BUILDING STONE AND ROAD METAL.

RECENT WORK ON NEW ENGLAND GRANITES.

By T. Nelson Dale.

AREA CONSIDERED.

During the summer of 1905 the writer visited all the important granite quarries in Maine, and in 1906 all those at the chief granite centers of New Hampshire, Massachusetts, and Rhode Island, namely, Concord, Conway, and Milford, in New Hampshire; Milford, Quincy, and Rockport, in Massachusetts, and Westerly and Niantic in Rhode Island. The quarry at Chester, Mass., was also visited. The State of Maine cooperated with this Survey in bearing the expense of the work in its territory, but the work in the other States was done entirely at the expense of the United States Geological Survey.

WORK IN MAINE.

The results of the Maine work are soon to be presented in a bulletin entitled "The granites of Maine," to which Dr. George Otis Smith has contributed an introductory chapter and map showing the geographic and general geologic relations of the granites in that State. The bulletin will also include the statistics of granite production in Maine for 1905, prepared by Miss A. T. Coons.

A brief outline of this forthcoming report on the Maine quarries may be of interest to persons engaged in the granite industry.

The number of quarries and prospects visited, including those of "black granite" for monumental use, amounted to 129. The capital invested in the entire Maine granite industry in 1905 amounted to about $3,500,000. This estimate is based upon fair valuations of the quarries themselves, of the plants, and of the amount of "working capital" that is required to carry on the present business.

The report is designed to be helpful to those who are engaged in quarrying and working granite, as well as to architects, contractors, and dealers in monumental stone, and it will also make known to geologists

the results of such scientific observations as were made in the course of the work. In order to accomplish these various purposes it has been divided into two parts—a scientific and an economic part. The first is practically a brief text-book on granite in general, illustrated by the granite quarries of Maine and written as far as has been possible in untechnical language, so as to be intelligible to working and business men. This part treats of the origin, mineralogical and chemical composition, texture, structure, physical properties, and classification of granite and "black granites." Under the heading "Structure" the nature and origin of sheets, rift, grain, flow structure, joints, headings, and faults are considered. Dikes, veins, "knots" (segregations), geodes, inclusions, and contacts are described and discussed, as well as the discoloration and decomposition of granite.

In the economic part the various tests of granite, the adaptation of the stone to different uses, and the methods of granite quarrying are first considered. An economic classification of Maine granites based upon visual characteristics is next given, and next follow the descriptions of the quarries and their products, the matter here being arranged by counties in alphabetic order. These descriptions follow a uniform method, taking up, in succession, (1) the name and location of quarry, name and address of operator and superintendent; (2) the granite, including its description in the rough and under the microscope, together with the results of any tests and analyses; (3) the quarry, its dimensions, drainage, and water supply; (4) the stripping and rock structure; (5) the plant, including an enumeration of all machines and pneumatic tools, to show its capacity; (6) the means of transportation; (7) labor, both of men and animals; (8) product, its uses and market, together with the names and location of a few buildings or monuments in whose construction the stone has been used.

At the end of the report is a bibliography on the economic geology of granite and a glossary of such scientific terms as were unavoidably used and also of current quarry terms. The report includes 14 plates illustrating various features of scientific or economic interest in the quarries or their product and 39 text figures. Most of these text figures are diagrams showing the course of joints, headings, and dikes at the quarries, but others illustrate "rift," sheet structure, "sap," or the use of explosives, or show the location of individual quarries at the industrial centers. The situation of these centers is indicated by symbols on the geological map.

WORK IN OTHER STATES.

A report on the granite quarries of New Hampshire, Massachusetts, and Rhode Island will follow the plan of the economic part of that on Maine granites, but will include such supplementary matter of scientific interest as has been collected in the course of the work.

Eighty-eight quarries were visited. The granite of nearly all of these quarries differs from that of those in Maine, and some of the geological features of the quarries are also different. These granites differ also greatly among themselves, as may be seen by noting the various kinds produced. Among these are the fine-grained Westerly granites, so well adapted to the most delicate sculpture, and the Milford, N. H., and Chester, Mass., granites, which somewhat resemble them; the dark hornblende-augite monumental granite of Quincy, Mass., noted for its high polish; the massive structural granite of Milford, Mass., which is going into several important public structures; the medium-grained light-gray muscovite granite of Concord, N. H., used in the Congressional Library at Washington; the olive-colored granites of Rockport, Mass., and Redstone, N. H.; the pink granite of Redstone, N. H., and the mottled medium-gray granite of Rockport, Mass.

In describing these stones polished specimens of one or two typical granites from each district will be examined by the Rosiwal method, and the estimated percentages of the chief mineral constituents will be given in connection with the microscopic descriptions. Some of these estimates have already been completed, and are presented below in advance.

The "extra dark" hornblende-augite granite of the J. S. Swingle quarry at West Quincy, Mass., shows feldspar, 56; hornblende-augite, 10.50; smoky quartz, 33.50.

The "dark" granite of the Granite Railway Company's quarry at the same place shows feldspar, 58.79; hornblende-augite, 7.47; smoky quartz, 33.74.

The "dark" granite of the Maguire & O'Heron quarry at Milton, near Quincy, shows feldspar, 55.80; hornblende-augite, 11.10; smoky quartz, 33.10.

The "medium" granite of the Wigwam quarry of Badger Brothers at West Quincy shows feldspar, 69.51; hornblende-augite, 8.43; smoky quartz, 22.06.

These results indicate that the difference in the shade of Quincy granites, designated commercially by "medium," "dark," and "extra dark," is due partly to differences in the percentage of the hornblende-augite and partly to differences in that of the smoky quartz.

The medium gray granite from the Pigeon Hill quarry (Lower quarry) of the Pigeon Hill Granite Company at Rockport, on Cape Ann, Mass., shows feldspar, 58.86; hornblende, 7.26; smoky quartz, 33.88.

In examining the fine-grained granites the Rosiwal method is applied to camera lucida drawings made from thin sections, with an enlargement, in the finest ones, of 40 diameters. The finest of the

Westerly granites, the "white granite" of the New England Granite Works, which is really a medium pinkish gray, shows when thus examined feldspar, 59; black mica, 3.85; very slightly smoky quartz, 36; magnetic iron, 0.75; white mica, 0.50. It also shows that the average diameter of all the particles, including the very fine particles of magnetic iron, is 0.0069 inch, or 0.175 millimeter; but the coarser particles of feldspar, quartz, and mica as measured with the micrometer range in diameter from 0.015 to 0.439 inch, or 0.39 to 1.122 millimeters.

The study of the numerous economic and scientific data obtained at all these quarries is not sufficiently advanced to permit any further preliminary publication.

The two reports together will, it is hoped, constitute an important contribution to an authoritative compend of the economic geology of New England granites.

SURVEY PUBLICATIONS ON BUILDING STONE AND ROAD METAL.

The following list comprises the more important publications on building stone and road metal by the United States Geological Survey:

ALDEN, W. C. The stone industry in the vicinity of Chicago, Ill. In Bulletin No. 213, pp. 357–360. 1903.

BAIN, H. F. Notes on Iowa building stones. In Sixteenth Ann. Rept., pt. 4, pp. 500–503. 1895.

DALE, T. N. The slate belt of eastern New York and western Vermont. In Nineteenth Ann. Rept., pt. 3, pp. 153–200. 1899.

——— The slate industry of Slatington, Pa., and Martinsburg, W. Va. In Bulletin No. 213, pp. 361–364. 1903.

——— Notes on Arkansas roofing slates. In Bulletin No. 225, pp. 414–416. 1904.

——— Slate investigations during 1904. In Bulletin No. 260, pp. 486–488. 1905.

——— Note on a new variety of Maine slate. In Bulletin No. 285, pp. 449–450. 1906.

DALE, T. N., and others. Slate deposits and slate industry of the United States. In Bulletin No. 275. 1906.

DILLER, J. S. Limestone of the Redding district, California. In Bulletin No. 213, p. 365. 1903.

ECKEL, E. C. Slate deposits of California and Utah. In Bulletin No. 225, pp. 417–422. 1904.

HILLEBRAND, W. F. Chemical notes on the composition of the roofing slates of eastern New York and western Vermont. In Nineteenth Ann. Rept., pt. 3, pp. 301–305. 1899.

HOPKINS, T. C. The sandstones of western Indiana. In Seventeenth Ann. Rept., pt. 3, pp. 780–787. 1896.

——— Brownstones of Pennsylvania. In Eighteenth Ann. Rept., pt. 5, pp. 1025–1043. 1897.

HOPKINS, T. C., and SIEBENTHAL, C. E. The Bedford oolitic limestone of Indiana. In Eighteenth Ann. Rept., pt. 5, pp. 1050–1057. 1897.

KEITH, A. Tennessee marbles. In Bulletin No. 213, pp. 366–370. 1903.

RIES, H. The limestone quarries of eastern New York, western Vermont, Massachusetts, and Connecticut. In Seventeenth Ann. Rept., pt. 3, pp. 795–811. 1896.

SHALER, N. S. Preliminary report on the geology of the common roads of the United States. In Fifteenth Ann. Rept., pp. 259–306. 1895.

——— The geology of the road-building stones of Massachusetts, with some consideration of similar materials from other parts of the United States. In Sixteenth Ann. Rept., pt. 2, pp. 277–341. 1895.

SIEBENTHAL, C. E. The Bedford oolitic limestone [Indiana]. In Nineteenth Ann. Rept., pt. 6, pp. 292–296. 1898.

SMITH, G. O. The granite industry of the Penobscot Bay district, Maine. In Bulletin No. 260, pp. 489–492. 1905.