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Education Department Bulletin

Published fortnightly by the University of the State of New York

Entered as second-class matter June 24, 1908, at the Post Office at Albany, N. Y. under the act of July 16, 1894

No. 522 ALBANY, N. Y. JULY 1, 1912

New York State Museum

JOHN M. CLARKE, Director

Museum Bulletin 161

THE MINING AND QUARRY INDUSTRY

OF

NEW YORK STATE

REPORT OF OPERATIONS AND PRODUCTION DURING 1911

BY

D. H. NEWLAND

ALBANY

UNIVERSITY OF THE STATE OF NEW YORK

1912

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New York State Education Department

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Dr Augustus S. Downing

Acting Commissioner of Education

SIR: I beg to transmit to you herewith the manuscript of our annual report on *The Mining and Quarry Industry of New York State,* covering the operations and production of the year 1911, and to recommend this for publication as a bulletin of the State Museum.

Very respectfully

JOHN M. CLARKE

Director

STATE OF NEW YORK
EDUCATION DEPARTMENT
COMMISSIONER'S ROOM

Approved for publication this 14th day of June 1912

Augustus S. Downing

Acting Commissioner of Education

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JOHN M. CLARKE, Director

Museum Bulletin 161

THE MINING AND QUARRY INDUSTRY OF NEW YORK STATE

REPORT OF OPERATIONS AND PRODUCTION DURING 1911

BY

D. H. NEWLAND

INTRODUCTION

The mineral industries of the State shared the general dulness and reaction which marked the prevailing course of business operations during 1911. Very few branches showed progress as measured in terms of production figures. The period of short-lived prosperity experienced in the preceding year left a condition of overextension in its wake and necessarily caused a more or less radical curtailment of activity during the past season. That the setback is of no serious import to the development of the industries seems certain; in fact the current trend indicates an improvement which if continued should soon reestablish them on the former basis.

The census of production now completed for 1911 shows that the value of the materials taken from the mines and quarries in

that year amounted to $31,573,111. As in the preceding year the total reached $35,400,257, a decrease of a little over 10 per cent is indicated for the industries in general.

The figures are based on some 30 different substances in crude or first marketable forms, but can not be considered as representing the full share which the mineral industries have in the business activities of the State. They are serviceable, however, for standards to compare the conditions in these fundamental branches so closely allied with many other industries of chemical, metallurgical and manufacturing nature. It may be noted that the product of iron by the blast furnaces situated within the State alone is nearly equal in value to the output of crude ores and minerals on which the above totals are based.

The iron mines are among the first to feel the effects of market changes, and their contribution last year fell off considerably in response to the decreased demand and lower prices. The gross output was 1,258,873 long tons, as compared with 1,517,880 long tons in 1910. After allowance for concentration of the low-grade magnetic ores there remained for furnace use a total of 952,364 tons, which had a value of $3,184,057. The corresponding figures for 1910 were 1,159,067 tons valued at $3,906,478. The greater part of the product as usual came from the Adirondacks where are some of the largest mines in the East. Altogether there were 11 companies who reported a production, 2 less than in 1910.

The clay-working industries made an output valued at $9,751,659. This also represented a large decrease as compared with the return for the preceding year when the value amounted to $11,518,982. The loss was mainly in the branch that manufactures structural materials such as brick, building tile, terra cotta, fireproofing etc. for which the market was uniformly depressed in regard to both demand and prices. The output of these materials was valued at $6,473,857, against $8,067,098 in the preceding year. The number of brick for building purposes made in 1911 was 1,078,019 thousands, as compared with 1,404,345 thousands in 1910, of which the plants in the Hudson river region contributed about three-fourths. The value of the articles of pottery on the other hand showed a gain and reached the highest total — $2,196,054 against $2,136,518 in 1910 — ever recorded in the State. The number of firms and individuals engaged in the different departments of the clay-working industry last year was 189.

The lessened activity in the building trades also affected adversely the quarry industries which reported an aggregate value of $5,455,312 for their products, as compared with $6,193,252 in 1910. The total was divided acccording to various uses into building stone $632, 085; monumental stone $90,468; curb and flagstone $443,036; crushed stone $2,928,740; other uses $1,360,983. The output of slate, millstones and limestone used in making hydraulic cement is not included in these totals. All kinds of stone were quarried less extensively last year, though the falling off was particularly noticeable in granite, sandstone and marble which are used largely for structural purposes. The production of limestone and trap showed little change from the totals recorded in 1910.

For cement manufacturers the year was very unsatisfactory in that it witnessed the lowest prices known to the trade. That the output in the State should have been well maintained in the circumstances testified to the sound basis on which the local industry has been established. The aggregate production amounted to 3,691,373 barrels, as compared with 3,657,015 barrels in 1910. Portland cement constituted the main part of the total, in actual figures 3,416,400 barrels valued at $2,930,434. The natural cement mills contributed only 274,973 barrels, with a value of $134,900. Eleven plants in all were active, or 1 less than in 1910.

The production of salt from the mines and wells of the State amounted to 10,082,656 barrels, a little under the total of 10,270,273 barrels in 1910, but larger than that of any other year. The value of the output was $2,191,485. Rock salt was obtained from 2 mines in Livingston county, the other producers to the number of 28 obtaining salt from brine wells situated in Onondaga, Livingston, Schuyler, Wyoming, Genesee and Tompkins counties.

Gypsum, a material used principally for the manufacture of plaster of paris and wall plaster, is the basis of a large industry which has developed practically in the last 10 years. It is found in a belt which extends from Madison county on the east to Erie county, associated with the same rocks that yield the rock salt. The output last year, mainly by underground mines, was 446,794 short tons and the value of the marketed products totalled $1,092,598. In the year 1910 the output was reported as 465,591 tons with a value of $1,122,952.

The combined value of petroleum and natural gas, the only representatives of the class of mineral fuels obtained in the State,

amounted last year to $2,745,945, against $2,869,893 in 1910. The decline in value was due to the smaller prices secured for petroleum, which more than counterbalanced an increased production of natural gas. The total quantity of oil produced was 915,314 barrels valued at $1,198,868, as compared with 1,073,650 barrels with a value of $1,458,194 in 1910. The gas production was 5,127,571,000 cubic feet with a value of $1,547,077 against 4,815,643,000 cubic feet valued at $1,411,699 in the preceding year.

Among the smaller industries in which local enterprise has a prominent share may be mentioned those of talc, garnet, graphite, and pyrite. The talc is mainly produced from a single district in St Lawrence county, which enjoys a practical monopoly of the trade in fibrous talc. The production last year amounted to 65,000 short tons valued at $552,500, or about the same as in 1910. Garnet for abrasive uses is obtained in Essex and Warren counties, and the quantity reported for last year was 4285 short tons with a value of $121,759. The graphite, all of it the more valuable crystalline variety, amounted to 2,510,000 pounds valued at $137,750, a little under the previous year's total. Pyrite for acid manufacture was produced to the extent of 53,453 long tons valued at $251,466.

The remaining mineral materials which had a place in the list of products for last year were apatite, carbon dioxid, clay, diatomaceous earth, emery, feldspar, marl, millstones, metallic paint, mineral waters, slate pigment, quartz, slate, sand, sand-lime brick and zinc ore. The collected value of these materials was $3,052,143, against $3,579,488 in 1910.

It is worthy of record that a new industry so far as concerns New York State came into existence during the year with the shipment of zinc ore from St Lawrence county, where some promising developments have been in progress.

Mineral production of New York in 1910

PRODUCT	UNIT OF MEASUREMENT	QUANTITY	VALUE
Portland cement	Barrels	3 364 255	$2 939 818
Natural rock cement	Barrels	292 760	147 202
Building brick	Thousands	1 404 345	6 683 071
Pottery	.....	.....	2 136 518
Other clay products	.....	.....	2 699 393
Crude clay	Short tons	6 005	9 667
Emery	Short tons	978	11 736
Feldspar and quartz	Short tons	18 012	64 503
Garnet	Short tons	5 297	151 700
Graphite	Pounds	2 619 000	160 700
Gypsum	Short tons	465 591	1 122 952
Iron ore	Long tons	1 159 067	3 906 478
Millstones	.....	.....	6 613
Metallic paint	Short tons	8 063	70 841
Slate pigment	Short tons	1 400	10 900
Mineral waters	Gallons	8 432 672	675 034
Natural gas	1000 cubic feet	4 815 643	1 411 699
Petroleum	Barrels	1 073 650	1 458 194
Pyrite	Long tons	37 270	175 791
Salt	Barrels	10 270 273	2 258 292
Sand and gravel	.....	.....	2 129 708
Sand-lime brick	Thousands	14 053	82 619
Roofing slate	Squares	14 107	79 857
Slate manufactures	.....	.....	3 233
Granite	.....	.....	244 763
Limestone	.....	.....	3 245 807
Marble	.....	.....	341 880
Sandstone	.....	.....	1 451 796
Trap	.....	.....	909 006
Talc	Short tons	65 000	552 500
Other materials [1]	.....	.....	258 986
Total value	.....	.....	$35 400 257

[1] Includes apatite, carbon dioxid, diatomaceous earth, marl and lead ore.

Mineral production of New York in 1911

PRODUCT	UNIT OF MEASUREMENT	QUANTITY	VALUE
Portland cement	Barrels	3 416 400	$2 930 434
Natural rock cement	Barrels	274 973	134 900
Building brick	Thousands	1 078 019	5 443 303
Pottery	.....	.....	2 196 054
Other clay products	.....	.....	2 083 405
Crude clay	Short tons	14 193	11 982
Emery	Short tons	769	8 810
Feldspar and quartz	Short tons	21 802	75 719
Garnet	Short tons	4 285	121 759
Graphite	Pounds	2 510 000	137 750
Gypsum	Short tons	446 794	1 092 598
Iron ore	Long tons	952 364	3 184 057
Millstones	.....	.....	13 177
Metallic paint	Short tons	7 237	68 870
Slate pigment	Short tons	1 646	12 864
Mineral waters	Gallons	8 923 628	756 147
Natural gas	1000 cubic feet	5 127 571	1 547 077
Petroleum	Barrels	915 314	1 198 868
Pyrite	Long tons	53 453	251 466
Salt	Barrels	10 082 656	2 191 485
Sand and gravel	.....	.....	1 727 367
Sand-lime brick	Thousands	15 178	92 064
Roofing slate	Squares	11 273	52 311
Slate manufactures	.....	.....	Nil
Granite	.....	.....	148 633
Limestone	.....	.....	3 174 161
Marble	.....	.....	278 041
Sandstone	.....	.....	955 063
Trap	.....	.....	899 414
Talc	Short tons	65 000	552 500
Other materials [1]	.....	.....	232 832
Total value	.....	.....	$31 573 111

[1] Includes apatite, carbon dioxid, diatomaceous earth, marl and zinc ore.

CEMENT

The cement trade in 1911 showed a continuance of the conditions which were noted in the review for the preceding year. Prices were on the same low level, in fact averaging somewhat less than in 1910, but as the demand remained active most manufacturers were able to maintain operations at about the normal rate and thus to secure the greatest economy in production. The local market for cement has been very large owing to the unusual amount of engineering work in the way of public improvements that have been in progress in the State.

The steady decline in the prices that has lasted now for several years has subjected the cement mills to a severe test of efficiency. Some of the mills which were not advantageously situated for economic manufacture or were inadequately financed have been forced out of business. As a consequence the number of producers has fallen off from year to year, though this loss, so far as the portland cement business is concerned, has been more than made good by enlarging the capacity of other plants and by the erection of one or two new mills. In the natural cement branch the effect of the adverse conditions has been very noticeable in the output which has shrunk to a mere fraction of the former quota. The Rosendale district of Ulster county was represented last year by a single producer.

The aggregate output of cement for the year amounted to 3,691,373 barrels, as compared with 3,657,015 barrels in 1910 and 2,610,383 barrels in 1909. The production last year has not been exceeded since 1906. The returns showed that 11 plants were active, or 1 less than in 1910. In 1905 there were 21 cement mills in operation.

As shown in the accompanying table the portland cement mills contributed a total of 3,416,400 barrels valued at $2,930,434, a slight increase over the 1910 figures which were 3,364,255 barrels valued at $2,939,818. The average value of the product was 85.8 cents a barrel, against 87.4 cents in 1910. Seven plants were reported as active, 1 less than in the previous year.

The output of natural cement amounted to 274,973 barrels valued at $134,900, the greater part contributed by the single producer in Ulster county. The total for 1910 was 292, 760 barrels with a value of $147,202. In addition to Ulster county there was a small output in Onondaga county by 3 companies. Erie county, formerly a large producer, was not represented.

Production of cement in New York

YEAR	PORTLAND CEMENT		NATURAL CEMENT	
	Barrels	Value	Barrels	Value
1891	87 000	$190 250	3 931 306	$3 046 279
1892	124 000	279 000	3 780 687	3 074 781
1893	137 096	287 725	3 597 758	2 805 387
1894	117 275	205 231	3 446 330	1 974 463
1895	159 320	278 810	3 939 727	2 285 094
1896	260 787	443 175	4 181 918	2 423 891
1897	394 398	690 179	4 259 186	2 123 771
1898	554 358	970 126	4 157 917	2 065 658
1899	472 386	708 579	4 689 167	2 813 500
1900	465 832	582 290	3 409 085	2 045 451
1901	617 228	617 228	2 234 131	1 117 066
1902	1 156 807	1 521 553	3 577 340	2 135 036
1903	1 602 946	2 031 310	2 417 137	1 510 529
1904	1 377 302	1 245 778	1 881 630	1 207 883
1905	2 117 822	2 046 864	2 257 698	1 590 689
1906	2 423 374	2 766 488	1 691 565	1 184 211
1907	2 108 450	2 214 090	1 137 279	757 730
1908	1 988 874	1 813 622	623 588	441 136
1909	2 061 019	1 761 297	549 364	361 605
1910	3 364 255	2 939 818	292 760	147 202
1911	3 416 400	2 930 434	274 973	134 900

The one new producer added to the list during the year was the Knickerbocker Portland Cement Co., which began operation in the summer at its plant near Greenport, Columbia county. The mill is equipped with three rotary kilns, each 10 by 175 feet, and under full headway is expected to turn out 3000 barrels a day. The limestone quarries are situated on Becraft mountain close by and in proximity to those of the New York-New England Company, in an outlier of the Coeymans and Manlius formations. The clay is obtained locally.

CLAY

The clay-working industries rank first in the value of annual output among the mineral industries of the State. Their prominence is chiefly due to the widely distributed deposits of common clays suited for building brick, drain tile and materials of that class and the very extensive local markets for such articles. As the whole area of New York lies within the zone of Pleistocene glaciation, residual clays are of rare occurrence and of little commercial importance.

Most of the clays that are utilized are modified glacial deposits.

They are commonly of blue color, weathering to yellow at the surface, and contain rather high percentages of iron and fluxing ingredients. Extensive deposits occur in the Hudson and Champlain valleys where they form terraces at different elevations, from near water level to several hundred feet above, and also in some of the large valleys in the interior of the State. These clays generally burn at a relatively low temperature to a red color.

Deposits of white-burning and refractory clays are restricted to Long Island and Staten Island. They belong to the Cretaceous, and occur as scattered, but in some places heavy, beds. They are adapted for fire brick, stoneware, terra cotta and the better grades of building brick.

The single example of any considerable accumulation of residual kaolin that has come to notice is found near Shenandoah, Dutchess county. The property known as Fowler's kaolin mine has produced small amounts of white but rather quartzose material which has found use as stove cement. It appears to be a disintegration product of pegmatite formed in place and by some chance has escaped the general erosion.

The use of shale which is abundant in many of the stratified rock formations has been of increasing importance of late years. The principal beds are found in the Devonic, Hamilton, Portage and Chemung groups. They are worked mainly in the western counties for the manufacture of paving brick, tile and pressed building brick.

PRODUCTION OF CLAY MATERIALS

Details of the production of clay materials in New York State during the last two or three years are given in the accompanying tables which are based on reports from practically every producer in the several branches of the industry.

The general condition of the industry during 1911 can hardly be described as prosperous. Building operations in most of the larger cities were on a scale below the average of recent years and consequently the market for clay structural materials showed little activity. The Hudson river brick industry made relatively the poorest record of any branch, owing to the fact that the yards had to carry over a very heavy stock from the previous year; on the other hand it benefited by a slight increase of the prices in the New York market. The pottery trade fared better than most lines, and the production was well maintained.

The output of clay materials of all kinds in 1911 was valued at $9,751,659. Compared with the total for the preceding year, which

was $11,518,982, it represented a falling off of about 15 per cent. The number of firms or individuals engaged in the clay-working industry was 189 against 223 in 1910, and the product was distributed among 39 of the 61 counties of the State.

Production of clay materials

MATERIAL	1909	1910	1911
Common brick	$8 009 766	$6 563 212	$5 310 511
Front brick	149 330	119 859	132 792
Vitrified paving brick	207 970	333 511	307 529
Fire brick and stove lining	486 894	464 693	413 500
Drain tile	268 589	254 679	202 292
Sewer pipe	117 324	127 731	138 258
Terra cotta	962 497	1 062 017	718 700
Fireproofing	166 025	256 820	229 627
Building tile	54 397	65 190	82 217
Miscellaneous	101 497	134 752	20 179
Pottery	1 827 193	2 136 518	2 196 054
Total	$12 351 482	$11 518 982	$9 751 659

A comparison of the items entering into the production shows that the main part of the decrease came from building brick, the output of which was valued at $5,443,303 against $6,683,071 in 1910, a decline of $1,239,768. Common brick accounted for $5,310,511 in the totals against $6,563,212 in the preceding year, and front brick for $132,792 against $119,859. The vitrified paving brick industry showed a slight decline with a total of $307,529 against $333,511. Fire brick and stove lining amounted to $413,500 as compared with $464,693 in the preceding year. The output of drain tile was valued at $202,292 against $254,679, and of sewer pipe at $138,258 against $127,731. The production of terra cotta had a value of $718,700 against $1,062,017 in 1910; fireproofing of $229,627 against $256,820; and building tile, inclusive of roofing tile and floor tile, of $82,217 against $65,190. The miscellaneous clay manufactures, including such items as flue lining, fire tile and shapes, conduit pipes and acid-proof brick, amounted in all to $20,179, as compared with $134,752 in 1910. The potteries of the State reported an output valued at $2,196,054 against $2,136,518 in the preceding year.

Among the counties which contributed largely to the year's total Onondaga held first place and reported an output valued at $912,892. In the preceding year it was fourth in the list with a

value of $833,892. The potteries at Syracuse were the most important factors in the production. Ulster county ranked second with a reported value of $829,035, represented entirely by common building brick. Erie county maintained its position as the third largest producer and returned a value of $755,602. Rockland county, which was second in 1910, moved to fourth place last year, contributing an output valued at $747,040. The other counties that reported a value in excess of $500,000 were Dutchess ($648,151) and Orange ($565,152).

Production of clay materials by counties

COUNTY	1909	1910	1911
Albany	$750 754	$641 227	$470 503
Allegany	22 601	*a*	9 000
Cattaraugus	*a*	63 887	90 153
Cayuga	15 400	20 675	15 724
Chautauqua	118 897	129 331	166 322
Chemung	61 000	*a*	76 169
Columbia	472 280	454 550	284 475
Dutchess	880 707	649 862	648 151
Erie	753 362	841 726	755 602
Greene	346 982	266 452	139 578
Jefferson	11 175	7 997	*a*
Kings	490 946	569 720	602 756
Livingston	6 900	*a*	70 295
Monroe	278 991	264 421	325 849
Nassau	136 375	111 650	105 740
Niagara	22 923	22 882	25 426
Oneida	83 500	126 907	95 605
Onondaga	834 111	833 892	912 892
Ontario	196 345	269 549	255 298
Orange	814 440	761 500	565 152
Queens	435 182	551 375	402 398
Rensselaer	317 559	348 172	173 564
Richmond	698 991	633 010	470 591
Rockland	1 488 457	1 080 117	747 040
Saratoga	335 670	388 428	393 490
Schenectady	322 549	505 966	486 327
Steuben	205 036	219 615	149 649
Suffolk	68 370	101 560	73 750
Ulster	1 620 468	1 121 460	829 035
Washington	10 950	3 685	10 350
Westchester	438 243	371 328	297 997
Other counties *b*	112 318	158 038	102 778
Total	$12 351 482	$11 518 982	$9 751 659

a Included under other counties.

b In 1909, aside from counties marked (*a*), are included Fulton, Genesee, Montgomery, New York, St Lawrence, Tioga, Tompkins, Warren and Wayne counties. In 1910, aside from counties marked (*a*) are included Genesee, Montgomery, New York, St Lawrence, Tioga, Tompkins, Warren and Wayne counties. In 1911, aside from counties marked (*a*) are included Clinton, Genesee, Montgomery, New York, St Lawrence, Tompkins, Warren and Wayne counties.

MANUFACTURE OF BUILDING BRICK

The total number of common building brick made in New York State last year was 1,066,982,000. This represented a large falling off from the total reported for 1910 which amounted to 1,396,606,000, the actual decrease being 329,624,000 or 23 per cent. The decline was attributable mainly to the dull conditions in the building trades of the larger cities, notably of New York. The brick yards along the Hudson river which depend almost solely upon the New York City markets for their outlet were operated on a much reduced scale, and their product showed a decrease of nearly 300,000,000 for the year.

The value of the common brick was $5,310,511, or an average of $4.98 a thousand, as compared with $6,563,212, an average of $4.70 a thousand, in 1910. The improved showing was due to the slightly higher prices that were obtained by the manufacturers in the Hudson river valley. In 1909 the average price was $5.31 a thousand. These prices represented the average received at the yards, not inclusive of carriage or selling commissions.

In addition to the common building brick there were manufactured last year 11,037,000 front brick with a value of $132,792. In the preceding year the number of front brick made was 7,739,000 valued at $119,859. The aggregate output of brick for building purposes was thus 1,078,019,000 valued at $5,443,303, against 1,404,345,000 valued at $6,683,071 in 1910. The manufacture of building brick was carried on in 31 counties by a total of 153 companies or individuals. In 1909 there were 32 counties represented in the list with a total of 172 producers. A tendency toward the restriction of the industry to fewer plants and more favorable centralized localities has been in evidence for a number of years. It is more apparent in contrasting the present situation with that for example of 1906 when there were 213 active producers distributed over 37 counties.

Production of common building brick

COUNTY	1910		1911	
	NUMBER	VALUE	NUMBER	VALUE
Albany	74 496 000	$390 894	59 517 000	$319 503
Cattaraugus	612 000	5 984	1 088 000	8 109
Cayuga	2 403 000	16 075	1 813 000	11 724
Chautauqua	5 058 000	32 588	4 140 000	28 406
Columbia	92 700 000	454 550	57 695 000	284 475
Dutchess	147 696 000	649 862	133 229 000	648 151
Erie	51 244 000	283 207	35 975 000	222 673
Greene	30 374 000	137 452	28 779 000	139 578
Jefferson	1 068 000	7 997	.....	.....
Livingston	312 000	2 184	425 000	2 550
Monroe	19 531 000	111 758	21 100 000	116 600
Nassau	17 000 000	107 500	15 790 000	98 445
Niagara	3 434 000	22 882	3 178 000	25 426
Oneida	19 126 000	119 082	14 434 000	93 105
Onondaga	19 569 000	104 534	22 000 000	132 750
Orange	160 500 000	761 500	121 800 000	565 152
Rensselaer	14 600 000	72 800	13 352 000	67 760
Richmond	32 355 000	134 049	23 456 000	106 823
Rockland	251 190 000	1 080 117	162 400 000	747 040
Saratoga	84 639 000	387 268	81 575 000	392 427
Suffolk	16 360 000	98 560	11 500 000	68 750
Ulster	263 873 000	1 121 460	178 287 000	829 035
Westchester	66 836 000	332 027	52 654 000	263 498
Other counties *a*	21 630 000	128 882	22 795 000	138 531
Total	1 396 606 000	$6 563 212	1 066 982 000	$5 310 511

a Includes in 1910, Chemung, Clinton, Montgomery, Ontario, St Lawrence, Steuben, Tompkins, Warren and Washington counties. In 1911 the same counties are included excepting Steuben which reported no production.

Hudson river region. The greater part of the brick production of the State is made in the Hudson river valley in the stretch from Albany and Rensselaer counties southward to Rockland and Westchester counties. The existence of extensive clay beds suitable for the common grades of brick, the facilities for cheap transportation, and the proximity to the large market of New York City and vicinity combine to make this section the largest brick-manufacturing district in the United States.

The brick clays are found in terraced deposits on either side of the river, extending from the water level to a height of 300 feet or more in places. They are interbedded with and sometimes covered by layers of sand and gravel. Their thickness at any locality may exceed 100 feet, though usually it is much less. Some clay has been obtained by dredging from the bed of the

river, as at Haverstraw. The clays are usually of blue color weathering to red or yellow at the surface, and are quite calcareous with an average of from 3 to 6 per cent lime carbonate. In addition to their employment for common brick, they are utilized to some extent for fireproofing and hollow blocks. Slip clay used for glazing pottery is obtained from certain beds of the Hudson river clays.

The common brick are manufactured by the soft mud process and are burned in scove kilns. Machine molding has been tried successfully on some of the clays, but most manufacturers adhere to the old hand process.

There are more than 125 brick yards in the 9 counties along the river, with a combined capacity under full operation of over one and a quarter billion brick a year. So large an output is seldom warranted, however, by the market requirements, and the average product for recent years has ranged around one billion, reaching a maximum of 1,230,000,000 in 1906.

During the last two seasons the demand for brick has been below normal. At the beginning of 1910 the yards still had a stock of about 200,000,000 on hand that remained unsold and with the year's manufacture the total available supply was about 1,300,000,000, of which only 950,000,000 were actually consumed during that season. Consequently the yards carried over about 350,000,000 to 1911. With this formidable accumulation on hand, manufacturers were naturally loath to begin operations, and the opening of the season was delayed beyond the usual time. Many plants reduced their working force; others remained inactive throughout the year. In spite of this curtailment policy which reduced the outturn below that of any previous season for a long time, the market was not able to absorb the supply. It is estimated that about 250,000,000 brick were on hand at the close of 1911. As the number manufactured was approximately 800,000,000 the consumption may be placed at 900,000,000, or about 50,000,000 less than in 1910.

Despite the unfavorable conditions of demand, prices showed some improvement over those reported for the preceding year. The average price received for common brick throughout the district was $4.78 a thousand against $4.54 a thousand in 1910. This represented the average for the sales at the yard and not the New York prices which ranged about $1.25 a thousand higher, an amount equivalent to the cost of river shipment and commissions exacted by the dealers in New York.

The production for 1911 as given in the table herewith was 807,713,000 and was contributed by 96 plants. It has been many years since so few plants were in operation. The number in 1910 was 114. Ulster county as usual held first place in the industry; its contribution was 178,287,000 valued at $829,035, as compared with 263,873,000 valued at $1,121,460 in 1910. Rockland county was second in the list and Dutchess third, the latter displacing Orange county which ranked third in 1910.

The Greater New York Brick Co. was organized during the year to act as selling agents for the manufacturers.

Output of common brick in the Hudson river region in 1910

COUNTY	NUMBER OF PLANTS	OUTPUT	VALUE	AVERAGE PRICE PER M
Albany	12	74 496 000	$390 894	$5 24
Columbia	6	92 700 000	454 550	4 90
Dutchess	19	147 696 000	649 862	4 40
Greene	5	30 374 000	137 452	4 52
Orange	8	160 500 000	761 500	4 74
Rensselaer	4	14 600 000	72 800	4 98
Rockland	28	251 190 000	1 080 117	4 30
Ulster	24	263 873 000	1 121 460	4 25
Westchester	8	66 836 000	332 027	4 96
Total	114	1 102 265 000	$5 000 662	$4 54

Output of common brick in the Hudson river region in 1911

COUNTY	NUMBER OF PLANTS	OUTPUT	VALUE	AVERAGE PRICE PER M
Albany	10	59 517 000	$319 503	$5 37
Columbia	6	57 695 000	284 475	4 93
Dutchess	15	133 229 000	648 151	4 85
Greene	5	28 779 000	139 578	4 85
Orange	6	121 800 000	565 152	4 64
Rensselaer	4	13 352 000	67 760	5 08
Rockland	24	162 400 000	747 040	4 60
Ulster	20	178 287 000	829 035	4 65
Westchester	6	52 654 000	256 449	4 87
Total	96	807 713 000	$3 857 143	$4 78

OTHER CLAY MATERIALS

The manufacture of vitrified paving brick was carried on by four companies in Cattaraugus, Chautauqua, Erie and Steuben counties, the same number as in 1910. The number of paving brick made was 18,996,000 valued at $307,529 against 19,762,000 valued at $333,511 in the preceding year. The price received for paving brick averaged $16.19 a thousand, as compared with $16.88 a thousand for 1910.

The production of fire brick and stove lining was made in Erie, Kings, Rensselaer, Richmond, Schenectady, Washington and Westchester counties, and was valued at $413,500 against $464,693 in the preceding year. Fire brick numbered 7,192,000 valued at $330,659. The stove lining was valued at $82,841. There were 9 companies in operation, or 2 less than in 1910. Most of the refractory clay used by the manufacturers was obtained from without the State, though the company in Richmond county obtained its supply locally.

The output of drain tile was distributed among 9 counties, with Albany as the largest producer. The value of the output, $202,292, showed a considerable decline from the total of $254,679 reported in 1910. There were 16 firms engaged in the industry, 2 less than in the preceding year. The production of sewer pipe, mainly from Monroe county, reached a value of $138,258 against $127,731 in the preceding year. It was contributed by 3 companies.

Fireproofing, including terra cotta lumber, hollow brick, and various other kinds of hollow fireproofing, was made last year by 7 firms, distributed among Erie, Kings, Monroe, New York, Oneida, Onondaga and Rensselaer counties. The value of the output was $229,627 as compared with $256,820 in 1910, when 8 firms were active. Local clays are used for its manufacture. The use of fireproofing has grown quite rapidly and there would seem to be opportunity for an enlarged development of the local industry.

Building tile, inclusive of roofing tile, vitrified floor tile and terra cotta tile, was reported from Allegany, Erie, Kings and Monroe counties by a total of 4 firms, 2 less than in 1910. The output was valued at $82,217 against $65,190 in the preceding year. This is another department of the clay-working industry which deserves greater attention than it has received in the past.

Architectural or ornamental terra cotta declined in value from $1,062,017 in 1910 to $718,700 last year. Its manufacture is carried on by 3 firms in Queens, Richmond and Steuben counties. The Staten Island cretaceous clays are used in part for this product.

The miscellaneous clay materials accounted for a value of $20,179 against $134,752 in 1910.

POTTERY

New York is deficient in clays suitable for the finer grades of pottery such as china and porcelain ware. The clay beds of Long Island, Staten Island and Onondaga county have supplied some stoneware clays, and slip clay of excellent quality is obtainable at Albany. Common earthenware clays also are abundant. There are no kaolin deposits supplying pottery material, and the entire requirements of the local manufacturers are met by purchases from southern mines or by importations from abroad.

Notwithstanding the limitations of resources, the pottery industry has shown a fairly steady growth. The output last year was valued at $2,196,054 and was the largest that has ever been recorded. The corresponding total for 1910 was $2,136,578 and for 1909 it was $1,827,193. The potteries contributing to the total numbered 21, 1 less than in the preceding year, distributed among the following counties: Albany, Erie, Kings, Livingston, Nassau, Onondaga, Ontario, Queens, Schenectady, Suffolk and Washington. Onondaga county alone reported a production valued at $774,477.

Of the various pottery products stoneware is one of the few that has not shared in the general advance of the industry. The production in 1911 was valued at $39,095, or less than one-half of the output five years ago. Red earthenware consisting mainly of flower pots, amounted in value to $32,495, about the usual average. The white products, including china tableware, sanitary ware and electrical supplies, have shown the largest gains; the porcelain and semiporcelain wares were valued at $1,026,517. Most of the china tableware was made in Syracuse and Buffalo, the electrical supplies were made in Victor, Syracuse, Schenectady and Brooklyn; and the sanitary wares in Brooklyn.

Value of production of pottery

WARE	1909	1910	1911
Stoneware	$41 298	$41 925	$39 095
Red earthenware	32 800	25 713	32 495
Porcelain and semiporcelain [1]	999 663	1 027 249	1 048 872
Electric and sanitary supplies	697 573	991 131	1 026 517
Miscellaneous	55 859	50 500	48 075
Total	$1 827 193	$2 136 518	$2 196 054

[1] Includes china tableware and cream-colored ware.

CRUDE CLAY

The clay obtained in a few localities is not utilized by the original producer but is shipped to others for manufacture, some of it going to points outside the State. This production, therefore, is listed separately from that of clay materials. The clay most extensively exploited for shipment is the Albany slip clay which is found in layers within the ordinary brick clay of the Hudson valley. It resembles the latter in appearance but has a finer grain and a larger percentage of the alkaline constituents than the usual run of the deposits. It has consequently a low fusibility and when applied to clay wares as a "slip" gives a rich brown glaze.

The light-colored refractory clays of Long Island and Staten Island and various pottery clays are also shipped to some extent. Returns were received from 6 producers in 1911 and their total shipments of crude clay amounted to 14,193 short tons valued at $11,982. In the preceding year the reported shipments amounted to 6005 short tons valued at $9667. The relatively higher value assigned to the product in 1910 is explained by the large proportion of slip clay included in the total.

EMERY

The mining of emery has been carried on for a number of years near Peekskill, Westchester county, one of the few places in this country where the material is known to occur in quantity. The industry is small, as the native emery does not find so wide a market as the Grecian and Turkish product which can be imported at low cost.

The Peekskill emery is a mixture of corundum, spinel and magnetite chiefly, though the mineral composition is rather variable.

The corundum, which is the most valuable constituent from the abrasive standpoint, may constitute as much as 50 per cent of the entire rock, and in the typical material is often seen in the form of large porphyritic crystals scattered through a fine-grained mass of magnetite and spinel. The rock is dense and hard, of dark gray to nearly black color, sometimes mottled by the lighter crystals of corundum. It occurs as lenticular and banded masses within local intrusions of basic gabbroic rocks which are known as the Cortlandt series. The emery masses are believed to represent segregations of the heavier minerals of the gabbro while the latter were in a molten condition, a process similar to that which led to the formation of the titaniferous magnetites in the anorthosites and gabbros of the Adirondacks. Some of the deposits in Westchester county contain a fairly high percentage of magnetite and were once mined for iron ore, but owing to the high alumina content proved too refractory for furnace use.

The output of emery last year was below the usual average, showing a decline of about 200 tons from the total reported in 1910. The actual amount reported by the producers was 769 short tons with a value of $8810. In 1910 it was 978 short tons valued at $11,736. The maximum product for any recent year has been about 1500 tons.

The emery is all shipped in lump form to abrasive manufacturers, who grind and prepare it for use. The list of producers in 1911 included the Blue Corundum Mining Co., Easton, Pa.; Keystone Emery Mills, Frankford, Pa.; and John Buckbee, Peekskill. In former years the Hampden Corundum Wheel Co. and R. Lancaster have been active in the district.

FELDSPAR

The commercial grades of feldspar are obtained in this State from pegmatite bodies that accompany the crystalline formations of the Adirondacks and the southeastern Highlands. The pegmatite has the composition of granite and represents a coarse phase of that rock originating through specially favorable conditions of crystallization supplied, perhaps, by abundance of water vapor. It is commonly associated with granites and granitic gneisses, but may be found as offshoots or independent bodies surrounded by rocks of quite different character. In the granite areas it occurs frequently in lenticular and irregular masses which show no distinct boundaries but grade by imperceptible stages into the finer-grained

rock. Elsewhere the pegmatite shows intrusive relations with the county rocks, forming dikes and bosses with well-defined walls.

The feldspar is predominantly a potash variety, that is either orthoclase or microcline, but soda feldspar or albite and the lime-soda varieties are frequently represented. Microcline is by far the commoner of the potash feldspars in the New York localities. For pottery purposes it is an advantage to have the feldspar in large well-segregated crystals or masses so that it can be readily freed from the accompanying minerals. In the pegmatites which are quarried for pottery spar, the crystals range up to 3 or 4 feet in diameter. The pegmatites of finer texture and those in which the minerals are intimately intergrown have application principally for roofing material.

Quartz is an important ingredient of all pegmatites and if obtainable in pure condition may also have value. It is an important by-product, for example, of the Bedford quarries. It occurs in irregular masses, seldom showing any traces of crystal form, and is of gray, white, or pink color. When intergrown with the feldspar to any extent it detracts from the value of the latter for pottery use, though quartz is a necessary ingredient of the pottery mixture.

The accessory constituents of the pegmatites include a variety of minerals of which the commoner are the micas, hornblende, pyroxene, and tourmalin, while of less frequent occurrence are garnet, magnetite, pyrite, epidote, titanite, and beryl. Black tourmalin is nearly always present in the Adirondack pegmatites. These constituents may be of determinative importance with reference to the commercial value of a pegmatite occurrence, since if disseminated through the mass they preclude the extraction of high-grade material.

The only feldspar quarries that have been worked during the past year are situated in Westchester and Essex counties. Those near Bedford, Westchester county, have yielded most of the higher grade product used for pottery and enamel ware; they are operated by P. H. Kinkel's Sons. They are opened in a large mass of pegmatite that outcrops on the eastern and northern slopes of the hill lying a little south of Bedford village. In addition to the feldspar there is a considerable output of quartz which is sold for wood filler. The feldspar is shipped in three grades, of which no. 1

grade consists of pink microcline practically free of quartz. It is all sold in crude condition for pottery use. No. 2 consists of white albite with more or less quartz and is ground at the local mill before shipment. It goes mainly to enamel ware manufacturers. No. 3 grade carries quartz, as well as more or less of the iron-bearing minerals, and finds application in glass manufacture. It is likewise ground locally.

The quarries in Essex county are situated near Ticonderoga and Crown Point. Those at the former locality are owned by the Barrett Manufacturing Co., which utilizes the product mostly for prepared roofing material. The pegmatite is broken down and sent to the mill without sorting. It is thus a mixture of feldspar, quartz and other minerals.

The quarries of the Crown Point Spar Co., just south of Crown Point, produce crushed feldspar for roofing purposes, poultry grit and concrete, and some that finds use in enamel ware. They are situated on top of Breed's hill, an elevation mainly composed of black hornblende-biotite gneiss in which the pegmatite appears to form a bosslike intrusion measuring several hundred feet in diameter. The feldspar consists of pink microcline and white or greenish albite. It is frequently intergrown with quartz, but may form separate masses up to 5 or 6 inches in diameter. Biotite is the chief dark mineral and appears in seams, or as a coating on the feldspar. The pegmatite has been squeezed or fractured, and there is a noticeable development of secondary chlorite. The quarries are connected with the mill which is situated at the lakeside over a mile away by an aerial tram. The product is there crushed and graded into different sizes for use as roofing material, poultry grit, and in concrete. A part of the product is sold also to the enamel ware trade.

The production of feldspar, including crushed unsorted pegmatite, amounted in 1911 to 15,652 short tons valued at $61,769. This showed a slight gain compared with the totals reported for previous years. In 1910 the output was 12,132 short tons valued at $46,863 and in 1909 it amounted to 13,871 short tons valued at $46,444. Market prices remained unchanged; the crude feldspar for pottery uses brought about $3 a ton, the ground spar for pottery and enamel ware $6, and the crushed material for roofing, poultry grit, etc., about $3 a ton.

NOTES ON THE OCCURRENCE OF FELDSPAR IN NEW YORK

It is the purpose of the present notes to call attention to some little known or undeveloped feldspar deposits which were visited in the summer of 1911 during the course of a field investigation of the granite quarries of the State. A report on the feldspar deposits of the United States was issued in 1910 by the United States Geological Survey. The report, contributed by Edson S. Bastin, contains a very detailed description of the better known local occurrences from which the supplies of feldspar have been obtained in recent years, but omits mention of those here considered.

Crown Point, Essex county. The pegmatite occurrence called Roe's spar bed has been a source of feldspar for pottery purposes, having been worked some 15 years ago and the product shipped to potteries outside the State. It has received only fugitive attention in the geological reports relating to Essex county, though mentioned in one of the papers by J. F. Kemp as an important deposit. It is chiefly known at present as an interesting mineral locality.

The deposit is most conveniently reached from Crown Point, from which it lies about 8 miles distant in a northwesterly direction. It outcrops about 1 mile directly south of Towner pond at an elevation of between 1100 and 1200 feet, as shown on the topographic map. It is now the property of Mr H. W. Willcox.

The old quarry working shows a face about 50 feet high and 75 feet wide in a body of pegmatite which seems rather a lenticular or boss-shaped mass than a dike. The outlines, however, are not clearly revealed by outcrops and there is some uncertainty as to the extent of the deposit. The longer axis appears to run about n. 50° e., as indicated by a series of openings below the main quarry which follows that direction. The width of the exposed part at right angles is from 75 to 100 feet.

The pegmatite is very coarse and the components well segregated. Feldspars with a diameter of 3 feet are not uncommon. They often show crystal boundaries. Quartz is of subordinate importance, but is rather unequally distributed. It is partly of pink color and partly the milky variety. Graphic intergrowth of quartz and feldspar is not abundant. The iron-bearing minerals are chiefly biotite and tourmalin and though fairly plentiful on

the whole they are usually concentrated in certain parts of the deposit so that their presence would not necessarily entail any great waste in the production of pottery material. The existence of trap dikes, of which four were noticed in the quarry face, varying from 1 inch to 4 feet thick, is of some consequence though probably not a very serious drawback.

The feldspar includes a pinkish variety which shows the characteristic optical properties of microcline and a light-gray oligoclase. They appear to be in about equal amounts.

In the former operations which were carried on by Mr Roe, the spar was hauled to Crown Point for shipment. The costs of haulage are reported to have been $1.50 a ton in summer and $1.25 in winter. The stretch of road from the quarry to Crown Point Center is over a rough country but chiefly with descending grade.

Chestertown, Warren county. There are openings in a pegmatite body that is situated on the north side of a high ridge about 3 miles south of Chestertown and 1.5 miles east of the Warrensburg road. They are said to date back about 15 years. The purpose of the operations was to produce mica rather than feldspar. Two workings may be seen of which the principal one lies to the south and higher up on the ridge. This consists of an open cut about 50 feet long and 15 feet wide on a dike or elongated body of pegmatite that strikes northeast. The limits of the mass are indeterminate except on the east side of the pit where the county rock is exposed a few feet away. The northern pit reveals very little as to the size of the pegmatite mass or the conditions of its occurrence, being a narrow opening which at the time of the writer's visit was filled with water. It may be on a separate body.

The pegmatite is a coarse intergrowth of white feldspar, quartz and mica. The last named mineral is chiefly biotite with a brownish variety in subordinate amount. The latter may be muscovite but it is not of good quality being in imperfect crystals that show rulings. The largest crystals measure about a foot in diameter. Black tourmalin is quite common in the feldspar and quartz. The feldspar appears in pure masses and also as graphic intergrowths with the quartz. It belongs to the potash variety with the optical properties of microcline.

Fort Ann, Washington county. An exposure of pegmatite near this place has been worked at different times for feldspar and quartz. It is reported as one of the localities from which quartz was obtained for grinding at the mill that was operated at Fort

Ann about 25 or 30 years ago. More recently it has been a source of feldspar for shipment and has been worked intermittently according to the market demand, the last time by Dominick Ashley of Glens Falls.

The outcrop lies about 2½ miles northwest from Fort Ann at the base of the gneiss ridge of which the higher part is known as Putnam mountain. It is on or near the farm of Ira D. Gilmore. It consists of a rather irregular area, though the general shape is lenticular, with its longer direction nearly transverse to the general axis of the ridge, or to the northwest. An open cut about 125 feet long and from 30 to 40 feet deep has been made. The lens is broadest near the southeastern end where it measures fully 75 feet wide. To the northwest it gradually diminishes and wedges out in the gneiss 50 feet beyond the end of the pit. When visited by the writer the workings were partly filled with water and the deeper parts of the excavation consequently could not be inspected. The wall rock as seen in exposures nearby is a well-laminated biotite gneiss.

The pegmatite is made up largely of graphic granite, that is an intimate mixture of feldspar and quartz, but the two minerals also occur separately to a considerable extent. Masses of milky quartz up to 2 or 3 feet in diameter are found and also feldspar crystals of similar dimensions. The feldspar is mainly of grayish color and so far as tested appears to consist largely of microcline. There is present also a little pinkish feldspar which may be orthoclase. Tourmalin and the iron-bearing silicates generally have a very limited representation, though the pegmatite shows much iron stain, the result perhaps of pyrite.

Alteration of the feldspar is much in evidence in parts of the exposure. This results in the formation of kaolin and sericite and sometimes is accompanied by a greenish coloration of the secondary products which is probably the effect of intermingled serpentine. The presence of this mineral can not be traced to any magnesium component of the pegmatite, but seems referable to an interchange of the alkaline constituents of the feldspar for magnesium which has been introduced perhaps by ground waters.

Kushaqua, Franklin county. A large pegmatite body is found about 4 miles north of this place on the slopes of Sable mountain. It has been prospected during the last few years but has not supplied any feldspar in commercial quantity. The outcrop lies high up on the mountain near the summit at an elevation probably of

about 2500 feet above sea level. It is reached by a rough trail from Kushaqua.

Two openings have been made in the body which is elsewhere concealed by surface materials. The lower of these exposes the pegmatite over a width of 50 feet and a depth of 25 feet. The upper opening is a little smaller. There are said to be other prospects on the mountain which were not visited but which indicate that the pegmatite has the form of a dike and continues for over half a mile along the strike.

The feldspar is red microcline, showing little tendency to assume regular outlines. The rough and somewhat broken masses measure a little over a foot in diameter as a maximum. It is rarely free from admixture with other minerals and consequently could not be quarried to advantage for pottery use. Hornblende, tourmalin and biotite are the chief iron-bearing silicates.

De Kalb, St Lawrence county. The existence of a ledge of coarse pegmatite in this section was made known to the writer by J. H. McLear of Gouverneur. The locality is between East De Kalb and Bigelow, about 3 miles north of the latter place. The pegmatite is exposed in a natural outcrop that has not as yet been developed.

The principal showing consists of a ledge which exposes the pegmatite for a distance of 75 feet along the strike and 40 feet across it and then disappears below the surface deposits. The outcrop is fresh and free from iron stain. The pegmatite consists of white feldspar and milky quartz in fairly pure aggregates in a matrix formed by a fine intergrowth of the same minerals. The individual feldspar crystals range from 6 inches to 3 feet in maximum diameter. There appears to be very little admixture with other minerals usual to pegmatites. Pyrite, however, may be observed occasionally in the quartz. A second ledge in the same line of outcrop is exposed about 300 feet distant from the first, with similar characters. The quality of the feldspar so far as it may be estimated under the conditions, appears to be fairly good. The samples that were examined show it to be practically all microcline. A quantity of first-grade material could be extracted, but the main part owing to admixture with quartz would have to pass probably as lower grade. There is need for thorough prospecting to confirm the estimate that is formed on the surface showing, as well as to determine the size of the body.

Fowler, St Lawrence county. A dike of pegmatite carrying finely crystallized feldspar is found on the farm of C. W. Denesia about 2 miles south of Fullerville in the town of Fowler. It is only exposed, however, over a very limited area and where seen its width is not over 8 feet. The feldspars are developed in prismatic crystals from 2 to 3 feet long. They are inclosed in a ground mass of intergrown quartz and feldspar with which tourmalin and biotite are associated. They consist of a deep red microcline and a pinkish variety which is an intergrowth of microcline and albite. Unless the dike proves of greater magnitude than is indicated by the exposed part it would hardly be workable.

Fine, St Lawrence county. The occurrence of pegmatite on the farm of Fred Scott, about 4 miles north of Oswegatchie in the town of Fine, is of interest particularly for the associated minerals. These include fluorite, hornblende, pyroxene, pyrite, chalcopyrite and titanite in well-crystallized individuals. The feldspar occurs in pink, white and greenish varieties, evidently representing both the potash and lime-soda series. It is too much intergrown with the other minerals to have commercial value.

GARNET

The Adirondack garnet mines reported an output last year of 4285 short tons with a valuation of $121,759. This was less than in 1910 when the total amounted to 5297 short tons valued at $151,700 but may be considered as about the average outturn. The production has varied from year to year according to the activity of the market but at no time has taxed the full capacity of the mines. In fact the demand for abrasive garnet has shown very little tendency to increase, and there would seem to be little opportunity at present ror the development of new sources of supply.

No important changes in the industry have taken place during the past year. The principal producers, as heretofore, were the mines in the vicinity of North River. The largest factor in the industry has been for some time the North River Garnet Co. with mines and milling plant on Thirteenth lake, Warren county. The other active mines in that section included those on Gore mountain owned by H. H. Barton & Son Co. and those of the American Glue Co., a little farther north in Essex county. At Riparius, the Warren County Garnet Mills have operated in a small way. In northern Essex county near Keeseville the American mine shipped some material.

The conditions surrounding the occurrence of garnet in the Adirondacks have been described in several papers and in previous

issues of this report. The mineral is fairly widespread as a constituent of the metamorphosed igneous and sedimentary rocks, but only in a few places is it found in sufficient abundance and with the requisite characters to be worked for commercial abrasive purposes.

The value of abrasive garnet depends, of course, primarily upon its hardness. This is a variable character and on the usual mineral scale garnet is classed as having a hardness of from 6.5 to 7.5. The limits as given are only approximate, as it is difficult and even impossible to estimate hardness with precision. Chemical composition is undoubtedly a factor in determining the hardness of the common kinds of garnet found in the metamorphosed rocks, like gneisses, schists and crystalline limestones. The iron-alumina variety (almandite) is generally harder than the lime-alumina (grossularite), or the lime-iron variety (andradite). Well-crystallized garnet is tougher and probably also harder than the granular or massive garnet of similar chemical composition. The property of toughness or tenacity is very important in an abrasive which has to withstand considerable pressure as when used as polishing machines. Another factor which has a bearing upon the value of abrasive garnet is the size of the product which can be secured in the ordinary practice of mining and separation. If the crystals are small or have been badly shattered by compression after crystallization the product may be too fine to yield the necessary assortment of commercial sizes. It is an advantage, however, that the garnet should possess an imperfect cleavage or parting, so that on crushing the grains show one or more smooth surfaces. These surfaces permit firm attachment to the cloth or paper and also provide a sharp cutting edge. Color is no criterion of quality in ordinary garnet, but abrasive users seem to prefer the darker shades of red which approach the distinctive garnet color.

The local industry has very little competition from other mines in this country. Mines have been worked at different times in New Hampshire, Massachusetts, Pennsylvania and North Carolina but have not proved permanent factors in the trade. The importation of Spanish garnet, first noted in 1907, has assumed some importance as a substitute for the finer sizes of the Adirondack mineral. This garnet is said to be obtained by concentration of alluvial sands and can be produced cheaper than the domestic garnet, but comes only in the finer sizes. It pays no import duty. The importations in 1911 were 693 short tons, with an invoice

value of $10,526. In 1900 they amounted to 775 short tons valued at $14,830. The principal ports of entry are New York, Boston and Chicago, and the shipments are made from both Spanish and British ports.

GRAPHITE

No noteworthy developments were recorded for the graphite industry during 1911. The production amounted to 2,510,000 pounds, about the usual quantity, and represented a value of $137,750. The total for the preceding year was 2,619,000 pounds, with a value of $160,700. Prices appeared to be somewhat lower; the reported average was about 5.5 cents a pound, as compared with 6.1 cents in 1910.

The American mine at Graphite, owned by the Joseph Dixon Crucible Co., continued as the leading producer. This mine has long been the largest and most successful of the kind, not only in the State but in the country as well, and may be considered the pioneer enterprise in all that relates to the technology of treating the disseminated flake graphite which constitutes the principal source of domestic production. The methods of extracting and refining the graphite as developed by its management have seldom been applied elsewhere with similar results, owing in some measure undoubtedly to the unusually favorable natural conditions found at Graphite. The ore is a quartzite carrying flakes of graphite distributed along the cleavage planes. The flakes are relatively of large size, showing the appearance of having been squeezed out by regional compression, and measure up to one quarter inch in diameter. The average content in graphite may be placed at about 6 or 7 per cent. What is most important to the success of the milling operations is the practical absence of micaceous minerals which are more or less common in the graphitic schists and quartzites of the Adirondacks. When present in any amount a high-grade graphite product can not be expected.

The deposits of the American mine have a northeast-southwest strike and their extension to the southwest is found on the adjoining lands owned by W. H. Faxon of Chestertown, N. Y. This property has been explored recently with considerable thoroughness by test pits and diamond drilling, but still awaits active development. The exploration has demonstrated the continuity of the graphite beds over a distance of fully 4000 feet along their course to the southwest and with some interruptions for several hundred feet on the dip which follows a low angle to the southeast. The same series of gneisses, limestones and graphitic quartzites is found here as in the

area under exploration. The graphitic quartzite that constitutes the principal ore body has a thickness ranging from 5 or 6 to 25 feet, showing local pinches and bulges as is usual in the Adirondack deposits. There is considerable variation in the size and abundance of the flake, but as a whole the character of the quartzite is quite like that in the American mine. Near the southwestern end of the property the graphite series outcrops in a little ravine where a short drift has been extended into the north bank; two distinct beds are found here separated by a band of garnetiferous gneiss. In a drill hole (No. 2) 300 feet or so northeast of the drift a similar relation holds, the upper bed measuring about 4 feet and the lower 18 feet thick with 26 feet of gneiss between them. The two beds appear to merge a little further northeast for in No. 3 drill hole just east of the camp a single seam over 20 feet thick was encountered and this apparently continues with local variations as to thickness to the northeastern limits of the property, except in one place where the series is invaded by a gabbro intrusion. The deepest hole, No. 7, was put down in the flat about 600 feet east of No. 3 and twice that distance from the outcrop of the graphite bed on the ridge to the northwest. The data for this boring have been kindly supplied by Mr Faxon and are illustrative of the general conditions under which the graphite occurs.

STRATA	THICKNESS FEET	INCHES
Rock with large flake graphite	2	0
Garnetiferous gneiss	20	0
Garnetiferous gneiss and limestone	24	0
Limestone	9	0
Limestone and quartz	8	10
Limestone	36	8
Black rock (hornblende?)	4	0
Limestone	5	3
Lost core	1	6
Graphite	0	6
Good flake graphite	5	4
Fine flake graphite	5	6
Good large flake graphite	12	2
Garnetiferous gneiss	24	0
Black rock	5	8
Total	164	5

In hole No. 1 on the northeast, next to the American property the graphite bed measured 20 feet thick.

The Empire Graphite Co., owning mines in the town of Greenfield, Saratoga county, 4 miles west of Kings, was active during

a part of the year. The work consisted mainly of development incident to a change from surface to underground methods of mining. The deposit along the outcrop has been decomposed with the formation of clayey matter which complicated the separation of the graphite. The matrix is a feldspathic quartzite resembling that at the American mine, but the flake averages a little smaller in size. Two distinct beds are in evidence, separated by 4 feet of limestone and barren quartzite. The upper bed has a thickness of from 10 to 14 feet and the lower of from 4 to 5 feet. The immediate walls consist of mica schist, carrying pyrite, but thick-bedded garnetiferous gneisses occur in the upper part of the series, south of the workings. The outcrop of the beds strike nearly east and west and is marked by a slight depression in the easterly sloping ridge. It is traceable for 1500 feet or more from the present mine openings which are at the eastern end of the outcrop. The dip is about 30° south. The principal development aside from the open cuts consists of an adit driven in the side hill along the course of the upper seam for a distance of about 125 feet. Additional workings will be necessary before the mill can be maintained in steady operation. This is a large concrete structure situated on the side hill at the mines. It is equipped with a gyratory crusher, 10 stamps, and rolls for the reduction of the ore. The separating equipment includes buddles, settling tanks, screens and dryers.

The Saratoga Graphite Co. has lately erected a mill near Kings Station north of Saratoga Springs.

The other properties in the eastern Adirondacks that have been active during the last few years include the Conklingville mine of the Sacandaga Graphite Co., and the mine near Chilson lake, owned by the Crown Point Graphite Co.

A small quantity of graphite has been shipped recently by the Macomb Graphite Co., from its property near Popes Mills, St Lawrence county.

GYPSUM

The remarkably rapid progress that has characterized the gypsum industry during recent years was interrupted in 1911 and the output showed a decline amounting to about 4 per cent. The setback may be attributed doubtless to the lessened activity in the building trades, as most of the output was used for the manufacture of calcined plasters and for admixture with portland cement. There was a similar falling off in many other industries based on the production of building and structural materials. It may also be said

that the period of rapid expansion marking the development stage of the gypsum industry is probably over and that progress henceforth will be slower and less constant than in the past.

The output based on the crude rock mined or quarried last year amounted to 446,794 short tons. The corresponding total for the preceding year was 465,591 short tons, showing a decrease of 18,797 short tons, compared with a gain of 87,359 tons in 1910. With the one exception the product last year was the largest on record.

Of the total as given about 70 per cent was consumed by the local calcining plants operated in connection with the mines for the manufacture of plaster of paris and wall plasters. The reports of these plants showed a production of 262,249 tons of calcined plasters with a value of $871,106. The outturn for 1910 was 250,228 tons valued at $838,340. The quantity of gypsum ground for land plaster was reported as 9959 tons valued at $18,508, against 12,597 tons valued at $28,100 in 1910. The sales of crude or lump gypsum, chiefly to portland cement works, accounted for 144,035 tons valued at $202,984, as compared with sales of 178,518 tons valued at $256,512 in the preceding year.

Production of gypsum

MATERIAL	1910		1911	
	SHORT TONS	VALUE	SHORT TONS	VALUE
Total output, crude	465 591	.....	446 794	.....
Sold crude	178 518	$256 512	144 035	$202 984
Ground for land plaster	12 597	28 100	9 959	18 508
Wall plaster, etc. made	250 228	838 340	262 249	871 106
Total	.....	$1 122 952	.....	$1 092 598

The output of gypsum and gypsum products as given was reported by 14 firms and was divided among the five counties of Onondaga, Cayuga, Monroe, Genesee and Erie. The greater quantity of rock was obtained in the western section where it found use mainly in the production of calcined plasters.

In Onondaga county there was less activity than usual. The Fayetteville Gypsum Co. produced most of the crude gypsum obtained in the county and shipped the output to New York City for calcination. The property operated by the company was the

Severance quarry near Lyndon, notable for the great thickness of the gypsum beds which are exposed around the summit of a hill and have a vertical extent of from 40 to 60 feet. They are worked by open cut excavation, after first blasting down the overlying shale and limestone which are from 20 to 25 feet thick. The lump gypsum is loaded on 20-ton wagons and hauled 2 miles by a traction engine to the Erie canal for shipment. The quarry formerly worked by the National Wall Plaster Co., in the same vicinity, produced some gypsum which was ground in the local mills to land plaster.

The quarries at Union Springs, Cayuga county, were worked during the year by local interests, the lease under which they had been operated for several years by the United States Gypsum Co. having expired. Most of the output from this place has been used for land plaster and for portland cement. The gypsum ranges from 20 to 30 feet thick and is worked by quarry methods.

In Monroe county around Garbutt the usual activity was manifest, though there was one less producer than in the preceding year. The Garbutt Gypsum Co., one of the pioneers in the district, closed down its mine and mill. The active companies were the Consolidated Wheatland Plaster Co., the Empire Gypsum Co., the Lycoming Calcining Co., and the Oatka Gypsum Co., the last named succeeding the Monarch Plaster Co. The gypsum occurs in two seams, each from 5 to 8 feet thick, separated by from 6 to 12 feet of limestone. Only the upper seam has thus far been attacked. The work is all underground, conducted through adits or shallow vertical shafts. About one-fourth of the output last year was marketed as crude or ground raw gypsum, the rest being converted into calcined plasters. Monroe county held second place in quantity and value of its products.

The active mines in the western section were those of the United States Gypsum Co. and the Niagara Gypsum Co. near Oakfield, Genesee county, and of the American Gypsum Co. and the Akron Gypsum Co. near Akron, on the Erie-Genesee county boundary. Their output was consumed mainly in the manufacture of wall plasters by the plants located at the mines. The American Gypsum Co., however, shipped most of its output to portland cement makers. The gypsum beds in this section are rather thin, averaging not more than 4 or 5 feet, but they are of high-grade character, well adapted for calcination. The mines are worked through vertical shafts in a manner similar to that employed in coal mining. Their equipment and management are based on the most modern approved methods, some of the mines being operated by electric power.

IRON ORE

The record of the iron mining industry last year was uneventful. The reports from the individual companies covering the year's operations indicated the usual number of active enterprises but the average quota was less than for some time and in most sections diminished attention was given to exploration and development work. Unsatisfactory market conditions were responsible for the poor showing. The large production of iron in the preceding year proved to be in excess of the market requirements and brought on a slump which extended well into the season of 1911. There was consequently very little inquiry for ore during the early months. The absorption of the surplus output was facilitated by radical price cutting and by the middle of the year the conditions so far as related to the demand were somewhat improved. This change in the situation proved permanent and enabled the mining companies to dispose of most of their output for the year though at reduced prices. At the close of the season the outlook for the immediate future seemed fairly encouraging.

The production of iron ore in the State during the last two decades is shown in the accompanying table. The figures are based on lump ore and concentrates of commercial grades and not on the mine output which is considerably larger. The volumes of the *Mineral Resources* published by the United States Geological Survey have supplied the data for the years previous to 1904.

Production of iron ore in New York State

YEAR	MAGNETITE	HEMATITE	LIMONITE	CARBONATE	TOTAL	Total value	Value per ton
	Long tons	Long tons	Long tons	Long tons	Long tons		
1891	782 729	153 723	53 152	27 612	1 017 216	.....	.....
1892	648 564	124 800	53 694	64 041	891 099	$2 379 267	$2 67
1893	440 693	15 890	35 592	41 947	534 122	1 222 934	2 29
1894	.....	.....	.....	.....	242 759	.....	.....
1895	260 139	6 769	26 462	13 886	307 256	598 313	1 95
1896	346 015	10 789	12 288	16 385	385 477	780 932	2 03
1897	296 722	7 664	20 059	11 280	335 725	642 838	1 91
1898	155 551	6 400	14 000	4 000	179 951	350 999	1 95
1899	344 159	45 503	31 975	22 153	443 790	1 241 985	2 80
1900	345 714	44 467	44 891	6 413	441 485	1 103 817	2 50
1901	329 467	66 389	23 362	1 000	420 218	1 006 231	2 39
1902	451 570	91 075	12 676	Nil	555 321	1 362 987	2 45
1903	451 481	83 820	5 159	Nil	540 460	1 209 899	2 24
1904	559 575	54 128	5 000	Nil	619 103	1 328 894	2 15
1905	739 736	79 313	8 000	Nil	827 049	2 576 123	3 11
1906	717 365	187 002	1 000	Nil	905 367	3 393 609	3 75
1907	853 579	164 434	Nil	Nil	1 018 013	3 750 493	3 68
1908	663 648	33 825	Nil	Nil	697 473	2 098 247	3 01
1909	934 274	56 734	Nil	Nil	991 008	3 179 358	3 21
1910	1 075 026	79 206	4 835	Nil	1 159 067	3 906 478	3 37
1911	909 359	38 005	5 000	Nil	952 364	3 184 057	3 34

The production in 1911 as reported by all the active mines was 952,364 long tons valued at $3,184,057. Compared with the reported output of 1,159,067 long tons for 1910 there was a decline of 206,703 tons or about 18 per cent. The average value was $3.34 a ton against $3.37 a ton in the preceding year; but the decline in the market prices was greater than indicated by this comparison since the average grade of the ore as shipped was considerably higher in 1911 than in 1910.

Of the output magnetite constituted a total of 909,359 long tons and represented a value of $3,088,869. The quantity of hematite mined was 38,005 long tons, all from the Clinton belt, with a value of $88,188. A few thousand tons of limonite were shipped from the Dutchess county district. No carbonate ore was produced.

The output of magnetite was made up largely of concentrates and consequently did not represent the full quantity of that ore hoisted from the mines. The actual mine output of magnetite was 1,215,868 tons. The total quantity of ore of all kinds hoisted during the year therefore was 1,258,873 tons. In 1910 the corresponding total was 1,517,880 tons.

The list of companies that were active in the industry last year included for the Adirondack region: Witherbee, Sherman & Co. and the Port Henry Iron Ore Co., at Mineville; the Cheever Iron Ore Co., Port Henry; the Chateaugay Ore and Iron Co., Lyon Mountain; and the Salisbury Steel and Iron Co., Salisbury Center. The Benson Mining Co., at Benson Mines, was engaged in erecting a new mill but did not contribute any output last year. The producers of magnetite in southeastern New York were the Hudson Iron Co., Fort Montgomery, and the Sterling Iron and Railway Co., Lakeville. The single producer of limonite in the region east of the Hudson river was the Amenia mine. The output of hematite was made by C. A. Borst, Clinton; Furnaceville Iron Co., Ontario Center; and Ontario Iron Ore Co., Ontario Center.

Mineville. The two companies at Mineville maintained steady operations throughout the year, though on a somewhat reduced scale as compared with their output in 1910. The amount of ore hoisted was reported as 734,353 tons, against 953,553 tons in the preceding year, which was the largest on record.

The mines operated by Witherbee, Sherman & Co. included the Old Bed, Harmony and Barton Hill groups. Both lump ore and concentrates were shipped, the concentrates being supplied from No. 1 and No. 2 mills on the Old Bed and No. 3 mill on the Harmony group. The lump ore came from the Old Bed.

The Old Bed workings, reached through the Joker and Bonanza shafts, have been enlarged recently by the development of a separate bed underlying the main deposit. This lower ore body spreads over a considerable area as a nearly flat sheet, in strong contrast with the complex overlying body, and has a thickness up to 30 feet. The ore resembles that of the Old Bed proper, but contains a little less apatite. Both the Joker and Bonanza shafts have been connected through to the deposit which furnished last year about one-half of the quantity hoisted from the Old Bed group. The ore body extends for a considerable distance to the north and west, and it is intended to connect the workings with the Miller pit, as a provision for safety and ventilation.

The Harmony mines have been usually active, the output going to the new No. 3 mill completed in 1910. The products consist of ordinary concentrates with about 64 per cent iron and extra high grade concentrates with 71.4 per cent iron, the latter being used for making electrodes for arc lamps. The tailings from the mill also find application for road and concrete work. A complete description of this mill which contains many advanced features in the magnetic separation of iron ore has been given by H. Comstock,[1] Assistant General Manager of Witherbee, Sherman & Co.

The work in the Barton Hill mines has been mainly of development character, preparatory to their steady operation. From the new tunnel a raise has been excavated to the old Orchard pit encountering good ore all the way. For the treatment of the future mine output a new mill is in course of construction, the fourth erected by the company. The mill is designed for a capacity of 100 tons crude ore an hour. It is to be an all-steel structure with corrugated iron cover. The crushing department will be equipped with a 24 by 36 inch jaw crusher and two no. 5 Gates gyratory crushers from which the product will go to a storage bin of 1200 tons capacity. From the storage bin the ore passes to revolving screens making four sizes each of which is delivered to independent separators of the drum and belt types. These make three products, concentrates that go to the shipping bin, tailings to the stock pile, and middlings which are reground by rolls, sized and again separated. The power for driving the crushers and separators will consist of four motors of 150 h. p. each.

The Port Henry Iron Ore Co. obtained most of its product from the Clonan shaft in the southern part of the "21" ore body, but

[1] The Iron Trade Review, Nov. 9, 1911, p. 825-29.

also hoisted some ore from the upper workings reached by the incline. The Welch shaft farther north contributed a small output.

Cheever mine. The recently revived operations at this mine near Port Henry continued to afford a good output during the past year. The southern end of the old workings have thus far received most attention. Though no extensive bodies of rich ore have been found, a large quantity of material of concentrating grade has been developed, sufficient to assure a steady production for some time to come. The shipments are all in the form of concentrates, made in a local mill.

Some prospecting has been under way during the year on the northern continuation of the Cheever ore belt. The results of the work which was carried on by a Buffalo company have not been given to the public.

Lyon Mountain. The mines at Lyon Mountain were operated as usual for the supply of the Standish furnace.

Benson Mines. No production of ore was made by these mines last year. The results obtained with the old mill proved so unsatisfactory, that work was suspended and preparations started toward its replacement by a new structure. This is now in course of erection. The mill which is planned for two units will be first equipped for a single unit with a capacity of 1000 tons crude ore a day. The scheme of separation involves the use of dry magnetic belt and drum machines following the general plan adopted in the other Adirondack mills. A storage capacity of 10,000 tons of dried ore will be provided so as to insure continuous work during the winter season which is rather severe in that region. Power for the mines and mill is to be supplied from an independent hydro-electric station.

MINERAL PAINT

Under this title are included the natural mineral colors which require nothing more than grinding or washing in their preparation for the market. The raw materials found in the State that have been used for the purposes are iron ore, ocher, shale and slate. New York is also one of the leading producers of artificial pigments, specially those made from lead, but as the materials are derived from outside sources no account of them is taken in this place.

The Clinton hematite affords an excellent base for the manufacture of metallic paint and mortar color. The beds with a relatively high iron content are employed, as they possess the softness and

uniformity of texture, as well as depth of color, which are generally sought for. The mines owned by C. A. Borst at Clinton, Oneida county, and those of the Furnaceville Iron Co., at Ontario, Wayne county, supply most of the ore for paint. The hematite from the former locality belongs to the oolitic variety and that sold to paint manufacturers carries about 45 per cent iron. The ore in Wayne county is of fossil character carrying about 40 per cent iron. The red hematite from St Lawrence county is also used for metallic paint.

The manufacturers of metallic paint and mortar colors in New York State include the Clinton Metallic Paint Co., of Clinton, the William Connors Paint Manufacturing Co., of Troy, and the Rossie Iron Ore Paint Co., of Ogdensburg. A large quantity of the Clinton hematite is shipped to points outside of the State for manufacture.

Both shale and slate are ground for paint, their color depending largely upon the amount and nature of the iron oxids present. When there is a large proportion of ferric oxid the shale and slate may be sold as metallic paint. At Randolph, Cattaraugus county, beds of green, brown and bluish shale occurring in the Chemung formation have been worked for paint purposes. The red shale from the base of the Salina formation has been similarly utilized in years past, having been obtained from a locality in Herkimer county. At Roxbury, Delaware county, a shale in the Catskill series was once employed. The red slate of Washington county, which belongs to the Cambric, is the principal source of pigments of this character at present. The Algonquin Red Slate Co. of Worcester, Mass., and A. J. Hurd's Sons of Eagle Bridge are producers of red slate pigment.

The ferruginous clay called ocher is of common occurrence, but is not now worked in the State. Sienna, a deep brown variety of ocher, is found near Whitehall.

The production of mineral paints in 1911 included 7237 short tons of metallic paint and mortar color valued at $68,870 and 1646 short tons of slate pigment valued at $12,864. The totals for 1910 were 8063 short tons of metallic paint and mortar color valued at $70,841 and 1400 short tons of slate pigment valued at $10,900. These quantities represent only the pigments manufactured within the State from local materials.

MINERAL WATERS

New York has held for a long time a leading position among the states in the utilization of mineral waters. The different springs, of which over two hundred have been listed as productive at one time or another, yield a great variety of waters in respect to the character and amount of their dissolved solids. There are some that contain relatively large amounts of mineral ingredients and are specially valuable for medicinal purposes; Saratoga Springs, Ballston Springs, Richfield Springs, Sharon Springs and Lebanon Springs are among the more noted localities for such waters. Numerous other springs are more particularly adapted for table use containing only sufficient mineral matter perhaps to give them a pleasantly saline taste. Both kinds of waters are generally carbonated and sold in small bottles.

Of late there has developed an important business in the sale of spring waters which can hardly be classed as mineral in the common acceptance of the word, but which are extensively consumed for office and family use in the larger towns and cities. Their employment depends upon their freedom from harmful impurities, in which feature they are generally superior to the local supplies. In so far as such waters are an article of commerce they may well be included in a canvass of the mineral water industry. They are usually distributed in large bottles or carboys in noncarbonated condition.

Character of mineral waters. Among the spring waters that contain mineral ingredients in appreciable quantity those characterized by the presence of alkalis and alkaline earth are the most abundant in the State. The dissolved bases may exist in association with the chlorin and carbon dioxid, as in the springs of Saratoga county, or they may be associated chiefly with sulfuric acid, as illustrated by the Sharon and Clifton springs.

The mineral waters of Saratoga Springs and Ballston are found along fractured zones in Lower Siluric strata, the reservoirs occurring usually in the Trenton limestone. They are accompanied by free carbon dioxid which, together with chlorin, sodium, potassium, calcium and magnesium, also exists in dissolved condition. The amount of solid constituents in the different waters varies from less than 100 to over 500 grains per gallon. Large quantities of table and medicinal waters are bottled at the springs for shipment to all parts of the country. The carbon dioxid which issues from the wells at Saratoga is likewise an important article of commerce.

The waters at Richfield Springs contain the elements of the alkali and alkaline earth groups together with sulfuric acid and smaller amounts of chlorin, carbon dioxid and sulfureted hydrogen. They are employed for medicinal baths as well as for drinking purposes. The springs issue along the contact of Siluric limestone and Devonic shales. Sharon Springs is situated to the east of Richfield Springs and near the contact of the Lower and Upper Siluric. Clifton Springs, Ontario county, and Massena Springs, St Lawrence county, are among the localities where sulfureted waters occur and are utilized.

The Oak Orchard springs in the town of Byron, Genesee county, are noteworthy for their acid waters which contain a considerable proportion of aluminum, iron, calcium and magnesium, besides free sulfuric acid.

The Lebanon spring, Columbia county, is the single representative in the State of the class of thermal springs. It has a temperature of 75° F. and is slightly charged with carbon dioxid and nitrogen.

Ordinary spring waters. The greater quantity of spring waters consumed in the State belongs to the nonmedicinal, noncarbonated class, represented by such springs as the Great Bear, Deep Rock, Mount View, Sun Ray, Chemung etc. The waters are obtained either by flowing springs or from artesian wells and are shipped in carboys or in tank cars to the principal cities where they are bottled and distributed by wagons among the consumers. The essential feature of such waters is their freedom from noxious impurities. This is generally safeguarded by the care exercised in the handling of the waters which are also regularly examined in the chemical and bacteriological laboratories.

Carbon dioxid. This gas is given off in quantity by some of the wells at Saratoga Springs, and its collection and storage for shipment constituted for many years an important industry at that place. Over 30 wells have been bored there for gas alone. The industry has now been discontinued by force of a legislative enactment; it was considered that the pumping of the wells for the production of the gas was detrimental to the other springs that were utilized solely for their waters. For some time the value of the natural gas secured for the wells exceeded that of the mineral water sales.

List of springs. The following list includes the names and

localities of most of the springs in the State that are employed commercially, as shown by a canvass of the industry:

NAME	LOCALITY
Baldwin Mineral Spring	Cayuga, Cayuga co.
Coyle & Caywood	Weedsport, Cayuga co.
Diamond Rock Spring	Cherry Creek, Chautauqua co.
M. J. Spicer	West Portland, Chautauqua co.
Breesport Oxygenated Mineral Spring	Breesport, Chemung co.
Chemung Valley Spring	Elmira, Chemung co.
Chemung Spring Water Co	Chemung, Chemung co.
Lebanon Mineral Spring	Lebanon, Columbia co.
Monarch Spring Water Co	Matteawan, Dutchess co.
Mt Beacon Spring	Matteawan, Dutchess co.
Mount View Spring	Poughkeepsie, Dutchess co.
Ayers Amherst Mineral Spring	Williamsville, Erie co.
Elk Spring Water Co	Lancaster, Erie co.
Beauty Spring Water Co	Lyons Falls, Lewis co.
Cold Spring	New York Mills, Oneida co.
Lithia Polaris Spring	Booneville, Oneida co.
J. Wells Smith	Franklin Springs, Oneida co.
F. H. Suppe	Franklin Springs, Oneida co.
W. W. Warner	Franklin Springs, Oneida co.
Geneva Lithia Spring	Geneva, Ontario co.
Red Cross Lithia Spring	Geneva, Ontario co.
Crystal Spring	Oswego, Oswego co.
Great Bear Spring	Fulton, Oswego co.
J. Hagerty	Oswego, Oswego co.
Os-we-go Spring	Oswego, Oswego co.
Mammoth Spring	North Greenbush, Rensselaer co.
Shell Rock Spring	East Greenbush, Rensselaer co.
Massena Mineral Spring	Massena Springs, St Lawrence co.
Arondack Spring	Saratoga Springs, Saratoga co.
Artesian Lithia Spring	Ballston Springs, Saratoga co.
Chief Spring	Saratoga Springs, Saratoga co.
Coesa Spring	Saratoga Springs, Saratoga co.
Comstock Mineral Spring	Ballston Springs, Saratoga co.
Congress Spring	Saratoga Springs, Saratoga co.
Excelsior Spring	Saratoga Springs, Saratoga co.
Geyser Spring	Saratoga Springs, Saratoga co.
Hathorn Spring	Saratoga Springs, Saratoga co.
High Rock Spring	Saratoga Springs, Saratoga co.
Patterson Mineral Spring	Saratoga Springs, Saratoga co.
Quevic Spring	Saratoga Springs, Saratoga co.
Royal Spring	Saratoga Springs, Saratoga co.
Saratoga Seltzer Spring	Saratoga Springs, Saratoga co.
Saratoga Vichy Spring	Saratoga Springs, Saratoga co.
Star Spring	Saratoga Springs, Saratoga co.
Chalybeate Spring	Sharon Springs, Schoharie co.
Eye Water Spring	Sharon Springs, Schoharie co.
Gardner White Sulphur Spring	Sharon Springs, Schoharie co.
Sulphur-Magnesia Spring	Sharon Springs, Schoharie co.
Red Jacket Spring	Seneca Falls, Seneca co.
Pleasant Valley Mineral Spring	Rheims, Steuben co.
Setauket Spring	Setauket, Suffolk co.
Elixir Spring	Clintondale, Ulster co.
Sun Ray Spring	Ellenville, Ulster co.
Vita Spring	Fort Edward, Washington co.
Briarcliff Lodge Association	Briarcliff Manor, Westchester co.
Gramatan Spring Water Co	Bronxville, Westchester co.

Production. The reports received from the mineral water trade in 1911 showed sales of 8,923,628 gallons valued at $756,147. The number of springs contributing to the production was about 40. In the preceding year the sales amounted to 8,432,672 gallons valued at $675,034, reported by 46 springs. The value of the water is estimated at the spring water localities and does not include the cost of bottling. No account is made of the waters used in hotels, sanatoriums etc., run in connection with the springs, though this is an important item in the business in some places.

A comparison of the sales reported for a number of years back shows that the demand for the higher priced carbonated waters apparently has fallen off, but this decrease has been more than counterbalanced by the increased consumption of the ordinary spring waters supplied for office and family use.

Saratoga Springs. The plans for the creation of a State reservation which is to include practically all the springs hitherto employed for the commercial production of mineral waters and carbon dioxid have begun to take definite form. The commission empowered to effect the transfer of the property from private to State ownership had taken over at the close of the year the following springs: Hathorn (nos. 1, 2, 3), Coesa or Carlsbad, Champion, Red, Patterson, Putnam, Star, Governor, High Rock, Seltzer, Magnetic and Peerless, Victoria, Geyser, Adams and Congress. Those not included in the transfer at that time were the Arondack, Vichy, Chief, Excelsior and Quevic. Of the springs on the State reservation a few were utilized for commercial production by Hathorn & Co., under lease.

NATURAL GAS

The natural gas resources of the State are undergoing steady development, the production being little influenced by the varying trade conditions that affect other branches of mining. The supply, though it has increased markedly of late years, falls far short of meeting the requirements in the territory around the gas fields, and is helped out by importations from other states, chiefly Pennsylvania. Natural gas has been in use locally for nearly a century; there is a record of its employment for fuel and light as far back as 1825 at which time wells were in operation in Chautauqua county for the supply of natural gas to households.

The industry of supplying gas for general consumption first assumed importance, however, with the development of the oil dis-

tricts in Allegany and Cattaraugus counties, the gas being recovered as a by-product and sold to distributing companies who piped it to the towns and villages in the surrounding section. In the nineties of the last century exploration for gas was carried on actively all through the western part of the State and some new fields were discovered, notably in the section along the shore of Lake Ontario. A little later an important field was opened in Erie county, east of Buffalo. The gas pools were encountered in the Medina sandstone and led to the exploration of this formation along the dip in southern Erie and northern Chautauqua counties where some very productive wells have been opened at depths of 2000 feet or more.

Altogether there are 16 counties in the State that produce natural gas. The principal fields are found in Erie, Genesee, Chautauqua, Allegany and Cattaraugus counties. Outside of these the pools are of subordinate extent and importance, so far as they have been tested, and are scattered rather sparsely over the western section of the State, from Lake Erie and the Niagara river to the east end of Lake Ontario. Exploration of the rocks in eastern New York has been unsuccessful in locating valuable pools.

The supply of natural gas is derived from several geologic horizons, from the Potsdam sandstone in the Cambric to the Chemung strata at the top of the Devonic. The more productive formations include the Trenton limestone of the Lower Siluric, the Medina sandstone of the Upper Siluric, and the Portage and Chemung shales with interbedded sandstones belonging to the Devonic. With few exceptions the gas pools now producing occur in one or another of these formations.

The oil fields of Allegany and Cattaraugus counties have contributed, and still do contribute, considerable quantities of gas. The pools are found in sandstones at different horizons in the Devonic, such as the Bradford, Kane, and Elk "sands" of the Chemung. Some of the supply is consumed in the gas engines for pumping the oil, and the remainder is used for lighting and heating in the local towns or is piped to Buffalo. The distribution of the gas is mainly in the control of a few companies, like the Empire Gas and Fuel Co. of Wellsville, the Producers Gas Co. of Olean, and the United Natural Gas Co. of Oil City, Pa. Some of the local towns supplied from the fields are Olean, Andover, Wellsville, Friendship, Hornell and Geneseo. In the northwestern part of Cattaraugus county there is a small field of which Gowanda is the center and which extends across the border into Erie county. The gas is said to occur in the

Marcellus and Onondaga formations of the Middle Devonic. The output is distributed by the Gowanda Gas Co. for use in Gowanda. Explorations have been under way recently in northern Cattaraugus county between Gowanda and Cattaraugus where pools are reported at depths from 2500 to 3300 feet in what is supposed to be the Medina sandstone.

In Chautauqua county the productive area comprises a belt bordering Lake Erie from Silver Creek southwest to the Pennsylvania state line. Until quite recently the supply has been obtained from wells a few hundred feet deep in the Portage and Chemung beds and the individual output was small, sufficing only for a few families at most. Deep drilling during the last few years has resulted in the discovery of more productive pools, lying at depths from 1900 to 2300 feet in what is considered Medina sandstone. Some very large flows have been encountered in the vicinity of Silver Creek, Dunkirk, Forestville, Sheridan and Westfield. These wells are mainly owned by local companies who sell the output in the neighboring towns and villages. The principal operators include the Frost Gas Co., Silver Creek Gas and Improvement Co., South Shore Gas Co., and Welch Gas Co. During the past year the United Natural Gas Co. has been engaged in exploration in the town of Arkwright east of Fredonia and is reported to have encountered gas in quantity at depths around 2100 feet.

Erie county contains several fields. A few wells have been put down within the limits of Buffalo. East Aurora, Collins, North Collins, Angola and Springville in the southern part are centers of a more or less active industry. Within the last 15 years a field has been opened east of Buffalo in the towns of Cheektowaga, Amherst, Lancaster, Clarence, Alden and Newstead, which for some time has been the most productive in the State. The gas is found in the Medina sandstone at depths of from 1200 to 1600 feet, and the wells have proved quite persistent producers. It is transported in pipe lines to Buffalo, Tonawanda, Batavia, Lancaster, Depew, Honeoye Falls and other towns in the vicinity. There are over 200 productive wells in the field.

In Genesee county a prolific field has been developed at Pavilion during the last five years. The gas is found in the same horizon as in eastern Erie county, at depths of about 1700 feet. The Pavilion Natural Gas Co. and the Alden-Batavia Natural Gas Co. are the chief operators in the field and supply the gas to Pavilion, Leroy and Batavia.

In Wyoming county a few wells are in operation at Attica; in Livingston county at Caledonia, Avon and Lima; and in Ontario county in the towns of East Bloomfield and West Bloomfield. Farther east in Onondaga county there are wells at Baldwinsville and Phoenix which supply gas for local use. The pools are found in the Trenton shales and limestone. Oswego county marks the eastern limit of the productive territory, with wells at Pulaski and Sandy Creek.

Production. The value of the natural gas production during the last 4 years is shown in the accompanying table which is arranged to show also, so far as practicable, the contributions from the principal fields. The returns for the year 1911 indicated a total of $1,547,077, against $1,045,693 for 1909, an increase of approximately 50 per cent in the two years. The quantity of gas produced was approximately 5,127,571,000 cubic feet as compared with 4,815,643,000 cubic feet in 1910 and 3,825,215,000 cubic feet in 1909. These amounts include estimates for some of the smaller producers who have no meters attached to their mains, but they are believed to be close approximations of the actual production. The average value of the gas was 30 cents a thousand, against 29 cents and 27 cents a thousand respectively in the preceding years.

Production of natural gas

COUNTY	1908	1909	1910	1911
Allegany, Cattaraugus..	$264 736	$282 964	$337 427	$402 931
Chautauqua.....	153 019	174 597	202 754	222 023
Erie [1].....	451 869	461 531	717 038	813 279
Livingston [2].....	54 083	59 888	60 997	73 357
Onondaga.....	13 837	12 310	12 733	12 972
Oswego.....	12 800	14 402	14 783	14 913
Wyoming [3].....	37 431	40 001	65 967	7 602
Total.....	$987 775	$1 045 693	$1 411 699	$1 547 077

[1] Includes all the output in Genesee county for 1911 and a part of it for the preceding years.
[2] Includes also Seneca, Schuyler, Steuben, Ontario and Yates.
[3] Includes Niagara and also some of Genesee except for 1911.

The reports for 1911 covered a total of 1403 productive wells.

A comparison of the figures shows that Erie county leads all others in quantity and value of output. Its contribution including also that of Genesee county, amounted last year to 2,444,721,000

cubic feet valued at $813,279. There were 342 productive wells in the two counties.

The production given under Allegany and Cattaraugus counties included mainly the gas collected from oil wells, but there was a small output also from fields in the northern parts of the two counties where no oil is produced. The combined output taken from the reports of the pipe-line companies and the individual producers amounted last year to 1,600,317,000 cubic feet valued at $402,931, from a total of 766 wells.

The wells in Chautauqua county made an output of 804,713,000 cubic feet valued at $222,023. The principal part of the supply came from the deep wells which have been put down in the last few years in the belt along Lake Erie.

Genesee county has shown the largest relative increase in production during the past years, but the figures are included with those of Erie county.

PETROLEUM

The anticipated effects of the recent decline in crude oil prices were very manifest during 1911, at least in the New York field. There was less activity in exploration than for many years and with the comparatively poor record of new drilling in 1910, the productive conditions were most unfavorable. The maintenance of the local industry for a long time has been the small increments of yield obtained by redrilling old territory, for which the main incentive existed in the high market value of the local product. The recent decline, amounting to over 50 cents a barrel, practically put an end to such developments.

The total production in 1911, as reported by the pipe-line companies operating in the New York oil region, amounted to 915,314 barrels. The total for the preceding year was 1,073,650 barrels, showing a falling off of 158,336 barrels, or 15 per cent. The output in 1909, which was a year of good prices on the whole, amounted to 1,160,402 barrels. The value of the product last year was $1,198,868, or an average of $1.31 a barrel, against $1,458,194, an average of $1.36 in 1910, and $1,914,663, an average of $1.65 in 1909.

The production of oil during the last two decades is shown in the accompanying table. The figures for the years 1892–1903 have been compiled from the annual volumes of the *Mineral Resources*,

while those for subsequent years are based on the reports received from pipe-line companies who transport the oil to the refiners. The following companies operate pipe lines in the New York field: The Allegany Pipe Line Co., Columbia Pipe Line Co., Union Pipe Line Co., and Fords Brook Pipe Line Co., of Wellsville; Vacuum Oil Co., of Rochester; New York Transit Co., of Olean; Emery Pipe Line Co., Kendall Refining Co., and Tide Water Pipe Co., Limited, of Bradford, Pa.

Production of petroleum in New York

YEAR	BARRELS	VALUE
1892	1 273 343	$708 297
1893	1 031 391	660 000
1894	942 431	790 464
1895	912 948	1 240 468
1896	1 205 220	1 420 653
1897	1 279 155	1 005 736
1898	1 205 250	1 098 284
1899	1 320 909	1 708 926
1900	1 300 925	1 759 501
1901	1 206 618	1 460 008
1902	1 119 730	1 530 852
1903	1 162 978	1 849 135
1904	1 036 179	1 709 770
1905	949 511	1 566 931
1906	1 043 088	1 721 095
1907	1 052 324	1 736 335
1908	1 160 128	2 071 533
1909	1 160 402	1 914 663
1910	1 073 650	1 458 194
1911	915 314	1 198 868

The average quotations for crude oil from the Appalachian districts were lower in 1911 than at any time since 1901. The prices of Pennsylvania crude, which are taken as the basis for rating the New York output, were $1.30 a barrel at the opening of the year and remained unchanged until the last week in December when they advanced to $1.35. The outlook for the current season would appear more favorable, as the tendency in the early months was toward a higher level.

The records for the year showed that 195 new wells were completed, as compared with 283 wells in the preceding year, and 457 wells in 1909. The increment of production from the new wells amounted to 201 barrels a day, while in 1910 it was 368 barrels and in 1909 it amounted to 715 barrels. Of the number of wells

given 59 were dry, as compared with 61 and 32 respectively for the two preceding years.

The oil pools found in the State constitute the northern extension of the Appalachian field which reaches its main development in Pennsylvania, Ohio and West Virginia. They underlie small areas in Cattaraugus, Allegany and Steuben counties near the Pennsylvania border. The first well was drilled in Cattaraugus county in 1865, and Allegany county began producing about 1880. The oil is found in fine-grained sandstones of dark color belonging to the Chemung formation of the upper Devonic. In Cattaraugus county the productive area embraces about 40 square miles, mostly in Olean, Allegany and Carrolton townships. The pools of which the principal ones are the Ricebrook, Chipmunk, Allegany and Flatstone, occur at several horizons from 600 to 1800 feet below the surface. The oil district of Allegany county extends across the southern townships of Clarksville, Seneca, Wirt, Bolivar, Alma, Scio and Andover and is divided into several pools that are considered to be more or less independent. The Bolivar, Richburg and Wirt pools have been most productive. The oil is found at depths of from 1400 to 1800 feet. The Andover pool lies partly in the town of West Union, Steuben county, and is accountable for the production in that section. The reports of the *Mineral Resources* covering the year 1910 showed a total of 10,995 productive wells in the State, of which number Allegany county had 7859, Cattaraugus county 2917 and Steuben county 219. Practically all the wells are pumped and the average yield is less than one-third of a barrel a day.

There has been a great deal of exploration outside the districts mentioned, but up to the present time has not led to any positive additions to the productive area. Some of the more interesting and promising developments have been in northern Allegany county. A discovery of oil was reported a few years since in the town of Granger on the Livingston county border, considerably north of the other pools, and about 30 wells were drilled as a test. Some of these flowed under natural pressure, but they soon gave out, yielding less than 3000 barrels altogether. In the last year or two another section near Swain, town of Grove, has been under exploration. The original discovery was reported on the Fred Bennett farm where oil and gas were encountered in a well put down to 740 feet depth. Some other holes in the same vicinity were dry. Recently drilling has been under way on the Harman

place, and two productive wells are reported to have been brought in of which the first produced from 5 to 6 barrels a day. The second was dry when drilled, but began to flow after having been "shot." The oil is said to be of a dark, heavy quality.

PYRITE

Pyrite is obtained commercially in St Lawrence county. The mines of that section have been worked intermittently for many years but have come into prominence only of late, largely as the result of the systematic operations carried on by the St Lawrence Pyrite Co. The property of this company is situated at Stellaville near Hermon, and comprises a number of mines that have been more or less extensively developed, a large concentrating plant, and other equipment including the branch railroad from Hermon to De Kalb Junction which it built to secure an outlet for its product. The shipments are in the form of concentrates which are sold to sulfuric acid makers.

In addition to the Stellaville mines, the Cole property near Gouverneur has been a producer during the last two years, having been reopened in 1910. It is worked under lease by the Hinckley Fibre Co., which uses the output in crude form for the manufacture of sulfite pulp at its plant at Hinckley, Oneida county.

The employment of the crude low-grade ore for direct conversion of the sulfur into sulfurous acid to be used in the sulfite pulp process is a new development which if permanently successful, as it appears likely to prove from present indications, may have important consequences for the Adirondack mining industry. The output of sulfite fiber by the mills in that section is reported as about 900 tons daily for which 135 tons of commercial sulfur are imported at an average cost of $3300. To supply the equivalent amount of sulfur from pyrite would require from 400 to 600 tons of the usual grade of St Lawrence county ore, or say 150,000 tons a year. According to information privately communicated to the writer, there is an important economy in the use of the pyrite whenever it can be laid down at the mill at a fair price. In the case of such low-grade ores, its uses, however, necessitate special apparatus and methods which have been the subject of extended investigation; that success, to a certain degree at least, has attended the experiments seems to be evidenced by the continued shipments from the Cole mine.

Pyrite is rather abundantly distributed in the Adirondack region, and is represented in larger quantity in association with the Gren-

ville series of gneisses, schists and crystalline limestones. The principal deposits thus far found occur in the belts of these rocks, which are regarded as metamorphosed sediments, on the western border in St Lawrence and Jefferson counties. One large belt extends from near Antwerp, Jefferson county, across Gouverneur, De Kalb and Hermon townships of St Lawrence county, a distance of over 40 miles. It is the same belt which carries the red hematite ores of that region. The pyrite is disseminated through the schists and gneisses, but here and there it occurs segregated in bands or lenses so as to constitute mineable deposits, though of rather low-grade character. The bodies are arranged in conformity with the major structural features of the county rocks, so far as can be determined, having usually a northeast-southwest strike and a northerly dip as are prevalent throughout the region. They show local modifications in the way of folding, swells and pinches and were no doubt accumulated before the final period of regional compression which has affected the wall rocks.

The ore as mined consists normally of a granular aggregate made up of crystals and irregular particles of pyrite distributed through a gangue of which quartz is the chief component. The texture and grade of the ore is quite variable. Considerable masses of practically pure pyrite are found as an intergrowth of large-sized crystals, but the chief part of the output is represented by a mixture of medium to fine-grained pyrite showing no crystal development, with fairly large amounts of gangue materials. Besides quartz the accompanying minerals include hornblende, biotite, feldspar and alteration products of chloritic nature. Zinc blende and chalcopyrite are found occasionally in small amounts in the ore.

In some parts of the belt pyrrhotite occurs as an associate of the pyrite or in separate bodies of closely related features. It is found for instance at High Falls or Pyrites in distinct shoots though in the same mineralized zone with the pyrite. It has not been considered, hitherto, of any economical value, yet recent progress in the use of low-grade sulfides may be regarded as affording some prospect for its future industrial employment. The sulfur content is naturally lower than that of the pyrite, the theoretic amount being a little under 40 per cent and the average of the usual grade of material probably not over 25 per cent. The pyrrhotite gives a slight reaction for nickel.

The mines at Stellaville operated by the St Lawrence Pyrite Co. are opened on a parallel series of deposits, of which the largest is known as the Stella. A second important deposit, the Anna, is

found in the footwall, 1600 feet to the southeast, and others occur in the interval. The ore carries from 15 to 40 per cent of sulfur, with an average probably between 25 and 30 per cent. A small quantity is marketed as hand-cobbed ore or "spalls" with about 33 per cent sulfur, but the main product consists of mill concentrates with a content of 40 per cent or more. The concentrates are shipped to acid burners in the East. Though of lower sulfur content than the imported ores, they are a desirable material for acid-making on account of their freedom from arsenic and other injurious impurities. A comprehensive account of the Stellaville mines and their equipment has been contributed by Felix A. Vogel to volume 16 of the *Mineral Industry*.

The Cole mine at Gouverneur is based on a large outcropping deposit that was first worked as an open cut. The early development was carried out by the Adirondack Pyrite Co., later succeeded by the American Pyrite Co. The latter company ceased work in 1907 and dismantled the mining and milling plant. The property remained idle until the Hinckley Fibre Co. took it over in 1910. As shown in the present workings the ore lies in two parallel bodies separated by 15 or 20 feet of quartz rock. The lower deposit is about 15 feet thick and dips 40° to the northwest. It was first worked by open-cut methods and afterwards through an inclined shaft. The present supply of ore is taken mainly from the overlying body, which at the point of attack shows a thickness of about 50 feet and which is being developed through a raise from the lower workings. The present development of the mine is insufficient to afford much information in regard to the actual relations of the ore bodies and their extent. The crude ore as shipped carries from 25 to 40 per cent sulfur, with an average probably of 30 per cent or slightly less.

The deposits at Pyrites which were taken over by the Oliver Mining Co. about five years ago have remained inactive. They consist of a series of lenses that strike northeast and dip northwest at an angle of 15°. Their line of outcrop extends across the Grasse river under which there are workings reached from an island in the river. They have been explored in depth by the diamond drill but nothing can be stated as to the results beyond the fact that the ore appears to be persistent.

Besides the deposits mentioned that have been developed as mines, there are many prospects and exposures of pyrite in the

metamorphic region of St Lawrence and Jefferson counties. Some of the better known localities are on the Alexander Farr farm, two and a half miles northeast of Bigelow; on the George Styles farm, one and a half miles west of Bigelow; the farm of S. Hendricks, one mile south of Bigelow; and that of S. Hockens, seven miles west of Rensselaer Falls. Near Antwerp pyrite is found in the vicinity of the Dixon and Old Sterling iron mines. As has been noted by C. H. Smyth, jr, the hematite deposits of that section are often accompanied by bodies of pyrite in the adjoining wall rocks. Their distribution may afford a useful clew to exploration for the latter. There is an extensive belt of pyrite and pyrrhotite in the vicinity of Ox Bow.

The zinc ores near Edwards which are under development carry more or less pyrite intermixed with the blende. The pyritous ores are being reserved for mill treatment by which it is intended to make a pyrite concentrate as a by-product.

SALT

The salt industry throughout the State was practically unchanged last year. There were no additions to the list of producing plants. The output continued at about the rate established in the preceding year or two, and the market conditions, so far as prices were concerned, were almost stationary, at least showing no definite tendency toward recovery from the previous low levels. The selling prices of the various grades of evaporated salt have undergone a marked decline of late years, and it is doubtful if any further extensive reduction could take place without reacting injuriously upon that branch of the industry. The only real gains in the production recently have come from the rock salt mines and from the wells whose output of brine is consumed without evaporation for manufacture of soda products.

The total quantity of salt taken from the mines and wells during the year was 10,082,656 barrels of 280 pounds. This was a slight decrease from the total of 10,270,273 barrels reported for 1910, the largest ever recorded in the State, but exceeded the output of any other year. The actual decline was thus 187,617 barrels, or a little less than 2 per cent of the gross amount. Converted to a tonnage basis the product in 1911 was equivalent to 1,411,572 short tons against 1,437,838 short tons for the year 1910.

The value of the salt production, as fixed by the reports from the companies, amounted to $2,191,485, as compared with $2,258,-292, the value reported for the year 1910. These figures are based on the values at the mines or works, exclusive of costs of package. The average was 21.7 cents a barrel, against 22 cents a barrel in 1910, 23.3 cents in 1909, 23.7 cents in 1908 and 25 cents in 1907. Prices have thus fallen steadily for a number of years. It is to be noted, however, that the average values as given are reduced considerably by the inclusion of salt used in the form of brine for alkali manufacture. Since this salt is not marketed as such, and is not even evaporated, it is given only a nominal valuation, representing practically the mere cost of pumping. The production of this brine is confined to a single company, the Solvay Process Co., which has a number of wells in the town of Tully, Onondaga county, whence the brine is carried through a pipe line to the alkali works near Syracuse.

The accompanying tables give the statistics of salt production for recent years. For the years 1910 and 1911 the output is given according to grades, so far as the classification could be made without revealing the individual figures. The grades depend upon methods of manufacture and purposes for which the salt is used. Rock salt and salt in brine consumed by the alkali industry appear in the last item of the detailed tables which also includes small quantities of evaporated salt not specially classified in the returns. The evaporated salt is chiefly marketed under the grades of common fine, table and dairy, common coarse, common solar, and packers salt. Table and dairy salt includes the finest grades of artificially evaporated specially prepared for the table and for butter and cheese making; it brings the highest market price. Under common fine are listed the other grades of fine, artifically evaporated salt that are not specially prepared. Common coarse represents the coarser product from artificial evaporation. Coarse solar salt is made by evaporation of brine in shallow pans exposed to the sun's heat. This process is employed only by the manufacturers in Syracuse and vicinity, and can be carried on, of course, only in the summer months. Packers salt includes the product sold to meat packers and fish salters.

Production of salt by grades in 1910

GRADE	BARRELS	VALUE	VALUE PER BARREL
Common fine [1]	1 322 015	$378 547	$ .28
Common coarse	243 928	81 233	.33
Table and dairy	1 258 089	611 271	.49
Coarse solar	439 780	129 295	.29
Packers	37 935	13 277	.35
Other grades [2]	6 968 526	1 044 669	.15
Total	10 270 273	$2 258 292	$ .22

[1] Common fine includes a small amount of common coarse.
[2] Include rock salt, salt in brine used for soda manufacture, and small amounts of brine salt for which the uses were not specified in the returns.

Production of salt by grades in 1911

GRADE	BARRELS	VALUE	VALUE PER BARREL
Common fine [1]	1 143 886	$328 127	$ .29
Common coarse	285 407	96 968	.34
Table and dairy	1 312 000	629 581	.48
Coarse solar	434 414	131 247	.30
Packers	40 721	11 402	.28
Other grades [2]	6 866 228	994 160	.14
Total	10 082 656	$2 191 485	$ .217

[1] Common fine includes a small quantity of common coarse.
[2] Include rock salt, salt in brine used for soda manufacture, and small amounts of brine salt for which the uses were not specified in the returns.

The output in 1911 was contributed by 30 mines and works distributed among six counties of the State. Onondaga county was represented by the largest number of producers, having 20 in all. Livingston county was represented by 3, of which 2 were rock salt mines, the only ones now active. Schuyler, Tompkins and Wyoming counties each had 2 producers, and Genesee county which completes the list had 1.

Production of salt in New York since 1887

YEAR	BARRELS	VALUE
1887	2 353 560	$936 894
1888	2 318 483	1 130 409
1889	2 273 007	1 136 503
1890	2 532 036	1 266 018
1891	2 839 544	1 340 036
1892	3 472 073	1 662 816
1893	5 662 074	1 870 084
1894	6 270 588	1 999 146
1895	6 832 331	1 943 398
1896	6 069 040	1 896 681
1897	6 805 854	1 948 759
1898	6 791 798	2 369 323
1899	7 489 105	2 540 426
1900	7 897 071	2 171 418
1901	7 286 320	2 089 834
1902	8 523 389	1 938 539
1903	8 170 648	2 007 807
1904	8 724 768	2 102 748
1905	8 575 649	2 303 067
1906	9 013 993	2 131 650
1907	9 657 543	2 449 178
1908	9 005 311	2 136 736
1909	9 880 618	2 298 652
1910	10 270 273	2 258 292
1911	10 082 656	2 191 485

The large number of producers in Onondaga county is incident to the solar salt industry which is carried on extensively around Syracuse. The brine used by the solar evaporating works or salt yards is stored in glacial gravels and is pumped and distributed by central plants. The principal supply comes from the old Onondaga Salt Springs Reservation that was sold by the Indians to the State in 1788. The manufacture of salt was placed under State control in 1797 from which time complete records of the industry are available. At one time artificial evaporation was extensively practised but this has been given up almost entirely in recent years with the increased competition from other districts. The solar salt is sold through the agency of the Onondaga Coarse Salt Association.

With the exception of the salt made at Syracuse the entire production is obtained from the deposits of rock salt which are found in the Salina formation, a succession of shales and limestones with intercalated beds of gypsum and rock salt. The Salina strata outcrop in an east-west belt across the State from Albany county to

the Niagara river and are represented by a smaller separate area in southeastern New York. Well tests indicate that the salt deposits are restricted to the western section of the main belt beginning in Madison county; east of there the strata diminish in thickness to such an extent as to preclude their existence. They are encountered only at a depth of 1000 feet or more where there has been sufficient cover to protect them against solution by ground waters. As the whole stratified series has a dip uniformly toward the south the mines and wells are all located on the southern side of the outcrop which lies about on the line of the forty-third parallel. The dip averages 40 or 50 feet to the mile. The most easterly point where rock salt has been found is at Morrisville, Madison county. Between that place and Lake Erie it has been shown to exist in almost all of the middle tier of counties.

The exploration of the rock salt beds dates from 1878 when a well bored for oil near Wyoming, Wyoming county, encountered 70 feet of salt at 1270 feet from the surface. Discoveries were subsequently made at Warsaw, Leroy, Rock Glen, Batavia and numerous places in Livingston, Wyoming and Genesee counties. Practically the whole valley of Oatka creek, from Leroy to Bliss and the Genesee valley south of Monroe county has been found to be salt-bearing. The region is now the most productive in the State. Livingston county has the largest annual output which is contributed by the two rock salt mines at Retsof and Cuylerville owned respectively by the Retsof Mining Co. and the Sterling Salt Co., and by the evaporating plant of the Genesee Salt Co. at Piffard. The other companies now active in this section include the Leroy Salt Co., of Leroy; the Rock Glen Salt Co., of Rock Glen; and the Worcester Salt Co., of Silver Springs.

In Schuyler county salt is obtained around Watkins. The Glen Salt Co. sank the first well there in 1893 and encountered a deposit at 1846 feet depth. The plant is now operated by the International Salt Co. The Watkins Salt Co. also has works at this place.

A well drilled at Ithaca, Tompkins county, in 1885 passed through seven beds of salt aggregating 248 feet in thickness at depths below 2244 feet from the surface. The discovery was followed by active developments at Ludlowville in 1891 by the Cayuga Lake Salt Co., and at Ithaca in 1895 by the Ithaca Salt Co. The plants were taken over in 1899 by the National Salt Co., which was merged in 1905 into the International Salt Co. The Remington

Salt Co. later erected a plant at Ithaca which is now in operation, obtaining its salt from three wells at a depth of about 2100 feet.

The Solvay Process Co. derives its supply of brine from a number of wells located in the town of Tully, 20 miles south of Syracuse. The brine is carried in pipe line to the works at Solvay.

In Erie county rock salt has been found at Eden Valley, Springville, Perry and Gowanda, but there is no output at present in that county. Among the localities where discoveries have been made may be mentioned Vincent and Naples, Ontario county; Dundee, Yates county; Seneca Falls, Seneca county; and Aurora, Cayuga county. None of these deposits are worked. A well put down in 1909 in the town of Burns, Allegany county, is reported to have passed through 75 feet of clean unbroken salt at 3050 feet depth.

SAND AND GRAVEL

The production of sand and gravel for use in engineering and building operations, metallurgy, glass manufacture, etc., is an important industry involving a very large number of individual operations. The building sand business is specially extensive as there are deposits suitable for that purpose in every section of the State, and nearly every town or community has its local source of supply. Such sand, of course, possesses little intrinsic value. The deposits of glass sand and molding sands are more restricted in their distribution and their exploitation is the basis of a fairly stable industry; certain molding sands are even shipped to distant points, as in the case of those obtained in the Hudson river region.

The sand and gravel beds of the State are mainly of glacial origin, as the whole territory within the limits of New York, in common with the northern section of the United States east of the Rocky mountains, was invaded by the Pleistocene ice sheet which removed all the loose material accumulated by previous weathering and erosion, and left in its retreat a mantle of transported boulders, gravels, sands and clays. In places these accumulations have the character of unmodified drift or morainal accumulations in which the materials are more or less intermixed, and are then of little industrial value. But more generally the deposits show a sorted stratiform arrangement due to their having been worked over by the glacial streams and lakes. Such is the condition in many of the larger valleys like those of the Hudson, Champlain and Genesee where the sands, gravels and clays occur separately in terraced

beds extending far above the present water level. Later water action may have effected a beneficial re-sorting of the materials as instanced by the beach sands of Long Island and some of the lakes in the interior of the State.

A measure of the importance of the sand and gravel industry may be had from the accompanying table which, however, lacks something in the way of completeness and accuracy. The figures relating to the molding sand production are believed to be a close approximation to the actual totals, but those for building sand and gravel may vary considerably from the true quantities, perhaps understating them by as much as 25 per cent. The building sand operations are so widely scattered and in many sections carried on in such haphazard or fugitive manner that it is extremely difficult to cover them all in a statistical canvass.

Production of sand and gravel

MATERIAL	1909	1910	1911
Molding sand	$437 402	$424 015	$420 780
Core and fire sand	30 230	33 709	27 484
Building sand	*b*	1 016 598	*c* 750 000
Other sand *a*	*b*	65 835	*c* 50 000
Gravel	*b*	589 551	479 103
Total	.....	$2 129 708	$1 727 367

a Includes glass sand, filter sand, engine and polishing sand.
b Statistics not collected.
c Partly estimated.

Molding sand. The use of sand for the casting of metals calls for a large supply of special grades which have a rather restricted distribution, compared with building sands, and consequently greater value.

In New York there are two main areas in which good molding sands occur: (1) on the lands bordering the Hudson river from Orange county to Saratoga county; (2) in Erie county. The sand is found in shallow beds immediately beneath the sod and often covers extensive tracts. In the Hudson river region, which is by far the most important, beds 8 inches thick may be worked if convenient to transportation. From this they range up to 7 or 8 feet thick, though usually the finer grades occur in relatively thin deposits. The sand is graded roughly according to size, which varies

from extremely fine sand that will pass through a 100 mesh screen to rather coarse gravel. The business of digging and shipping the sand is mainly conducted by a few large companies who operate in several places and are able to furnish all the grades in demand by foundries.

The production of molding sand in 1911 amounted to 476,014 short tons valued at $420,780, or a little more than in 1910 when the total was 471,351 tons valued at $424,015. The greater part of the output came from the Hudson river region, which contributed altogether 435,868 short tons with a value of $388,561. The counties represented in that section included Albany, Dutchess, Greene, Orange, Rensselaer, Saratoga and Schenectady. The counties in other sections that reported a production were Cayuga, Chautauqua, Erie, Essex, Livingston and Queens.

Core sand used in connection with molding sand for the cores of castings is chiefly produced in Erie and Oneida counties. The product is listed with fire sand, the combined production of the two kinds amounting last year to 49,900 short tons valued at $27,484.

Glass sand. Sand for glass manufacture is obtained from the beach sands of Oneida lake and Long Island. The crude sand undergoes purification by washing to remove the clay, mica, organic matter, etc. The manufacture of window glass was once an important industry in the district around Oneida lake where there are extensive deposits of very fine sand, but it has succumbed to competition with the factories situated in the natural gas region of Pennsylvania and the West. At present the product is shipped elsewhere for manufacture. A total of 20,821 short tons of glass sand valued at $16,000 was reported from the Oneida and Queens counties last year.

Building sand. The use of sand and gravel in building and engineering work calls for enormous quantities of these materials and is the basis of a productive industry that is carried on more or less actively in nearly every county of the State. The business is purely local, as the towns and villages are well supplied with deposits close at hand. The value of the materials is mainly represented in the cost of excavation.

A complete census of this branch of the sand industry would entail labor and expense incommensurate with the value of the results, and therefore nothing more has been done than to arrive at a basis for an approximate estimate. The combined value of the sand and gravel produced in 1911 is placed at $1,229,103, against a value of $1,606,149 in 1910. The quantity of sand was approxi-

mately 2,900,000 cubic yards and of gravel 1,013,470 cubic yards, as compared with 3,838,976 cubic yards of sand and 1,037,026 cubic yards of gravel produced in 1910. Nassau county from which much of the sand used in building operations in New York is obtained, contributed alone a total of 1,874,837 cubic yards of sand and 659,106 cubic yards of gravel last year.

SAND-LIME BRICK

The manufacture of sand-lime brick last year was somewhat larger than usual. Five companies reported as active and contributed a total of 15,178,000 bricks with a value of $92,064. This was but little short of the record production which was reported in 1907 and which amounted to 16,610,000 valued at $109,677. The outturn in 1910 was 14,053,000 with a value of $82,619. The selling price of the brick, fixed at the yard, averaged $6.05 a thousand last year, against $5.88 a thousand in 1910.

The following were the active plants: Composite Brick Co., Rochester; Dyett Sand-Lime Brick Co., Port Jefferson; Buffalo Sandstone Brick Co., Buffalo; Paragon Plaster Co., Syracuse; Granite Brick Co., Glens Falls.

The Grant Brick Co. of Brooklyn and the Sandstone Brick Co. of Schenectady reported as active in 1910 but did not manufacture last year.

STONE

The quarrying of stone and its preparation for the varied requirements of building, engineering construction, etc., hold a prominent place in the industrial activities of the State, and the value of the annual contribution ranks second only to that of clay among mineral materials. No other mineral industry includes so many individual enterprises or is so widely represented in the different sections. The resources are abundant and varied, comprehending all the principal varieties known to the trade. The greater number of quarries, however, are opened in the limestones and sandstones and supply material chiefly for engineering work, highway improvement and such purposes which do not entail any considerable amount of elaboration previous to shipment. In the development of the building, monumental and ornamental branches the local industry has not attained the relative importance that it deserves by reason of the natural wealth of materials adapted to those uses and the advantages for marketing; herein lies, it would appear, the principal field for future enterprise.

The statistics of production which have been collected from year to year show that the industry in general remains practically stationary; in fact lately it has taken a downward trend, falling below the average level of earlier years. This has been due in part to the recent business reaction that has affected practically all industries and in part undoubtedly to the gaining favor of cement and concrete for certain construction purposes. The latter has manifested itself particularly in the loss of trade among the bluestone quarries which supply flagstone to New York and other eastern cities. This branch of the industry has shown a decline of over 50 per cent in the last four years.

The total value of the stone quarried in 1911 was $5,455,312, as compared with a reported value of $6,193,252 in 1910. The decrease thus indicated was $737,940 or 12 per cent. The output for 1909 had a value of $7,061,580, showing that a falling off of about 30 per cent has taken place in the interval. It should be noted that the above figures do not include slate, millstones, or limestone used for cement manufacture, which are reported separately.

The output of granite participated in the decline to a marked extent, falling from a value of $244,763 in 1910 to $148,633 last year. The quarries in the Adirondacks and on the St Lawrence river reported a reduced business, and those in southeastern New York were less active than heretofore. New developments in the syenite and anorthosite areas of Clinton and Essex counties have been under way but have not yet reached the stage that enables large shipments to be made.

No great change occurred in the limestone production; the quarries of that material reported a value of $3,174,161 against $3,245,807 in the preceding year. The wide use of limestone for concrete and road work has steadied the market, though conditions in some branches were rather unfavorable.

The value of the marble that was quarried last year amounted to $278,041 against $341,880 in 1910. The main decrease was in building marble from the Dutchess county quarries. The output of monumental marble from Gouverneur was fairly well maintained. The sandstone quarries registered a large falling off in production, returning a total value of only $955,063, less than reported in any recent year. The output in 1910 had a value of $1,451,796. Most of the decrease came from the bluestone quarries.

The trap quarries in the Palisades section produced about as usual, though the reduction or extinction of the present industry

is in prospect for the near future owing to the inclusion of the quarry properties in the new Palisades park. One of the quarries terminated its activity during the past season. The production of trap in the State amounted in value to $899,414, against $909,006 in the preceding year, practically all of it in the form of crushed stone.

Production of stone in 1909

VARIETY	BUILDING STONE	MONUMENTAL	CURBING AND FLAGGING	CRUSHED STONE	ALL OTHER	TOTAL VALUE
Granite	$35 019	$33 818	$1 352	$182 029	$227 737	$479 955
Limestone	217 109	.....	15 363	1 744 314	1 323 597	3 300 383
Marble	262 934	104 495	25	6 403	6 159	380 016
Sandstone	358 589	.....	783 880	220 200	477 129	1 839 798
Trap	.....	.....	.....	1 061 428	.....	1 061 428
Total	$873 651	$138 313	$800 620	$3 214 374	$2 034 622	$7 061 580

Production of stone in 1910

VARIETY	BUILDING STONE	MONUMENTAL	CURBING AND FLAGGING	CRUSHED STONE	ALL OTHER	TOTAL VALUE
Granite	$40 911	$12 989	*a*	$91 988	$98 875	$244 763
Limestone	99 049	.....	$3 888	1 815 809	1 327 061	3 245 807
Marble	252 965	88 684	.....	.....	231	341 880
Sandstone	387 498	.....	408 132	225 408	358 848	1 451 796
Trap	.....	.....	.....	908 931	75	909 006
Total	$780 333	$101 673	$484 020	$3 042 136	$1 785 090	$6 193 252

a Included under "All other."

Production of stone in 1911

VARIETY	BUILDING STONE	MONUMENTAL	CURBING AND FLAGGING	CRUSHED STONE	ALL OTHER	TOTAL VALUE
Granite	$30 684	$11 353	*a*	$72 401	$34 195	$148 633
Limestone	112 082	.....	$11 989	1 936 292	1 113 798	3 174 161
Marble	171 748	79 115	.....	.....	27 178	278 041
Sandstone	317 571	.....	431 047	23 883	182 562	955 063
Trap	.....	.....	.....	896 164	3 250	899 414
Total	$632 085	$90 468	$443 036	$2 928 740	$1 360 983	$5 455 312

a Included under "All other."

GRANITE

In the strict sense granite is an entirely crystalline rock made up of feldspar and quartz, usually with subordinate amounts of one or more minerals of the mica, hornblende and pyroxene groups. Among quarrymen and builders, however, the name granite is

given to various other massive rocks that consist chiefly of silicate minerals, such as the heavier and darker colored types included under diorites, norites and gabbros, also syenite which resembles granite but lacks quartz, as well as metamorphic varieties included under gneisses and schists. This usage will be followed for the purposes of the present report, except that the basic dike rocks which are chiefly exploited for crushed stone are treated under the head of trap.

The granite trade for the past few years has not been in a flourishing condition. The production in 1911 showed a considerable decline compared with the reported total for the preceding year which was well below the output in 1909. The decrease has been largely in the less valuable grades of crushed stone and paving blocks, but on the other hand the trade in building and monumental granite has failed to reveal any decided upward trend.

The total production of granite in 1911 had a value of $148,633 against $244,763 in 1910, and $479,955 in 1909. Building stone, rough and dressed, accounted for $30,684 in the total, as compared with $40,911 in the preceding year and $35,019 in 1909. The output of monumental stone was valued at $11,353 against $12,989 in 1910; crushed stone at $72,401 against $91,988; rubble and riprap at $28,162 against $20,272; and all other kinds at $6033 against $78,603 in 1910.

Production of granite

	1909	1910	1911
Building stone	$35 019	$40 911	$30 684
Monumental	33 818	12 989	11 353
Crushed stone	182 029	91 988	72 401
Rubble, riprap	12 737	20 272	28 162
Other kinds *a*	216 352	78 603	6 033
Total	$479 955	$244 763	$148 633

a Includes curbing, paving blocks and minor uses.

NOTES ON THE GRANITE QUARRIES OF NEW YORK

The following notes relating to the granite industry are based on the results of a field investigation carried out during the summer of 1911, as an initial step toward the preparation of a comprehensive account of the quarry resources in the State. Assistance in the

field work has been given by R. W. Jones of the State Museum staff.

No complete report on the quarry materials of the State has been issued since the publication of Smock's *Building Stone in New York,* which appeared in 1890 as Bulletin 10 of the State Museum. This work presents a brief but serviceable description of the quarries in existence at the time, as well as chapters on the use of stone in cities, physical tests, and the durability and causes of decay of building materials; it is still a valuable reference work though, of course, scarcely representative of present conditions in the industry. A short paper on the granite quarries in southeastern New York is included in the report of the State Geologist for 1900. This paper, prepared by Edwin C. Eckel, was intended to be only preliminary to a more detailed treatment of the granite and marble industries of the whole State. It affords information in regard to many quarry localities not mentioned in Smock's report, and gives a short description of the geological structure of the region as a basis for the classification of the building stones.

Adirondack region. The great expanse of crystalline rocks included in the Adirondacks and the bordering area affords a variety of quarry materials. The commoner types which are useful for building or monumental stone comprise granites proper, syenites and anorthosite. These are found in both massive and gneissoid development. Gabbros and various dike rocks of which diabase is the most abundant representative occur locally and have limited application for purposes of road improvement and engineering construction.

The quarry industry of this region has made slow progress. Until recent years its development was greatly retarded by lack of adequate transportation facilities and the high costs of shipment to the important markets. Though of less consequence than formerly, the factor of transportation is still of critical importance in some sections, particularly as competition has became very keen with the advantage naturally inclining toward the long-established enterprises of other districts which have attained a certain prestige in the trade. At present the only promising fields for industry are to be found in the marketing of special grades of stone which command attention through their exceptional attractiveness or their adaptability to certain uses.

Among the better known quarry materials for building and monumental purposes are the red granites on the northwestern side of

the Adirondacks, the green syenite which is found in various sections as larger or smaller intrusive masses, and the light gray anorthosite which constitutes the great central core of the mountains and is exposed in outliers to the north and east of the main area. Some of the more accessible and important localities for these materials will be described.

St Lawrence river granites. The red granite of Grindstone, Picton and Wellesley islands in the St Lawrence river is one of the characteristic products of the region, widely known as an excellent building and monumental stone. It ranks with the best native granites of its kind. The several exposures on the group of islands between Clayton and Alexandria Bay belong to a single large but irregular mass which in the recently issued geological report covering that section is described and mapped as the Picton granite. In general it is a bright red coarsely textured granite in which the predominant ingredient is feldspar in large red individuals, with quartz and biotite. Most of the product in earlier years came from Grindstone island which furnished large quantities of structural and monumental material to the cities on the St Lawrence and the Great Lakes. Paving blocks were also made in quantity. These quarries are now idle or worked only in a small way. They are situated mainly along the western shore of the island. The quarry of the old Chicago Granite Co., now owned by H. B. Kelly of Clayton, has been more active than the others of late and has furnished stone for many of the structures along the river. The Forsyth quarry in the same vicinity supplied the large columns erected in the Senate chamber of the Albany Capitol. Though of coarse texture the stone has excellent polishing qualities.

The principal quarry operations in the area are now carried on by the Picton Island Red Granite Co., whose property is situated on the northern end of Picton island, between the larger Grindstone and Wellesley islands. The company has three quarries opened in the natural ledges which rise directly from the shore line to a height of 50 or 75 feet and which afford great advantages for economic work. The output as it comes from the quarries or from the cutting yards can be loaded directly on boats for river and lake shipment. Rail shipments are made from Clayton where the company has its own docks and yards. The granite is of finer texture than that from Grindstone island; two varieties are obtained, one with a medium grain and red body flecked with black and the other of finer grain with a uniform pink tint. The latter finds special

favor for monumental work on account of its capacity for taking fine tool work and the strong contrast of the hammered and rubbed surfaces. The medium grained granite is very suitable for structural material, its rock and hammered surfaces having a pleasing warm tone, of lighter shade than the polished material. Some of the structures for which this stone has been used include the new part of the American Museum of Natural History in New York, the National Bank in Clayton and the Maryland Museum Building (polished columns) in Baltimore.

An exposure of granite in the vicinity of Alexandria Bay has been of some importance for the production of paving blocks and rough stone. It is a finely textured stone which shows the effects of regional compression, and belongs really to the gneissic types that are so widespread in the western Adirondacks. The principal quarry is a little south of Alexandria Bay and is opened in a knob that rises 100 feet or more above the river. It is owned by J. Leopold & Company of New York. The granite is rather variable in color which is a drawback to its general use for cut stone though well adapted for other purposes. It belongs to the biotite-muscovite class and is mainly composed of alkali-feldspar and quartz.

Granite in southern St Lawrence county. One of the largest areas of massive granite in the Adirondacks is found in the towns of Fine and Pitcairn, St Lawrence county, probably extending also into the adjacent section of Lewis county. The area has not been delimited or mapped as yet, and has never attracted attention apparently for quarry development though traversed by the Carthage & Adirondack Railroad which makes it accessible to the markets of northern and central New York. The granite appears in practically continuous outcrop for a distance of 8 miles along the railroad, in the stretch between Harrisville and Benson Mines. The more available section lies between milestones 56 and 64 of the railroad line, or 25 miles east of Carthage and a little over 40 miles from Watertown. The granite for the most part shows a coarse massive texture, but medium grained types appear near the borders where also it becomes more or less gneissoid. Compared with the Thousand Islands granite it has a lighter color, being light red to pink, with often a mottled pink and white appearance from the varicolored feldspar. There are abundant quarry sites along the railroad, as many of the ridges within the central part of the area afford natural exposures several hundred feet high. The results of field and laboratory examination show the stone to be sound and free of

injurious ingredients and practically fresh at the surface. The following analysis of a sample of the granite is by R. W. Jones:

SiO_2	72.69
Al_2O_3	14.11
Fe_2O_3	.26
FeO	2.89
MgO	.28
CaO	.64
Na_2O	2.37
K_2O	5.16
H_2O+	.24
H_2O-	.02
	98.66

Sulfur was tested for but not found. The minor constituents including manganese, phosphorus and zirconium, the presence of which was indicated by microscopic analysis, were not estimated.

The granite is bordered on the west by a great intrusion of syenite that is estimated by C. H. Smyth, jr, to cover not less than 75 square miles. The syenite is a grayish green to dark green or nearly black rock composed largely of feldspar but containing considerable amounts of pyroxene, amphibole and magnetite. In its original or unaltered phase it has a coarse massive texture, but the general appearance is that of a granulated and more or less recrystallized rock, showing much more evidence of pressure metamorphism than the granite. The syenite is not adapted for building stone on account of its somber color. For engineering purposes it should prove very serviceable.

Quarries in Clinton and Essex counties. In the eastern Adirondacks the available quarry materials suitable for architectural and monumental work consist of granite, syenite and anorthosite. These formations are of widespread occurrence but in comparatively few places do they possess the qualities requisite for cut stone as they have been largely metamorphosed into gneisses and schists. The unreduced or slightly modified residuals of the igneous intrusions which are found here and there along the borders afford the basis for quarry operations.

The vicinity of Ausable Forks presents many advantages for quarrying in connection with both anorthosite and syenite. For several years past a considerable quantity of monumental stone has been shipped from this section, and recently additional developments with a view to the extraction of all classes of rough and cut stone have been planned.

The Adirondack Granite Co., formed in 1910 as a consolidation

of the properties formerly owned by Moore Brothers and the Ausable Granite Co., controls a large acreage of the syenite and anorthosite in that vicinity which as yet is only partly developed. The syenite quarries lie on both sides of the Ausable river, the more important property covering the ridge which lies north of the river and just east of the village. This is an excellent situation, both for economic extraction and shipment. The syenite is of medium grain and has a bright green color on polished surfaces. It is composed mainly of alkali-feldspar and magnetite. It is particularly adapted for monumental work, taking a lustrous polish and showing the finest tracery in strong relief. It is sold under the name of "Adirondack green granite." The company has a second quarry on the west side of Ragged mountain, south of the river, where the rock is of finer grain and darker color. This is marketed as "Killarney green granite." The anorthosite properties are situated south of the village on the ridge along the east branch of the Ausable. This has been opened only in one place, the Wienholz quarry, from which some building stone has been shipped. The anorthosite belongs to the border phase, having a fine ground mass of crushed feldspar which lends a medium gray tone to the rock as seen in large samples, whereas the characteristic Adirondack type has a very coarse texture and dark gray or green color. The light body is set off by inclusions of black pyroxene and hornblende, with an occasional fragment of dark uncrushed feldspar showing the iridescent play of colors peculiar to labradorite. The color effect of the rough and dressed surfaces is about that of a medium gray granite, for which it is an all-round substitute. Owing to its simple mineral character the anorthosite has superior fire-resisting qualities, an important consideration for some purposes. It is no doubt a strong and durable stone.

The syenite quarries owned by F. G. Carnes of West Chazy are situated just south of Ausable Forks. The Keystone lies near the base of Ragged mountain and yields a green syenite of lighter shade than that from the quarries at a higher elevation. The Emerald quarry is situated on the westward continuation of the exposure across the river. The stone from this locality is a medium dark green and rather fine in texture. Both afford excellent monumental material.

Another syenite quarry, known as the Clements quarry, is situated on the side of Ragged mountain overlooking Ausable Forks. It has shipped some monumental stock.

There are a number of anorthosite exposures in the vicinity of Keeseville, from which building material has been taken for local structures and also for shipment in years past. The stone passed in the trade as Ausable granite. The Prospect Hill quarries, just south of Keeseville, are described in Smock's reports as having been operated between the years 1888 and 1890.

Southeastern New York. Massive igneous rocks play a subordinate part in the structure of the Highlands region. Local intrusions of granite, diorite and syenite in the form of dikes, sills and bosses occur, however, in various sections, and afford a fairly varied assortment of quarry materials. Among the more extensive bodies which have gained some prominence as sources of constructional stone may be mentioned the Peekskill or Lake Mohegan granite, the granites near New Rochelle and Garrisons, and the Pine Island bosses in Orange county. An area of somewhat gneissoid diorite, called the Harrison diorite, is found in eastern Westchester county, as an offshoot from the large intrusions of the same rock in Connecticut.

The very basic intrusives are represented by the Cortlandt series of gabbros, having a large boss just south of Peekskill, but showing such variability of composition and appearance as to be of little value for quarry purposes. In this class also belong the serpentines of Westchester and Richmond counties. The great sill of diabase which forms the lines of vertical cliffs known as the Palisades extending along the west side of the Hudson river south from the Highlands has been a prolific source of material for crushed stone of the best quality.

The gneisses which are the most important element in the geology of this section have a composite character, including both igneous and sedimentary derivatives. Some types in the northern and central Highlands appear to be only slightly modified granites, as exemplified by the exposures on Storm King, Crow's Nest and Breakneck mountains at the portal of the Hudson gorge. They have been employed for dimension stone, but mainly for rough work, concrete and road material. Much of the gneiss in the central Highlands is of so variable a nature through injection of igneous material and inclusions of different character as to admit of no extensive application.

In Westchester county the Yonkers gneiss is of considerable importance for local construction purposes. It is a fairly uniform, though distinctly foliated, biotite gneiss of blue or reddish color.

Another member of the gneiss series, the Fordham, occupies extensive belts in the county; it is a banded biotite gneiss and finds limited use for local building and rough work.

Peekskill granite. This is one of the best known constructional granites of the region. It is exposed in two areas about a mile south of Lake Mohegan and five miles east of Peekskill, the two outcrops probably belonging to the same intrusion. The more northerly outcrop is included in the quarry lands of the Mohegan Lake Granite Co.; the other to the south and nearer Peekskill has been worked as the Millstone Hill quarries.

The former quarries were opened in 1892 to supply stone for local engineering works and have since furnished large quantities of building stone, chiefly to New York City and for such notable structures as the new Episcopal Cathedral. The granite is a biotite-muscovite variety, of medium grain, massive and free of knots and streaks. It occurs in two contrasting colors — yellow and light gray. The rare and very attractive yellow granite forms the surficial outcropping part of the mass, changing to the normal gray at about 50 feet depth. The peculiar coloration is the effect of limonite stain introduced by seepage of ground water, and is not brought about by weathering of the stone itself. The quarries are large and well equipped. There is also a crushing plant for employment of the waste material.

The Millstone Hill quarries opened in a north-facing ridge, across the valley from the above mentioned property, are owned by Rudiger Brothers, but have been worked until recently by the contractors of the Croton dam. Besides all the stone used in that structure they have supplied some building material for use in Peekskill and other places. The excavations cover an area of about 500 feet long by 200 feet wide and extend to a depth of 40 feet. The granite is of medium grain, very light gray, with more muscovite than that from the Mohegan Lake quarries. There has been little infiltration of limonite, and the gray color persists practically to the surface. The granite is well adapted for building and all general purposes.

Quarries near Garrison. About five miles north of Peekskill and half that distance south of Garrison is an isolated intrusion of granite which has supplied a considerable quantity of building stone. The quarries were worked by the King Granite Co. and later by Doern & Sons, but have not been active since 1906. They will not be reopened, though there is some prospect of starting

work at a new place, on lands owned by Raymond Moore, just south of the King quarries. The granite is of light gray color, medium to fine in grain, and belongs to the biotite variety. A characteristic component is red garnet in small but plainly visible grains or crystals disseminated through the body of the rock. Like the Peekskill granite it belongs rather to the basic class allied to the diorites and may be an offshoot of the Cortlandt intrusion. The granite has been employed mainly in buildings in the towns along the river. The guard house at West Point is a specimen structure.

Yonkers gneiss. There are only a few quarries now active in the Yonkers gneiss, though a considerable number are listed by Eckel[1] as having been worked at the time of his report and the few preceding years. The principal area of the gneiss is a belt that extends from near Van Cortlandt Park to Scarsdale in southern Westchester county and that forms the ridge west of the Bronx river. It also occurs in a considerable area between White Plains and Kensico to the east of the Harlem railroad. There are different color varieties of the gneiss and Eckel states that the red varieties are more open to decay than the blue, though for what reason he does not explain.

One of the large quarries in the Yonkers gneiss is that of Hackett Brothers situated at the junction of Midland and Central avenues, Dunwoodie. It is opened for a distance of 800 feet and has a working face 40 feet high. The stone in the quarry has a bluish appearance, but the hand specimens have a decided pink tinge from the prevailing color of the feldspar. The grain is fine and the arrangement somewhat foliated owing to the regular distribution of the biotite in parallel bands. The jointing is not so close as to preclude the extraction of large-sized blocks. Most of the output is dimension stock. Good examples of the stone from the quarries are found in many of the buildings in Yonkers, including St John's and St Joseph's hospitals and several of the public schools.

In the same vicinity is the quarry worked by John Russo. It produces building stone in small quantity for local sale. In character and appearance the gneiss is similar to that obtained at the Hackett quarry, but the jointing is more closely spaced, permitting the extraction of few large blocks.

The quarry of Louis Perri lies a little east of the Hackett quarry.

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[1] The Quarry Industry in Southeastern New York. Ann. Report State Geologist 20, 1902. Also published separately.

The opening is about 100 feet square with a face of 30 feet. Most of the output, which is small, is cut and dressed on the property.

The Flannery quarry, also at Dunwoodie, is an occasional producer of building material. The quarries formerly worked at White Plains, Hartsdale, Tuckahoe, Hastings and Tarrytown have been closed down and the lands converted to other uses.

Fordham gneiss. The Fordham is a light gray banded gneiss, made up of feldspar, quartz and biotite. It is regarded as a metamorphosed sediment, though in places it has been so injected with granite that the igneous material predominates. The gneiss varies much from place to place and even in the limits of a single quarry. Its use, consequently, is mainly for rough stone in foundation work.

The quarry owned by Patrick Reilly in the village of Dublin, Westchester county, has been one of the few producing building material. It has been worked more or less actively for the past 35 years, and recently has been under lease to Thomas Murphy of Irvington. It is opened for a width of 200 feet, with a face from 30 to 50 feet high. The rock is hard, much contorted gneiss, seamed with granite and pegmatite. It has been used in several residences and for some local public buildings.

The Lefurgis quarry, near Unionville, consists of an opening about 100 feet wide with a face of 30 feet. It affords building and rough stone and is to be equipped with a crushing plant. It is operated under lease by William Nichols, jr.

A quarry at Glenville is worked by Duell & Holloway for crushed stone. The old quarries at Uniontown, Bryn Mawr, Lowerre and Fordham are no longer active.

Storm King granite gneiss. The granite exposed on Storm King, Breakneck, Crow's Nest and other prominences in the northern Highlands represents the most considerable body of that rock in massive or slightly modified condition existing anywhere in the southeastern section. It belongs doubtless to the early Precambric series, older than the small granite intrusions around Peekskill. Its appearance in places is that of a medium to coarse massive granite, but more often it shows a distinctly gneissoid arrangement of the minerals and more or less crushing effects. It is a strong and very durable stone that has been used mainly for rough construction and crushing purposes. Its color ranges from medium to dark according to the relative proportion of hornblende that is admixed with feldspar and quartz, the general tone being reddish or greenish. There are quarries and crushing plants at the base of

Storm King mountain below Cornwall and also directly opposite on the east bank of the river, on the side of Breakneck ridge. The latter, known as the Bailey quarries, have supplied considerable building stone.

Granite near Warwick. Several granite intrusions occur in the southeastern part of Orange county, near the New Jersey state line. Two of them constitute bosses that rise into the conspicuous twin peaks Adam and Eve on the edge of the Wallkill "Drowned Lands." Both are made up of coarse hornblende granite, somewhat gneissoid in places and showing pegmatitic and aplitic variations. Mt Eve, the larger, occupies an area about two miles long and a mile wide. Mt Adam is a nearly round mass one-half mile in diameter. There are small knobs of the same granite near Big Island, northeast of Mt Eve, and also in the section southwest along the general axis of the intrusion. Another large intrusion is found on Pochuck mountain, a broad ridge which mainly lies in New Jersey. The northern end that comes within New York State consists of coarse quite massive hornblende granite bordered on the west by biotite gneiss. Quarries have been opened on the northern slope of Mt Adam and the western slope of Mt Eve. The Mt Adam Granite Co. worked at the former locality for several years, beginning about 1889. The quarry opening has a length of 250 feet and a face from 20 to 30 feet high. The granite is mainly a coarse, medium gray, hornblende variety, but with this is associated a finer grained aplitic granite that forms bands and inclusions in such amount as to prevent the extraction of uniform material.

The Mt Eve quarries were opened about 1890 by the Empire Granite Co. which was also engaged in operating the Pochuck mountain quarries. They are situated a little way up the western slope of Mt Eve in the notch. The granite is less broken and more uniform in quality than on Mt Adam. It was employed quite extensively for dimension stone which was sold in Orange, N. J., and other places. The quarries lie one and a half miles from the railroad.

The Pochuck mountain quarries were worked up to about five years ago and have produced mainly building stone and paving blocks. They are opened for a width of 200 feet along the mountain showing a face from 30 to 40 feet high. The granite is slightly foliated in places, but has an attractive appearance, with a pink body mottled by gray and black. Its use as a building stone is exemplified in the post office at Paterson, N. J.

LIMESTONE

The stone classified under this heading consists for the most part of the common grades of limestone and dolomite such as are characterized by a compact granular or finely crystalline texture and are lacking in ornamental qualities.

A smaller part is represented by crystalline limestone and by the waste products of marble quarrying which is sometimes employed for crushed stone, lime-making or flux. Limestone used for the manufacture of portland and natural cement is, however, excluded from the tabulations so as to avoid any duplications of the statistics.

Limestones have a wide distribution in the State, the only region which is not well supplied with this stone being the southern part where the prevailing formations are sandstones of Devonic age. The noncrystalline varieties occur in regular stratified order in the Cambric, Lower Siluric, Upper Siluric and Devonic systems. In most sections they occupy considerable belts and have been little disturbed from their original horizontal position. On the borders of the Adirondacks and in the metamorphosed Hudson river region, however, they have been more or less broken up by faulting and erosion and in places have a very patchy distribution.

The Cambric limestones are found in isolated areas on the east, south and west sides of the Adirondacks. They are usually impure, representing a transition phase between the Potsdam sandstones below and the high calcium limestones above. The lower beds of the Beekmantown formation as originally defined are now known to belong to the Cambric system. The Little Falls dolomite is perhaps the most prominent member of the Cambric limestones and is extensively developed in the Mohawk valley with quarries at Little Falls, Mayfield, Amsterdam and other places. It is a rather heavily bedded stone of grayish color, suitable more especially for building purposes. In Saratoga county the Hoyt limestone is in part the equivalent of the Little Falls dolomite; it has been quarried for building stone just west of Saratoga Springs. On the west side of the Adirondacks the Theresa limestone is described by Cushing as a sandy dolomite which may in part belong to the Cambric system. It is comparatively thin and has no importance for quarry purposes.

The Beekmantown limestone which is now taken as including the middle and upper beds of that series as earlier defined is mostly restricted to the Champlain valley. It occurs on the New York shore in rather small areas, usually down-faulted blocks, that are

the remnants of a once continuous belt. It is also represented doubtless in the basal portion of the limestone area that extends across Washington and Warren counties. The only place where it has been extensively quarried is at Port Henry where the purer layers have been worked for flux. In the Lake Champlain region it is a bluish or grayish magnesian limestone occurring in layers from a few inches to several feet thick.

The Chazy limestone is found in the same region as the Beekmantown in discontinuous areas along the eastern Adirondacks from Saratoga county north to the Canadian boundary. It attains its maximum thickness in eastern and northeastern Clinton county, and has been quarried around Plattsburg, Chazy and on Valcour island. The Chazy is the earliest representative of the Paleozoic formations characterized by a fairly uniform high calcium content; analyses commonly show 95 per cent or more of calcium carbonate. It has a grayish color and finely crystalline texture. The fossiliferous beds afford attractive polished material which is sold as "Lepanto" marble. It is used also for lime and furnace flux. There are old quarries on Willsboro point, Essex county. On the west side of the Adirondacks the Pamelia limestone described in the areal reports of that section belongs to the Chazy series. It covers a considerable area in Jefferson county between Leraysville and Clayton, and has been quite extensively quarried for building stone and lime, though of subordinate importance to the Trenton limestones of that section.

In the Mohawkian or Trenton group are included the Lowville (Birdseye), Black River and Trenton limestones which have a wide distribution and collectively rank among the very important quarry materials of the State. They are represented in the Champlain valley, but are specially prominent on the Vermont side; from the latter area a belt extends southwest across northern Washington county to Glens Falls in Warren county and is continued into Saratoga county. Another belt begins in the Mohawk valley near Little Falls and extends northwesterly with gradually increasing width across Oneida, Lewis and Jefferson counties to the St Lawrence river. There are isolated areas of Trenton limestones in the Hudson valley south of Albany. The limestones vary in composition and physical character according to locality and geologic position. They are often highly fossiliferous. In the northern section they are mostly gray to nearly black in color, contain little magnesia and run as high as 97 or 98 per cent calcium carbonate.

The lower part of the group is heavy bedded and well adapted for building stone; the upper beds commonly contain more or less shale. They are used for various purposes including building and ornamental stone, crushed stone, lime, portland cement and flux. In the Champlain valley quarries are found near Plattsburg, Larabees Point and Crown Point; in Washington county at Glens Falls where there are extensive quarries that supply material for building purposes, portland cement and lime. The well-known black marble from Glens Falls is taken from the Trenton. Numerous quarries have been opened in Herkimer, Oneida, Lewis and Jefferson counties. The output of the last named county is specially important, including limestone for building and road construction, and lime for manufacture of calcium carbide. The principal quarries in Jefferson county are at Chaumont.

The next assemblage of limestones in the order of stratigraphic occurrence includes the Clinton, Lockport and Guelph members of the Niagaran group. The Clinton limestone has a variable importance in the belt of Clinton strata that extends from Otsego county a little south of the Mohawk river across the central and western parts of the State on the line of Oneida lake and Rochester to the Niagara river. East of Rochester the limestone is relatively thin, usually shaly and split up into several layers, but on the west end in Niagara county it becomes the predominant member and has a more uniform character. Large quarries have been opened recently at Pekin, Niagara county, for the supply of flux to the blast furnaces of the Lackawanna Steel Co. at Buffalo. The upper beds of bluish gray fossiliferous limestone from 10 to 12 feet thick are the purest and analyze from 90 to 95 per cent calcium carbonate. The Lockport is a magnesian limestone, in places a typical dolomite, and is rather silicious in the lower part. It outcrops in a continuous belt, several miles wide, from Niagara Falls east to Onondaga county and then with diminishing width across Madison county. The upper layers are quite heavy and yield material suitable for building purposes, road metal and lime. There are quarries around Niagara Falls, Lockport and Rochester. It is worked to some extent in Wayne, Onondaga and Madison counties. The Guelph, also a dolomite, occupies a limited area in Monroe and Orleans counties and is worked near Rochester.

The Cayugan group includes among its members the Cobleskill, Rondout and Manlius limestones, which are economically important. They have furnished large quantities of material for the manufacture of natural cement, being the source of the cement rock in the

Rosendale district and in Schoharie and Onondaga counties. The cement rock of Erie county is found in the Salina formation. The purer layers are employed in Onondaga county for lime-making. The Manlius limestone is used for portland cement in the eastern part of the State.

At the base of the Devonic system appears the Helderbergian group which is very prominent for its calcareous strata. Limestones of this age are strongly developed along the Hudson river in Albany, Columbia, Greene and Ulster counties. The Coeymans or lower Pentamerus and the Becraft or upper Pentamerus limestones afford material for building, road metal, lime and portland cement. The limestone for the portland cement works at Hudson and Greenport is obtained from Becraft mountain, an isolated area of limestones belonging to the Manlius, Helderbergian and Onondaga formations. The works at Howes Cave use both the Manilus and Coeymans limestones. Extensive quarries are located also at Catskill, Rondout and South Bethlehem.

The Onondaga limestone, separated from the preceding by the Oriskany sandstone, has a very wide distribution, outcropping quite continuously from Buffalo, Erie county, eastward to Oneida county and then southeasterly into Albany county, where the belt curves to the south and continues through Greene, Ulster and Orange counties to the Delaware river. It is in most places a bluish gray massive limestone with layers and disseminated nodules of chert. The chert is usually more abundant in the upper beds. The limestone finds use as building stone and the less silicious material, also, for lime-making. Quarries have been opened at Kingston, Split Rock (near Syracuse), Auburn, Waterloo, Seneca Falls, Leroy, Buffalo and other places.

The Tully is the uppermost of the important limestone formations and likewise the most southerly one represented in the central part of the State. Its line of outcrop extends from Ontario to Madison county, intersecting most of the Finger Lakes. Its thickness is not over 10 feet, and on that account can not be worked to advantage except under most favorable conditions of exposure. For building stone it is quarried only locally and to a very limited extent. It finds its principal use in portland cement manufacture, being employed for that purpose by the Cayuga Lake Cement Co. in its works at Portland Point, Tompkins county.

Marl is a useful substitute for the hard limestones for some purposes and is quite extensively developed in the central and western parts of the State. It is found particularly in swampy tracts and

old lake basins associated with clay and peat. In the Cowaselon swamp near Canastota the marl underlies several thousand acres and is said to be 30 feet thick. The Montezuma marshes in Cayuga and Seneca counties contain a large deposit which at Montezuma is 14 feet thick. In Steuben county the marls at Arkport and Dansville have been employed for lime-making. Until recently marls have been used quite extensively for portland cement and plants were operated at one time in the marl beds near Warners and Jordan, Onondaga county; at Montezuma, Cayuga county; Wayland, Steuben county; and Caledonia, Livingston county. Their principal use at present is for agricultural and chemical purposes.

Production of limestone. The limestone quarries rank first in importance among the stone industries. The product for 1911 was valued at $3,174,161 and was distributed among 31 counties. The returns showed a slight decrease as compared with the output in 1910, which was valued at $3,245,807, and was also below that reported for 1909.

Production of limestone

MATERIAL	1909	1910	1911
Crushed stone	$1 744 314	$1 815 809	$1 936 292
Lime made	452 874	365 839	400 396
Building stone	217 109	99 049	112 082
Furnace flux	434 311	538 491	454 800
Rubble, riprap	82 748	30 819	20 328
Flagging, curbing	15 363	3 888	11 989
Miscellaneous	353 664	391 912	238 274
Total	$3 300 383	$3 245 807	$3 174 161

Erie county had the largest output of any county; its products are chiefly building stone, crushed stone and furnace flux. The total value of the limestone quarried in the county last year was $843,615.

Onondaga county ranks second in the list, but its importance is chiefly due to the operations of the Solvay Process Co. which uses the limestone in alkali manufacture. The company has recently opened new quarries at Jamesville, with equipment for the production of sufficient limestone to meet its requirements. The old quarries at Split Rock have been abandoned.

The other counties reporting a value of over $100,000 in 1911

were Dutchess, Rockland, Genesee, Warren, Ulster, Niagara, and Albany, ranking in the order given.

The distribution of the limestone production by counties and also according to uses is shown in the accompanying tables.

Crushed stone. Limestone finds its principal application as crushed stone in which form it is extensively employed for road metal, concrete and railroad ballast. There are large quarries in Erie, Genesee, Dutchess and Rockland counties besides a great number of smaller ones elsewhere, that are equipped with crushing plants. The canal and highway improvements which have been in progress recently have created a large market for the material, and the production has shown a steady increase. The waste or fine dust that results from crushing is finding use as a fertilizer for soils deficient in lime.

The value of the crushed limestone for 1911 was reported at $1,936,292, as compared with $1,815,809 for the preceding year. The total quantity represented was 3,116,958 cubic yards against 2,800,000 cubic yards in 1910. Erie county alone contributed an output valued at $489,881. The other counties reporting a value of over $100,000 last year were Dutchess, Rockland, Onondaga, Genesee and Albany.

Lime. The total value of the lime made in 1911 was $400,396. This represented a considerable advance from the total of $365,839 reported in 1910, but fell short of the record for 1909. The lime made by the Solvay Process Co. and the Union Carbide Co. has not been included in the totals given, but classed under "Other uses." The leading counties in the manufacture of lime for the trade were Warren, Clinton and Jefferson.

Building stone. The limestones found in the State have only a limited sale for building purposes and few quarries supply more than a local demand so that their output fluctuates greatly from year to year. The restricted market seems to be largely due to the fact that the limestones are prevailingly of grayish color in medium to dark tints, whereas the present demand is for white or very light gray stone such as the Bedford limestone. The extending use of concrete has also been a factor in the recent decline of the cut stone trade, though it has increased the sale of crushed stone.

The returns for 1911 showed a total product of building stone valued at $112,082, as compared with a value of $99,049 in the preceding year. The small gain indicated by these totals did not suffice to counterbalance the decline in the previous years; in 1908

the product of building stone reached a value of $245,655. Erie county contributed a value of $77,689 to the total last year. The industry in Schoharie and Herkimer counties, once quite important, has shrunk to small proportions.

Furnace flux. The value of the limestone used in furnaces for flux is second only to that of crushed stone. The principal quarries of this material are in the Onondaga limestone of Erie and Genesee counties and the Clinton limestone of Niagara county. They supply the iron furnaces at Buffalo and vicinity. Some flux is obtained in the Gouverneur marble region for use in the furnaces at Charlotte. The furnaces in the Lake Champlain section derive their flux from quarries in Clinton and Essex counties.

The production of flux in 1911 was valued at $454,800 representing a total of 792,248 tons. The shipments were smaller than in the preceding year, owing to the dull conditions in the iron market. Erie county contributed the largest value, $268,082, and Niagara county ranked second with $141,824.

Production of limestone by counties in 1910

COUNTY	CRUSHED STONE	LIME MADE	FURNACE FLUX	BUILDING STONE	OTHER USES	TOTAL
Albany	$125 450	$4 500	.....	.....	.....	$129 950
Cayuga	39 019	.....	.....	$7 690	.....	46 709
Clinton	13 549	48 823	$12 364	4 160	.....	78 896
Erie	476 490	152	322 067	53 881	$13 745	866 335
Genesee	118 797	5 000	90 132	480	200	214 609
Greene	8 225	.....	.....	.....	.....	8 225
Herkimer	8 520	3 114	.....	.....	.....	10 434
Jefferson	1 693	*a* 55 837	.....	200	168 265	225 995
Lewis	1 195	3 200	.....	520	726	5 641
Madison	52 028	.....	2 625	800	.....	55 453
Monroe	17 423	29 520	.....	2 589	1 719	51 251
Montgomery	29 810	.....	.....	8 622	2 125	40 557
Niagara	5 000	4 000	76 695	3 197	406	89 298
Onondaga	150 640	*a* 1 620	.....	12 092	233 228	397 580
Rensselaer	15 000	.....	.....	100	70	15 170
St Lawrence	870	7 240	27 008	362	1 116	36 596
Saratoga	15 114	.....	.....	7	.....	15 121
Schoharie	12 441	128	.....	1 567	624	14 760
Seneca	1 625	192	192	1 192	75	3 276
Ulster	20 654	11 897	.....	.....	.....	32 551
Warren	31 378	140 576	.....	1 583	.....	173 537
Washington	50 000	44 200	.....	.....	.....	94 200
Westchester	59 387	.....	.....	.....	3 802	63 189
Other counties *b*	561 501	5 840	7 408	7	518	575 274
Total	$1 815 809	$365 839	$538 491	$99 049	$426 619	$3 245 807

a Lime made by Solvay Process Co. and Union Carbide Co. included in "Other uses."
b Includes Columbia, Dutchess, Essex, Fulton, Oneida, Ontario, Orange and Rockland counties.

Production of limestone by counties in 1911

COUNTY	CRUSHED STONE	LIME MADE	FURNACE FLUX	BUILDING STONE	OTHER USES	TOTAL
Albany	$132 925	.....	.....	.....	.....	$132 925
Cayuga	28 494	.....	.....	$12 100	.....	40 594
Clinton	12 192	$62 002	$9 511	625	$579	84 909
Erie	489 881	300	268 082	77 689	7 663	843 615
Genesee	204 896	.....	.....	.....	.....	204 896
Greene	2 625	.....	2 000	.....	.....	4 625
Herkimer	9 283	2 603	.....	.....	.....	11 886
Jefferson	16 749	*a* 18 625	.....	.....	40 220	75 594
Lewis	2 850	35 000	.....	95	91	38 036
Madison	34 361	22 625	5 000	100	.....	62 086
Monroe	16 133	18 780	.....	3 291	994	39 198
Montgomery	39 000	.....	.....	5 338	11 184	55 522
Niagara	.....	525	141 824	800	.....	143 149
Onondaga	170 402	*a* 53	.....	10 178	190 704	371 337
Rensselaer	16 556	.....	100	.....	1 268	17 924
St Lawrence	287	6 824	24 186	652	13	31 962
Saratoga	3 792	.....	.....	.....	.....	3 792
Schoharie	19 640	300	.....	457	4 600	24 997
Seneca	5 650	22	61	487	74	6 294
Ulster	167 472	19 300	.....	.....	.....	186 772
Warren	18 161	165 064	.....	270	5 621	189 116
Washington	1 000	10 000	.....	.....	.....	11 000
Westchester	.....	21 072	253	.....	4 027	25 352
Other counties *b*	543 943	17 301	3 783	.....	3 553	568 580
Total	$1 936 292	$400 396	$454 800	$112 082	$270 591	$3 174 161

a Lime made by Solvay Process Co. and Union Carbide Co. included in "Other uses."
b Includes Columbia, Dutchess, Essex, Fulton, Oneida, Ontario, Orange and Rockland counties.

MARBLE

The granular crystalline limestones and dolomites classed as marble are found in the metamorphosed areas of the Adirondacks and southeastern New York. A few varieties of compact, non-crystalline limestone, such as the black limestone of the Trenton formation occurring at Glens Falls and the fossiliferous Chazy limestone along Lake Champlain, possess ornamental qualities that fit them for special uses and pass as marble in the trade.

The principal quarries of monumental marble are situated in the vicinity of Gouverneur, St Lawrence county. The typical product is a rather coarse-grained, mottled white and gray marble which takes a lustrous polish. It is graded according to color effect into "light," "medium," "dark," and "extra dark." The best quality is employed for monumental and ornamental work; building stone is of secondary importance. The quarries are operated by the

Gouverneur Marble Co., St Lawrence Marble Quarries, J. C. Callahan & Sons, and the Northern New York Marble Co.

The belt of metamorphosed limestones which extends from Columbia county through Dutchess and Westchester to Manhattan island contains in places a good grade of white and gray marble. Quarries have been worked in the past at Ossining, Dobbs Ferry, White Plains, Pleasantville, Tuckahoe, Greenport, and other places. Tuckahoe has been a notable locality for white marble used in the buildings of New York City. At present the only active quarries worked for building stone are at South Dover. The South Dover Marble Co. has been the chief producer of late years and has supplied material for many of the large structures in New York, Washington and other cities. The Dover White Marble Co. has recently worked quarries in the same vicinity. The stone from this locality possesses uniformity of grain and color and is undoubtedly one of the best white marbles in this county.

A mottled pink and gray marble suitable for interior decorations is obtained from the Chazy formation at Plattsburg. The quarries recently operated by the Rutland-Florence Marble Co. have been acquired by the Vermont Marble Co.

Black marble — a fine-grained, compact, black variety of the Trenton limestone — is quarried for ornamental purposes at Glens Falls by Finch, Pruyn & Co. who ship the stone mainly in the rough state.

The production of marble in the State last year was valued at $278,041, an amount considerably below that reported in any other recent year. The value of the output in 1910 was $341,880. In 1908 it was $692,851 or more than double the output last year. The falling off, as shown in the accompanying table, has been mainly in the marble used for building purposes.

Production of marble

VARIETY	1909	1910	1911
Building marble	$262 934	$252 965	$171 748
Monumental	104 495	88 684	79 115
Other kinds	12 587	231	27 178
Total	$380 016	$341 880	$278 041

SANDSTONE

Under sandstone are included the sedimentary rocks which consist essentially of quartz grains held together by some cementing substance. Among the varieties distinguished by textural features are sandstones proper, conglomerates, grits and quartzites.

Of the sedimentary rocks which occur in the State, sandstone has the largest areal distribution, while in economic importance it ranks second only to limestone. Nearly all the recognized stratigraphic divisions above the Archean contain sandstones at one or more horizons. The kinds chiefly quarried are the Potsdam, Hudson River, Medina and the Devonic sandstones. A few quarries have been opened also in the Shawangunk conglomerate and the Clinton and Triassic sandstones.

The Potsdam of the upper Cambric is the lowest and earliest in age of the sandstones that have a fairly wide distribution and are utilized for building purposes. The most extensive outcrops are along the northern and northwestern borders of the Adirondacks in Clinton, Franklin, St Lawrence and Jefferson counties. Other exposures of smaller extent are found in the Lake Champlain valley and on the southeastern edge of the Adirondack region. These latter areas represent the remnants of a once continuous belt that has been broken up by folding, faulting and erosion. The Potsdam sandstone has in many places the character of a quartzite, consisting of quartz grains cemented by a secondary deposition of quartz, and then is a very hard, tough and durable stone. The quartzite from St Lawrence county has sustained a crushing test of more than 42,000 pounds to the square inch. The color varies from deep red to pink and white. The principal quarries are near Potsdam and Redwood, St Lawrence county, and Malone and Burke, Franklin county. Besides building stone which is the chief product, there is some flagstone sold, mainly by the quarries at Burke for shipment to Montreal.

The so-called Hudson River group is essentially a series of sandstones, shales, slates and conglomerates, ranging in age from the Trenton to the Lorraine, but which have not been sufficiently studied to permit the accurate delimitation of the various members on the map. The group is exposed in a wide belt along the Hudson from Glens Falls southward into Orange county and also in the Mohawk valley as far west as Rome. The sandstone beds are usually fine grained, of grayish color and rather thinly bedded. Over wide stretches they provide practically the only resource in

constructional stone and consequently they have been quarried at a great number of places to supply the local needs for building and foundation work. Some of the stone is crushed for road metal and concrete.

The Medina sandstone is found along the southern shore of Lake Ontario from the Niagara river east to Oswego county; in central New York it is represented by a coarse conglomeratic phase called the Oneida conglomerate. As developed in the western part of the State where it is principally quarried, it is a hard fine-grained sandstone of white, pink or variegated color. The pink variety is specially quarried for building stone and has an excellent reputation. Many of the large cities of the county and most of the important towns and cities of the State contain examples of its architectural use. The large quarries are situated in Orleans county, near Albion, Holley and Medina, along the line of the Erie canal, but there are others at Lockport and Lewiston, in Niagara county and at Brockport and Rochester in Monroe county. The Medina sandstone also finds extensive application for curbing and flagging and for paving blocks. It is employed more extensively for the latter purpose than any other stone quarried in the State.

The Shawangunk conglomerate is more widely known for its use in millstones than for constructional purposes. It outcrops along Shawangunk mountain in Ulster county and southwesterly into New Jersey, with an outlier near Cornwall, Orange county. The quarries near Otisville have supplied considerable quantities of stone for abutments and rough masonry.

The Clinton sandstone is mainly developed in central New York, being absent from the Clinton belt in the western part of the State. It forms ledges of considerable extent on the south side of the Mohawk valley from Ilion to Utica and beyond. It consists of reddish brown and gray sandstones, of medium texture and hardness. The stone has been used for foundations and building in Utica and other places in the vicinity.

Of the Devonic formations which cover about one-third the whole area of the State, the Hamilton, Portage, Chemung and Catskill contain important sandstone members serviceable for quarry operations. These sandstones are popularly known as bluestone, a name first applied in Ulster county where they are distinguished by a bluish gray color. They are for the most part fine-grained, evenly bedded, bluish or gray sandstones, often showing a pronounced tendency to split along planes parallel to the bedding so as to yield smooth thin slabs. For that reason they are ex-

tensively used for flag and curbstone, and a large industry is based on the quarrying of these materials for sale in the eastern cities. Most flagstone is produced in the region along the Hudson and Delaware rivers, where there are convenient shipping facilities to New York, Philadelphia and other large cities. The Hudson river district includes Albany, Greene and Ulster counties, but the quarries are mainly situated in the area that includes southern Greene and northern Ulster, with Catskill, Saugerties and Kingston as the chief shipping points. The Delaware river district includes Sullivan, Delaware and Broome counties; the shipping stations are along the Erie and the Ontario & Western railroads. The sandstone of this section ranges from Hamilton to Catskill age. In the area to the west the quarries are confined to the Portage and Chemung groups, with the most important ones in the Portage. There are large, well-equipped quarries near Norwich, Chenango county, and Warsaw, Wyoming county, which produce building stone for the general market. Numerous small quarries are found in Otsego, Chemung, Tompkins, Tioga, Schuyler, Steuben, Yates, Alleghany, Cattaraugus and Chautauqua counties.

Production of sandstone. The accompanying tables give the production of sandstone during the last two years, divided according to bluestone and other kinds.

There was a very large falling off in the value of the output last year, the returns showing the lowest aggregate reported at any time since the statistics of the industry have been collected by this office. The combined value of both bluestone and sandstone amounted to $955,063, as compared with $1,451,796 in 1910, a decrease of $496,733 or nearly 35 per cent. The value reported in 1909 was $1,839,798. The industry has thus declined nearly 50 per cent in the two years.

All districts in which sandstones are quarried have felt the effects of the depression, but the greatest falling off has been in the bluestone quarries which produce chiefly curb and flagstones. The value of the bluestone output in 1911 was $614,334 against $1,037,637 in 1910 and $1,301,950 in 1909. Of the total for last year, curb and flagstone constituted $337,300, as compared with $385,825 in 1910 and $608,116 in 1909. The value of bluestone used for building purposes amounted to $270,284 against $351,603 in 1910 and $298,631 in 1909. The large decrease in crushed stone last year was due to the completion of a large enterprise in the Hudson river district.

Sandstone other than bluestone, constituted a value of $340,729 against $414,159 in the preceding year and $537,839 in 1909. The showing was thus comparatively better than in the bluestone trade. Orleans county reported a product valued at $255,862 as compared with $332,382 in 1910 and $385,281 in 1909.

Production of sandstone in 1910

DISTRICT	BUILDING STONE	CURBING AND FLAGGING	PAVING BLOCKS	CRUSHED STONE	RUBBLE, RIPRAP	ALL OTHER
Bluestone						
Hudson river	$26 689	$164 593	.....	$200 000	$42 000	$500
Delaware river	33 965	212 463	.....	.....	55 010	170
Chenango co	74 985	7 879	.....	.....	1 165	.....
Wyoming co	208 444	.....	.....	.....	327	237
Other districts	7 520	890	.....	790	.....	10
Total bluestone	$351 603	$385 825	.....	$200 790	$98 502	$917
Sandstone						
Orleans co	$23 403	$83 539	$202 773	$4 003	$14 869	$3 755
Other districts	12 402	10 768	26 080	20 615	6 125	5 827
Total sandstone	$35 805	$94 307	$228 853	$24 618	$20 994	$9 582
Combined total	$387 408	$480 132	$228 853	$225 408	$119 496	$10 499

Production of sandstone in 1911

DISTRICT	BUILDING STONE	CURBING AND FLAGGING	PAVING BLOCKS	CRUSHED STONE	RUBBLE, RIPRAP	ALL OTHER
Bluestone						
Hudson river	$14 377	$123 189	.....	.....	$560	$200
Delaware river	31 775	204 629	.....	.....	1 775	1 245
Chenango co	72 933	9 482	.....	.....	250	1 210
Wyoming co	145 519	.....	.....	$600	910	.....
Other districts	5 680	.....	.....	.....	.....	.....
Total bluestone	$270 284	$337 300	.....	$600	$3 495	$2 655
Sandstone						
Orleans co	$21 395	$83 519	$145 575	$1 081	$4 257	$35
Other districts	25 892	10 228	16 645	22 202	6 913	2 987
Total sandstone	$47 287	$93 747	$162 220	$23 283	$11 170	$3 022
Combined total	$317 571	$431 047	$162 220	$23 883	$14 665	$5 677

TRAP

The quarrying of trap is a somewhat specialized branch of the stone industry which may be treated with advantage under a separate head. Trap is not a distinct rock type, but the name properly belongs to the fine-grained, dark-colored igneous rocks that occur as intrusive sheets or dikes. In mineral composition it differs from the other igneous rocks classed in the trade as granite, by the prevalence of lime-soda feldspars and higher percentages of the lime, magnesia and iron minerals and correspondingly lower amounts of silica, with little or no free quartz. The name is sometimes applied to fine-grained igneous rocks of granitic or syenitic composition and even to rocks of sedimentary derivation, but such usage is misleading and indefensible.

The particular value of trap is due mainly to its hardness and toughness. Its fine, compact homogeneous texture gives it great wearing powers and it is eminently adapted for road metal and for concrete of which heavy service is required. It has been used to some extent in this State as Belgian blocks. As a building stone it finds very little application, probably on account of its somber color. The expense of cutting and dressing trap is also an obstacle to its employment for building or ornamental purposes.

The trap quarried in New York is properly a diabase, made up of plagioclase feldspar in lath-shaped crystals and pyroxene as the main constituents, and amphibole, olivine and magnetite as subordinate minerals. The largest occurrence is represented by the Palisades of the Hudson, which begin near Haverstraw and extend southward into New Jersey. The Palisades represent the exposed edge of a sill or sheet of diabase intruded between shales and sandstones of Triassic age. The sheet is from 300 to 800 feet thick and about 70 miles long. Most of the trap quarried in this State has been obtained from this region, chiefly from the vicinity of Haverstraw and Nyack, but to some extent from near Richmond, Staten Island, where the sheet has its southern termination. Smaller occurrences of diabase are found in the Adirondacks and the bordering area. There are countless numbers of trap dikes in the interior of the Adirondacks, but few have any considerable thickness and in general they are too remote from the market to be profitably quarried. In the outlying region the dikes at Greenfield, Saratoga county, and at Little Falls, Herkimer county, are the most notable. Quarries have been opened at the former locality and the trap is crushed for road metal.

The production of trap in 1911 amounted in value to $899,414, a small decrease from the total of $909,006 reported in the preceding year. Most of the output was employed for road metal and the quantity thus used was 850,322 cubic yards valued at $696,367. Crushed stone for other purposes chiefly concrete and railroad ballast amounted to 267,930 cubic yards valued at $199,797. The building stone had a value of $3250. Altogether there were 7 firms represented in the industry, of which 6 operated quarries in Rockland county, and 1 the quarry at Greenfield, Saratoga county. The Manhattan Traprock Co. of Nyack discontinued operations during the year having disposed of its quarry property to the Palisades Park Commission.

The future of the trap industry in the Palisades region is involved with the plans for the creation of the park which has received legislative approval in both New York and New Jersey. It is possible that all quarrying operations may eventually be brought to an end. Thus far the only company that has withdrawn from business is the one mentioned, which worked quarries on Hook mountain, north of Nyack.

Production of trap

MATERIAL	1910		1911	
	CUBIC YARDS	VALUE	CUBIC YARDS	VALUE
Crushed stone for roads	1 000 187	$766 733	850 322	$696 367
Crushed stone for other purposes	185 493	122 198	267 930	199 797
Other kinds	100	75	185	3 250
Total	1 185 780	$909 006	1 118 437	$899 414

TALC

The talc mines in the Gouverneur district were quite active last year, though their output was somewhat curtailed by the impairment of mill capacity incident to the long period of dry weather in the late summer and fall, a condition that has been repeated during each of the last three seasons. The production amounted to about 65,000 short tons, all shipped in ground form and mainly, as heretofore, for use in paper manufacture. Prices averaged nearly the

same as in the previous year, or about $8.50 a ton; the prevailing quotations for paper stock were between $8 and $9, with a slight reduction for the coarser or inferior grades used for other purposes.

Some interesting developments have taken place in the district during the year. The most important, perhaps, was the entrance of the Uniform Fibrous Talc Co. into the field of commercial operations. This company had been engaged for the last two years in the opening of a mine near Talcville and the erection of a mill and hydro-electric power plant; it began active production in January 1911. The body of talc that has been developed was long neglected on account of the unpromising appearance of the outcrop, but the explorations in depth have demonstrated the existence of a good grade of mineral over a width of 30 feet or more as shown by some of the stopes. Both fibrous and foliated varieties are found, with sufficient of the former to give the mill product the desired quality for the usual commercial applications of the Gouverneur talc.

The present mill, a fire-proof concrete and steel structure, is only partly equipped, being about one-half the capacity that can be obtained when the full complement of machinery is in place. The process of grinding differs somewhat from that employed in the other mills of the district and will be described elsewhere in this article. The power plant that generates the electricity by which both mine and mill are operated is situated on the west branch of the Oswegatchie river, about a mile distant. The dam and power house are built of reinforced concrete. A twin turbine direct connected to a 75 -K.W. alternator supplies the present requirement of power, but a second unit of similar capacity can be added if needed.

The Ontario Talc Co. continued to operate the Potter mine which is now in shape to supply a steady output. The mine is opened on two levels for a horizontal distance of 300 feet, and the shaft is being sunk in preparation for another level. The thickness of the body ranges from 15 to 25 feet or more, with very little waste rock exposed in the workings. It yields a white and very uniform product in which there is a large proportion of fiber. A feature of the mine is the occurrence of considerable masses of the long fiber variety that much resembles asbestos. The mill of the Ontario Talc Co. is about a mile south of the mine near Fullerville, on the west branch of the Oswegatchie. It is operated by a local water power which will probably be supplemented by other supply in the near future, as the company intends to enlarge the milling capacity. Improvements to that end are now under way.

The other producer in the district, the International Pulp Co.,

made its usual large output, though it concentrated its attentions upon fewer properties than in the previous years. Of the mines owned by the company only three were steadily worked, these including No. 2½ and No. 3 at Talcville and a new mine which has been opened in the vicinity of the old Wight mine in the southwestern section of the district. The mine formerly worked by the United States Talc Co. and taken over by the International Pulp Co. in the recent consolidation was closed down during the year. This has been one of the most productive and best known mines in the district. Little talc was taken from the Arnold and Balmat mines of the old Union Talc Co. The company operated the new No. 6 mill which has a capacity of about 125 tons a day, as well as No. 3 and the Columbia mill. It has recently converted No. 4 mill at Hailesboro into a power plant.

Outside of the Gouverneur district the only talc occurrence that received attention during the year was that near Natural Bridge in Lewis county, mentioned in the preceding issue of this bulletin as under development by the St Lawrence Talc and Asbestos Co. The property is situated about one mile northeast of Natural Bridge in a belt of crystalline limestones and schists that parallels the St Lawrence county district, from which it is 10 or 15 miles distant. The talc, so far as opened, belongs to the massive and platy varieties rather than to the fibrous mineral so characteristic of the Northern belt. There appears to be more or less serpentine in close association with it. Tremolite was observed in a boulder outcrop near the mine. A vertical shaft has been put down on the property, and a crushing plant and mill were under construction last year.

THE GOUVERNEUR TALC DISTRICT

This description of the St Lawrence talc mines is intended only as a sketch of the principal features surrounding the occurrence of the deposits and their industrial utilization. The information on which it is based has been taken largely from published sources, though with such revision as to make the treatment representative of present conditions.

General geology. The investigations of the geology of this section have been carried out mainly by C. H. Smyth, jr. The work hitherto has been in the way of a reconnoissance, as there have been no adequate maps with which to conduct detailed studies of the region which is very involved in its structural and stratigraphic features. The rock formations belong, however, to the same general classes that compose the central Adirondack region and have been

described at length in the several areal reports issued by the State Museum.

The talc deposits are immediately associated with crystalline limestones and schists of Grenville age. These occupy belts that have a northeast-southwest trend in conformity with the general structural arrangement throughout the Adirondacks. One of the largest belts begins in the town of Antwerp, Jefferson county, and crosses the towns of Gouverneur and De Kalb, St Lawrence county. It is of considerable economic importance in connection with the marble quarries at Gouverneur. A second belt some 12 miles long and from 1 to 3 miles wide is found a few miles to the east in the towns of Fowler and Edwards. It is this area that contains the fibrous talc deposits. A third belt to the south and east of the latter and lying across the St Lawrence-Lewis county line includes the Natural Bridge talc occurrence that has been recently under development.

The limestones are bordered by members of the Adirondack gneisses, some of which are light in color and have the composition and appearance of slightly modified granites and diorites. A very prominent member in the stretch between Gouverneur and the talc district is a dark hornblende variety which is usually well laminated and garnetiferous and is injected by light red granite. In places the granite forms a branching network that incloses the darker rock in its meshes, producing a mosaic pattern. These granite injections are no doubt offshoots of some of the larger bodies of that rock, while the darker gneiss may belong to the sedimentary series. Of the general relations of the gneiss group it can be said that the igneous types are apparently the youngest and are all later than the limestones. It is not clearly demonstrated as yet whether any of the gneisses in the region are older than the Grenville.

Occurrence of the talc. The talc deposits occur along minor belts within the Grenville limestones and schists. They are locally called veins and have been described as such by some writers, though they have nothing in common with mineral veins, being layers or beds included within the limestones. They have the same strike and dip as the latter and show a fair degree of regularity and persistence. In thickness they range from seams of a few inches up to 50 feet or more. The dip is uniformly toward the northwest at angles that vary usually between the limits of 30° and 60°.

The associated schists are mainly composed of tremolite, but in some places carry considerable quartz. They are singularly free

from other minerals. The tremolite is white or light gray in color and is usually developed in finely fibrous individuals which when felted form a compact and tough rock. The pink variety known as hexagonite is of limited occurrence. Bands and irregular masses of the tremolite occur within the talc deposits, and the immediate walls generally consist of the schist, the border being marked by alternating layers of talc and schist.

The association is suggestive of the derivation of the talc which has been the subject of study by C. H. Smyth, jr.[1] The tremolite is no doubt the parent mineral. As explained by Professor Smyth, the limestones were originally impure calcareous sediments and by metamorphic influences have taken on a crystalline character and became impregnated with silicates. Certain limestone beds seem to have contained sufficient magnesia and silica to permit their complete transformation to tremolite, forming a tremolite schist, while other layers, with a preponderance of lime have undergone a partial change, showing scattered crystals and aggregates of silicates within the limestone. The subsequent change of tremolite to talc is the result of weathering and takes place through the agency of ground waters holding carbon dioxid. The alteration may be formulated chemically as follows: $CaMg_3Si_4\ O_{12} + H_2O + CO_2 = H_2\ Mg_3Si_4\ O_{12} + CaCO_3$. The change is accompanied by an increase in volume of talc and calcite amounting to 25.61 per cent, though if the talc alone is considered there is a decrease of .83 per cent as compared with the tremolite. There is little or no calcite in the talc, so that it probably has been removed with the progress of the alteration.

The talc is really a pseudomorph after the tremolite and it is due to this that it possesses a fibrous character. Microscopic examination of specimens from almost any of the mines will show a little residual tremolite in the centers of the fiber aggregates, and in some samples there is a very considerable proportion of unaltered mineral. Foliated talc accompanies the fibrous variety, being more abundant apparently the farther the process of alteration has gone. It is of course a separate development deposited by the circulating waters which have taken the materials of the schist into solution.

The view that the tremolite has been formed by metamorphism from the ingredients of the limestones without addition of material

[1] Report on four townships in St Lawrence and Jefferson counties, N. Y. State Mus. Rep't 47, 1894, p. 491–515. Also, Report on the Talc Industry of St Lawrence County, N. Y. State Mus. Rep't 49–2, 1898, p. 661–71.

from other sources is perhaps the least conclusive part of the explanation as given. This entails a rather unusual chemical composition that is hardly in conformaty with the character of the limestones in the district. As a rule they are not particularly silicious or impure. An alternative to that view, which would seem equally probable in the circumstances, may be found in the introduction of silica and magnesia along certain beds by underground circulations after the limestones were formed.

It is of interest to note that a belt of metallic ores is found in the same limestones on the footwall side of the talc beds. The ores include zinc blende, pyrite and hematite and occur at intervals from Sylvia lake on the southwest to beyond Talcville. They have undoubtedly been deposited by solutions subsequent to the formation of the limestones, and from the similar associations it seems reasonable to connect their introduction with the suggested mode of genesis of the tremolite.

General characters. The fibrous talc is the predominant variety and the usual grade consists of the same felted mass of fine fibers that characterizes the tremolite schist. The fibrous nature is very persistent and can be seen by the microscope to exist even in samples that appear to the unaided eye as massive. Foliated talc, that is the crystallized variety, occurs more specially in the mines on the southwestern end of the belt. It is found as intercalated seams between the fibrous talc.

The fibrous variety is commonly known as agalite, whereas the name rensselaerite is often applied to the foliated mineral. The latter designation seems to rest upon a mistaken identification. The type specimens of rensselaerite collected by Ebenezer Emmons show it to be a mineral of the serpentine family, and to be an alteration of pyroxene.

The color of the talc is white or light gray, with a greenish tint in the foliated variety. The freshly mined material bleaches to a lighter shade on exposure to the air through the evaporation of the mechanically held water. Near the surface the deposits show discolorations from iron and organic matter, but at a depth usually of 40 or 50 feet they pass into commercial rock.

There is no uniform practice followed in selecting or grading the talc before it is sent to the mill. In most mines the foliated talc forms such a small percentage of the average that it does not influence appreciably the quality of the ground product. Certain mines in the town of Fowler produced at one time considerable

quantities of this variety, which were sorted out and milled separately. The principal attention is directed toward the character of the material with regard to gritty impurities. It is aimed to leave the gritty talc in the walls and pillars and to send only the milling grade to the surface. The best of the mine output is ground for paper stock, as any appreciable amount of grit affects the sale of the talc in the paper trade.

Mining of talc. The mines are situated along the outcrop of the beds which are included in the section from Sylvia lake in the town of Fowler to near the village of Edwards. Most of the mines have been opened in the northeastern part near Talcville, where there are between 10 and 15 different workings, many of them now abandoned. The chief producers in this section of late years have been the mine of the United States Talc Co., now a part of the International Pulp Co., and No. 2½ and No. 3 mines of the latter company. The Uniform Fibrous Talc Co. has a mine just west of Talcville. The Potter mine of the Ontario Talc Co. is in the central part of the district on the west branch of the Oswegatchie river below Fullerville. On the southwest end of the belt near Sylvia lake are the mines formerly worked by the Union Talc Co., including the Balmat, Arnold, and Wight mines, and the new mine recently opened by the International Pulp Co.

Many of the mines are worked on a leasing system, the operators paying a certain royalty to the owner for each ton of talc extracted. The average royalty is about $.75, which is to be considered as very high for such material.

Mining is carried on entirely by undergound methods. The general practice in the district does not differ materially from that employed in working ore deposits that are similarly situated, though of course the soft and slippery nature of the material necessitates that the pillars left for roof support should be of large size. The workings are reached through inclines carried down on the footwall. In case the bed is not over 15 feet or so thick, a single drift is run from either side of the incline at intervals of from 50 to 75 feet. The drift is carried nearly the full width of the bed and connected with the level above at short intervals by raises, after which the talc is removed between the levels, leaving pillars 25 feet or more square to support the roof. With a bed of greater thickness two drifts may be run on the same level, leaving a wall of talc between to assist in supporting the roof.

Drilling is mostly by machines of the percussion type and the rock

is blasted by dynamite. It splits readily along the cleavage planes. The large blocks or slabs from blasting are reduced by sledges to a size convenient for handling. From the stopes the talc is loaded into cars and run out to the incline where it is dumped into skips and hoisted to the surface.

Preparation for the market. The processes in use for grinding and preparing the talc have been gradually evolved out of long continued experimentation. It is said that the first prepared talc shipped from the district was ground in a grist mill. With the discovery of the value of the fibrous variety as a paper filler, attention was directed to the methods of treatment which have been perfected until capable of producing the desired quality and uniformity of grade.

The mills, all of which are run in connection with the mines, number 7 or 8 in all. They have a combined capacity of between 75,000 and 100,000 tons of prepared talc a year. They are situated along the Oswegatchie river in the stretch between Gouverneur and Edwards, the sites being selected with reference to water power facilities. The mines of the International Pulp Co. at Talcville ship their product by railroad to the mills at Hailesboro.

The reduction of the talc is accomplished in several stages. The lump talc as mined is first broken in a jaw crusher of the Blake type. The product then goes through a cone grinder or through rolls where it is reduced to .5 inch or less. In the third stage the crushed talc may be ground between buhrstones of special manufacture or in a centrifugal grinder of which the Griffin mill is a common type. The talc is then passed through a bolt of about 60 mesh and goes to the finishing cylinders, or the finest material may be separated by air currents which blow it into settling chambers and then forms one of the grades for the market. The common practice is to make the final reduction in revolving cylinders charged with pebbles. The Alsing cylinder is the one generally used and is from 8 to 10 feet long and 6 feet in diameter. It is lined with porcelain brick. It is turned from 20 to 25 times a minute. The charge consists of 1 ton of talc and 3 tons of flint pebbles. The grinding of a single charge takes from 2 to 5 hours, depending upon the grade of product that is desired. The fibrous character of the talc is maintained throughout the grinding to the end product, so that it is difficult to size the ground talc by screening; consequently the degree of fineness is regulated entirely by the duration of the final grinding process.

In the new plant of the Uniform Fibrous Talc Co. the Hardinge conical mill is employed in preparing the talc for the finishing process. The crude rock is first passed through a jaw breaker which reduces the lump talc to about 1.25 inch size; and then the product is screened and fed into the Hardinge mill where it is ground to pass a 10 mesh screen for the cylinders. The latter are of the usual intermittent type.

Tube mills of large size, such as are used in the fine grinding of cement and ores, have been installed in one or two plants. They take the place of the Alsing cylinder. They have the advantage over the latter of being continuous in regard to feed and discharge, but are more difficult to regulate so as to give the desired finish to the product.

A coarser grade known as buhr stock is produced by omitting the last stage of grinding in the Alsing cylinder. This is used as a substitute for asbestos in the manufacture of asbestos paper and packing. The ground talc, or mineral pulp as it is called, is put up in paper sacks of 50 pounds each, or in cloth bags of 200 pounds. Shipments are made by the Gouverneur and Oswegatchie Railroad, near the line of which most of the mills are located. Prices are usually quoted from Gouverneur.

Cost of production. The conditions vary so much in the different mines and mills that it is impossible to fix any average basis for estimating the costs of production. The mining and milling operations are perhaps the least variable factors of all, and these may be figured approximately at from $1.50 to $2 a ton. Royalty is an important item in the leased mines; it is usually fixed at about $.75, but may be as low as $.25. The haulage from mine to mill and from the mill to the shipping point is a heavy tax in some cases, as the country is rough and the roads are very poor. This may amount to as much as $1.50 or $2 a ton. The cost of package is about $1.

Uses. The fibrous talc is mainly used in the paper trade as filler for book and writing paper and to a considerable extent for newspaper. It is more readily incorporated with the paper stock than clay and at the same time has a beneficial influence upon the strength of the paper. The manufacturers of gypsum wall plasters are consumers of the talc which takes the place of hair, wood fiber or asbestos in these plasters. Among the minor uses are in the manufacture of waterproof paints and steam pipe coverings.

Chemical analyses. The following analyses indicate the composition of the talc from this district. No. 1 and No. 2 are from Dana's System of Mineralogy. No. 3 is quoted from Professor Smyth's article. For No. 4 the writer is indebted to Mr A. McLintock of the Uniform Fibrous Talc Co.:

	1	2	3	4
SiO_2	60.59	59.92	62.10	68.9
Al_2O_3	.13	.50	.....	1.3
Fe_2O_3	.....			
Fe O	.21	.76	1.30	.....
Mn O	1.16		2.15	.....
Mg O	34.72	31.37	32.40	26.6
Ca O	.....	.57	.....	.8
Na_2O	.....	.48	.....	.....
H_2O	3.77	6.25	2.05	2.4
	100.58	99.85	100.00	100.00

Production. The first shipments of talc from the district were made during the seventies of the last century. The earliest regular operations are said to have been instituted by a mineralogist named Minthorne who formed a company for mining and milling talc on the Wight farm in the town of Fowler. By the year 1880 shipments were made in considerable quantity. The production from that date as given in the volumes of the *Mineral Industry* or reported by this office have been as follows:

Production of talc in New York

YEAR	SHORT TONS	VALUE	YEAR	SHORT TONS	VALUE
1880	4 210	$54 730	1896	46 089	$399 443
1881	5 000	60 000	1897	57 009	396 936
1882	6 000	75 000	1898	54 356	411 430
1883	6 000	75 000	1899	54 655	438 150
1884	10 000	110 000	1900	63 500	499 500
1885	10 000	110 000	1901	62 200	483 600
1886	12 000	125 000	1902	71 100	615 350
1887	15 000	160 000	1903	60 230	421 600
1888	20 000	210 000	1904	65 000	455 000
1889	23 476	244 170	1905	67 000	519 250
1890	41 354	389 196	1906	64 200	541 600
1891	53 054	493 068	1907	59 000	501 500
1892	41 925	472 485	1908	70 739	697 390
1893	36 500	337 625	1909	50 000	450 000
1894	50 500	454 500	1910	65 000	552 500
1895	40 000	320 000	1911	65 000	552 500

ZINC

Work on the zinc blende occurrence near Edwards, St Lawrence county, was resumed last year. The Northern Ore Co. recently succeeded to the ownership of the property which had lain idle since 1904 owing to legal complications. It began systematic development of one section of the deposit on April 1st and continued active operations throughout the remainder of the season. As a result the company had at the close of the year about 8000 tons of milling ore on the surface, besides a much larger quantity blocked out underground. Shipments of several hundred tons of selected blende were made for experimental purposes, the first commercial product ever sent to a zinc smelter from this State.

The developments on the property give hope that a substantial mining industry may be established. They are considered sufficiently encouraging by the company to warrant the erection of a milling plant, on which work has already been started at Edwards. The mill is planned for a capacity of 50 tons crude ore a day, and present expectations are that it will turn out concentrates averaging about 60 per cent zinc. Though about one-third of the ore developed last year would bear shipment in crude state, the distance from the zinc-smelting districts makes concentration an advantage and probably all of the output will pass through the mill. This will enable the production, also, of a valuable by-product in the form of pyrite. Some of the ore, furthermore, carries an appreciable quantity of galena which will doubtless be saved by the mill treatment.

Only a limited area of the mineralized zone has been explored as yet. The work during the past year was directed to the underground exploration of a single outcropping lens that had been previously uncovered and followed to a depth of 40 or 50 feet. This has been developed through an inclined shaft following the dip of the ore and by a series of drifts and crosscuts. At the time of the writer's visit to the property in June 1911, the shaft had been sunk about 100 feet and showed a continuous band of ore all the way from 4 to 7 feet thick. According to recent information communicated by A. J. Moore, manager of the Northern Ore Co., at Edwards, the conditions have continued favorable with the further progress of the shaft and additional ore bodies have been encountered in some of the crosscuts.

The ore lens that has been under development is remarkably high in grade, the whole mass being almost solid blende and pyrite.

There is considerable variation in the proportions of the two minerals, though blende is much the more common and in some parts of the deposit is practically the only ingredient. Assays of the richer material show from 40 to 50 per cent zinc. The blende is black, nontransparent, and apparently carries relatively large amounts of iron.

The general features of the ore occurrence in the Edwards section were presented in the issue of this report for the year 1905, but in view of the discoveries that have since been made, it may be of interest to enter upon their discussion here.

The existence of the zinc in this part of St Lawrence county has been known since the early part of the last century and is mentioned briefly by Ebenezer Emmons in his Report on the Geology of the First District, published in 1838. Some attempts were made to work the ores in the early days, as shown by the excavations on the Balmat property which are said to have been undertaken for the purpose of extracting the lead and silver values rather than the zinc. The intimate mixture of galena, blende and pyrite proved no doubt a rebellious material to treat by the methods then available; at any rate mining was soon abandoned. The present interest in the deposits dates from about 1902 when the attention of local mining men was attracted to some specimens of rich blende that were uncovered in the Edwards locality about 12 miles northeast of the old Balmat prospect. These appeared so promising that leases were secured on the property and work was begun under the direction of T. M. Williams. After a short period of exploration which showed promising results the company became involved in legal difficulties that have but recently been removed, and nothing was done in the interval from 1904 to 1911.

The ores are found along a well-marked zone which parallels the talc deposits and lies on the footwall of the latter. The wall rock is crystalline limestone of the same nature as that inclosing the talc; it belongs to the Grenville series, widely represented on this side of the Adirondacks. The limestones are interstratified with thinly bedded quartzose schists, tremolite schists and heavier hornblende gneisses, and the whole series has been invaded then and there by granitic intrusions. The limestones and included schists of this particular district are exposed in a belt that extends from near Sylvia lake, town of Fowler, on the southwest to a point a little north of Edwards village, on the northeast. They represent regionally metamorphosed and compressed sedimentaries which are

among the very earliest of the Adirondack formations. The granite is found in dikes, stringers and irregular bodies and belongs probably to one or more of the great invasions of that rock which took place in the Adironacks at different times in the Precambric period. Both fine-grained and pegmatitic varieties occur. The other important Adirondack intrusives including syenite, gabbro, diabase etc., are absent so far as known. There are no Paleozoic strata though they begin a few miles to the west with horizontal beds of Potsdam sandstone. They no doubt extended over this area at one time and reached far into the interior of the Adirondacks, but have been planed off by erosion.

The limestones and schists have a northeasterly strike and are upturned at a high angle, the dips being usually 45° or over toward the northwest. The limestone is coarse and carries abundant silicates. The latter in places constitute the greater part of the mass. The tremolite schists from which the talc beds are derived represent the extreme stage in the silication of the limestones. The quartzose schists and hornblende gneisses are probably metamorphosed products of impure sandstone and shales.

The zinc ores at Edwards occur in a mass of impure serpentinous limestone which forms a low ridge just north of the Oswegatchie river on the road to Trout lake. On the north end of the ridge there is a shallow open cut showing a band of mixed blende and limestone about 15 feet thick. The blende occurs in irregular bunches which apparently are the brecciated fragments of what was once a more or less solid lens or band of the ore. There is evidence of intense compression which has forced the limestone into the fractures and recemented the mass. The limestone for some distance away from the lens is impregnated with blende so as to form a lean ore. The occurrence has not been tested for any considerable depth. Several other showings of ore are found on the sides and top of the ridge to the south of this opening. About 1000 feet away and on the opposite or eastern side of the ridge is the one which has been explored during the past season, as above mentioned. In this place the ore shows less evidence of compression or disturbance and admixture with limestone. The lenses also have well-defined walls. The blende is finely granular without any trace of crystal form. The pyrite is sprinkled through the mass in rounded grains which range up to one-fourth inch in diameter and occasionally show a cubical development. Barite is found in some quantity in the walls. On the weathered outcrop it shows prominently as a spongy aggregate that was first mistaken for smithsonite.

In the interval between Edwards and the Balmat prospect there have been several discoveries of ore which, however, have not been sufficiently prospected to reveal anything definite as to their extent. They indicate that the mineralization follows a fairly definite zone parallel and in proximity to the talc deposits.

The Balmat occurrence is described briefly by Emmons in the report already referred to as "a remarkable occurrence of the sulfurets of zinc, lead and iron in about equal proportions . . . . The direction of the vein is north-northeast and south-southwest and the width about 8 inches, but not well defined. The sulfurets traverse a bed of serpentine 40 to 50 feet wide. The occurrence of zinc intermixed with lead is not favorable to the reduction of the latter." There are two shafts on the ore body about 1000 feet apart. The outcrop of the ore where it is revealed shows a vein or band up to 3 feet thick. Near the south shaft a short adit has been driven into the ore from the side hill, the only part of the workings now accessible, and shows the vein at this point to be from 4 to 5 feet thick. There is much more galena in this occurrence than at Edwards and usually more pyrite.

Another ore locality in the southwestern section is on the lands owned by J. H. McLear, south of Little York and near Sylvia lake. The deposit was originally opened with a view to the working of iron ore which occurs in the form of specular hematite. Some of it was used in the Fullerville furnace nearby. The hematite occurs in a lens of uncertain size, some of it being nearly pure and other parts charged with pyrite and blende. The sulfides are specially developed along one of the walls. Specimens from this part have assayed above 20 per cent zinc. There has been no recent work done on the deposit.

From the present stage of development there is insufficient evidence to base any prediction as to the possibilities of the district as a producer of zinc ore. It is evident, however, that a small output is assured by the results obtained at Edwards where thus far only a single outcropping has been attacked. If the developments there continue as favorable during the coming season as they have been in the past they will go far toward proving the persistence of the deposits in depth which is of most importance to the future of the district and about which least is now known. In the case of such issue there will be much encouragement, also, for the extension of exploration to other parts of the mineralized area. Though the deposits are narrow as compared with those found in the important zinc-producing districts of other states, they possess an

advantage over most in their average tenor. They are furthermore exceptionally situated for economic exploitation, with convenient shipping facilities, cheap electric power available, and efficient labor to be had in the district.

The derivation of the ores is an interesting problem that need not be given detailed treatment in this place. The apparent close association of the zinc and talc deposits may be pointed out as a feature of practical importance to exploration and it seems very likely to reflect some underlying geological principle. The geological relation, if such exists, is probably between the tremolite and the zinc ores rather than between the latter and the talc itself which is an alteration product of the tremolite. The extensive development of tremolite in belts within the limestone is regarded by the writer as the work of underground circulations which have brought in silica and perhaps also a part of the magnesia necessary for the conversion of the lime carbonate to the magnesia-lime silicate. These circulations, it is reasonable to suppose, may have carried other ingredients including zinc, lead and iron which have gone to form the metallic deposits.

The zinc deposits have the general appearance of replacement bodies rather than the fillings of open fissures or cavities. In most places their boundaries are not clean cut but are in the nature of transition zones shading off gradually into the limestone. The lens of compact ore which has been under recent development shows, however, fairly sharp contacts. The internal structures are not those characteristic of open-fissure fillings as there is no appearance of banding or crusts or drusy cavities lined with crystallized minerals. The compact granular nature of the ore suggests deposition at considerable depth and under pressure. In that event it may be inferred also that the deposits are very old, possibly of Precambric age. Erosion in this part of the Adirondack region seems to have been comparatively slight since Cambric times and has been mainly effective in removing the mantle of Paleozoic sediments which now are only found in the bordering area.

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New York State Education Department

New York State Museum

JOHN M. CLARKE, Director

PUBLICATIONS

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These reports are made up of the reports of the Director, Geologist, Paleontologist, Botanist and Entomologist, and museum bulletins and memoirs, issued as advance sections of the reports.

Director's annual reports 1904–date.

1904.	138p. 20c.	1908.	234p. 39pl. map. 40c.	
1905.	102p. 23pl. 30c.	1909.	230p. 41pl. 2 maps, 4 charts.	*Out of print.*
1906.	186p. 41pl. 25c.	1910.	280p. il. 42pl. 50c.	
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Geologist's annual reports 1881–date. Rep'ts 1, 3–13, 17–date, 8vo; 2, 14–16, 4to.

In 1898 the paleontologic work of the State was made distinct from the geologic and was reported separately from 1899–1903. The two departments were reunited in 1904, and are now reported in the Director's report.

The annual reports of the original Natural History Survey, 1837–41, are out of print.

Reports 1–4, 1881–4, were published only in separate form. Of the 5th report 4 pages were reprinted in the 39th museum report, and a supplement to the 6th report was included in the 40th museum report. The 7th and subsequent reports are included in the 41st and following museum reports, except that certain lithographic plates in the 11th report (1891) and 13th (1893) are omitted from the 45th and 47th museum reports.

Separate volumes of the following only are available.

Report	*Price*	*Report*	*Price*	*Report*	*Price*
12 (1892)	$.50	17	$.75	21	$.40
14	.75	18	.75	22	.40
15, 2v.	2	19	.40	23	.45
16	1	20	.50	[*See* Director's annual reports]	

Paleontologist's annual reports 1899–date.

See first note under Geologist's annual reports.

Bound also with museum reports of which they form a part. Reports for 1899 and 1900 may be had for 20c each. Those for 1901–3 were issued as bulletins. In 1904 combined with the Director's report.

Entomologist's annual reports on the injurious and other insects of the State of New York 1882–date.

Reports 3–20 bound also with museum reports 40–46, 48–58 of which they form a part. Since 1898 these reports have been issued as bulletins. Reports 3–4, 17 are out of print, other reports with prices are:

Report	Price	Report	Price	Report	Price
1	$.50	11	$.25	20 Bul. 97)	$.40
2	.30	12	.25	21 (" 104)	.25
5	.25	13	*Out of print*	22 (" 110)	.25
6	.15	14 (Bul. 23)	.20	23 (" 124)	.75
7	.20	15 (" 31)	.15	24 (" 134)	.35
8	.25	16 (" 36)	.25	25 (" 141)	.35
9	.25	18 (" 64)	.20	26 (" 147)	.35
10	.35	19 (" 67)	.15	27 (" 155)	.40

Reports 2, 8–12 may also be obtained bound in cloth at 25c each in addition to the price given above.

Botanist's annual reports 1867–date.

Bound also with museum reports 21–date of which they form a part; the first Botanist's report appeared in the 21st museum report and is numbered 21. Reports 21–24, 29, 31–41 were not published separately.

Separate reports for 1871–74, 1876, 1888–98 are out of print. Report for 1899 may be had for 20c; 1900 for 50c. Since 1901 these reports have been issued as bulletins.

Descriptions and illustrations of edible, poisonous and unwholesome fungi of New York have also been published in volumes 1 and 3 of the 48th (1894) museum report and in volume 1 of the 49th (1895), 51st (1897), 52d (1898), 54th (1900), 55th (1901), in volume 4 of the 56th (1902), in volume 2 of the 57th (1903), in volume 4 of the 58th (1904), in volume 2 of the 59th (1905), in volume 1 of the 60th (1906), in volume 2 of the 61st (1907), 62d (1908), 63d (1909) reports. The descriptions and illustrations of edible and unwholesome species contained in the 49th, 51st and 52d reports have been revised and rearranged, and, combined with others more recently prepared, constitute Museum Memoir 4.

Museum bulletins 1887–date. 8vo. *To advance subscribers,* **$2** *a year, or* **$1** *a year for division* (1) *geology, economic geology, paleontology, mineralogy;* 50c *each for division* (2) *general zoology, archeology, miscellaneous,* (3) *botany,* (4) *entomology.*

Bulletins are grouped in the list on the following pages according to divisions.

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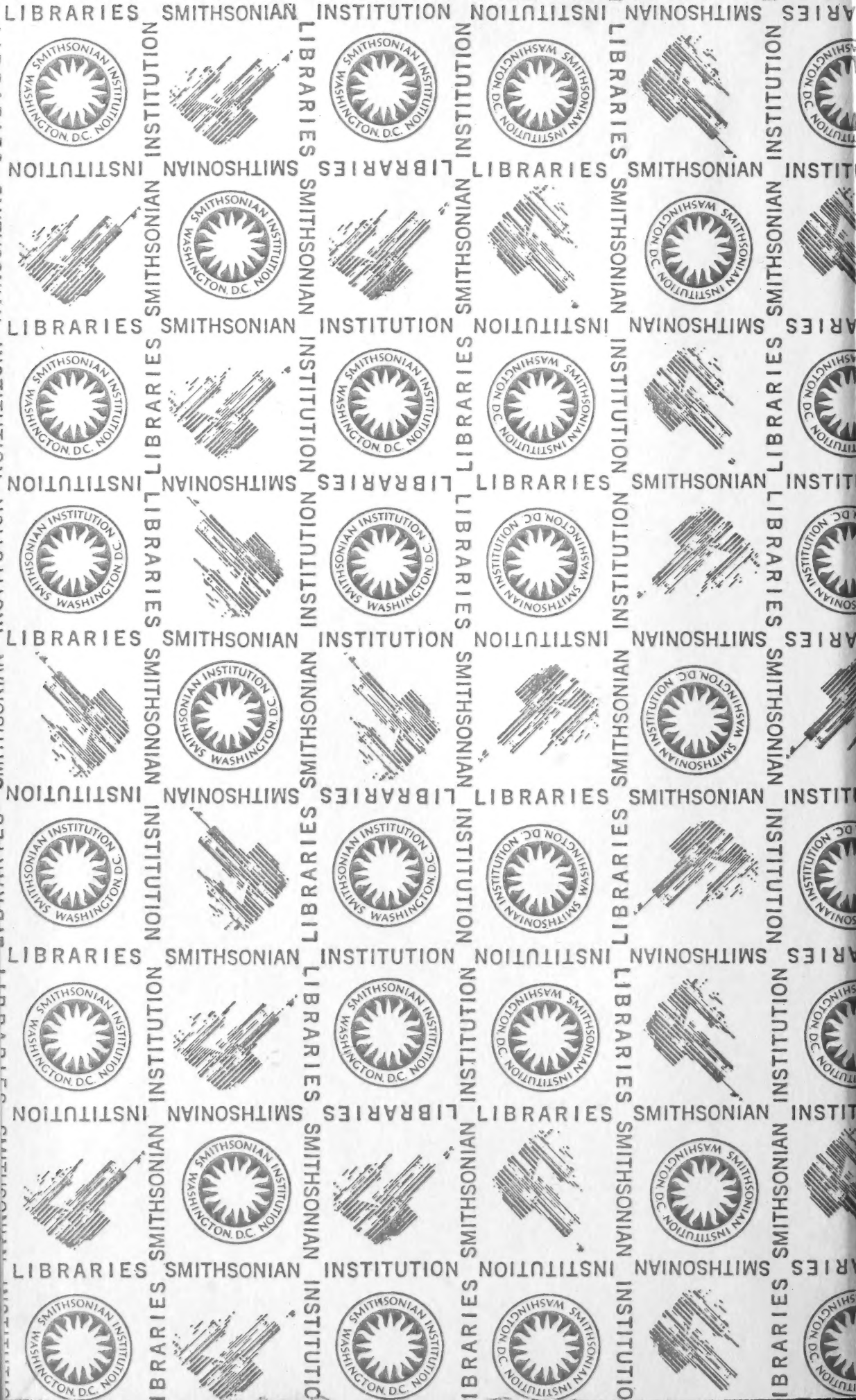
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