ART. LVI.—*The Geology of Block Island (Continued)*; by
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THE short article with the above title, in the last number of this Journal (pp. 295–298), was essentially a preliminary notice in the discussion of a much larger question relating to the presence or absence of the Jurassic formation on the Atlantic coast, a subject that I have been investigating for several years. The main object was to record my own observations at a few points, with the conclusions suggested, leaving a discussion of the whole subject for another occasion.

As my conclusions were so different from any that had been expressed by previous writers, I thought it best to present them based on my own investigations, rather than to attempt a discussion of the views of all others. To have cited the entire literature of the subject, extending over a century, would have taken the greater part of the limited space then at my command, and seemed hardly necessary.

Since my article was published, I have had further opportunity to follow out the investigation in several directions, and hope soon to place these results, also, on record. I may say here, however, that an examination of both the Raritan and Staten Island clay deposits has supplied two links in a chain of evidence, that I had not before known from personal observation. This chain now extends from the Potomac River to Martha's Vineyard, along the natural line of the Jurassic horizon, and indicates the Jurassic age of this series of strata beyond reasonable doubt.

Many and various opinions have been expressed as to the geological age of this series of strata, especially of the clays east of the Hudson River which are here under consideration.

The brilliant, variegated cliffs of Gay Head seem to have first attracted the attention of both mariners and geologists, and descriptions of their geological features began more than one hundred years ago. In 1786, Samuel West and William Baylies together explored Gay Head, and separately recorded what they saw, in vol. ii, *Memoirs of the American Academy of Arts and Sciences*, 1793. They discovered the bones of

whales, sharks' teeth, petrified shells, and fossil wood, and agreed that the cliffs were due to volcanic action, an opinion still maintained by the existing Gay Head Indians.

In 1824, John Finch, in discussing the "Tertiary Formations in America" (this Journal, vol. vii, pp. 31-43, 1825), stated his opinion that the Gay Head clays, as well as some on Long Island, and at Amboy, New Jersey, and still others farther south, were of the same age as the Alum Bay clays (Oligocene) on the Isle of Wight. E. Hitchcock, in the same year, and in the same volume of this Journal, pp. 240-248, regarded the Martha's Vineyard clays as the equivalents of the Plastic clay (Eocene) of Europe. Hitchcock, again in 1832, as state geologist, mapped and described this region as Tertiary, and in his report published in 1833 gave figures and descriptions of Gay Head fossils. The final report, 1841, contained a more complete description, and the Eocene age of the clays of Martha's Vineyard is still maintained. Lyell, in 1844 (Proc. Geol. Soc. London, vol. iv, and this Journal, vol. xvi, pp. 318-320), made a study of Gay Head and other localities on the island, and regarded the cliffs as of Miocene age. E. Desor and E. C. Cabot, in 1849, announced that certain clays on Nantucket were Miocene, and the equivalents of those on Gay Head (Quart. Jour. Geol. Soc. London, vol. v, pp. 340-344). W. Stimpson, in 1860, pronounced the strata at Gay Head, Cretaceous (this Journal, vol. xxix, p. 145), but subsequently withdrew that opinion in favor of their Tertiary age.

In more recent times, also, this opinion still prevailed, and even the later age of Post-pliocene or Quaternary was, in 1885, assigned to the Gay Head clays by F. J. H. Merrill (Trans. N. Y. Acad. Sci., vol. iv, p. 79). Shaler, whose valuable memoirs on Martha's Vineyard and Nantucket (1888-'89) I quoted in my previous article, still regarded the basal clays of both islands as Tertiary or later. In another paper (Bull. Mus. Comp. Zool., vol. xvi, p. 89, 1889), he discussed the discovery of marine Cretaceous fossils in the drift of Martha's Vineyard. In a still later paper (Bull. Geol. Soc. America, vol. i, pp. 443-452, 1890), he considered the lower portion of Gay Head, Cretaceous, and the middle, Tertiary. He adds that A. F. Foerste observed, on Block Island, beds probably of the same age as the Tertiary at Gay Head.

A study of the fossil plants of Gay Head, in 1890, by David White, indicated that some of the clays of Martha's Vineyard were Mesozoic, and they were pronounced by him Cretaceous, and probably middle Cretaceous (this Journal, vol. xxxix, p. 99). To this important paper, I am indebted for various references. These researches were made under the direction of L. F. Ward, whose comprehensive work on the Potomac formation (U. S. Geol. Surv., 15th Ann. Rep., 1895) is invaluable to all interested in that horizon.

Block Island, owing probably to its diminutive size and isolated position, has attracted but little attention from geologists, although situated as it is between Long Island and Martha's Vineyard, it is an intermediate station of considerable importance. The first notice of its geological features is apparently that of C. T. Jackson, in 1840, in his report as state geologist of Rhode Island, pp. 111-120. He carefully described the Block Island clays, and considered them of Tertiary age, although he was unable to find in them any remains of marine shells.

The next notice of importance is by W. Upham, in 1879, who regarded nearly all the Block Island clays as of glacial origin. Some of them appeared to be older, but he makes no statement as to their age. After discussing Long Island, he sums up the effects of glacial action, as follows:—

“Excepting the pre-glacial deposits which have been mentioned, and a small area of gneiss and hornblende schist at Long Island City and Astoria, the whole of Long Island, Block Island, Martha's Vineyard, Nantucket, the Elizabeth Islands, and the peninsula of Cape Cod, consist of drift deposits which owe their accumulation, as has been here shown, to the action of the ice-sheet and its rivers in amassing them at its termination” (this *Journal*, vol. xviii, pp. 91, 92, and 207).

This general opinion has widely prevailed, and I referred to it in my previous article. Another paper on Block Island, which I have not seen, is by Merrill, 1895 (*Trans. N. Y. Acad. Sci.*, vol. xv, pp. 16-19).

The literature relating to the geology of Long Island is quite extensive, but cannot be cited here. The basal clays of this island have been variously regarded as Glacial, Tertiary, and Cretaceous, but not older. The most important of the early descriptions is by Mather, in his *Report on the Geology of the First District of New York*, 1843. One of the later papers of special interest is by Merrill, *On the Geology of Long Island*, 1885 (*Ann. N. Y. Acad. Sci.*, vol. iii, pp. 341-364).

Newberry, in 1874, pronounced the plants from Lloyd's Neck similar to those from the lower Cretaceous of the West (*Proc. N. Y. Lyceum Nat. Hist.*, vol. ii, p. 127). This reference of the fossil plants of Long Island to the Cretaceous has since been followed by many authorities.

One of the latest writers on this subject is A. Hollick, who has kindly sent me, at my request, a number of his papers which I had not before seen.

The mutual relations of all the series of strata here considered, which I regard as Jurassic, I hope to discuss in the next number of this *Journal*.

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