the marsh will first be submerged by the high tides and later buried in salt marsh deposits; and so the various evidences advanced in favor of coastal subsidence will be produced without any vertical movement of the land.

A valuable demonstration of the importance of this principle has been furnished by nature on a fairly large scale near Scituate, Mass. The "Portland Storm" of 1898 broke through the bar which almost separated the North River marshes and bay from the ocean, thereby allowing a freer access of water to the bay and raising the high tide surface from one to several feet above its former position. Within two years the shores of the marsh were bordered by a zone of dead trees, the width of the zone varying from a few feet to a number of hundred feet and being widest where fresh-water vegetation had formerly encroached some distance on the marsh surface. To-day the marsh is gradually building up toward the new high-tide level, and one may see an old dyke completely covered with salt-marsh vegetation, and dead trunks of pines, cedars, birches and oaks standing surrounded by the salt grasses. A bathing pool in the North River, formerly of fresh water, is now saline; and the fresh marshes some distance up the river are now being transformed to salt marshes.

Boston Harbor and the smaller bays and marshes which ramify inland from it have been much altered during the last three-quarters of a century. In particular, large areas of bay and marsh have been reclaimed from the sea, thereby decreasing the extent to which tidal waters must spread out after passing through such narrows as that between Boston and East Boston. It is inevitable that such changes should affect the level of the high-tide surface, and perhaps that of half-tide as well. One must doubt, therefore, the validity of evidence in favor of subsidence based on the fact that an accurately established bench mark no longer bears its original relation to tidal heights.

Both on the Massachusetts and on the New Jersey coast conditions favor appreciable changes of high-tide level due to changes in the shorelines. In the light of the facts stated above, the evidence of recent subsidence along these coasts thus far presented must be considered inconclusive. That there has been subsidence in the past seems reasonably certain; but the writer knows of no satisfactory evidence of recent subsidence in these two areas.

D. W. JOHNSON

THE GLACIAL ORIGIN OF THE ROXBURY CONGLOMERATE

IN England, as long ago as 1855, Sir Andrew C. Ramsay found evidence of glacial action in the Permian rocks of the Midlands. Since that time evidence of the Permian Ice Age has been found in India, Australia, South Africa and South America.

Dr. La Forge, while engaged in the geological survey of the Boston region, for the United States government, came upon a curious outcrop of the conglomerate known as the Roxbury, at a locality in the town of Hyde Park, south of Boston. Last December we visited this section. Here the rock contains pebbles and boulders up to several feet in diameter, largely angular or subangular, scattered rather sparsely through a "pasty" matrix which forms the greater part of the bulk of the rock. There are no traces of bedding or of water action during deposition, and Mr. Sayles was so impressed by the resemblance of the rock to a glacial deposit that he at once suggested the probability of its being *tillite*. Other localities where the rock displays the same characters were visited, but soon a heavy snow-fall prevented any systematic work until spring, when Mr. Sayles made a careful search at several localities for definite evidence of glacial origin, and secured numerous chipped or faceted pebbles, some showing apparent glacial striæ.

More recently, in company with Dr. Ellsworth Huntington, we visited the extensive exposures at the same horizon on the peninsula of Squantum, in Quincy, southeast of Boston, where the rock is much like that at Hyde Park, but the proportion of pebbles to matrix is greater, the matrix is often more

sandy, and there is some evidence of the presence of water during deposition, such as occasional sorting and bedding of the pebbles, and intercalated lenses of sandstone. There is indication of at least one brief period of cessation of till deposition, with accompanying deposition by water of a thin irregular sheet of sand and mud. By later ice movement this was over-ridden—apparently in a direction from the east toward the west—deformed and partly broken up, and a considerable further thickness of till deposited upon it. Later in the day we revisited the Hyde Park locality, where a quartzite pebble was found, imbedded in the matrix, having a well-developed "sole" or beveled face, upon which are scorings in at least two directions, the moulds of which show in the matrix.

The tillite occupies the upper portion of what has been known as the Roxbury conglomerate, and at Squantum is from 500 to 600 feet thick, and is overlain by about 60 feet of stratified conglomerate, sandstone and interbedded slate, which make the top of the Roxbury and form a transition to the overlying Cambridge slate. The possible glacial origin of the Roxbury conglomerate has been suggested by the late N. S. Shaler and others, but these are the first known discoveries in that formation of definite evidence of glacial action or of the existence of glacially deposited beds. In the absence of determinative fossils, the age of the Roxbury and Cambridge formations has never been definitely known, but they have been assigned on general grounds, chiefly the analogy of their structural relations to those of similar beds in the Narragansett Basin, to the upper part of the Pennsylvanian Series, of the Carboniferous System. In view of the accumulating evidence of glaciation in many parts of the world in Permian time, it seems a reasonable assumption that if glacial conditions prevailed in eastern New England at some time late in the Carboniferous Period, they were contemporaneous with similar conditions elsewhere, and hence that glacial deposits found in the Carboniferous rocks of the Boston region were formed in Permian time. There are no known grounds for objecting to the assignment of a Permian age to the Roxbury and Cambridge formations, and in fact such a view explains some of their observed structural relations rather better than the older view. In the opinion of Dr. Huntington, the discovery of this tillite is the best evidence yet brought to light upon the age of the Roxbury conglomerate.

The above account will be followed shortly by a more complete, illustrated article.

Robert W. Sayles,
Laurence LaForge

A CONTRIBUTION TO THE PROBLEM OF COON BUTTE

It has seemed to the writer that the chief difficulty in the way of acceptance of the volcanic origin of Coon Butte has been an assumed impossibility of breaking the grains of the gray sandstone into angular fragments by hot water action. If this can be done, the former, though now subsided, volcanic activity of the region within a few miles of the crater would give a presumption of its formation by such agency, especially as no meteorite large enough to make such a crater has been found, although searched for by Messrs. Barringer and Tilghman by means of pits and borings.

Dr. Merrill suggests that the impact of the body developed heat enough to volatilize it. This view does not seem warranted by what we know of smaller meteorites whose falls have been witnessed, but if heat of sufficient intensity to volatilize a mass of iron, say 500 feet in diameter, could be so developed it would surely leave undeniable marks in fused and metamorphosed crater walls. No such effects are to be seen.

There are some features of the crater that seem inconsistent with its formation by a projectile. The powdered sand grains come mainly from the gray sandstone lying 200 feet or more below the surface while the red sandstone cap, on which the body would have fallen, and the yellow silicious limestone next below seem chiefly to have been broken into fragments.

Again, of the powdered silica Tilghman says: