

**REPORT ON THE
GEOLOGICAL MAP
OF MASSACHUSETTS**

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Report on the Geological Map of Massachusetts by W. O. Crosby

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W. O. CROSBY

**REPORT ON THE
GEOLOGICAL MAP
OF MASSACHUSETTS**

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ON
THE GEOLOGICAL MAP
OF
MASSACHUSETTS,

PREPARED BY

W. O. CROSBY,

ASSISTANT IN THE LABORATORY OF THE BOSTON SOCIETY OF
NATURAL HISTORY, PROF. ALPHEUS HYATT
IN CHARGE.

UNDER THE DIRECTION OF THE MASSACHUSETTS COMMISSION
TO THE CENTENNIAL EXPOSITION.

BOSTON:
PRESS OF A. A. KINGMAN.
1876.

HON. LEVERETT SALTONSTALL,
Massachusetts Commissioner to the Centennial Exposition :

SIR: I have the honor to present herewith the Report on the Geological Map of Massachusetts, prepared under the direction of the Commission.

My effort has been to unite the latest and most reliable information, whether published or unpublished, and, with these results, to give such a view of the Geology of the State as would represent the advances made since the Wall Map of Prof. Edward Hitchcock was published in 1844.

Over and above the function of directing the work, and securing the execution of this plan, I do not assume any credit for the collection of the materials, or the results reached by this means. Most of the outlines of the formations remain substantially as they appear on Prof. Hitchcock's map; though many of the details, and almost the entire eastern portion of the State, will be found to have been much changed, when compared with any previous map. For these and other matters of original and unpublished interest, the Commission is indebted to the voluntary labors of Mr. W. O. Crosby, Assistant in the Laboratory of the Boston Society of Natural History, Mr. L. S. Burbank, of Woburn, Mr. T. T. Bouvé, President of the Boston Society of Natural History, Prof. N. S. Shaler, of Harvard University, Prof. W. H. Niles, of the Massachusetts Institute of Technology, Prof. B. K. Emerson, of Amherst College, Mr. W. W. Dodge, of Cambridge, Mr. F. W. Very, of Dedham, Mr. W. W. Jacques and Mr. C. W. Kempton, both of Newburyport, Mr. Mathew Anderson, of

Cambridge, and others. The particular facts which they have contributed will be found in the body of the text. Information with regard to the eastern boundary of the Miocene on the island of Marth's Vineyard, and some other points, were contributed by Prof. N. S. Shaler, from maps prepared by him for the United States Coast Survey, and our acknowledgments are also due to them.

Valuable and efficient aid, without which much of the work would necessarily have remained undone, has been received from the Presidents and Directors of the following Railroad Companies, in the form of free passes over their respective lines: the Eastern, Fitchburg, Old Colony, Boston and Providence, and Connecticut River. The Boston Society of Natural History has also, in the loss of the services of the Custodian and his Assistant, while engaged in the construction of the Map, contributed largely to its successful completion.

Mr. Crosby has been much in the field, the weather having been very favorable during the past winter. Mr. Burbank and others have also spent considerable time in this way. In fact, everything has been done to make the original work accurate, which the time and the necessarily limited appropriation would permit.

With great respect,

Your Ob't Serv't,

ALPHEUS HYATT,

Custodian Boston Soc. Nat. Hist.

REPORT
ON THE
GEOLOGICAL MAP OF MASSACHUSETTS.

By W. O. CROSSY.¹

In 1830 the Government of Massachusetts instituted, at the public expense, a Geological Survey of the Commonwealth, and Prof. Edward Hitchcock, Sen., of Amherst College, was charged with the work of exploration. His final report, accompanied by a Geological Map of the State, was published eleven years later, in 1841. This map, enlarged, and revised by Prof. Hitchcock, was republished in 1844, in connection with the Topographical Wall Map of Simeon Borden. No Geological Map of Massachusetts materially differing from this has since appeared. The work of Prof. Edward Hitchcock, Sen., remains the last general contribution to the geology of the State; and the map to which the present report relates—which, since it has been prepared under the direction of the Massachusetts Commission to the Centennial Exposition, may, for the sake of a convenient designation, be called the Centennial Map—is based primarily, as all subsequent maps must necessarily be, upon those published by him. It should be stated in this connection, however, that some as-

¹ Those parts of this report which relate to that portion of the State lying east of Worcester and north of Rhode Island have been taken from my thesis for graduation in the Mass. Institute of Technology, on the "Geology of Eastern Massachusetts," which will be published during the ensuing summer in the Proceedings of the Boston Society of Natural History.

sistance has been derived from the geological map of Prof. C. H. Hitchcock, which was published in 1871 in Walling's Atlas of Massachusetts, and differs in some points of minor importance from the earlier maps referred to.

It is proposed to embody in this report a brief account of all the observations, by whomsoever made, upon which the changes appearing in this Centennial Map, as compared with previous maps, are based; with the exception of the data furnished by Mr. L. S. Barbank, whose researches in the Nashua and Merrimac Valleys have been of very material assistance, and will be found fully described in his report which accompanies this.

In some instances, as in the eastern part of Plymouth county, the alterations of boundaries are based upon the observations of Prof. Edward Hitchcock, published in his final report of 1841, but of which different views have been taken. In such, as in all other cases, the sources of the data used will be clearly indicated.

My own contributions to the map are based upon observations extending over a period of four years, and during the last year I have been in the field almost constantly. It is only justice to Dr. T. Sterry Hunt to express here a recognition of my indebtedness to him for much valuable instruction and advice, while a student in the Massachusetts Institute of Technology, without which the performance of this work by me had been impossible. But, though placed in a position most favorable to a thorough acquaintance with Dr. Hunt's views concerning the origin of crystalline rocks and their relations to the more recent, fossiliferous rocks, I entered the field a year ago with a general disbelief in the applicability of these ideas to the rocks of this region, which my first observations only strengthened; and any confirmations of these views which may be found in this report, have been reached in opposition to preconceived ideas wholly at variance with them.

That enormous period in the history of the earth, commonly known as geological time, is usually divided by geologists into four great eras, which, in their order of sequence, are the Eozoic, Paleozoic, Mesozoic, and Cenozoic; and in Massachusetts rocks are found belonging to each of these grand divisions of past time. The rocks of Massachusetts are mainly crystallines, which are believed to belong wholly to the Eozoic era; and it is a noteworthy fact, that the rocks belonging to the successive eras in this State steadily diminish in amount from the Eozoic to the Cenozoic, so that Massachusetts is, in this respect, an epitome of the world. The oldest rocks in Massachusetts, as will be presently shown, are on its eastern border, facing the Atlantic; and proceeding westward across the State the crystallines become gradually newer, until, in Berkshire county, we find the semi-crystalline beds believed by an increasing number of geologists to represent the close of Eozoic time.

The Eozoic rocks of Massachusetts may, to a large extent at least, be divided lithologically and chronologically, into three divisions, which, stated in their order of sequence, are the Norian, the Huronian, and the Mont Alban. I weigh my words well when I describe these divisions as both lithological and chronological; for, although, as already stated, I began my study of the crystallines of this State with a wholesome distrust of the value of lithological data in establishing chronological divisions, and am not yet wholly prepared to apply this principle to wider regions, I do not hesitate to affirm that the lithological characters of the divisions which have been worked out among the crystallines of this region — the chronological and geographical distinctness of which I cannot doubt — are as unlike as the flunæ of any two successive geological formations.

NORIAN.

But two small areas of the rocks of this age have thus far been found in Massachusetts. The largest and most important

includes the city of Salem, Salem Neck, the islands of Great Misery and Little Misery, Baker's Island, Naugus Head on the north end of Marblehead, various small islands between Marblehead and Great Misery, and several narrow strips along the Beverly shore. The second area includes all but the seaward end of large Nahant. The rocks of this formation, though frequently stratified, seem in general to have been somewhat fluent, and usually exhibit more or less extravasation; but doubtless in some cases the metamorphic action has stopped short of this extreme term, though destroying all traces of bedding. In many places, as notably on Winter Island and Great and Little Misery, the entire formation seems to have been fluent, and the extravasation has been so extensive that the character of the rock changes nearly every rod. One important fact should be noted here, viz.: nowhere in this region does the Norian series appear to be cut by eruptives belonging to another formation, for all the extravasated rocks of this system may be easily referred to, or shown to be derived from, its stratified members.

The stratified rocks occur chiefly on Marblehead, and on the Beverly shore, west of Curtis Point. On Marblehead the strike is E.-W., with a vertical dip, while on the Beverly shore the strike varies from N.-S. to N. E.-S. W., and the dip is 30° to vertical to the N. W. The average strike of the whole system is N. E.-S. W. More or less distinct bedding has also been observed on the north side of Great Misery, at several points on Salem Neck, on Coney Island, and at one point on the north-east shore of Nahant.

The rocks of this formation are composed chiefly of feldspar and hornblende, or pyroxene. These minerals occur mixed in very various proportions. It has been proved by analysis that some of the feldspar is *not* labradorite, though closely resembling that species in some of its physical characters; and it yet remains to be proved that there is any labradorite in the formation. But its occurrence here is deemed probable, and as only one analysis has been made,