

ART. V.—*On the Relations of the Menevian Argillites and associated Rocks at Braintree and vicinity, in Massachusetts;* by W. W. DODGE.—With a map.

THE well known syenite of Quincy, Massachusetts, occupies an area a mile and three quarters wide with its northern and southern sides running approximately east and west,—a little north of east, and south of west. It forms two principal east-westerly lines of steep sided hills, or ridges cut across by glaciation. From the base of these, the rock extends to some distance on the more level ground. From Quincy, the rock extends into Milton on the west, and a short distance into Braintree on the south.

The northern of the two lines of hills ends near the Old Colony Railroad on the east, but in the southern there is a detached eminence, known as Penn's Hill, east of the railroad. This hill is separated from those to the westward by a valley half a mile broad, in which the local rock, whatever its character, is concealed by stratified gravel and sand there forming a plain about forty feet above high tide, in which the railroad runs, and through which Town River flows from Braintree to its outlet east of Quincy (Center) village.

Some of the several hills may represent independent outflows (the syenite is an eruptive rock), but the valley referred to is in its present shape a channel of erosion and glaciation.

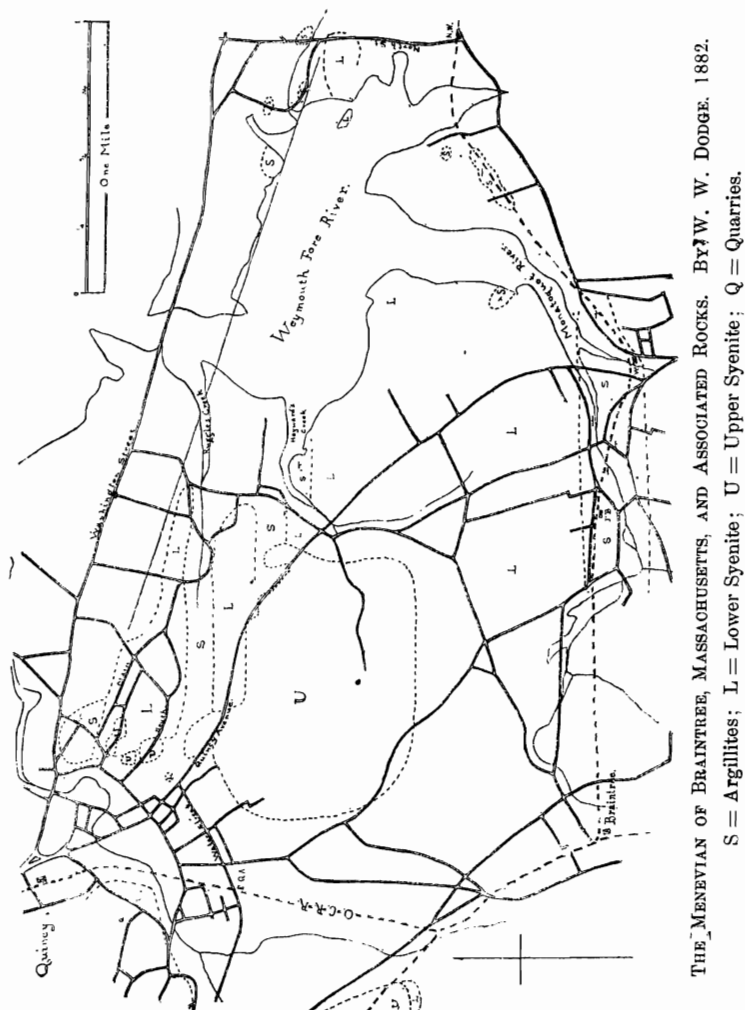
North, east and south of Penn's Hill, between the Cobasset Branch Railroad and Washington Street (the road from Quincy to North Weymouth and Hingham), in Quincy and Braintree, the most abundant surface rock is a fine-grained syenite, which underlies the coarse Quincy syenite, and is entirely distinct from it. The fact that the two are not merely varieties of the same rock seems to have been overlooked. For the purposes of the following account of the two eruptives, the older will be called the Braintree syenite.

The expanse of the older rock is interrupted by bands of argillite, in which at one point occur *Paradoxides* and other fossils.

Stratified Rocks (S on the accompanying map.)—Concerning the stratified deposits at the south shore of Boston Harbor, only such details need be here presented as seem to have significance concerning the relations of the strata and their disposition with reference to older and newer rocks.

Of the stratified rocks in an anticlinal fold bordering on the north the coarser syenite in Quincy, the sandstones and slates on the north side of the narrow conglomerate axis measure.

so far as exposed, 288 feet west of the railroad, 312 at Hough's Neck, the strata being nearly vertical. The conglomerate as seen on the south side of Hough's Neck is penetrated by various eruptives, feldspathic as well as pyroxenic.



The coarse-grained, bright-colored syenites in Hingham and the adjoining towns (frequently micaceous), and in Weston, have a strong resemblance to each other, so far as regards the body of the rock. That in Weston is porphyritic with large simply-twinned feldspar crystals; Mr. Crosby has noted the occurrence of the same peculiarity at one place in Hingham.

An area of syenite west of the southern part of Hingham Harbor is nearly surrounded by conglomerate, which like the Roxbury conglomerate contains frequent pebbles of distinctly stratified rock. Pebbles also occur which evidently had their sources in the local representative of what has been named "Shawmut amygdaloid," found in place, for example, north and west of Squirrel Hill, as the Roxbury conglomerate has numerous pebbles of the similar rock which occupies a large area and several small spots in Newton and Needham. The conglomerate and syenite are found together eastward as far as the seashore. South of the Cohasset Branch Railroad, between the Hingham and West Hingham stations, are about 700 feet of conglomerate, sandstone and slate dipping southerly 55° , with much intrusive rock of various character, often amygdaloidal, in one place coarsely porphyritic and containing well-developed crystals of magnetite of good size. Beds of sandstone and slate bend around the western side of the conglomerate and extend northeasterly along the west shore of the town, showing at Beal's Cove a thickness of about 500 feet, there standing nearly vertical, the highest beds (above a dike) inverted to an easterly dip. North and east of Hewitt's Cove are large masses of diabase. In this rock, at one point near the beach at the head of the Cove, calcite has replaced large crystals of triclinic feldspar.

An anticlinal of slates more than a mile long, 1100 feet wide, occupies the valley of Monatoquot River in Braintree, and extends into Weymouth. The strike is about east and west. The strata on the north side dip at 70° , so far as observed, giving a thickness of about 475 feet; on the south the dip is occasionally much lower. The southern half of the fold is overlaid in Weymouth at its eastern end by a light-colored eruptive, chiefly quartzo-feldspathic; and this is cut and capped by diabase, which may also be seen in contact with the slate on both sides of Washington street at the corner of Commercial, in Braintree. At its western end and to some extent on its southern margin, this band of slate passes under hills of drift. Westward, in the northern part of Braintree, the surface configuration shows it probable that the slates continue beneath the surface in that direction.

On the western side of Weymouth Fore River, in the extreme eastern part of Braintree, and along, and also about two hundred feet north of, the railroad west of North Weymouth station, are slates. In the railroad cut (where the strike is about east-west) they may be seen bending over from 85° , the usual dip, to 15° under the masses of eruptive rock at the south side of the railroad. This last named rock, while quite unlike the typical form of the Braintree syenite, resembles a

variety of it which occurs on the north side of the quarry lane leading from Hayward's Creek toward Penn's Hill.

At the trilobite quarry, south of Hayward's Creek, the strike is east-west, the dip 65° south. Passing westward to the other side of the creek, the Braintree syenite is found at the surface, and this in turn disappears, farther in the same direction, under the Quincy syenite, while north of these the slates appear with the same strike, making the full width of the band about 1000 feet, from which the thickness may be estimated at 450 feet.

The next band, more than an eighth of a mile northward, lying between Quincy avenue and South street, is more than 400 feet wide, and over half a mile long. The strata of this fold have high dip; their strike is substantially east and west.

Half a mile east-southeast of Quincy railroad station are 450 feet of slates dipping southward, and with strike N. 75° W. These slates, extending S. 75° E. beneath the surface, would lie along the northeasterly side of the adjoining area of Braintree syenite. In Weymouth, outcrops are found half a mile north of the railroad, near Pearl street on both sides of North street, extending for nearly half a mile, 500 feet wide, with Braintree syenite immediately south of them. At both of these places the slate has frequent large oval cavities partially filled with epidote, which are sometimes irregularly scattered, sometimes distributed along lines of decoloration (perhaps also intrusion) parallel to the stratification plane. Diabase is found with the slate in Quincy (east side of Union street), where its presence, securing immunity from glaciation, accounts for the abundant exposures of the various rocks to the southward. The rocks, not rising to great elevation, are somewhat masked at Quincy Point and North Weymouth by the gravel and sand plain which has been already referred to in its extension west of Penn's Hill. The North Weymouth beds lie in the direction of the strike of the fossiliferous beds at Hayward's Creek, and would naturally be regarded as the eastward continuation of these. Their own strike at North street is N. 80° W., and although nearer Fore River it is west, their westward extension may be parallel to Washington street. It is not improbable, however, that the northern surface limit of the most northerly area of Braintree syenite is determined by glaciation rather than by the actual extension of the rock, and that the slates north of this have, except locally, the more common east and west direction.

There seems to be no reason to doubt that the argillites of all these folds are of the same age. Their maximum thickness appears to be not far from 500 feet. The relation of the argillites and the Hingham conglomerates can be more safely deter-

mined after examination of the relation of the Weymouth and Hingham syenites.

Braintree Syenite (L on the map).—Over a region extending a mile and three-quarters north from the Monatoquot Valley, this rock occupies the spaces between the bands of slate described. Abutting against the steep sides of the folds, it shows straight and prolonged lines of junction. The two rocks may usually be found exposed within a few feet of each other along the contact line, but the actual contact is most readily observed at the southerly margin of the Ruggles' Creek strip of slates. Near the contact, the syenite becomes compact and black or dark brown, porphyritic with occasional crystals imbedded in the ground mass but distinguishable on fresh fractures by the luster of the cleavage planes. This form is found on a face of rock bordering a narrow valley which crosses Main street east of Union, in Quincy (not shown on the map); the presence of drift-covered slates in this channel through the syenite may be safely inferred, although no outcrop can be detected. The syenite is generally light or dull brown, but varies to yellow and to speckled gray. Near dikes of diabase, the rock is blackened, assuming a very different appearance from its usual condition. The feldspar crystals in the typical form of the rock are often three-eighths of an inch long, but are enclosed in a finer ground mass. Quartz is abundant, but in very minute grains, often undistinguishable with the unaided eye. The hornblende is in places well crystallized and plentiful, usually not conspicuous, sometimes is much decomposed.

This rock occupies but a small area in Weymouth, unless rocks south of the railroad are to be included with it; its widest expanse is in Braintree, where it spreads from Weymouth Fore River to the valley west of Penn's Hill. It probably extends southward beyond the limits of the map. It never rises to as great elevation as does the Quincy syenite. West of the Old Colony Railroad, it forms the southern side of a small hill near the Quincy-Braintree line, west of the Granite Branch Railroad. Southwest of Pine Hill, it occurs on Willard street near the town boundary, but northward along the West Quincy valley it does not appear.

Quincy Syenite (U on the map).—The quarries at Pine Hill show this rock to hold inclusions of two kinds,—one a light colored, fine-grained quartzose syenite with white feldspar, the other a porphyritic diabase. The small hill east of Pine Hill, above referred to as made up in part of the lower syenite, is capped with this rock. Its northeast side is composed of it, and there a glaciated ledge near the West Quincy Branch Railroad shows the coarse syenite to be crowded with inclusions of diabase (?), fine grained, black, porphyritic and highly mag-

netic, sometimes pyritiferous. The fragments vary in size from a few inches in longest diameter, to many feet in length. Coarse syenite south of the Monatoquot slates holds inclusions of fine grained syenite.

Penn's Hill is composed chiefly of the Quincy syenite, although based on the older eruptive. The principal area covered by this newer rock at that place is a mile in longest diameter; at various points about its edge, the rock occurs in patches alternating at the surface with exposures of the underlying syenite. It is found at the top of a hillock two hundred yards north of East Braintree station, apparently protected against removal by glaciation by the presence of diabase.

No modification in the Quincy syenite where it is in contact with the underlying syenite has been observed. The older rock may have been yet hot when the more recent covered it. No inclusions of the older in the newer have been identified.

The great abundance of quartz in conspicuous lumps in the upper rock makes it easily distinguishable from the older eruptive. On weathered surfaces the former is rough with these lumps, even when heavily lichenized, the latter smooth and of a general yellow or brown color. The variety of the newer rock most quarried is blue, but the brown is also used.

Mr. Wadsworth has published* the result of a microscopic examination of this syenite, both the typical form and the "bands" in it. One of these dikes (?), exposed at a quarry in Milton near the Quincy line, is five feet wide, with a direction E. 2° N., and inclination or dip to the northward, 25° . It meets the rock on each side with a distinct junction. It is finer grained than the adjoining rock, of similar color in the central portion, while in the outer inch or two it is very much lighter colored and in the next two or three inches inward, of intermediate tint.

The rough woodland of western Quincy is much less favorable for accurate examination of the distribution of the rocks, than the cleared, settled and carefully mapped parts of the town. The coarse syenite lies in great hill ranges, and the massive dark gray argillites lying upon the steep hill sides are much covered by fallen debris from the crests of the hills. The slates on the east side of Randolph Turnpike have a strike N. 70° - 75° E., and are there exposed for a width of about ninety feet.

Examination of the accompanying map shows that two slate bands pass under the Penn's Hill syenite on its eastern border. The most that can be said as to the identity of the strata that appear from under these wide-spreading masses of eruptive rock at different points is that their similarity of char-

* Proceedings of the Boston Society of Natural History, vol. xix. p. 309.

acter makes it extremely probable that there is no break in their continuity in the prevalent line of strike.

The relation between the Quincy syenite and the adjoining Blue Hill region of southwestern Quincy and southern Milton, in which the rocks are in part at least of sedimentary origin, remains to be determined. The strata at this last named locality may well be examined in connection with the highly altered stratified rocks with associated eruptives at Mattapan in Boston and at northern Hingham.

Diabase.—Dikes are doubtless of frequent occurrence throughout the area discussed in this paper, but no search has been made for them. South of Quincy avenue, one ten or fifteen feet thick runs east and west near the junction of the coarse and fine syenites; and nearly in the line of this dike, northeast of the avenue, the Braintree syenite is cut by a dike one or two inches thick. The dike at the Sheldon & Co. quarry west of West Quincy runs N. 60° W., this like the preceding having a northerly dip. The syenite is injured as a quarry stone by the intrusion of these dikes, but no particular visible change of its character seems to be produced.

From what has been above stated, it will be seen that there are eruptives older than the conglomerates of this region and others younger; also eruptives both older and younger than the Quincy syenite; the dikes which cut the latter have the east-westerly direction (prevalent in Hingham and Weymouth south of the region under consideration) which belongs to those dikes cut across by a system of north-southerly dikes in some places in the vicinity of Boston.

Penn's Hill is strewn with bowlders of stratified rock. A small circle on the map, in the southwestern part of the largest area of Quincy syenite, marks the position of a tower at the top of the hill. The quarry, quarter of a mile or more east of this, is at the base of the hill.