limestone which form the basis of the State's lime industry. The beds being worked at present are located in Swanton, Fonda Junction, Winooski, New Haven Junction, and Leicester Junction, while at Proctor selected waste marble is burned and hydrated.

### Production

The lime production, including hydrate, for the past five and one-half years, as compiled from the returns of the individual companies to the Geologist, are as follows:

<sup>1</sup>The Calcite Marble and Dolomite of Eastern Vermont; 9th Rpt. Vt. State Geol. (1913-14).

	Short tons	Value
1929 .....	43,923	\$362,169
1930 .....	40,648	319,108
1931 .....	31,218	236,508
1932 .....	29,027	194,359
1933 .....	30,753	200,582
1934 (six months) .....	20,852	128,352

Here again it should be noted that the first six months' production is not a true criterion for the year, since probably more lime is burned then than during the balance of the year.

### *Producing Companies*

#### CHAMPLAIN VALLEY LIME COMPANY

Main office, Worcester, Mass.  
 Branch office, Winooski.  
 Officers: President, H. D. Brewer; secretary, Fred C. Smith; manager, R. W. Foster.  
 Quarry and kilns, Winooski.  
 Products: See Green Mountain Lime Company.

#### THE GREEN MOUNTAIN LIME COMPANY

Main office, Worcester, Mass.  
 Branch office, Winooski.  
 Officers: President, H. D. Brewer; secretary, Fred C. Smith; manager, R. W. Foster.  
 Products of both the above companies: Building, chemical, spraying, agricultural limes, etc.

Among the hydrated lime brands produced by the Green Mountain Lime Company are: "Chemical Hydrate," "Masons' Hydrate," "Snow Fluff Spraying Hydrate," "Agricultural Hydrate," "Sure Crop," etc.

#### THE VERMARCO LIME COMPANY

This is a subsidiary of the Vermont Marble Company and produces a hydrated lime for building, chemical, and agricultural purposes.

#### THE SWANTON LIME WORKS

Main office, Swanton.  
 Proprietor, John P. Rich.  
 Quarries and kilns at Swanton.  
 Products: Lime for paper, leather, building, agricultural uses, etc.

#### THE FONDA LIME COMPANY

Main office, St. Albans.  
 Manager, L. F. Willson.  
 Quarries and kilns at Fonda Junction.  
 Products: Lime for chemical, building, agricultural purposes, etc.

#### THE BRANDON LIME AND MARBLE COMPANY

Main office at Leicester Junction.  
 Proprietor, H. B. Huntley.  
 Quarry and kilns at Leicester Junction.  
 Products: Lime for chemical and paper manufacturing, tanning uses, etc.

## Fire Clay

One of the most successful of the mineral industries of Vermont has been built up and carried on by the

### RUTLAND FIRE CLAY COMPANY

Main office, Rutland.  
 Officers: President, A. W. Perkins; treasurer, C. A. Perkins; secretary, C. S. Perkins.  
 Quarries at Rutland, east of the plant.  
 Manufacturing plant, Rutland.  
 Products: Stove linings, patching plaster, furnace cement, boiler covering, roofing cement, pipe-joint cement, water-pipe cleaner, water glass.

### *Production*

	Short tons
1929 .....	9,925
1930 .....	9,938
1931 .....	8,570
1932 .....	7,039
1933 .....	8,100
1934 (six months) .....	3,753

## Kaolin

Among Vermont's mineral resources must be included kaolin, or China clay, the extent and quality of which are coming more and more to be realized as modern methods of exploration are applied.

That clay of commercial quality existed is shown by the fact that as long ago as 1793 Capt. John Norton and his son, William, moved from Sharon, Connecticut, and settled in Bennington, where they started a pottery which was continued by the Norton family till the death of Edward L. Norton, in 1894.

Other potteries were established in the early days of the State at St. Johnsbury, Dorset, Middlebury and Burlington, while the iron and manganese ores, associated with the clay, were worked for paint making and in steel manufacture, respectively, for several years. It is recorded that the eminent English geologist, Sir Charles Lyell, visited the deposits at Brandon, then being worked for their iron content, and gave it as his opinion that "the clay alone would be found eventually to possess a value exceeding that of iron," a prediction that has been amply fulfilled.

### *Occurrence*

The writer has shown<sup>1</sup> that the chief deposits of Vermont China clay occur as a broken chain in the southwestern part of the State, extending along the Green Mountain front for about ninety miles, from Monkton to Pownal. The known deposits are at Monkton, Forestdale, Rutland, South Wallingford, Tinmouth, North Dorset, Shaftsbury, and Bennington, while there are probably others as yet undiscovered.

### *Geology*

Interest in Vermont kaolin today is centered in the area, about twelve miles long, comprising parts of the townships of Shaftsbury, Bennington, Woodford, and Pownal. Frederick A. Burt<sup>2</sup> has studied the area in detail. He finds that the kaolin deposits lie along the fault zone formed by the overthrusting of the Green Mountains westward onto the Stockbridge limestone. Arthur

<sup>1</sup>The Clay Deposits and Clay Industry of Vermont; 15th Rpt. Vt. State Geol. (1925-26).

<sup>2</sup>The Origin of the Bennington Kaolins; 16th Rpt. Vt. State Geol. (1927-28).

Keith<sup>1</sup> calls this overthrust the Mountain Border Fault. It runs through the entire length of the State.

Burt concludes, as the result of his studies, that:

1. "The deposits are residual rather than transported in type.
2. "The kaolin has been developed by normal weathering processes. The parent rocks are primarily the pre-Cambrian gneisses of the area, and to a less extent the feldspathic and argillaceous phases of the quartzite.
3. "The kaolin, associated sands, and iron-manganese ores represent different members of the same formation.
4. "The formation is of Tertiary age and was protected from glacial erosion by its topographic position at the base of cliffs against which the glacier impinged.
5. "The known deposits do not form a continuous belt, but there is some evidence that their continuity is more nearly complete than surface conditions indicate, and that originally it was complete."

### *Production in the Past*

In the past the Forestdale deposit of kaolin was operated by the Horn, Crockett Company, which began work in 1902 and in the following twenty years produced some 80,000 tons of clay. The deposit had been practically worked out by 1925 and was abandoned.

At East Monkton a limonite iron ore was mined many years ago by the Boston Iron Company. North of its pit kaolin was found cropping out for at least a mile, and this deposit was worked, off and on, for several years. Mr. O. N. Williams formed the American Paper Clay Company and operated the deposit till the mill burned down, about 1923.

Immediately south of this opening Frank E. Bushy & Son worked the deposit for several years, producing about a thousand tons annually, the clay being air-dried and shipped to the Rutland Fire Clay Company's plant for use in its products.

The Green Mountain Kaolin Corporation was formed in 1925 and, purchasing a tract of land about 150 acres in extent, lying east of Bennington, investigated the adaptability of the clay for paper-making, face-brick manufacture, etc. As far as the writer knows, there is no record that this corporation ever succeeded in its endeavors.

<sup>1</sup>Cambrian Succession in Northwestern Vermont; American Journal of Science, Fifth Series, No. 5-6 (1923).

*Recent Developments*

It is in the great deposits in South Shaftsbury and East Bennington that the future of the Vermont kaolin industry lies. These deposits are owned or controlled by the Vermont Kaolin Corporation.

## THE VERMONT KAOLIN CORPORATION

This corporation was organized under the Vermont laws in 1923.

Main office, Bennington.

Officers: President, Sanford C. Lyons; treasurer, Henry D. Fillmore; clerk, Flora E. Lyons.

Mines at South Shaftsbury and East Bennington.

Mills at East Bennington.

Products: White, washed paper clay, sagger clay, fire clay, clays for water purification, for light-colored brick, etc.

Capacity, when present plans are completed, to be 25,000 tons annually.

*Historical Note*

The deposits were operated, superficially, in the latter part of the seventeenth century for use in the Bennington Potteries, to which allusion has already been made.

About 1862 Lafayette Lyons and A. Booth began washing the white kaolin from the Shaftsbury deposit and selling it to paper makers in many parts of the country. Operations continued without interruption until 1911 when, due to crude and cumbersome washing processes, remoteness from the railroad, and interruptions of work in the winter months, operations were transferred to the Bennington deposits. Meantime the properties had passed into the hands of S. C. Lyons & Brothers who were occupied until 1923 in improving their mill and experimenting with various milling processes better adapted to the clays to be treated and to the rigors of the Vermont climate.

Due to the death of Henry F. Lyons the partnership was dissolved in 1923 and the Vermont Kaolin Corporation was formed.

In 1926 the Merrimac Chemical Company of Everett, Massachusetts, leased the entire properties of the corporation and proceeded to develop them, primarily as a source of raw material for use in the manufacture of aluminum sulphate, but also for the production of paper clay, sagger clay, fire clay, etc.

Extensive core drilling on the Bennington deposit showed the presence of some 600,000 tons of crude kaolin within an area of about six acres, lying within, on an average, thirty feet of the surface.

In 1929 the lease was terminated and the Vermont Kaolin Corporation purchased the improved equipment that had been

developed in the interim and continued the production of paper clay, sagger clay, fire clay, and crude kaolin for the manufacture of light colored facing bricks. In 1930 shipments of clay from Bennington amounted to 11,000 tons, the highest ever reached.

Since the business depression began, in 1929, production has naturally fallen to a low ebb, but the corporation has continued its researches looking to improved washing and decolorizing methods and proposes to develop a plant capable of producing at least 25,000 tons of white, washed paper clay annually.

Chemical analyses of Bennington kaolin:

	Washed kaolin	Same before washing
SiO <sub>2</sub> .....	48.90	58.00
Al <sub>2</sub> O <sub>3</sub> .....	34.88	26.87
Fe <sub>2</sub> O <sub>3</sub> .....	1.18	1.46
TiO <sub>2</sub> .....	1.15	1.40
CaO .....	.30	.42
MgO .....	.86	.94
K <sub>2</sub> O .....	1.29	2.16
Loss on ignition .....	11.47	8.89
	<hr/>	<hr/>
	100.03	100.14

## Brick Clays

As pointed out by the writer,<sup>1</sup> there are in the State tremendous amounts of glacially-transported clays, classifiable as Estuarine Clays, Lake and Pond Clays, Flood-plain and Terrace Clays, Drift or Boulder Clays, and Seasonal or Varve Clays. Their abundance and wide distribution are indicated by the number of brick dwellings in the country, oftentimes in out-of-the-way places, as well as in urban centers.

The largest known deposits are found along the Connecticut River and other streams, but deposits also occur along the lake shores and in former natural depressions which were filled with the clay sediments by streams flowing from the retreating ice sheet.

### *Brick Yards*

Considerable brick yards have been in operation in the past at East Ryegate, Westminster, Putney, and Bennington but, as far as the writer is informed, none of these plants is at present in operation.

#### THE DRURY BRICK AND TILE COMPANY, INCORPORATED

Office, Essex Junction.

Officers: President, H. D. Drury; vice-president, H. K. Drury; treasurer, M. W. Drury.

Quarries and kilns at Essex Junction.

Products: Sand-struck and water-struck bricks.

Capacity, six million sand-struck and one and one-half million water-struck bricks annually.

An analysis of the clay, made some years ago by the writer, gave the following results:

SiO <sub>2</sub> .....	53.69
Al <sub>2</sub> O <sub>3</sub> .....	21.24
Fe <sub>2</sub> O <sub>3</sub> .....	8.65
TiO <sub>2</sub> .....	.41
MnO .....	.02
CaO .....	2.84
MgO .....	1.03
Na <sub>2</sub> O .....	1.78
K <sub>2</sub> O .....	3.94
H <sub>2</sub> O .....	5.36
Moisture .....	.79
	99.75

<sup>1</sup>The Clay Deposits and Clay Industry of Vermont; 15th Rpt. Vt. State Geol. (1925-26).

# REPORT OF THE STATE GEOLOGIST ON THE MINERAL INDUSTRIES AND GEOLOGY OF VERMONT 1935-1936

TWENTIETH OF THIS SERIES

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