[From The American Journal of Science, Vol. III, April, 1897.]

A RELATIVELY ACID DIKE IN THE CONNECTICUT TRIASSIC AREA;

By Edmund Otis Hovey.

ART. XXVI.—*A relatively Acid Dike in the Connecticut Triassic area;* by EDMUND OTIS HOVEY.

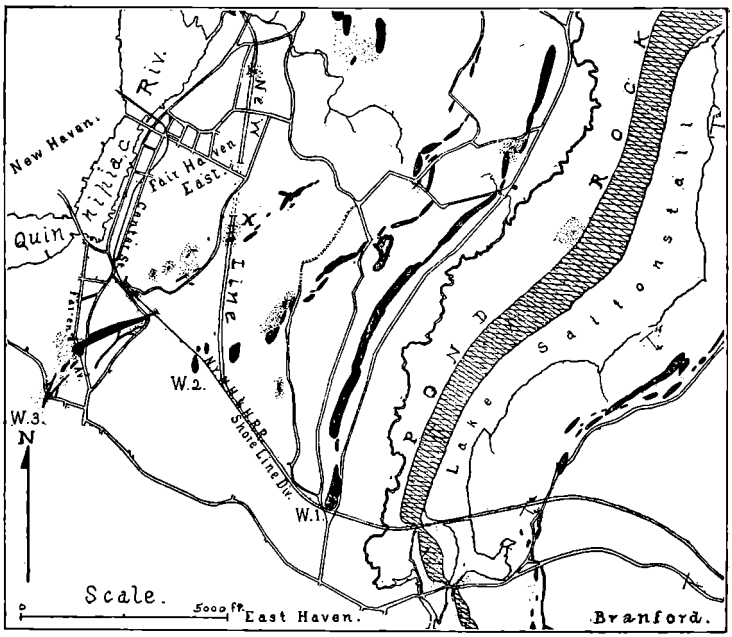
DURING the years 1893 and 1894 the New York, New Haven and Hartford Railroad Company made great changes in the layout of its Shore-line division, especially in the eastern part of the town of New Haven, Conn. Here it abandoned its old route entirely and cut its way through the Triassic sandstone by means of a deep trench and a long tunnel nearly half a mile east of its old course. For a considerable portion of the distance the new cut (50 feet deep in places) followed a shallow valley at the base of one of the low bluffs of sandstone which characterize the topography of the region. This proved to be one of the numerous fault planes of the district and the sandstone encountered was much broken and slickensided, so much so as to necessitate the lining of the entire tunnel with heavy brickwork. The cut revealed the presence of several dikes which are of some interest. All of them are transverse to the strike of the sandstone and the three largest (which are of ordinary diabase) and southernmost connect two of the ranges of dikes indicated on Percival's map* and shown in more detail on that published by the present writer,† a portion of which is reproduced here, with additions, as figure 1. The two smallest dikes as shown in the east wall of the cut coalesce in the floor, appearing as one in the west wall of the cut. The rock of these is different from the diabase of the region in chemical composition and structure, and approaches keratophyre, to which class it is provisionally referred. Slickensided surfaces in the middle of the largest dike (50 feet wide) show that some differential movements in the region have acted on the trap as well as the sandstone.

The relations of the dikes to one another and to the sandstone are so clearly indicated by the accompanying plan (fig. 3) and section (fig. 2) that extended comment on this feature is unnecessary. The dikes are seven in number, but Nos. 1 and 1*a* are evidently parts of the same; Nos. 2 and 3 probably meet a little east of the cut and Nos. 4 and 4*a* meet in the floor of the cut, so that the number of relatively independent dikes is four or, at most, five (see fig. 3). They vary in size from one or two inches up to about fifty feet, and extend in a belt about 440 feet wide diagonally across the railroad cut from northeast to southwest, the smallest ones being at the north and about

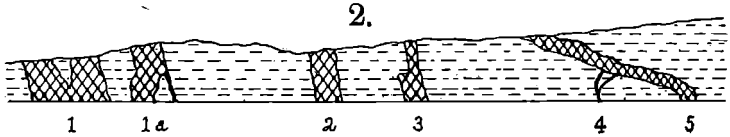
* Geol. Rept. of Conn., 1842, J. G. Percival. Reproduced in part in Dana's Manual of Geology. Fourth edition. p. 801, 1895.

† This Journal, III, xxxviii, pl. IX, Nov., 1889.

1.



2.



3.

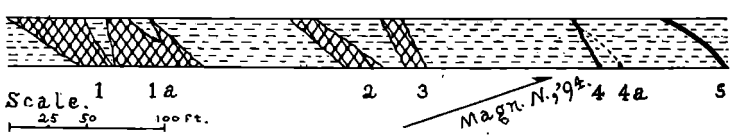


FIG. 1. Map of part of the towns of New Haven, East Haven and Branford, Conn. Solid black and cross-lined areas indicate exposures of trap; dots indicate sandstone associated with the trap. The dikes discussed in the present paper are located at X.

FIG. 2. Section of sandstone and trap as exposed in the west wall of the railroad cut at X, on the map. Scale as in figure 3.

FIG 3. Plan of floor of railroad cut at X, on the map. In this and the preceding figure sandstone is indicated by the broken lines and trap by the solid black and crossed lines. Horizontal and vertical scale the same.

110 feet from the southern entrance to the tunnel, which passes under East Grand avenue half a mile east of the Quinnipiac river. This is the best place near New Haven for the study of the phenomena of dikes: the differences in coarseness of grain in the dikes themselves on account of different widths; the increase in coarseness from each wall toward the center, especially in the larger dikes; columnar structure perpendicular to the walls in the heavy dikes; inclusion of country rock in the mass of a dike and the effect upon the igneous rock and the included block; contact phenomena on sandstone strata of varying nature, etc. Two-fifths of a mile north of the tunnel and a fourth of a mile from the Fair Haven station of the railway, an isolated dike crosses the cut. It is very irregular, from two to four feet wide, and trends N. 60° W. (magnetic) and hades 25° to 30° to the northeast. The course of the cut and tunnel is N. 18° E. (Observation made in October, 1894.)

The dikes which furnish the rock which is such a departure from the normal diabase of the region as to merit special description are numbered 4 and 4*a* on the plan, but 4*a* appears only in the east wall of the cut and although it is four or five inches wide at the level of the track, it pinches out about fifteen feet above, and does not reach the surface. In appearance it is like number 4 and is an offshoot from it. No. 4, from which the hand specimen about to be described was taken, is less than two inches (45^{mm}) wide at the level of the railway track on the east side of the cut and slowly and irregularly increases to about 8 inches in width toward the surface. The course across the bottom of the cut is about N. 80° W. (magnetic) and its hade on the east side of the cut is 33° to the south, but its inclination changes to the other side of the vertical on the west side of the cut and it passes very irregularly through the sandstone, separating into two branches as shown in the figure and being apparently intersected by No. 5. The color of No. 4 near the bottom of the cut on the east side is a light brick-red, very much like that of the inclosing sandstone but banded with different shades parallel to the sides of the dike and having small bluish green spots (chlorite) along the middle; green predominates above. On the west side the dike is grayish green with red edges. No. 4*a* is red. No. 5 is much wider than either of these, 3½ feet (1·1 meter), and its color and appearance are like those of the well known diabase dikes of the region: a very dense, greenish black rock with phenocrysts of augite. Under the microscope the rock of No. 5 presents a variation from the ophitic structure of typical diabase in that the augite of the groundmass is granular crystalline around the labradorite instead of being in broad plates penetrated by the feldspar. It is evident that dikes No. 4 and

4*a* cannot be offshoots from No. 5, on account of the difference in microscopical structure and mineralogical composition.

Petrography.—The hand specimen from dike No. 4 represents the whole breadth of the dike at the place from which it was taken and is from 4 to 4·5^{cm} wide. The texture is aphanitic at the sides and somewhat coarser in the middle, some of the larger feldspar phenocrysts and many areas of calcite and chlorite being discernible with an ordinary hand lens. Under the microscope the gradual increase in coarseness from wall to center is well shown. The rock consists essentially of feldspar. There are two sets of phenocrysts of feldspar. One is made up of relatively large tabular, cuboidal and lath-shaped twinned crystals which tend to form groups of twos and threes. The angles of extinction measured on the twinning trace, 18° to 19° on each side, and the predominance of soda shown by the chemical analysis indicate the probability of these being albite. The other and by far the larger set of feldspar phenocrysts consists of minute acicular crystals, which are scattered very thickly through the section where it cuts the middle of the dike, but become less numerous toward the sides. These minute crystals seem to be simple (not twinned) and are referred to anorthoclase, on account of the chemical analysis. They show a tendency toward prolongation of the corners, producing forms not unlike those of orthoclase described by J. P. Iddings* from the rhyolite of Pinto Peak, in the Eureka district, Nevada, in which the extensions do not diverge.

The relations of the two sets of feldspar phenocrysts seem to indicate that the groups of relatively large crystals (albite) are older than the others. The albite areas also show a few inclusions and some alteration.

The ferro-magnesian minerals are conspicuous by their absence from the thin sections studied, but the areas of secondary calcite and chlorite for the most part have definite outlines which strongly suggest the original presence of phenocrysts of pyroxene (augite) in the rock. In some instances these areas are partly penetrated by the acicular crystals of feldspar, somewhat after the manner of diabase augite and feldspar.

The base or groundmass is cryptocrystalline and is made up for the most part of crystals like the smaller feldspar phenocrysts. Sphærocrystalline structure was observed in some places. Some areas are not resolved by a No. 7 Fuess objective, but may be devitrified glass, as they affect polarized light.

Chemistry.—A chemical analysis of this peculiar dike was very kindly made for the writer by Dr. H. S. Washington with

* Hague, Geology of the Eureka District, U. S. G. S., Mon xx, p. 378, pl. iii, fig. 14, 1892.

the results given in column A. Column B gives an analysis of New Haven (West Rock) diabase by G. W. Hawes,* introduced for the sake of comparison as illustrating the normal diabase. The analysis given in column A was made on mate-

	A		B
SiO_2	60·13		51·78
TiO_2	tr.		1·41
Al_2O_3	20·47		12·79
Fe_2O_3	1·04		3·59
FeO	0·72		8·25
MnO	tr.		0·44
MgO	1·15		7·63
CaO	2·59		10·70
Na_2O	9·60		2·14
K_2O	1·06		0·39
Ign. (CO_2 and H_2O)	3·44	H_2O	0·63
		P_2O_5	0·14
	100·20		99·89

rial dried at 110° C. The specific gravity of the rock at 11° C. was 2·63 (Washington). Since the powdered rock effervesces rather strongly on the addition of cold HCl and considerable calcite is seen under the microscope, the loss on ignition must be largely CO_2.

This composition indicates that the rock belongs to the group of keratophyres (or possibly the bostonites of Rosenbusch), though the percentage of Al_2O_3 is rather high and the soda predominates over the potash to a greater degree than usual. About 87 per cent of the rock is feldspar and it would all seem to be anorthoclase, with the exception of the albite phenocrysts. The rock shows more CaO and MgO than the keratophyres quoted by Zirkel in his "Lehrbuch der Petrographie," but the excess of the former may be accounted for by the amount of secondary calcite present in it.

One of the striking features of the Triassic igneous rocks of the Atlantic border from Nova Scotia to North Carolina is their uniformity in appearance and in mineralogical and chemical composition. Particular emphasis has been put upon this feature by J. D. Dana† and it has been referred to by many of the writers on these Triassic areas. In his treatise on "The Newark System," I. C. Russell‡ has noted this uniformity in

* This Journal, III, ix, 186, 1875, and U. S. Nat. Mus. Proc., vol. iv, p. 132, [1881] 1882.

† This Journal, III, vi, 104–115. Also in his Manual of Geology and elsewhere.

‡ Bull. U. S. Geol. Survey, No. 85, pp. 67, 68, 1892.

these igneous rocks and has given a complete series of references to papers dealing with their mineralogical and their chemical composition, to which the reader is referred for any further details. H. D. Campbell and W. G. Brown,* however, describe petrographically and give the chemical analyses of two trap rocks from the Triassic of Culpeper county, Virginia, which depart from the "normal diabase" of Hawes and other observers. One of these is a hypersthene-diabase and the other an olivine-hypersthene-diabase. Another departure from the monotonous trap has been reported by L. S. Griswold,† who describes a very basic dike consisting essentially of augite, hornblende and biotite, with almost no feldspar, from Beseck Lake, near Baileyville, Conn., but gives no chemical analysis of the rock. The three instances of variation just cited are all of rocks as basic as or more basic than the normal or average diabase of the Triassic areas mentioned. The dike described in the present paper is the first one to be recorded from these areas in which the rock is acid or relatively acid.

* Bull. Geol. Soc. Amer., ii, 339–347, 1891.
† Bull Mus. Comp. Zool., xvi, 239–242, 1893.

Am. Mus. Nat. Hist., New York, Feb., 1897.