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IV.

GEOLOGY OF THE BOSTON BASIN

BY

WILLIAM O. CROSBY.

VOL. I.

PART II.—HINGHAM.

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BOSTON:
BOSTON SOCIETY OF NATURAL HISTORY.
1894.

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INTRODUCTION.

The town of Hingham, Mass., forms the south shore of Boston Harbor for three miles, from Weymouth Back River across Hingham Harbor to Weir River Bay; and extends inland from six to seven miles, crossing the present border of the Boston Basin, *i. e.*, the southern limit of the sedimentary and volcanic rocks. The town is thus divided into two distinct and very unequal geological areas; and, as the general map (Pl. 1) shows very clearly, the dividing line is quite irregular. The sedimentary rocks and the interbedded lavas are limited almost wholly to the northwest corner of the town, extending but little south of the railroad and having only a slight areal development east of the harbor. While over the remainder of the town, embracing more than five sixths of the total area, the numerous ledges comprise only granitic rocks (granite, diorite, and felsite), and intersecting dikes of diabase.

The granitic area of Hingham is essentially similar to, as well as continuous with, that of Cohasset and Nantasket on the east and Weymouth and Braintree on the west, the entire South Shore district being a unit in this respect. But, as was pointed out on page 2, the sedimentary and volcanic rocks bordering the granite on the north and forming the immediate shore of the harbor are far less uniform in character and structure, and by their diversity fully warrant or necessitate the division of the South Shore into several distinct areas, which are best described separately. These geological areas agree approximately with the political divisions, the geology of North

Hingham contrasting with that of Weymouth on the west and still more with that of the Nantasket areas on the east. The promontory of Rocky Neck, northeast of Planter's Hill, at the mouth of Weir River Bay, is, however, essentially a part of the Nantasket area, and it has been described in that relation, the true or natural boundary between the Hingham and Nantasket areas being marked approximately by the eastern shore of Hingham Harbor.

On account of the more abundant drift-deposits, Hingham does not present the almost continuous rock exposures which characterize the Nantasket area. But, fortunately, a different type of structure prevails, and extended outcrops are less essential to the correct interpretation of the geology. Plication, to a large extent, takes the place of faulting, the sedimentary and volcanic rocks being involved in deep and almost isoclinal folds; and hence, although the actual disturbance and displacement of the strata are probably greater in Hingham than in Nantasket, the beds are more continuous and more easily traced in infrequent outcrops. Again, while Nantasket shows repeated alternations of beds of conglomerate with flows of both basic and acid lavas (melaphyr and porphyrite), the porphyrite, so far as known, is wholly wanting in Hingham and the melaphyr is limited to one flow or bed of great thickness; and the principal problem of the Nantasket area — the identification of the successive flows of lava — is really not presented at all to the students of Hingham geology. On the other hand, while the sedimentary rocks of the Nantasket area, south of the beach, are almost exclusively conglomerate, the Hingham series embraces many beds of sandstone and brownish slates and a great volume of pure gray slate; and the special feature of the geology of Hingham, the feature in which it excels not only Nantasket but the entire Boston Basin, is the extended series of alternating beds of conglomerate, sandstone, and slate which it presents in three different sections, and the seemingly clear exhibition of the relations of this conglomerate series to the great slate series. It is possible, as will appear later, that the Hingham ledges supplement the Nantasket ledges, the basal beds of conglomerate, resting upon the granite floor, having a remarkably fine development in the latter, while the former afford continuous exposures of the upper beds of conglomerate and the overlying slate.

In my work on the geology of Hingham I have been greatly assisted in various ways by Mr. T. T. Bouvé. In fact, we have traversed a large part of the ground together, have compared notes at nearly every step, and have discussed together all the interpretations of the facts occurring to either. I thus find myself wholly unable to determine in all cases what part of the work is really my own; but gratefully acknowledge my indebtedness to Mr. Bouvé for ideas as well as material assistance in the field-work. Mr. Bouvé has prepared a general account of the geology of Hingham, which forms a part of the history of the town; and the Committee in charge of this work have kindly permitted the Society to coöperate in the printing of the three special maps of Hingham accompanying this paper.

TOPOGRAPHY.

Fundamentally, or so far as the hard rocks are concerned, the topography of Hingham is based upon the westward extension of the broad peneplain which we have traced in Cohasset and Nantasket, and which forms the entire south shore of Boston Harbor. In Hingham, as farther east, the peneplain is proved by the generally uniform height of the rocky elevations; and the evidence is equally clear that the plain itself represents prolonged preglacial erosion; while the deeply channeled and fragmentary form which the plain now presents must be attributed, as before, mainly to the comparatively rapid erosion attending the strong elevation of the land at the beginning of the great ice-age. Owing chiefly to the large proportion of slate and the fact that the conglomerate and sandstone are less generally indurated through intimate association with the volcanic rocks, the sedimentary rocks of Hingham are less prominent, topographically, than those of Nantasket. The slate, where occurring in large bodies, is very generally eroded nearly to or below the present level of the sea, while the conglomerate and melaphyr are found mainly below the contour of forty feet, and never rise much if any above seventy feet, attaining their greatest elevation in the ridge along South Street in Hingham Village. The granitic area, on the other hand, is, as a whole, somewhat more elevated than in Cohasset, owing probably to its greater distance from the sea; the average or normal elevation of the ledges south of the railroad ranging, probably, from 60 or 70 feet to nearly or quite 150 feet in the south part of the town. Although the hard rocks thus show, from the lowest slate to the most elevated ledges of granite, a notable range in altitude, there are, properly speaking, no rock hills except such as have resulted from the division of the peneplain and its reduction to a fragmentary condition by glacial erosion. Especially do we note the absence, as in Cohasset and Nantasket, of dominant rock hills or those decidedly overlooking the peneplain. The characteristic features of an ancient topography—well-defined ridges with culminating summits separating broad level valleys—are wanting here and in Cohasset and throughout this region; but we find instead the comparatively narrow and abrupt valleys and the broad, plateau-like, interstream surfaces indicative of a region which, having been worn down to its base-level, has found a renewal of its topographic life in a comparatively recent elevation and is only now well started in a new cycle of topographic development. This topography is geologically ancient only in the sense that it starts, not from an elevated sea-bottom, a virgin land-surface, but from an elevated peneplain, itself the last expression of an earlier topography; and if the present stability of the land continues, the features of the modern topography will, after attaining a maximum of ruggedness and diversity, be gradually effaced in a new peneplain at the existing base-level.

Although the average height of the rock surface gradually increases as we recede from the shore, and especially as we pass from the sedimentary to the granitic areas, the drumlins, which are planted much more thickly near the harbor than farther inland, tend to neutralize this natural erosion gradient. In Hingham, as in Hull and Cohasset, the till, so far as exposed to observation, occurs mainly or almost wholly in the form of drumlins; and, as the general map so plainly shows, no less than eleven distinct drumlins rise from the low lands bordering the harbor and north of the railroad, including the two double drumlins of World's End and Planter's Hill, east of the harbor. Of the whole number, fully one half are especially typical in form and of nearly the first magnitude; and since they rise directly from the harbor or the salt marshes, with their graceful slopes unbroken, save by an occasional erosion terrace, they are more impressive than the inland drumlins, bordered and obscured by elevated ledges and sandplains. Crow Point, at the northwest corner of Hingham Harbor, finds its origin in a linear series of three closely connected drumlins; and it is noteworthy that the other four drumlins on the west side of the harbor lie north of or upon the ridge of granite extending from the south end of the harbor to Beal Street. South of the railroad the drumlins are much more scattering. The first to attract attention is the remarkable linear group or chain known as the Turkey Hills, on the boundary between Cohasset and Hingham. This consists (see the map) of one main drumlin of the first magnitude with a low ridge extending southwesterly from it in which we readily recognize three small and approximately equal drumlins. A fifth and closely connected drumlin lies immediately south of the main hill; and the very perfect detached drumlin concealed in the woods of Turkey Swamp may be referred to this group. Great Hill, south of West Hingham, belies its name, since it is one of the smaller drumlins of the town. Its height does not exceed 125 feet, and it rises less than 60 feet above the bordering sandplains. Nutty Hill, southwest from Great Hill, is a good example of a drumlin more than half buried in the sandplain. Southwest of the Turkey Hills is an extended area of elevated rocky woodland, lying partly in Hingham and partly in Cohasset, a singularly well-preserved section of the ancient peneplain. But, to the west of this tract, in the valley of Weir River, before we come to Prospect Hill, on the east side of the river and just beyond the southern border of the map, several rather inconspicuous drumlins have been observed. Prospect Hill is well named; for it is one of the largest drumlins in the Boston Basin, the highest point in Hingham (218 feet); and affords a wide prospect in all directions. The general map gives the position, form, size, trend, and, so far as known, the height of every recognized drumlin in the area which it represents.[1]

The rock surface of Hingham is masked not only by the drumlins, but much more by the modified drift, which is far more abundant than in Hull and Cohasset and is broadly developed in level plains as well as in rounded knolls or kames and winding ridges or eskers. Although the more or less continuous plains of sand and gravel occurring at different and increasing heights from the shore southward tend, as in Cohasset, to emphasize the plateau character of the peneplain, they also give a broadly step-like or terrace form to the topography in which the hard rocks certainly do not share. Some of these plains gained early recognition, as witness the names

[1] The elevations in northern Hull, including Peddock's and Little Hog Islands, were taken, by permission, from the unpublished charts of the Harbor Commissioners; while those in southern Hull, including Bumkin and Grape Islands, were measured with a hand-level, by the author. The chief elevations in Hingham and Cohasset, including nearly all those conveniently near the sea or salt marshes, were very accurately determined by levelling through the kindness of Mr. A. E. Woodward, Mr. Cyrus C. Babb, and Mr. H. W. Nichols, formerly students of civil engineering in the Massachusetts Institute of Technology; and, finally, the elevations in southern Hingham and Cohasset have been, for the most part, determined barometrically by the author, with the assistance of Mr. Nichols.

on the map — Lower Plain, Glad Tidings Plain, and Liberty Plain.

Lower Plain, with a normal height of from 50 to 55 feet, has its best development between High Street and the railroad, west of Weir River, including Hingham Centre and the district about Great Hill. Toward the west and northwest especially, it loses, very largely, the character of a plain, dividing into irregular rounded hummocks and winding ridges or eskers enclosing numerous kettle-holes and small ponds and bogs. In this fragmentary form, only rarely attaining its maximum height, this plain has a particularly interesting development in the Hockley district between West Hingham and Weymouth Back River. The fine series of eskers between Beal's Cove and Stoddard's Neck should be referred to this plain, and also the plain (40–50 feet) so well developed around the southern end of the harbor. Eastward, along the line of the railroad and East Street, it can be traced into Cohasset, where we have already recognized it as the principal plain of that town. There is, however, in the vicinity of the coast, a distinctly lower plain, with a normal height of from 20 to 30 feet. This is very perfectly developed between Beal Street and Huit's Cove and may be traced at intervals through the northwest part of the town. Glad Tidings Plain extends from the vicinity of High and Free Streets south to the northern margin of Liberty Plain, embracing Cushing and Fulling Mill Ponds and having a normal height of from 65 to 70 feet. Liberty Plain lies almost wholly south of the southern boundary of the map, embracing Accord Pond and extending into the adjoining towns. It rises very abruptly from Glad Tidings Plain to its normal height of 130 or 135 feet.

Each plain is developed to some extent in the form of outliers or islands on the next lower one, and, conversely, kames, eskers, or limited plateaus rising from the surface of either plain may be regarded as representing in height and age the next higher plain. The eskers known as Break-neck Hills, beyond the southern border of the map, on Cushing Street, hold this relation to Liberty Plain. Glad Tidings Plain may thus be traced as far north as Hobart Street, where it forms a very perfect plateau (Pigeon Plain), and it is probably represented by the high ridges or eskers (70–85 feet) between Fort Hill and Beal's Cove.

Although the sand plains testify to the postglacial flooding, if not to an actual depression of the land, the salt marshes and the drowned valleys of Weymouth Back River, Hingham Harbor, and Weir River Bay are a sufficient indication that the land formerly stood higher than at present, and that the existing level has been maintained for a very long time. It is obvious, then, that so far as the lithified formations are concerned, the relief features of Hingham may be summarized as follows: Hingham and the adjoining towns are an area of hard rocks which, in preglacial times, had been slowly worn down nearly to its base-level; and such topographic ruggedness as was developed in this old peneplain during the strong elevation which ushered in the glacial epoch is pretty well smothered by the marine deposits and the almost continuous mantle of drift.

In its drainage system Hingham is almost a unit. With the exception of the northwest corner of the town, which drains directly into the harbor and Weymouth Back River, and the limited basin of Fresh River, also tributary to Weymouth Back River, nearly the entire area is drained by Weir River and its branches; and this system derives but very little water from beyond the limits of Hingham. It rises in Valley Swamp, in Norwell, and in Accord Pond, which lies in the three towns of Norwell, Abington, and Hingham. The streams are all small, and, although the total fall is considerable, the drainage is, as a whole, decidedly sluggish, the streams meandering through broad level meadows and swamps, with little power to clear out their drift-encumbered channels. Strangely enough, Weir River is not now tributary to Hingham Harbor, but when within three fourths of a mile of the head of the harbor and one fourth of a mile of the Home Meadows, a salt marsh which is virtually a southward continuation of the harbor, it is abruptly deflected to the eastward by the ridge of modified drift along East Street, a spur from the Lower Plain, and pours its waters over the granite ledges into Weir River Bay. The facts concerning this very clear case of diverted drainage will be more fully presented in the section on the surface geology.

Not only the streams, but also the areas of obstructed drainage, the ponds, swamps, and marshes, have been traced out with considerable care; and all these features, so far as the scale will permit, are delineated with approximate but not uniform accuracy on the general map. With the exception of Accord Pond, which belongs only in part to Hingham and is beyond the limits of the map, the larger ponds, including Triphammer, Fulling Mill, Cushing, and Foundry Ponds, are all artificial, originating in the construction of dams at favorable points across Weir River or its tributaries. Round Pond, on the lower part of Fresh River, is also a mill-pond. Accord Pond, the principal source of the water supply for Hingham and Hull, and 135 feet above the sea, owes its existence to the sandplain and connecting esker which form a natural dam directly across the valley in which the pond lies. The swamps, which often represent ponds in course of extinction, still embrace occasional limited sheets of water; and kettle-ponds, or ponds occupying the deeper hollows in the modified drift, are fairly common in some districts, especially over the broad area of modified drift west of Weir River. Some of these are too small for accurate representation on the map, and the majority are wet-weather ponds only. The swamps and marshes represented on the map require no special description. At the lower end of every fresh-water marsh or swamp there is an obvious obstruction, usually of modified drift, rarely ledges. The feeble and sluggish character of the streams is seen in the little progress they have made in trenching these drift barriers. An occasional swamp crosses a low water-parting and drains in opposite directions. This is true of the swamp on Rockland Street, of that east of Huit's Cove, and of that between Hersey and Central Streets, the latter being tributary to both Town Brook and Weir River; while many of the smaller swamps, especially, have no visible drainage, occupying more or less irregular kettles or depressions in the sandplains. Some of what were originally salt marshes are now fresh, having been reclaimed by the construction of artificial dikes or barriers. These are the "damde meddowes" of the early inhabitants, and the two most important examples are those on Weir River Bay, south of Rocky Neck, and west of Pleasant Hill. The considerable swampy tracts which have been reclaimed by artificial drainage are not represented on the map.

The beach deposits, which are such a prominent feature of Hull and Cohasset, are almost entirely wanting on the more sheltered shores of Hingham; and there is a corresponding absence of erosion of the drumlins and other drift formations. The World's End is joined to Planter's Hill by a short barrier beach, but the most important beach of any kind is that on the north shore, northwest of Pleasant Hill, separating one of the "damde meddowes" just referred to, from the sea. The principal drowned or submerged valley lying wholly in the town is Hingham Harbor. The silting up of this basin has, over the greater part of its area, reached the eel-grass stage; and it would probably have become a salt marsh long ago if the scouring action of the tides had been checked by a barrier beach across its mouth. The same is true of Weymouth Back River. The tidal scouring is particularly efficient here on account of the contracted form of the basin.

MAPS.

This part is illustrated by one general and three special maps. The general map is but a continuation, on the same sheet, of that for Hull and Cohasset, and hence may be described in similar terms. The principal object of this map is to show the general distribution and relations of the hard rocks, the surface geology, and the topography. This map, as has been previously explained, affords, even in the absence of contour-lines, a general idea of the relief-features. The outlines of the principal elevations and depressions are shown in the drumlins and the drainage system; and the remainder of the surface consists either of the sandplains with the kettles and kames, or of ledges, the isolated remnants of the ancient peneplain. It thus requires only a little imagination to see in the map the actual form of the surface. The delineation of the surface features — the drumlins, streams, swamps, etc. — is far from being uniformly accurate. They have been traced out with the greatest care in the northern part of the town, and in general where the country is most open and accessible. Some of the wooded areas, remote from the streets and destitute of land-marks, have been only very imperfectly explored. This is especially true of the large tract of rocky woodland lying between King Street and Scituate Pond in Cohasset and Union Street and Beechwood River in Hingham, embracing more than four square miles and crossed by only one road — the most complete wilderness in the Boston Basin outside of the Blue Hills. For many of the names of the hills, streams, and other natural features which appear upon this map I am especially indebted to Mr. Edward T. Bouvé's most interesting contribution to the town history on the "ancient landmarks" of Hingham and Cohasset. The special maps, having been printed in co-operation with the Town of Hingham and before the plan of this work was fully decided upon, do not agree in scale and topographic detail with the special map of Nantasket, the most notable difference being the absence of contour-lines and the outlines of the swamps and marshes, and the representation (in black characters) of the actual outcrops, as well as the theoretical distribution (in colors) of the sedimentary and volcanic rocks. These special maps represent the three sections of special geological interest, exclusive of Rocky Neck; and, territorially, they are continuous from Crow Point *via* Huit's Cove, Beal's Cove, and West Hingham to the southern end of the harbor.

THE GRANITIC ROCKS OF HINGHAM.

On account of the more continuous development of the sand-plains, the outcrops of the granitic rocks over the greater part of Hingham are less frequent than in Cohasset; and nowhere in Hingham do we find any section of these rocks comparable in clearness and continuity with that along the Cohasset shore. There can be no question, however, that the granitic rocks of Hingham are essentially similar in most respects to those of Cohasset. They embrace in the same general proportions the three principal types—granite, diorite, and felsite. The diorite is, in every case, clearly the oldest rock, its relations to the granite being the same as in Cohasset. Considerable attention has been given, especially by Mr. Bouvé, to tracing the distribution of the diorite, with the object, originally, of representing it by a separate color on the map; but this has been found wholly impracticable. Its relations to the granite are so intimate and intricate that, in the absence of perfect and continuous exposures and a map on an inconveniently large scale, no lines could be drawn which would not include considerable granite or exclude a large part of the diorite. We have learned, however, as the result of this attempt to map the diorite, that, while occasional inclusions of diorite (often very small inclusions, it is true), may be observed in almost every good exposure of granite in Hingham, this rock occurs abundantly only in a fairly well-defined east-west belt near the northern edge of the granite. The limits of this belt are roughly indicated by the distribution of the V-shaped characters on the general map.[1] Commencing

[1] The diorite of Cohasset is similarly represented; but this feature of the map had not been adopted when the Cohasset text was printed.

at the Cohasset boundary, in the vicinity of the railroad, the diorite is observed most abundantly in the ledges along Hull Street, Weir River Lane, Kilby and East Streets; and then, after a partial gap of more than a mile where the ledges of all kinds are very generally concealed by the Lower Plain, northwest of Fort Hill, near West Hingham, for a short distance, until all the ledges are again blotted out by the modified drift. It should not be supposed, however, that these marks represent, in every case, continuous ledges of diorite, for the most of the ledges are of a mixed character, granite penetrating or inclosing diorite. This irregular belt, it will be observed, is in about the same latitude as the principal occurrences of diorite in Cohasset, and on the same east-west line are found the chief outcrops of diorite in Weymouth; but south of this belt we have observed no important or notable masses of diorite. In lithological character the diorite of Hingham is scarcely to be distinguished from that of Cohasset, showing similar variations, except that it nowhere exhibits a distinct flow-structure. It is usually finely crystalline and dark colored; but occasionally it is coarser, with the hornblende either very clearly and prominently developed or mainly wanting, giving a light-colored, feldspathic variety which might be readily mistaken for syenite or even granite. Epidote is, as usual, the principal secondary mineral, occurring chiefly as narrow and irregular segregations and veinlets, especially along the joint cracks.

Although the granite of Hingham almost certainly embraces the three distinct types—distinct in age and character—observed on the Cohasset shore, few ledges have been observed in which the relations of the two older types—the basic hornblendic granite of medium texture and the coarse acid granite—are clearly exposed. Perhaps the most favorable exposure of this kind is that afforded by Button Island, in Hingham Harbor. The bedrock of the island is wholly granite, with only a thin covering of drift. The granite is chiefly an unusually coarse and distinct example of the second or more acid type, enclosing small fragments of fine-grained diorite. But it also encloses on the south and west shores much larger masses of what appears at first sight to be the older and more basic granite of medium texture. The contacts are, however, somewhat ambiguous, appearing to favor the view that the finer-grained granite is the newer, and hence to be correlated with the third or microgranitic type. By far the greater part of the granite evidently belongs to the newer variety, the typical, sparingly hornblendic, usually coarsely and distinctly crystalline, gray to pink or red granite of the South Shore district. This is especially true where the granite is not most intimately associated with the diorite. The hornblendic element, as in Cohasset, is very generally replaced partially, sometimes wholly, by mica (chiefly biotite). This is seen very clearly in the abandoned quarry on Long Bridge Lane, which is, with one exception, the only point in Hingham where the granite, or any rock, has been systematically quarried. The feldspar (orthoclase) is commonly gray or pink, more rarely green, at least in part; and, very locally, as in some of the ledges along Thaxter Street, it is porphyritically developed.

Undoubtedly, one of the most interesting exposures of granite in Hingham is the small quarry about one third of a mile northeast of Abington Street, in the southwest corner of the town, and nearly two miles beyond the limits of the map. On going in from Abington Street by the quarry road, the ordinary, coarse, biotite granite gives way, with apparent abruptness, to a finely crystalline, homogeneous, light gray variety, which is rich in quartz, and contains but little of any dark accessory. The other limits of the fine granite were not observed, but it appears to cover a considerable area. The feature of particular interest which it presents is the remarkably perfect parallel joint-structure. In fact, it is the jointing that gives the granite its value as a quarry-stone. The parallel jointing is traceable over an area at least 500 feet long north and south, and half as broad; but it is most perfectly developed in the more northerly and larger of the two small quarries. The joints of one system are phenomenally perfect, close, and parallel, dividing the granite into almost absolutely plane sheets varying in thickness from half an inch to two feet or more, but mostly from four to twelve inches. The trend of the joints is approximately N. S. (S. 5° W.), and the hade about vertical (W. 0°–3°.) The granite thus, in a general view, simulates a bedded rock, like sandstone, very closely; and the surfaces of the sheets are so plane and smooth and the grain so perfect, that blocks suitable for building purposes are obtained with remarkable ease, the joint-structure serving the same useful purpose in this granite as in the Roxbury puddingstone. It is, of course, needless to dwell upon the obvious support which this example lends to the earthquake theory of parallel jointing.[1]

Irregular dikes and masses of the more finely crystalline and micro-crystalline granite, and of felsite, are frequently observed cutting through the coarser granites and also the diorite, precisely as in Cohasset. Perhaps the most interesting exposure of these older rocks is that on the summit of Fort Hill, where the diorite has been laid bare in grading the street. The diorite is very sharply and clearly intersected by numerous narrow, branching dikes of a finely crystalline pinkish granite. The dikes are broken by slight faults and enclose angular fragments of the diorite.[2] On the north side of East Street, between Andrew Heights and Kilby Street, the diorite is cut by an irregular dike of a gray felsite from eight to ten inches in width. This proves on analysis to be a basic felsite, agreeing in composition better with syenite than granite. At many points on Andrew Heights and along Kilby, East, and other

[1] Proc. B. S. N. H., v. 22, p. 72–85.

[2] Since the above paragraph was written, this beautiful and instructive exhibition of the relations of the granite and diorite has been entirely and ruthlessly obliterated by the further grading of the street; a fact which every student of Hingham geology will sincerely regret.

streets as far as the Cohasset boundary, the ordinary coarse granite can, in spite of the lichens, be seen to form irregular dikes in, or to enclose angular fragments and masses of, the diorite. The greenish gray quartz-porphyry obscurely exposed in South Street, east of Hersey Street, in Hingham Village, is probably a dike in the granite, but considerable digging would be required to prove it. In the rear of the first house on Lincoln Street and Fountain Square, north of the Unitarian Church, is a mass, clearly eruptive through the coarse granite, of a compact, flinty, purplish felsite, which has been proved by analysis to agree with the granite in composition.

The felsite of Hingham is not wholly intrusive, or in the form of dikes. The gray felsite, on the north side of Beal Street, at the western end of the granite, is quite probably part of a surface flow; and the beautiful red felsite occurring so plentifully in the form of bowlders in the vicinity of Lincoln and Thaxter Streets is unquestionably effusive. The former varies from a slightly greenish gray or white to a pinkish tint, and encloses many more or less distinct fragments of similar or darker felsite and an occasional fragment of granite. The breccia structure thus resulting is so marked in a portion of the rock that it was at first mistaken for conglomerate; and the isolated elliptical area on this part of the map marked and colored as conglomerate is really felsite. The exposures of the felsite are not sufficient to show clearly its relations to either the granite, which it seems to overlie, or the melaphyr, which probably once covered it.

The red felsite of Thaxter and Lincoln Streets is by far the most attractive of all the older rocks of Hingham. In fact, it is the most beautiful variety of felsite in eastern Massachusetts; and it is also unique in being the only felsite in the entire south shore district which is certainly effusive. Unfortunately, it occurs in an area which is covered almost continuously by salt marshes and drumlins, and there is practically no opportunity to study it *in situ*. This rock, which has attracted attention since the first settlement of the town, was described by Prof. Edward Hitchcock, in his final report upon the geology of Massachusetts, under the head of porphyry, as occurring in ridges a little north of the village. Such ridges do not exist now; and the statement of this accurate observer should, perhaps, be interpreted as referring to ledges along the line of Lincoln Street which have probably been effaced by the subsequent grading of the street. At the present time, the only actual exposure of the rock *in situ* is an obscure outcrop in the roadway at the junction of Crow Point Lane and Downer Avenue. This was formerly a somewhat protruding ledge, but it does not now rise above the level of the street, and might easily be overlooked. It is in an area colored as melaphyr on the map, and it is regarded as a boss of the felsite projecting, as the result of erosion, through the sheet of melaphyr. The character for felsite also appears on the map (Pl. 9) behind Mr. Bradley's barn, west of Thaxter Street and south of Lincoln Street. No actual ledge of felsite has been observed here, but a number of exceptionally large, angular bowlders in the drift, some of which can be seen on the surface, while others were exposed in a temporary excavation, suggest that the ledge is close by. Immediately north and west of this point there are outcrops of melaphyr, and no bowlders of felsite can be seen. Hence the northern boundary of the felsite may be regarded as accurately located at this point. But the boundary between it and the granite on the south is a mere matter of conjecture, although the line on the special map extending from Broad Cove, south of the solitary house on Lincoln Street, across Bradley's Hill and Thaxter Street, is probably an approximation to it. The distribution of the bowlders certainly suggests an east-west belt of the red felsite along the northern edge of the granite, and passing under Bradley's Hill. That it extends east under Broad Cove is at least probable; and that it extends west beneath Squirrel Hill we have some evidence in the ledge of felsite at the western base of this hill and some 500 or 600 feet south of Lincoln Street. At this point, however, the felsite, although still of a reddish or purplish color, is much more compact and homogeneous.

Although there is no opportunity to observe its relations to other rocks, the effusive or volcanic nature of the red felsite forming the numerous bowlders east of Squirrel Hill and the solitary ledge already referred to, on Downer Avenue, is abundantly proved by its structural features. It exhibits throughout a distinct but not conspicuous banding or flow-structure, which is usually rather fine, but sometimes quite coarse and often somewhat contorted, discontinuous, or otherwise irregular. The confused and irregular character of much of the banding is due in part to the enclosure of angular fragments of the same or a very similar felsite. The enclosed fragments vary from a small fraction of an inch to several inches in diameter, and are very irregularly distributed, so that while the greater part of the felsite is comparatively free from them, they vary in the remainder from thinly scattering to densely crowded, occasional masses of the rock being packed so full of fragments that the banding is completely obliterated and it closely resembles an ordinary breccia. This fragmental character of the felsite has suggested to several observers, including the present writer, that it is a metamorphic conglomerate. But having observed precisely similar structures (banding and brecciation) in modern obsidian, I have been for a long time thoroughly convinced that this metamorphic theory is untenable, and that the felsite is a true volcanic rock, a devitrified obsidian. Among the arguments against its sedimentary origin are the facts that the fragments are all of the same kind of rock; that they are never assorted or show in any way the action of water; and that the felsite appears, as has been proved by analyses in other cases, to be chemically essentially intact and homogeneous, still retaining in every part the full proportion of alkalies required for an acid feldspar, which would be very unusual in a clastic rock. The fact that the fragments or so-called pebbles show a gradation in distinctness from those that are very sharply defined to those that are perfectly blended with the enclosing felsite, is only what would be expected when fragments of glass (obsidian) are enveloped in melted glass. The only particularly obvious indications of chemical change in the felsite since its eruption are, first, the red color, which may be original, but is probably due in part at least to the peroxidation of iron during devitrification; and, secondly, the occurrence in the rock of inconspicuous streaks and masses of quartz, either vitreous, chalcedonic, or jaspery,—silica replacing the less stable portions of the glass. Red felsites are not uncommon in eastern Massachusetts; but the only occurrence at all closely resembling the Hingham felsite is the red felsite near the Neponset River, in Hyde Park. Structurally they are strikingly similar, except that the banding of the Hyde Park variety is rather coarser, and it is more generally brecciated; but the Hingham felsite, with its deeper and brighter color is the more beautiful of the two.

THE BEDDED ROCKS OF NORTHERN HINGHAM.

GENERAL RELATIONS AND ORIGIN.

It is unnecessary to repeat what has been stated under this heading for the Nantasket area; but the one topic may be regarded as supplementary to the other. The sedimentary rocks of Hingham present, as previously stated, a greater variety than those of Nantasket, embracing besides the conglomerate many intercalated beds of sandstone and slate of both brownish and greenish tints, and the great body of gray slate overlying this conglomerate series. The contemporaneous volcanic rocks or effusive lavas, on the other hand, are less varied, including no acid or fragmental varieties, but consisting wholly of rather typical melaphyr. Furthermore, the melaphyr appears to be limited to one heavy bed near the base of the conglomerate series; and the repeated alternations of sediments and lavas so characteristic of the Nantasket area are wanting in Hingham. The stratigraphic contrast is so great that a satisfactory correlation is impossible with the data now at command. It appears probable, however, as stated in the introduction, that the two areas are complementary, the Hingham series beginning with approximately the same beds with which the Nantasket series ends. This view naturally leads us to regard the melaphyr of Hingham as probably equivalent to the great bed of melaphyr near the top of the Nantasket section; and certainly the thick beds are far more likely than the thinner ones to extend over considerable areas.

Although the great slate series, consisting of gray slate without intercalated sandstone and conglomerate, appears to cover a considerable area in the northwestern corner of Hingham, it is well exposed only on the shores of Huit's Cove and Beal's Cove. These exposures, however, are sufficient to show, first, that the slate is certainly conformable with and essentially a continuation of the conglomerate series; and, secondly, that it probably overlies these coarser rocks. But the apparent absence of fossils in the slate and the entire lack of outcrops connecting the Hingham beds with the fossiliferous Cambrian slates of Weymouth and Braintree leave us no certain clue to the geological age of the Hingham strata, except what is afforded by their relations to the granitic rocks and the composition of the conglomerate. Fortunately, however, this evidence, which will be fully set forth in a later section, is sufficiently clear to permit us to say provisionally that, while the granite is certainly newer than the Paradoxides beds of Braintree, the conglomerate series of Hingham, like that of Nantasket, and hence the overlying slate, must be newer than the granite.

The history of the Hingham strata may, then, be outlined as follows: subsequently to the deposition and plication of the Paradoxides slates, subsequently to the eruption through them in succession of the granitic rocks,—diorite, granite, and felsite,—and subsequently to the extensive erosion which has so largely swept away these ancient sediments, began the progressive subsidence, accompanied in its earlier stages by volcanic activity, during which were formed the conglomerate and interbedded lavas of the Nantasket area. Only the latest bed of lava poured out in this part of the basin is exposed in Hingham, west of Rocky Neck; but the cessation of the igneous outbursts was followed by the great conglomerate series of Hingham, with its interstratified beds of sandstone and slate; and the variable character of the strata is a plain indication that the physical conditions were far from uniform during this period. The conglomerate occurs mainly in beds from twenty to eighty feet thick alternating with, usually, thinner beds of gray sandstone and red or gray slate, for a total thickness of nearly one thousand feet. In fact, no other part of the Boston Basin affords such clear and abundant evidence of: (1) frequent changes from beach or shallow water deposits (conglomerate and sandstone) to those formed in deep and quiet water (slate), and *vice versa;* and (2) the oscillations of the earth's crust, upon which these changes usually depend. This intermittent conglomerate series appears to pass somewhat gradually and with perfect conformity up into the great slate series, which consists throughout of a fine, dark gray slate, and has an apparent thickness of at least one thousand feet, without any interstratified beds of coarser material. This is sufficient to prove that the oscillations of level attending the formation of the conglomerate series were followed by a profound and prolonged subsidence; for during all the time when the slate was being slowly and quietly deposited, Hingham must have formed the floor of a comparatively deep ocean. But this tranquility could not last forever; for the subterranean forces were slowly gathering strength, and the formation of the slate was undoubtedly terminated by the advent of an epoch of severe compression of the earth's crust in this region, in consequence of which the sedimentary rocks were elevated to form dry land, folded, faulted, and injected by dikes of diabase. During all the long ages since this geographical revolution, Hingham has been mainly, if not continuously, a land area; and the slate, together with the underlying conglomerate, has suffered enormous erosion. These rocks have thus been completely removed from large areas of granite which they once covered; and they are preserved to us now only where they were most deeply folded or faulted down between the granitic masses, and thus protected from erosion.

GENERAL STRUCTURE OF NORTHERN HINGHAM.

The eastern shore of Hingham Harbor is not only the natural boundary line between the geological districts of Nantasket and northern Hingham, but it probably marks the position, as shown on the general map, of one of the great transverse faults of the South Shore; and it certainly corresponds, as already explained, to a very important contrast in geological structure, plication being as characteristic of the Hingham area as faulting is of the Nantasket area. As the general map so clearly shows, the key to the structure of the volcanic and sedimentary rocks of Hingham is the oblong area of granite and felsite lying north of the railroad and Beal Street, and bearing the three drumlins of Bradley's, Squirrel, and Baker's Hills. The general position of this mass is unquestionably anticlinal. This is most obvious at the western extremity, where the melaphyr and the sedimentary strata curve around the granite and dip away from it on both sides. Southward from this point, between Beal Street and Beal's Cove, the structure is monoclinal; and the ledges afford a nearly continuous section across the entire conglomerate series and a considerable thickness of the overlying slate, the latter undoubtedly marking the position of a synclinal axis; but the south side of the syncline is probably cut off by the boundary fault, for we seem to pass abruptly from the slate to the granite. In the vicinity of Hockley Lane a transverse fault appears to separate this normal succession of the strata from an inverted succession which extends thence eastward to Main Street or beyond. The melaphyr is now on the south side, overlying the conglomerate; and these stratified rocks, although occupying a synclinal position between the granite on the north and south, are, we must suppose, bounded on both sides by important dislocations and terminated on the east by the great fault along the east side of Hingham Harbor.

Northwest from the western extremity of the granite axis, a very steep, narrow, and broken monocline separates the granite from the great trough holding the main body of slate. This faulted monocline is marked by a second band of melaphyr, which broadens toward the northeast, forming the large quadrangular area of this rock east of Huit's Cove. This is the largest exposure of melaphyr in Hingham, and, although it appears to be bounded on all sides by downthrow faults, the quaquaversal dips of the bordering strata show that, in a lesser degree, it is essentially similar in its structural relations to the granitic area. On the west side, the upper bed of conglomerate and the slate are seen to dip away from the melaphyr. On the north, the downthrow of the sedimentary rocks is sufficient to conceal the conglomerate, and the slate lies with conformable strike against the melaphyr. On the south, the narrow monocline separating this body of melaphyr from the granite broadens somewhat, until it reaches the fault at the northwest end of Squirrel Hill, where it changes, perhaps abruptly, to a broad shallow syncline of melaphyr and conglomerate on the south, separated by a strike fault from a gentle southerly monocline of conglomerate and sandstone on the north. These features probably extend east under Broad

Cove and Otis Hill; and the monocline can be clearly traced still farther in the ledges of Melville Garden and in the three sedimentary islands of the harbor. Westward from the Garden, however, this monocline, of east-west strike and southerly dip, changes gradually but rapidly to a north-south strike and westerly dip, plunging down against the great mass of melaphyr already described.

It is obvious from this sketch of the geological structure that while, as previously stated, folds of various types are the dominant form of displacement and give character to the area, the flexures are profoundly modified by longitudinal and transverse faults. The correct interpretation of these main structure lines is evidently essential to the determination of the stratigraphic elements or the normal succession of the strata. Of the four sections accompanying the special maps, three are approximately complete, *viz.:* (1) the section south of the granite, through the village; (2) the section from Beal Street to Beal's Cove; and (3) the section from Melville Garden west toward Huit's Cove. They agree in their main features and especially in showing repeated alternations of coarse and fine sediments. But a more careful comparison reveals the fact that they cannot be exactly correlated or synchronized; and we are obliged to recognize, even in this limited area, important lateral changes in the character or thickness of individual strata; sandstone at one point being represented by conglomerate or shale at another, and so on. The following table of the strata of Hingham has been compiled from the first and second sections referred to above, and, with the foregoing qualifications, may be regarded as substantially correct. The individual beds are subject to constant variations in thickness; and since the outcrops are unfavorable to exact measurements, the thicknesses given are, as the round numbers indicate, simply approximations. Some of the beds attain the maximum thickness in the one section and some in the other; and hence the totals do not correspond to the actual sections.

Table of the Hingham Strata.

	Granitic rocks (diorite, granite, and felsite).	
1.	Conglomerate (basal). Thickness uncertain.	
2.	Melaphyr	120–240 feet
3.	Fine conglomerate and sandstone, alternating	120–200 "
4.	Gray slate	40– 60 "
5.	Conglomerate, sandstone, and slate, alternating	100–170 "
6.	Gray and red slate	90–130 "
7.	Conglomerate	30– 50 "
8.	Red slate	20– 40 "
9.	Conglomerate	40– 50 "
10.	Red slate	20– 30 "
11.	Conglomerate	75–100 "
12.	Red slate	50– 75 "
13.	Sandstone and conglomerate, alternating	200–300 "
		905–1445 "
14.	Gray slate	500 + "

Dikes of diabase intersecting the bedded rocks, owing chiefly, it is probable, to the less continuous outcrops, but partly, no doubt, to the fewer faults, are much less conspicuous in Hingham than in Nantasket. They probably agree with the Nantasket dikes in dating from the plication and faulting of the strata. The most important distinction is that between the great masses of coarsely crystalline diabase scores or hundreds of feet in breadth and very irregular in outline, and the ordinary, narrow, wall-like dikes of finely crystalline diabase. The latter, at least, belong chiefly to the east-west systems of Nantasket. No clear intersections have been observed; and no dikes which could certainly be referred to the youngest or north-south system of Nantasket.

LITHOLOGY.

The rocks of Hingham are, lithologically, so similar to those of Nantasket that a very brief treatment of this topic will suffice, the main purpose of these studies being to decipher the structure and physical history of the region and not to undertake a minute investigation of the different kinds of rocks. The granitic rocks (diorite, granite, and felsite) have been described in sufficient detail in the preceding pages. Mr. Merrill has kindly examined thin sections from some of the more typical dikes, and finds them all to be diabase essentially similar to that of the Nantasket dikes. He has also found that the melaphyr is in essential agreement with the common basic variety of Nantasket. It has commonly a dark greenish color, due to chlorite and epidote, but limited portions are often brownish or purplish owing to the local peroxidation of the iron. It varies in texture from almost perfectly compact or even slaty to distinctly and coarsely amygdaloidal. The amygdules consist chiefly of quartz and epidote, but include also chlorite, feldspar, and calcite. The quartz is usually crystalline, but sometimes chalcedonic or jaspery. These secondary minerals also occur commonly in veinlets and irregular segregations; but the brecciation so characteristic of the great bed of melaphyr near the top of the Nantasket series is rarely distinctly observed in Hingham; although the scoriaceous structure which one naturally looks for in the superficial portions of a flow is plain enough at some points, as in the mass of melaphyr near the junction of Downer Avenue and Crow Point Lane. The Hingham bed, like the Nantasket bed just referred to, is probably composite, a succession of flows, but the only observed facts, besides its great thickness, which clearly point to this conclusion, are the intercalated bed of sandstone and conglomerate which is exposed south of Beal Street, about midway between the street and the little pond (Pl. 8); and a small amount of banded slate or possibly tuff which a recent excavation has exposed in the melaphyr immediately west of West Hingham Station. The occurrence last mentioned is the only thing resembling volcanic tuff, or in any way suggestive of explosive eruptions, which has been observed in Hingham.

The conglomerate of Hingham is composed for the most part of small and well-rounded pebbles, chiefly of different varieties of felsite and granite. It is a typical puddingstone, becoming a breccia only where the basal conglomerate rests directly upon the granite. Being less intimately associated with melaphyr than the Nantasket conglomerate, it is, as a whole, less indurated, possessing less, probably, of a distinctly siliceous cement. This is especially noticeable, also, in the arenaceous layers, which in Nantasket have the flinty hardness of red quartzite, but in Hingham are more like normal sandstone. The well-rounded and assorted pebbles are usually less than an inch and rarely more than two or three inches in diameter. But at one locality, on the eastern shore of Huit's Cove, the conglomerate is exceptionally coarse and irregular in structure, containing rounded pebbles or bowlders of granite, etc., of all sizes up to a yard in diameter. It is interesting to note also that some of the pebbles at this point are an impure gray limestone, and that limited portions of the rock have a distinctly calcareous cement. The finer portions of the conglomerate frequently become gradually but distinctly arenaceous; and most of the beds show repeated alternations of true conglomerate with coarse, pebbly sandstone, so that it is quite impossible to map the two rocks separately. Although the conglomerate series is so largely arenaceous, there is comparatively little pure or typical sandstone; the most important occurrence of this kind being the bed of gray or brownish gray sandstone over a hundred feet thick in the Hersey Street section. The sandstone is usually gray to light brown in color, rarely distinctly ferruginous, and, as stated, rarely a good quartzite. The brown color is probably due more to the admixture of grains of red felsite than to a ferruginous cement.

The argillaceous rocks of Hingham are quite varied. The more limited beds of slate included in the conglomerate series are usually of some shade of red, brown, or purple; but the thicker beds are in large part of a greenish or a greenish gray color, the iron, evidently, being less highly oxidized. It is difficult, in the conglomerate series, to draw the line between slate and sandstone, and part of what has been mapped as slate might be otherwise classified. The great slate series above the conglomerate consists throughout of a homogeneous gray slate, a hard, firm, but not strictly impalpable rock. It is distinctly siliceous in composition, and a fine granular structure is often apparent under a lens. Although usually more or less distinctly banded, the stratification being marked by laminae of alternating colors, the Hingham slates, whether in the conglomerate series or in the slate series, are rarely shaly or exhibit a lamination cleavage; and only to a limited extent, as in the vicinity of Huit's Cove, is the true slaty cleavage, transverse to the bedding, well developed. A very perfect cuboidal or rhomboidal joint-structure can be seen in many exposures.

DETAILED STRUCTURE OF NORTHERN HINGHAM.

We are now ready for a systematic, ledge-to-ledge study of the bedded rocks of Hingham, following, as at Nantasket, the topographic order of the outcrops. The village area, bordering the railroad, south of the granite axis, is in most respects a convenient and natural starting point for a detailed examination of the sedimentary and volcanic rocks. The section between Beal Street and Beal's Cove is more complete, and presents a normal rather than an inverted succession of the strata, but the ledges are less continuous, and the beds are much less easily traced along the strike. Moreover, it is a wooded and swampy tract, while the village area is elevated and open, and readily accessible, in spite of the numerous houses and fences.

The Village Area.

This is the area represented on the first of the special maps (Pl. 7), embracing all the ledges between Main Street and Hockley Lane. Topographically it is essentially one continuous ridge, save where it is crossed by Town Brook and the railroad at West Hingham Station.

The most continuous exposures of this narrow belt are in the vicinity of Hersey Street; and the dip in this part of the area, especially, is quite constant — S. 70°. The most northerly outcrop along this line is the ledge of conglomerate (13)[1] about 150 feet west of Hersey Street, in the rear of the second and third houses from the corner, on South Street. A few yards south of this ledge, in the rear end of these lots and extending into the adjoining lot on the south, is an outcrop of dark red slate (12). The slate must cross Hersey Street at the first bend; and it is exposed repeatedly along the base of the conglomerate escarpment from 200 to 300 feet east of the street.

Going up Hersey Street from the railroad, the first rock actually seen is the conglomerate (11) bordering the red slate just referred to on the south. It commences a hundred feet or so west of the street; and its northern border forms a continuous escarpment from 15 to 20 feet high, due to the erosion of the red slate and extending about 500 feet east of the street. This escarpment is the northern edge of an area from 600 to 1,000 feet in length (E.–W.) and 500 feet in breadth, over which the ledges, as the map shows, are almost continuous, and the thickness of the several beds admits of accurate measurement. The conglomerate just described has a breadth of from 75 to 90 feet; and it is followed on the south in succession by about 20 feet of red slate (10); from 40 to 50 feet of conglomerate (9); 25 feet of red slate (8); from 35 to 45 feet of conglomerate (7); from 115 to 135 feet of red and gray slate (6); from 100 to 130 feet of gray sandstone with some gray slate (5); and 40 feet of conglomerate (5).

This Hersey Street section is broken by several large and irregular dikes (see Pl. 7); but the breadth of the trap is

[1] The numbers in parentheses refer to the general table of Hingham strata on page 202.

not included in the foregoing measurements of the beds which it intersects. Farther south on the line of Hersey Street the sandplain conceals everything for nearly 500 feet; and the first outcrops in that direction are granite and diorite, with other large masses of diabase.

Most of the beds which we have crossed on Hersey Street can be traced east by satisfactory outcrops to Lafayette Avenue. The strike gradually changes in this direction, however, from nearly due east-west to east-southeast, as the map shows. Of the most northerly conglomerate (13) there is only one small and rather uncertain exposure nearly 600 feet from Hersey Street. The first red slate (12), after a gap of 700 feet, is well exposed behind Mr. Lane's house on South Street. It forms an abrupt escarpment or cliff from 15 to 20 feet high, and has also been found in excavations 50 feet or more north of the cliff. The dip at this point is only 25°, which fully accounts for the increased breadth of the bed as shown on the map. South of this slate we are able to identify in almost continuous ledges the following beds: conglomerate (11); red slate (10), not clearly exposed, but represented by a blank depressed space of the proper width; conglomerate (9); red slate (8); conglomerate (7); red and gray slate (6); and gray sandstone and slate (5). The more southerly beds along this line have approximately the same dip as on Hersey Street — S. 70°; but toward the north the dip diminishes to 50° and 25°.

The first slate (12) and the first and second conglomerates (11 and 9) are well exposed also in the angle east and south of Lafayette Avenue. The structure here is much more complicated and interesting. Immediately in the angle of the avenue the slate is in contact with the conglomerate (11) as usual; but 100 feet farther east it rests in like manner against a parallel mass of granite; while the conglomerate abuts squarely against the granite and the great dike of diabase from 50 to 70 feet wide which interrupts the granite at this point. The granite, which has a breadth of from 40 to 50 feet north of the trap, is coarsely crystalline, and there is not the slightest indication that it is eruptive through the sedimentary rocks. No veins or apophyses of granite penetrate the slate, and the normal coarse texture of the granite is unchanged near the contact. But the abrupt way in which the diabase ends against the conglomerate and the obvious partial dislocation or lateral shifting of the slate are certainly very suggestive of faulting. Again, the slate, although its strike is parallel with the granite, clearly dips against the latter; and in all the outcrops it shows great disturbance, being strongly contorted and faulted, or, locally, completely crushed. The contact between the granite and slate is probably a strike-fault with the downthrow to the north; and all the sedimentary beds are probably cut by a transverse fault along the west side of the granite, which, as the arrows on the map indicate, downthrows to the west south of the granite-slate contact and to the east north of it. Along its contact with the slate the granite continues scarcely 200 feet, ending as abruptly as it began. In the direct line of the granite we here find broad outcrops of the slate, which, with a southerly dip of 80°, is exposed almost continuously for its normal breadth; while the dike of diabase, as before, abuts squarely against the conglomerate. Evidently, the granite and trap are bounded on the east as well as on the west by a fault; and these two faults are obviously reversed in throw or compensating. To avoid their indefinite extension, they are represented as converging northward; but that is not strictly required by the observed facts. The main point, however, is that the facts appear to justify us in regarding the granite and its included diabase as a somewhat rectangular block which has been elevated relatively to the bordering strata, the uplift having been sufficient to carry the sediments normally overlying this mass of granite above the present plane of erosion. Southward this block of granite is continuous with the main area; and it is simply a displaced portion of the general granitic floor upon which the sediments rest. The evidence for the second fault is materially strengthened by the marked change in the strike, from south of east to north of east, as we cross it.

In following the sedimentary rocks farther east we find an outcrop of conglomerate in front of the school house on Elm Street, nearly opposite the end of Central Street, and directly in the line of strike of the slate; while several exposures of the red slate are found in the field north of the school house. These facts clearly suggest the third transverse fault shown on the map. The character of this fault is wholly uncertain. No outcrops of slate or conglomerate have been observed south of Elm Street; and the map is here largely hypothetical. Quite certainly the fault does not downthrow to the west as the arrow indicates: but it is more probably a horizontal thrust-fault, the eastern extension of the strata having been shoved bodily to the northward from 100 to 150 feet. The rock showing in the field south of Elm Street and east of Central Street is diorite and probably *in situ*. This indicates a gradual narrowing of the sedimentary belt; but beyond this point there are no outcrops of any kind for more than half a mile; and where and how the sedimentary rocks terminate we can only conjecture. As previously stated, the general map is constructed in accordance with the view that they cross Main Street, pass beneath the sandplain occupied by the cemetery, and end in the Home Meadows against the great boundary fault between the Hingham and Nantasket areas, supposed to coincide in position and direction with the east shore of Hingham Harbor.

Returning to Hersey Street and tracing this series of strata westward, we find that all the beds which can be traced more than 200 feet from the street are distinctly flexed to the north, the flexure amounting to a horizontal shift of about 100 feet. It is necessary to suppose, of course, that, as shown on the map, the entire series is involved in the displacement; and there are some indications that the beds are actually compressed or pinched on the bend, as if they had experienced a transverse thrust or a tendency to shear. But, unfortunately, there is at this point a complete hiatus of nearly 300 feet in the outcrops; and the full extent and form of the fold can not be made out. That the east-west strike is quickly resumed is shown, however, by the ledges between this and West Hingham Station; and it is especially satisfactory to find that the very first exposures show the thick bed of gray sandstone, the most unique bed of the entire sedimentary series, and therefore the most to be relied upon in correlation.

About 100 feet back of the school house and 400 feet from South Street, an artificial excavation has uncovered the abrupt face of a ledge which shows 75 feet of greenish gray sandstone (5) with distinct slaty partings, dipping S. 70° beneath 40 feet of conglomerate (5); while fragments in the soil indicate that the conglomerate is overlain in turn by slate (4). The conglomerate and sandstone are easily traced to the westward several hundred feet, where they form the northern portion of a group of ledges affording the following nearly continuous section, beginning on the south:—granite, in several obscure outcrops; then, after an interval of a hundred feet or more, with one uncertain exposure of melaphyr, come without an appreciable break, 120 feet of melaphyr (2); 120 feet of fine conglomerate and sandstone (3); 50 feet of slate, mostly gray, but changing to red on the north (4), the red rock being well exposed behind one of the houses on South Street; 40 feet of conglomerate (5) and nearly 100 feet of gray slaty sandstone (5). The isolated and obscure outcrop of gray slate a few yards from the line of South Street (see map) undoubtedly marks the extension of the great bed (6) of the Hersey Street section; and on the north side of the street, in the rear of the second house from West Hingham Station, we have a satisfactory exposure of the conglomerate (7) which borders this slate on the north. The only remaining outcrop in this direction lies some 300 feet farther to the northwest, beyond the railroad and on the north side of the brook. It is a mass of conglomerate about 10 feet across, lying in the meadow, and is possibly only a bowlder. Assuming it to be *in situ*, or nearly so, it probably represents the most northerly conglomerate (13) of the Hersey Street section.

The section afforded by this group of ledges, it will be observed, overlaps on the south and supplements the section along Hersey Street, the two together affording a nearly complete section of the conglomerate series. The melaphyr of this section is the typical variety, greenish and purplish in color, and compact to highly amygdaloidal and scoriaceous in texture. The amygdules consist chiefly of epidote and quartz, and are usually small, or, if larger, rather scattering and not crowded. As a whole the rock is very massive, but portions of the bed show irregular veinlets and segregations of epidote and ferruginous quartz; and the distribution of the amygdaloidal and scoriaceous melaphyr is such as to suggest that this may be a composite flow. The contact between the melaphyr and the arenaceous conglomerate is very clearly exposed for about ten feet on the highest part of the ridge. It is straight, exactly parallel with the strike of the conglomerate, and shows only minute irregularities, variations of an inch or so from the mean line. The melaphyr does not penetrate the conglomerate any more distinctly than the conglomerate penetrates the melaphyr. Some irregular cracks in the lava appear to have been filled with fine sand, which is now highly ferruginous; but aside from these there are no distinct inclusions of the sedimentary rocks in the melaphyr. On the other hand, a few small pebbles of melaphyr similar to this were observed in the conglomerate, within a few inches of the contact. The conglomerate and sandstone exhibit no special alteration or unusual induration at this point; and in every way the facts are favorable to the view that the melaphyr is contemporaneous and not intrusive.

Between the ledges just described and those next to the west there is a gap of six hundred feet, occupied by the valley of Town Brook and the railroad. But immediately beyond West

Hingham Station, the melaphyr outcrops prominently, forming the summit and abrupt southern slope of a hill which is flanked by modified drift on the north. It is essentially similar in character to the melaphyr east of the railroad, except that a larger proportion of the rock is compact or not distinctly amygdaloidal, some of the exposures resembling a massive slate. Irregular segregations of epidote, etc., are common; and, as already stated, the melaphyr encloses at one point a broken or faulted layer a few inches in thickness of a beautifully laminated or banded slate. This is well exposed at the present time in the part of the ledge nearest to the station, where a new street is being graded up the hill from West Street. So far as can be determined, it is near the middle of the bed of melaphyr; and it is certainly far from any large body of slate. The most natural explanation appears to be that it is a thin layer of tuff, similar to some of the tuff beds of Nantasket, and hence another indication that the bed of melaphyr is composite, consisting of two or more flows. The melaphyr is exposed along the strike (W. by N.) in frequent ledges for about 1,000 feet, or to within 500 feet of Hockley Lane, and is of similar character throughout.

On the north side of the first hill, in the angle between the melaphyr and West Street, are several outcrops of conglomerate; but the contact is not exposed here. North and west from this point the stratified rocks are almost entirely concealed by the undulating modified drift. I have recently discovered, however, that the small ledges of melaphyr on the west slope of the main hill, lying between the two large groups of ledges and divided by the east-west fence, as shown on the map, are bordered on the north side by fine conglomerate and sandstone precisely similar to the rocks in contact with the melaphyr east of the railroad; and the contact, which is clearly exposed, is of the same character. It is very evident that the sedimentary rocks were deposited over the melaphyr, for they fill cracks in it and are partly made up of débris derived from it. Near the melaphyr the fragments of that rock are large and angular; but the conglomerate as a whole is composed chiefly of felsite and granite, and cannot be classed as a tuff. The dip is as usual about S. 70°. Irregular veinlets of iron oxide are seen in both the sandstone and the melaphyr; and cannot be regarded as evidence that the melaphyr is intrusive. The northern border of the melaphyr, as drawn on the map, is shown by these recent observations to be too far to the north at this point; and it is possible that a small transverse flexure or fault separates this contact ledge from the remaining outcrops of melaphyr in the next field to the west. In this field it is quite noticeable that the melaphyr is more compact toward the granite on the south or the supposed base of the flow, and more amygdaloidal and scoriaceous toward the sedimentary rocks on the north or the supposed top of the flow. Going north from these ledges into the adjoining field we find, after an interval of nearly 75 feet, or 15 feet beyond the fence, 60 feet of fine conglomerate and sandstone with an apparent dip S. 45°; 50 feet concealed; and 10 feet of sandstone. These exposures, which are marked on the map, must evidently be referred to the same bed (3) which we have elsewhere found in contact with the melaphyr; and more recently I have discovered north of these, small and obscure exposures of purple slate (4), dipping S. 70°; and conglomerate (5). These scanty outcrops serve to show that the Village series of strata probably extends without essential change this far to the west.

We come now to the interesting group of conglomerate ledges in the field south of the melaphyr and Hockley Lane, and bordered on the east and south by granite (see the map). The relations of the granite and conglomerate are very intimate, and could be fully known only by removing all the superficial detritus from this area. Along the south side of the field, especially, and on both sides of the fence, we pass repeatedly and abruptly from the one rock to the other; and there are probably several or many bosses or knobs of granite projecting through a thin and approximately horizontal bed of conglomerate; although the surface relations of the two rocks might be partly explained by faulting. That the granite is not younger than and eruptive through the conglomerate is proved beyond the shadow of a doubt by the nature of the contact and the composition of the conglomerate. The latter is made up very largely, especially where it lies directly upon or against the granite, of the angular and half rounded débris of exactly the same coarsely crystalline red granite; and the fragments, which range from single grains of quartz and feldspar to masses two feet or more in diameter, are sometimes only imperfectly separated from the parent ledge, the finer sediment appearing to penetrate cracks in the granite. The relations are essentially the same as on Rocky Neck and Granite Plateau of the Nantasket area, where the basal conglomerate rests upon the granite; and they also agree with the contacts resulting from the rapid deposition of coarse sediments over a disintegrated land-surface, as recently described by Professor Pumpelly[1] and Professor Emerson.[2] On purely structural grounds, this conglomerate should certainly be correlated with the basal conglomerate of Nantasket; which would, apparently, separate it widely from all the other Hingham strata. The melaphyr marked on the map as outcropping in the midst of this basal conglomerate, probably overlies it. It is amygdaloidal and otherwise similar to the rest of the Hingham melaphyr, but may, of course, be the equivalent of any of the earlier basic flows of Nantasket.

This completes the detailed examination of the ledges of the Village area. If, as appears necessary, we regard the series as inverted, the general structure and the relations to the granite must be approximately as represented in the section accompanying the map. A long, narrow block of strata is faulted down between walls of granite, the drop on the north

[1] Bull. geol. soc. America, vol. 2, p. 209–224.

[2] Bull. geol. soc. America, vol. 2, p. 451–456.

being so much greater than that on the south as, in conjunction with a horizontal or plicating stress, to overturn the beds. Or it may be otherwise described as an inverted syncline deeply folded down in the granite and the northern half carried away by the fault which elevated the granitic axis on the north. The map shows two areas of slate along the northern border of the conglomerate series. These are not based upon any outcrops; but the topography is favorable to the occurrence of slate here, and they are introduced in accordance with the foregoing explanation of the structure. The same is the case also with the conglomerate shown south of the melaphyr, east of the railroad; but the conglomerate which is represented in the section as lying upon the granite is the basal conglomerate already described south of the melaphyr, near Hockley Lane.

The Beal's Cove Area.

This is the area indicated by the second special map (Plate 8). It is crossed diagonally by Beal Street and embraces all the ledges between Beal's Cove and Lincoln Street. Topographically it belongs chiefly to the broad lower or lowest sandplain, but includes Tucker's Swamp and the western slopes of Baker's and Squirrel Hills. This area has been already described as affording, between the granite on Beal Street and Beal's Cove, the most complete and normal section of the Hingham strata.

The western extremity of the granite axis is, fortunately, well defined, as the map shows, by numerous outcrops north of and in the street and the obscure but reliable outcrops between the houses south of the street. The granite is overlain at this point, as already described, by several irregular patches of effusive felsite, including the mass wrongly marked as an outlier of conglomerate. One proof that not only this felsite but also that farther east, in the vicinity of Thaxter and Lincoln Streets, are part of a surface flow or truly effusive has not been stated; *viz.*, that it occurs only near the junction of the granite and the bedded rocks, which, it is so evident, were deposited upon the granite. In other words, we find the felsite upon what we know to have been the ancient surface of the granite, from which the sedimentary deposits have recently been denuded; and wherever erosion has cut below this surface the effusive felsite is wholly wanting and we observe only an occasional narrow and irregular dike of intrusive felsite.

Along the northwest side of the granite there is a line of conglomerate ledges sufficient to indicate a narrow but continuous or nearly continuous band of conglomerate separating the granite from the overlying melaphyr. This conglomerate undoubtedly extends considerably farther than it is marked, the more northerly outcrops having escaped observation at the time the map was drawn. One of these is on the west side of the winding road known as Hawke's Lane running south from Lincoln Street to an isolated house; and another, which will be referred to later, is on the south side of Lincoln Street west of the lane. This conglomerate is a true puddingstone, consisting of rounded fragments of granite, felsite, and melaphyr; but the contact with the granite is not clearly exposed, and we can only conjecture that the relations of the two rocks are, perhaps, the same as south of Hockley Lane. This supposed basal conglomerate can not be traced around the extremity of the granite axis, and the narrow belt of it marked along the southern margin of the granite is unsupported by a single outcrop, finding its justification simply in the depression between the granite and melaphyr; while the fact that outliers of melaphyr rest upon the granite north of Beal Street is rather against its existence. In the two sections accompanying the map, it is omitted from the one extending south from Beal Street to Beal's Cove; although represented, as the facts justify, in the other, running northwest from the granite.

South of the granite, the main bed of melaphyr is well exposed in two large groups of ledges. It is the typical green, basic variety, and is abundantly but coarsely and irregularly amygdaloidal, with many irregular veinlets and segregations of impure epidote, etc., portions of the rock being of a distinctly scoriaceous character. A coarse flow-structure is sometimes indicated by the arrangement of the amygdules in parallel sheets or layers, which have the normal dip of the section, S. 60° or more. As the map shows, the breadth of the belt varies, perhaps, with the dip, from about 160 to more than 300 feet. In the western group of ledges, a little north of the middle of the belt, a thin layer of conglomerate, passing upward into sandstone, the entire thickness being, possibly, less than ten feet, interrupts the continuity of the melaphyr. This is the normal reddish conglomerate, consisting chiefly of granite and felsite: and it can not be classed as a tuff or a fragmental melaphyr. The dip of the conglomerate is S. 60°; and there is no reason to doubt that it is essentially conformable with the melaphyr above and below. But since neither contact is clearly exposed, the facts are evidently insufficient to reveal the true significance of the conglomerate. We can not determine conclusively whether it is a true interbedded conglomerate, or simply an outlier of the very similar overlying conglomerate, displaced by faulting. The latter view would readily explain the unusual breadth of the melaphyr at this point; and it may be added that, independently of this conglomerate, there is no special indication that the melaphyr is a composite flow.

In the eastern group of ledges, in the angle between Beal Street and Portuguese Lane, the contact of the melaphyr and overlying conglomerate is satisfactorily exposed, and is decidedly favorable to the view that the melaphyr is contemporaneous, *i. e.*, that the conglomerate has been deposited upon its surface. The melaphyr is here very coarse and scoriaceous; and the numerous cracks and inequalities of its surface are filled with the finer part of the conglomerate, in such a way as to place the relations of the two rocks beyond question. The conglomerate contains, however, comparatively little débris that can be referred to this melaphyr; and this fact, together with the rough character of the melaphyr, points to the conclusion that it suffered but little erosion before the conglomerate was spread over it, and hence that it is probably a submarine flow.

The conglomerate dips south or away from the melaphyr at the normal angle; and these eastern ledges overlap and supplement the extensive and prominent outcrops farther west, in the vicinity of the small pond, the entire breadth of the bed being thus satisfactorily exposed. This bed is throughout a normal, massive, well-indurated puddingstone, embracing very little arenaceous material. The pebbles are mainly from one to two or three inches in diameter: but in certain layers the maximum rises to six inches or even a foot. The southerly displacement of the conglomerate in passing from the eastern to the western ledges is very noticeable, and evidently related to the increased breadth of the melaphyr in that direction. Two explanations have been suggested for the latter: first, a diminished dip, which would cause a curvature of the overlying strata, as shown on the map, even though they retain throughout their normal high inclination; secondly, a strike-fault, as indicated by the conglomerate enclosed in the melaphyr, which might have the same result as regards the overlying beds, or, ending against transverse faults, might involve an actual dislocation of the sedimentary series. Unfortunately, the entire absence of outcrops along this north-south line makes it impossible to choose between these explanations; and it may well be that both of them are true.

With this introduction, we can pass rapidly over the entire section from the granite southward, since it is, in a large measure, a repetition of the Village section. The strike ranges from S. 65° to S. 80° E.; and the dip, except perhaps with the melaphyr, varies but little from S. 80°. The thicknesses are chiefly approximations, the beds, either on account of not being sharply defined or from lack of continuity in the outcrops, rarely admitting of exact measurement. The numbers refer to the general table of Hingham strata and also indicate the correlation of this section with the Village section, although the sequence here is normal and not reversed, as follows :—

Granite and felsite, with outliers of melaphyr. Conglomerate (1), not observed. Melaphyr (2), 140 feet (minimum). Conglomerate (3), medium to coarse puddingstone, very much coarser and thicker than in the Village section, 175 feet. Slate (4), not exposed, but represented by a depression, 65 (?) feet. Fine conglomerate alternating repeatedly with sandstone (5), 170 feet. The broad outcrop south and east of Portuguese Lane shows that this is a complete mixture or blending of coarse sandstone and fine conglomerate; while in the Village section there are two distinct beds—40 feet of conglomerate without sandstone and 100 feet of sandstone without conglomerate. Purplish and gray slate (6), probably 100 feet. Concealed by kames and swamp; and only one outcrop, east of Portuguese Lane. Conglomerate (7), 35 feet. A single ledge on the west side of the lane, passing south into the solitary outcrop of the next bed. Red slate (8), 40 feet. This crosses the lane just north of the point where it divides; and a few yards east of the junction is the principal exposure of the next stratum. Fine conglomerate and sandstone (9), 50 feet. Red slate (10), not exposed, but there is room between the nearest outcrops of conglomerates 9 and 11 for 25 or 30 feet of slate. Conglomerate (11), fine but without much sandstone, about 80 feet; forms extensive ledges east of the lane. Red slate (12), about 50 feet; several good outcrops east of the lane. Fine conglomerate and sandstone (13), a broad belt of uncertain width. If correctly mapped, the thickness must be about 300 feet. The more prominent ledges are chiefly fine conglomerate; but there is undoubtedly a large proportion of sandstone. Outcrops, it will be observed, are almost wholly wanting in the southern half of this belt; and the southern limit is quite uncertain. Gray slate (14), of unknown thickness. The exposures begin near the north shore of Beal's Cove; and along the shore of the river the outcrop is continuous from the end of Portuguese Lane south to the point, the total exposed thickness being, probably, not less than 500 feet. The slate is of a very uniform character,—gray, rather coarse, very thinly and evenly bedded, well jointed, but without marked cleavage. Some layers are finely pitted by weathering and wave-action, indicating, possibly, some lime in the rock; and there are some indistinct concretions. But although the section appears in every way favorable for the occurrence of fossils, I have searched for them in vain. In the most northerly outcrop of the slate it is distinctly and repeatedly interstratified with layers of hard, gray, and rather coarse sandstone, from two inches to two feet thick. Since such intercalations of coarse material are wholly wanting in the remaining 500 feet of the slate, this outcrop is regarded as marking the transition from the underlying conglomerate and sandstone (13) to the slate; and it is the chief fact relied upon in drawing the boundary on the map. It is unnecessary to dwell upon its importance as evidence that the slate conformably overlies the conglomerate series. It may well be, however, that, as in the case of the conglomerate in the Huit's Cove section, to be described in the following pages, this intercalated coarse material is underlain by a considerable thickness—100 feet or more—of slate.

It is impossible to carry the section farther south; for the east and south shores of Beal's Cove are wholly composed of modified drift which rises from 30 to 80 feet above the water, and extends southeast across the Hockley district to the railroad, blotting out everything but an occasional ledge of granite. Following the east shore of Weymouth Back River south from Beal's Cove, no ledges of any kind are observed for about 800 feet from the south angle of the cove, and then, when nearly opposite the south side of Whale Island, we reach the beginning of an outcrop of coarse granite which is almost continuous along the shore for 500 feet. The granite is divided by three large east-west dikes; but there is not a trace of slate or any sedimentary rock. Between the nearest outcrops of slate and granite there is thus a gap of fully one fourth of a mile, and concerning the exact position and the character of the contact we know simply nothing.

The stratigraphic continuity of the section from the granite north of Beal Street across the melaphyr and the conglomerate series to Beal's Cove is unquestionable; and, although the relations of the Beal's Cove slate to the conglomerate series are not so fully and clearly exposed as could be desired, the perfect agreement in strike and dip and the indications of a gradual transition afforded by the interstratification of sandstone and slate, appear to justify us, as already stated, in regarding it as a part of the same conformable sequence of strata. If, as this view requires, the slate conformably overlies the conglomerate series, Beal's Cove must mark the position of a synclinal axis; and, since the slate must, in this case, be much newer than the granite, the south side of the syncline is probably cut away by a fault with the downthrow to the north, for there is evidently not room enough south of the axis for a repetition of the conglomerate series and melaphyr. Between the granite north of Beal Street, which still holds its normal relation to the bedded rocks deposited upon it, and the granite against which they end, as the result of faulting, on the south, we have, then, a steep monocline (one half of a syncline) and, as previously stated, one complete section of the Hingham strata.

Eastward from Beal's Cove and south of Tucker's Swamp, there are, fortunately, sufficient outcrops to connect the section just described with the ledges in the vicinity of Hockley Lane. The single small outcrop of the true slate (14) east of the cove is much nearer the water than represented, and evidently below the highest bed on the west side of the cove. About 1,000 feet east of the salt marsh bordering the northern arm of the cove, and immediately beyond where the boundary of Tucker's Swamp bends to the north, we come to a considerable exposure of the newest conglomerate and sandstone

(13), with a large but imperfectly exposed dike of diabase, while farther east we are able to identify slates 12 and 10 and conglomerates 11, 9, and 7; and north of the swamp, apparently conglomerates 5 and 3, in very obscure outcrops. Several of these outcrops are not marked on the map, and others are incorrectly marked. It is evident, however, that some of these beds, if they continue, must abut against the end of the melaphyr of the Village section. This is suggestive of a transverse fault. Farther north the outcrops are so imperfect on both sides of the line that a lack of correspondence or continuity can not be easily proved. Farther south along the supposed fault line, however, we find evidence which, so far as it goes, is entirely satisfactory. This is afforded by the slate which is mapped as forming a short northwest and southeast line of outcrops south of the end of Hockley Lane. This slate is the purplish variety, with occasional thin streaks of sandstone. It strikes in the direction named and dips N. E. 70°. In the direction of the strike the slate is exposed very near the granite, and it is evident that it is cut off by the granitic rocks on both the east and south. The most careful search fails to reveal any evidence whatever that the granite is intrusive in the slate; but the most satisfactory explanation of their relations is that proposed on the map. This slate has been somewhat doubtfully referred to the great bed (14); and, judging from its dip, it belongs on the south side of the synclinal axis, which implies a shallowing of the trough in this direction. The marked southeasterly strike may be regarded as in some way the result of the transverse displacement.

Having now brought the strata of the Beal's Cove area face to face with those of the Village area, it is readily apparent that they can be correlated only by completely reversing the one series or the other. This is most obvious in the case of the melaphyr, which is on the south in the Village area and on the extreme north in the Beal's Cove area. The entirely normal character of the Beal's Cove section leaves no room to doubt that, as previously stated, it is the Village section which requires reversing. This transverse fault is, then, the one important dividing line for the entire district between the Home Meadows and Beal's Cove. West of this line we have a steep but normal monocline, terminated against the granite on the south by faulting; while east of it a great displacement along the northern border of the bedded rocks, accompanied by a severe plicating strain, has completely inverted and dislocated this end of the series. It is interesting to observe, also, that this change or break occurs opposite the southwest angle of the granite axis on the north, showing that this mass of granite is, as previously pointed out, a dominant or controlling factor in the structure of this region. The foregoing outline of the structure of this narrow southern trough will, perhaps, be more readily or fully comprehended if its various phases are presented in succession, as follows: From the Home Meadows to Beal's Cove there was originally, or would have been but for the faulting, one continuous syncline. This is broken transversely by the Hockley Lane fault. The western half remains an open syncline; but the greater part of its southern slope is carried away by a strike-fault, which brings up the underlying granite in that direction. The eastern half, owing to the stronger compression, being in the narrowest part of the granite vise, becomes an inverted isocline with the axial plane dipping to the south; and its northern side is partly carried away and partly concealed by a strike-fault, bringing up the granite axis which these strata once covered.

In attempting to trace the various strata of the Beal's Cove section westward, we find them passing at once beneath almost continuous deposits of modified drift, including several high kames. The slate series and the more southern members of the conglomerate series are thus hopelessly cut off. But the melaphyr and the strata immediately above it emerge sufficiently from the sea of drift so that their relations to the extremity of the granite axis can be observed. It is very plain that these beds curve regularly around the granite, following its northwestern as faithfully as its southern margin. The broadening of each bed as it rounds the angle is due to the natural diminution of the dip at this point. North of Beal Street the belt of melaphyr is, at first, apparently, scarcely 100 feet wide, but it gradually broadens northward, possibly as the result of a diminished dip. It is seen in contact with the basal conglomerate at several points. The most northerly and most satisfactory exposure of the contact is in a small excavation on the southwest side of Hawke's Lane, where the conglomerate is not marked on the map; but in every case the appearances are best explained by regarding the melaphyr as contemporaneous rather than intrusive. It fills the inequalities in the surface of the conglomerate; but does not properly penetrate that rock. Although the great bed of conglomerate (3) overlying the melaphyr is well exposed for the entire distance between Beal Street and Lincoln Street, not a single good contact could be found.

Scattered through the woods and swamp, stratigraphically above this conglomerate, are numerous outcrops of conglomerate, sandstone, and slate which it is difficult to connect satisfactorily in continuous belts. These are somewhat generalized on the map, and the correlation indicated there is probably not entirely correct. It can hardly be doubted, however, that we have here, in normal sequence, the red slate (4), conglomerate and sandstone (5), and red slate (6); and then follow in succession conglomerate, slate, conglomerate, melaphyr, and conglomerate, as shown on the map. South of Beal Street, however, and disregarding this melaphyr, it would not be difficult to divide the nearly continuous line of outcrops so as to identify or represent every bed in the Beal's Cove section up to the highest conglomerate (13). The interpretation of this part of the Beal's Cove area is one of the puzzles of Hingham geology. The general structure appears to be synclinal; and the map and section are constructed in accordance with this view. The dip, for the most part, varies but slightly from 90°; but still, the advocate of the synclinal theory can find some ground for its support in the attitude of the strata. It should be pointed out, however, that the dip of the ledge of slate on the north side of Beal Street is W. 85°, and not E. 85°, as marked; while the ledges southwest of this point and east of the Alms House are vertical. According to the map and section the western strata are a repetition of those on the east side of the belt; and the syncline, although closely appressed, is shallow, holding only the lower half of the conglomerate series, up to and including the second slate (6); and as it approaches the shore it is merged rapidly with the east-west monocline or rather with the main syncline.

Although this interpretation seemed the most satisfactory at the time when the special map and section were drawn, subsequent observation and reflection have caused the alternative view to appear more acceptable; *viz.*, that all the beds of the Beal's Cove section pass in regular order around the granite, the structure being monoclinal in both directions from the granite. This later and present view is expressed on the general map, and hence the two maps are not in agreement here. The ledges of slate south of the Alms House and nearest to the shore appear at first sight to stand in the way of the later interpretation. But the strike of these outcrops is really much more northerly than mapped, being directly toward the most westerly ledges east of the Alms House. Certain irregularities in the strike were made the most of to bring the ledges into conformity with the earlier explanation; and the dip, which is W. 85°, was also regarded as a local irregularity. I am now disposed to refer these ledges to the highest bed of red slate (12), placing them on the northwest side of the great bend, but very near the turning point. And the still higher beds, the massive conglomerate (13) and the gray slate (14), instead of bearing away to the westward, as if to cross the river, are now regarded as bending to the north with the shore and following the lower beds around the bend. This great bend is, of course, the extremity of the great central and dominant anticline of Hingham, and that it is the *extremity* is proved by the undeniable fact that the axis here plunges steeply downward to the west. Southward from this axis the beds form a monocline of from 80° to 85°, extending to Beal's Cove; and on the northwest side a monocline of from 85° to 90° extends out beneath the level sandplain.

At the time of my first observations in this locality, fifteen years ago, I was deeply impressed by the fact, that there are, northwest of the granite, two similar and parallel ridges of conglomerate and melaphyr, with an intervening valley composed chiefly of sandstone and slate. This strong topographic suggestion of a syncline biased all my later observations, until the present writing compelled a broader and more rigid examination of the facts, and the absence of any real geological evidence of a synclinal structure became apparent.

Whichever view of the structure of the beds on the northwest side of the axis is accepted, important strike-faults must be introduced to explain the second belt of melaphyr. This melaphyr is essentially similar to that on the east side, against the granite, and one naturally regards it at first as marking a denuded anticline. Its eastern edge, however, is quite clearly transgressive with reference to the bordering strata: and it is necessary either to introduce a fault here or to regard the melaphyr as a dike. No reliable dips have been observed in the conglomerate on the west side of this melaphyr; but it may be reasonably correlated with that on the shore of Huit's Cove, which dips westward away from the melaphyr and beneath the slate series. This belt of melaphyr is a direct prolongation of the great body of melaphyr lying east of Huit's Cove, and can not be regarded as intrusive unless we are prepared to ascribe that origin to the entire area, or in fact to all the melaphyr of Hingham. The fault separating the melaphyr from the slate series on the west conceals for the entire distance all but the highest bed of conglomerate, and this also is cut out or, rather, concealed for a part at least of the distance between the cove and Lincoln Street, the slate lying here directly against the melaphyr. The area crossed by the western portions of Beal and Lincoln Streets is an unbroken sandplain, and the broad expanse of slate represented here is unsupported by a single outcrop. The map finds abundant justification, however, in the topography and in the extensive outcrops of slate on the shores of Huit's Cove, since, if continued, and we have no reason to suppose the contrary, these beds must cross this area. The tongue of melaphyr can not be traced south of a point 500 feet north of Beal Street; and whether the bounding faults actually meet, as mapped, and, if so, whether the united fault extends farther to the southwest, it is impossible to determine. The general interpretation of the geologic structure here proposed makes it unnecessary to suppose that any of the Hingham strata extend far into Weymouth. All of which tends to emphasize the importance of Weymouth Back River as a geologic boundary; and we may reasonably assume that this valley follows a fault comparable in magnitude and structural importance with that along the east side of Hingham Harbor, separating areas which are strongly contrasted in their geologic features.

The Lincoln Street and Broad Cove Area.

This area is represented by the southern part of the third special map (Plate 9), or all that part southeast of the melaphyr and south of the great dike. It embraces but few ledges, being covered almost continuously by the Squirrel Hill and Bradley Hill drumlins and the low sandplain and broad meadows into which they sink.

The monocline northwest of Squirrel Hill can be readily traced to the northeast across Lincoln Street, as the map shows, as far as Huit's Cove Lane. All the beds, so far as observed, are vertical ; and it is obvious that there is room for not more than half of the conglomerate series between the melaphyr on the southeast and that on the northwest. The lower beds, from the melaphyr (2) and the great conglomerate (3) to the third conglomerate (7), are clearly continuous. Hence there can be but little doubt that the missing beds belong in the upper half of the section, or that their absence is due to a great fault which has elevated the melaphyr on the northwest. The map represents the melaphyr between the conglomerate series and the granite as broadening rapidly toward the northeast, and this would seem to indicate a marked flattening of the dip. Outcrops are wholly wanting, however, south of Lincoln Street and east of Hawke's Lane ; and it now seems much better that this area should be colored as granite. But even then there would be a decided increase in the breadth of the melaphyr east of the lane.

The steep monocline can not be traced beyond Huit's Cove Lane. The first one of the two transverse faults represented here appears to be justified by the offsetting of the strata as seen in the actual ledges ; and it is probably less important than the other, which is based upon the general interruption of the outcrops and especially upon the fact, that to the eastward of this line, so far as the scattering ledges allow us to judge, an entirely different type of structure prevails. The dips, of both the melaphyr and the sedimentary rocks, are everywhere low and indicate broad shallow folds. In the absence of outcrops immediately east of the north end of Huit's Cove Lane, we can not know whether this change takes place abruptly or gradually, by faulting or otherwise ; but the fault line on the map calls attention to the fact that a change occurs somewhere in that vicinity, and it also makes it easier to interpret the outcrops along the line of Lincoln Street east of Huit's Cove Lane.

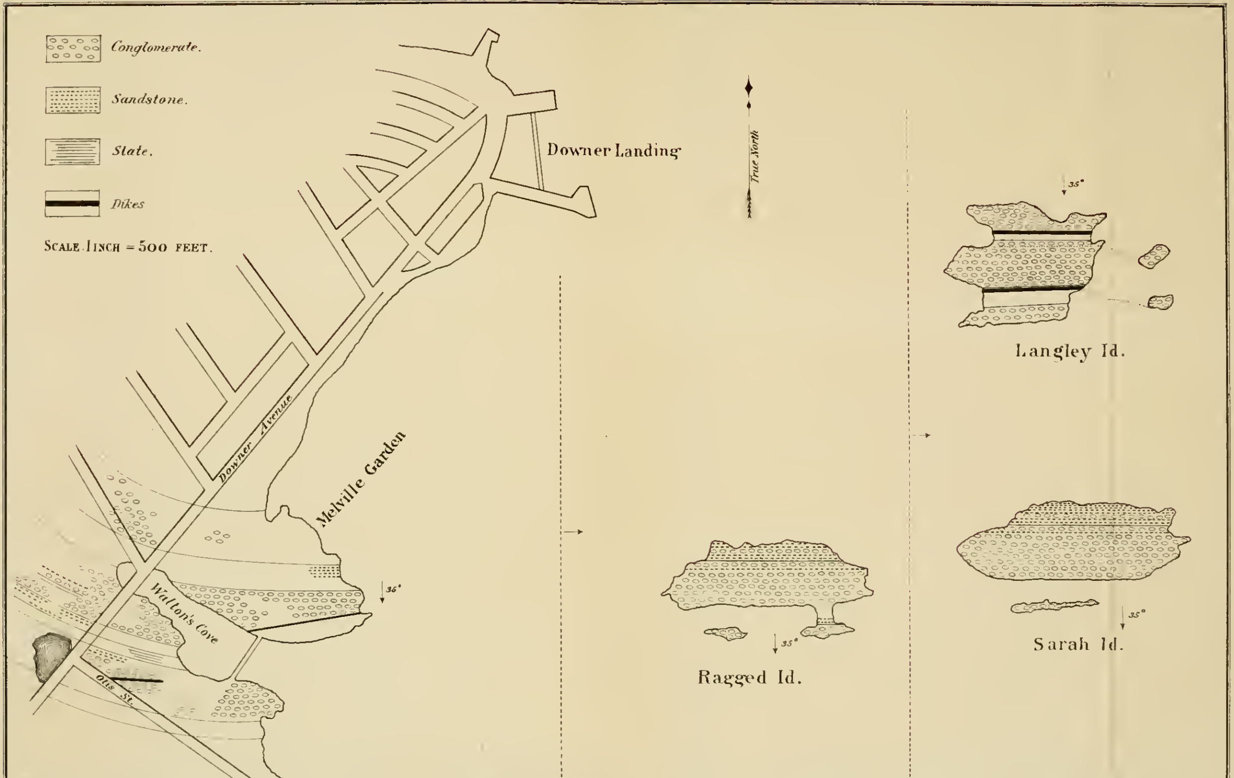
The melaphyr south of Lincoln Street and west of Thaxter Street, at the northern base of Squirrel Hill, is mostly greenish, sometimes reddish or purplish, abundantly and rather coarsely amygdaloidal in certain parts, with segregations of epidote and ferruginous silica, and in every essential respect similar to that which we have followed all the way around the granite from Portuguese Lane. The dip, so far as can be judged by the flow structure—the sheets and layers of amygdules—is nearly horizontal. The occurrence of felsite behind Mr. Bradley's barn, just west of Thaxter Street, as already described, makes it necessary to curve the southern boundary of the melaphyr to the north here. The last exposure of this melaphyr is in Thaxter Street, a few yards south of Lincoln Street; but it is assumed, in the absence of evidence to the contrary, to form a continuous belt bordering the granite as far east as the harbor. The melaphyr in the angle east of Huit's Cove Lane and north of Lincoln Street is of precisely the same character, except that it is, perhaps, more profusely amygdaloidal; and the layers of amygdules indicate very plainly a gentle southerly dip, suggesting that the conglomerate on Lincoln Street, between Thaxter Street and the Lane, in which the dip has not been made out, lies in a shallow syncline, and that the melaphyr is continuous beneath it. This correlates the conglomerate with the great bed (3), which we have elsewhere found lying directly upon the melaphyr. It is the broad and open character of this fold, as thus indicated, that has led me to extend the conglomerate color so far beyond the observations.

The large outcrop of melaphyr west of the junction of Downer Avenue and Crow Point Lane is quite varied in character. It is not conspicuously amygdaloidal, and the lower and northern part of the mass, although somewhat brecciated and containing irregular, angular segregations of bright red jasper, is mainly quite compact and massive. Above, however, the melaphyr is very scoriaceous, with numerous jaspery and epidotic segregations and veinlets and distinct indications of a true conglomerate with well-rounded pebbles lying upon and filling the inequalities of its surface. We have exposed here, apparently, the original upper surface of the nearly horizontal bed of melaphyr. Care is required to distinguish the segregations of jasper from the inclusions of red felsite. Several small fragments of felsite similar to that a hundred yards away, at the junction of Downer Avenue and Crow Point Lane, and one mass a yard or more in diameter of a slightly more granitic character, were observed imbedded in the melaphyr, indicating very plainly that this ancient basic lava broke through the still more ancient acid lava on its way to the surface. The outcrop in the street, as previously explained, probably represents a knob or boss of felsite projecting through the flow of melaphyr where erosion has cut most deeply into the latter. The extension on the general map of these two belts of melaphyr eastward across Broad Cove and Otis Hill to the harbor is, no doubt, somewhat hazardous; but no reason is apparent for terminating the melaphyr west of the shore, and its extension finds some, if not sufficient, justification in the bowlders of melaphyr observed on Button Island. The only rock observed in place on this islet, as previously stated, is granite; but the numerous large and angular bowlders of amygdaloidal melaphyr on the north and northwest shores prove that, although this rock does not form part of the island, it must underlie the portion of the harbor immediately to the northward. The melaphyr forming these bowlders is similar to that in the vicinity of Lincoln Street, being of greenish and reddish tints, coarsely and distinctly amygdaloidal with epidote and quartz, and exhibiting numerous irregular segregations or veinlets of the same minerals.

The great dike represented on the special map as extending west from Downer Avenue across Planter's Fields Lane to the eastern angle of the Huit's Cove melaphyr is probably the best interpretation of the outcrops which it embraces. These are all of precisely the same character, a typical coarsely and uniformly crystalline, massive diabase, the texture being proportional to the magnitude of the dike. Another argument for the dike is that the strata on opposite sides of this line of outcrops are, as the map shows, clearly and entirely at variance in dip and strike, and a fault coinciding with the dike is a structural necessity. Whether the dike actually ends against the melaphyr as represented, it is impossible to determine, since it passes in this direction beneath an extensive wet meadow and outcrops are wholly wanting. The coarse, holocrystalline, and homogeneous character of the diabase utterly forbids connecting the dike with the melaphyr as a possible channel of supply for the latter. The melaphyr is certainly older and the dike is just as clearly newer than the bordering sedimentary rocks; and the smaller dikes running south through the sandstone and conglomerate are probably, as indicated on the map, branches of the main dike.

The strata between the great dike and the melaphyr of Downer Avenue and Lincoln Street form, apparently, a low monocline of 15°—30°. We commence on the avenue, north of Planter's Fields Lane, with outcrops of a purplish and gray slate passing south into gray sandstone with fine pebbly layers, the whole dipping S. 30°. The sandstone can be traced west across the fields, as mapped, and is seen to change gradually upward into the small-pebbled conglomerate which outcrops so prominently along the entire distance, especially west of the lane. The dip of the conglomerate was not clearly observed; but it passes on the south, through sandstone to a finely banded slate, 75 feet in breadth, with a southerly dip of only 15°. South of the slate are several slight exposures of sandstone before we come to the conglomerate crossed by the lane, near the melaphyr. This outcrop is more extensive than marked, extending 200 feet southwest of the lane.

The correlation of these beds is not easy. Their surface exposures or developments, as compared with other sections,



CROW POINT AND THE NEIGHBORING ISLANDS

B. Meisel lith.

are, of course, greatly broadened by the relatively low dips; and there is nothing to show conclusively with which part of the Beal's Cove section, for example, they should be identified. No dips, however, have been observed south of the slate; and it is possible that the low and wavering dip of the slate itself should be interpreted as marking a synclinal axis, the sandstone and conglomerate on the south being a repetition of that on the north. The conglomerate could then, perhaps, be correlated with the first great bed (3) and regarded as passing up over the melaphyr, which would thus mark an anticlinal axis; and we should be able to dispense with the fault between the conglomerate and melaphyr.

The Melville Garden and Planter's Fields Area.

This area embraces the district east of the Huit's Cove melaphyr and north of the great dike and Otis Hill, including a large part of the tract known as Planter's Fields, Melville Garden, Pleasant Hill, the smaller drumlins forming Crow Point, and the adjacent islands of Hingham Harbor—Ragged, Sarah, and Langlee. From the western base of Pleasant Hill eastward, north of Melville Garden, to Downer Landing, the drumlins are continuous, as shown on the general map, and the hard rocks are wholly concealed; while curving around the south and west sides of this drift area, as previously noticed, is a well-exposed belt of strata, the third and last general section of the conglomerate series.

The most perfect outcrops are those afforded by the islands,[1] which, it may be noted in passing, are a beautiful illustration of the dependence of relief upon geologic structure. The shores of these islets are almost continuous exposures; and the attitude of the strata is exceedingly constant, the strike being nearly due east-west and the dip S. 35°–40°. Langlee Island is an approximately rectangular mass 600 feet long and 400 feet

[1] See the uncolored special map (Pl. 10).

wide, with two detached half-tide ledges on the eastern end, making the extreme length 800 feet. The two small bays indenting the western shore correspond to depressions crossing the island parallel with the strike and due, no doubt, to the erosion of the softer strata. Commencing with the lowest or most northerly beds, the island presents the following section :—

Conglomerate, coarse to medium,	100	feet,	equal	to	thickness	of 60	feet.
Concealed, probably slate,	35	"	"	"	"	" 20	"
Conglomerate, medium to fine,	170	"	"	"	"	" 100	"
Streak of sandstone near the northern edge.							
Concealed, probably slate,	70	"	"	"	"	" 40	"
Conglomerate,	60	"	"	"	"	" 35	"
	435					255	

Along the north side of each depression there is a dike of uncertain width, the north dike having a northerly hade of 15° : but it is improbable that the depressions are due wholly or even chiefly to the erosion of the dikes. Langlee Island is separated by about 600 feet of water from Sarah Island, an oblong mass 275 feet in breadth and 835 feet in extreme length, with a long, half-tide ledge about 100 feet from and parallel with the south shore. It is constituted as follows, in ascending order: Sandstone, gray and coarse, 85 feet, equal to thickness of 50 feet, with a streak of conglomerate near the middle of the bed. Conglomerate, medium to fine, 190 feet, equal to thickness of 115 feet, with a streak of sandstone near the northern edge. Water, probably concealing sandstone and slate, 75 feet, equal to thickness of 45 feet. Conglomerate, forming half-tide ledge.

West of Sarah Island, with about 300 feet of water intervening, is Ragged Island, 235 feet in breadth and 735 feet in extreme length, with two linear ledges parallel to the southern shore and 100 feet distant. These two islands are thus essentially similar in form ; and they present identical sections, except that in the depression south of Ragged Island a little sandstone is exposed, making it probable that, as stated, this break covers a bed of sandstone, or of sandstone and slate. The sandstone forming the north shore encloses from 5 to 10 feet of fine conglomerate, which becomes finer toward the west, changing to sandstone. It encloses masses of banded slate of various colors, some of which are possibly large pebbles; but the greater number, it is clear, can not be explained in that way, and must be referred to the irregular deposition of fine silt with the coarse. In most cases the stratification planes of the slate coincide exactly with the bedding of the sandstone and conglomerate. The correlation of the two sections is unquestionable; but when we carry the line of strike from either island across to the other a lateral displacement is observed, each longitudinal feature on Ragged Island being about 100 feet farther south than its continuation on Sarah Island. This want of alignment seems to be best explained by a transverse fault between the two islands; with the downthrow to the east, as shown on the map. If such a fault exists, the vertical displacement must be about 75 feet.

Some 300 or 400 feet southwest of Ragged Island, a pile of angular blocks of fine conglomerate projects from the mud flat when the tide is out. These masses probably represent an underlying ledge, although it is possible they were derived from the Ragged Island bed.

In the general line of strike of Ragged Island is the high and massive ledge of conglomerate forming the headland and the north shore of Walton's Cove, in Melville Garden. The conglomerate has a breadth of at least 150 feet in the garden, probably passing beneath the water on the south; and it may be safely correlated with the main bed on the southern islands. More careful observation, however, shows that there is here, again, a lack of alignment, the southern border of the conglomerate on Ragged Island coinciding in direction very closely with the northern border of the conglomerate in the garden. This means a horizontal displacement of perhaps 150 feet, and a vertical slip of at least 100 feet, with the downthrow to the east, the transverse fault between Sarah and Ragged Islands being repeated between Ragged Island and the main land.

Northwest of the bridge across the cove, the conglomerate slopes steeply down to the water in one broad diagonal joint-face. On the north side of the headland at the eastern end of the ledge the conglomerate shows very distinctly a southerly dip of 35°.[1] The shore retreats here, the headland giving way to a small sandy beach, at the north end of which a gray sandstone outcrops with the same dip as the conglomerate. It is very evident that the sandstone is really as broad as the beach, that the base of the abrupt northern face of the conglomerate marks the contact of the two rocks, and that this sandstone is the continuation of that forming the northern shores of Ragged and Sarah Islands. Between the buildings in the northern part of the garden is an exposure of conglomerate (see map) which is stratigraphically below the sandstone; and westward on this line, across Downer Avenue and east of Whiton Avenue, it outcrops sufficiently to prove a bed of considerable thickness. In its eastward extension this bed must, of course, pass wholly to the north of the southern islands. The outer part of Walton's Cove clearly corresponds to the gap between the islands and the ledges parallel with their southern shores; but the inner part, influenced no doubt by the diagonal jointing of the conglomerate already referred to, is oblique to the stratification, and the same bed of conglomerate forms both shores. South of this conglomerate, and in line with the outer part of the cove, there are outcrops, as the map shows, of a purple, banded slate and gray sandstone. The slate is contorted, and is, doubtless, underlain as well as overlain by sandstone. The dips of the slate are, of course, unreliable, but the sandstone shows that the dip observed north of the conglomerate still continues. South of these soft beds, and forming the south shore of the cove, east of the bridge, is a third bed of con-

[1] By mistake the dip is made 25° on the map.

glomerate. This is small pebbled, and is probably the bed forming the ledges south of the islands, although distinctly smaller pebbled. South of this conglomerate there are no outcrops east of Downer Avenue.

On the west side of the avenue, we have first the conglomerate already referred to east of Whiton Avenue, followed by a blank space wide enough for the sandstone north of Walton's Cove; and then we come, in the western part of Melville Garden, to a broad exposure of the main conglomerate. In passing westward the strike changes gradually from east-west to northwest, and there is, apparently, a marked flattening of the dip, intercalated layers of slate and sandstone showing a southwesterly dip of only 5°—10°. South of this conglomerate are ledges of sandstone followed by a blank space which probably conceals the bed of purple slate already noticed east of the avenue; and then come, in the western part of the garden, near Crescent Avenue, 30 feet in breadth of the sandstone seen south of the purple slate, and after a blank of 50 feet, 100 feet in breadth of massive gray sandstone with a southwesterly dip of 20°. Following the strike of this heavy bed of sandstone east across the small pond and the avenue, we have, apparently, no alternative but to connect it with the third or most southerly conglomerate in that part of the garden. If this correlation is correct, we have here a remarkable instance of rapid lateral change in the character of the coarser sediments, in view of which we may well hesitate in correlating this section with those south and west of the granite axis. Although this explanation has the merit of simplicity, and has been followed in the construction of the map, it appears best, on the whole, as will be more clearly shown later, to introduce a third transverse or north-south fault here, the fault cutting obliquely across Downer Avenue between the two ponds.

The beds of slate are commonly marked by an absence of outcrops, forming smooth open lanes or narrow valleys between the conglomerate ridges; and this peculiarity is the only fact that can be cited in support of the bed of slate shown on the map south of this sandstone bed. That is, the topography is suggestive of slate, but no outcrops have been observed. Following this blank, comes a belt of fine conglomerate a good hundred feet in breadth. It outcrops boldly on the southwest border of the garden, northwest of the larger pond; and can be satisfactorily traced westward along the east side of Grove Avenue to a point 750 feet northwest of Crescent Avenue, where it passes beneath the Pleasant Hill drumlin. The outcrops of this bed, in connection with the preceding, first fully outline the great curve in the strike; and it will be noticed that while the lower part of this general section is based upon outcrops conforming with the eastern area of the curve and dipping south, the numerous outcrops of the upper half, yet to be described, follow the northern area and dip west. Northwest of the pond, Grove Avenue utilizes one of the narrow slate lanes, and the slate, which is brown and dips west about 30°, comes to the surface in the northwestern extension of the avenue. The breadth of this slate is scarcely 30 feet; and then follow in continuous outcrops 30 feet in breadth of gray sandstone, 40 feet of fine conglomerate, 30 feet of brownish slate, 90 feet of conglomerate with streaks of sandstone, and 40 feet of gray sandstone. These beds are clearly traceable along the strike for nearly one third of a mile, as shown on the map; and the dip, throughout, varies but little from 30°, although constantly changing in direction.

We have now reached a slate valley of unusual breadth. At the southeast end, near Grove Avenue, there is an obscure outcrop of brown slate; and greenish gray slate, changing west to brown or reddish, is well developed on the west side of the artificial pond. But the only complete section is in the northern part of the valley. Here the outcrops, across the strike, are almost continuous, and the breadth of the slate, from the sandstone on the east to that on the west, is about 350 feet. The slate is somewhat variable in character; being mainly brownish or chocolate-colored near the upper and lower borders, and gray or greenish gray, banded with dull red, in the middle of the belt. It is, throughout, thin-bedded, banded or shaly, and finely jointed. The dip is constantly to the west and southwest, but inconstant in amount. The angle given on the map—60°—is the highest observed, the normal variation being from 30° to 40°.

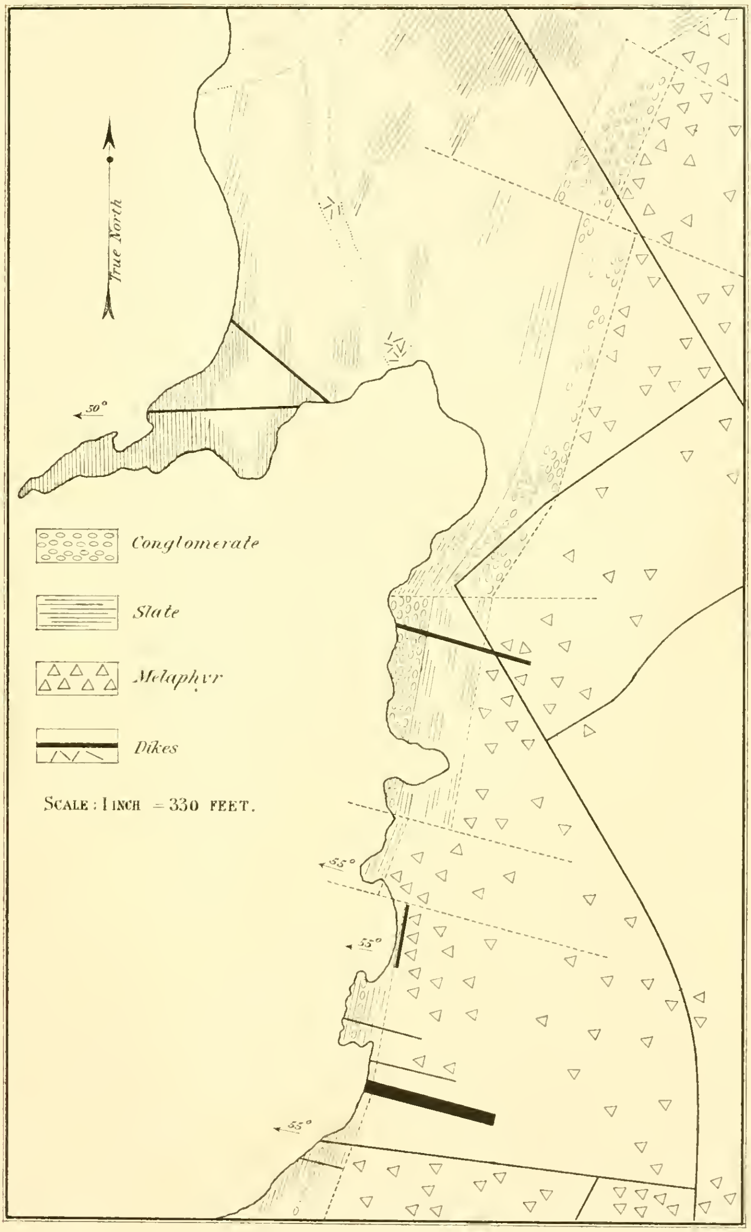
The slate valley is bounded on the west by 60 feet or more of coarse gray sandstone, about 30 feet of brown slate, and 100 feet of sandstone; and these beds can be traced south by frequent outcrops to the end of Planter's Fields Lane. The last sandstone is here overlain on the west by a bed of brown slate, which can not be traced far to the north. Then comes a heavy bed of conglomerate, which at the northern end is actually exposed for a hundred feet in breadth and seems to broaden southward, possibly enclosing, as the map shows, another bed of brown slate. At the extreme north this conglomerate is, apparently, overlain by still another bed of sandstone. That all of these beds are cut off on the south by the great dike scarcely admits of doubt; but whether we have reached the end of the series toward the west, and how it terminates in that direction, we can only conjecture, as there is an absolute blank of about 400 feet between the last of the sedimentary outcrops and the first appearance of the Huit's Cove melaphyr, except at the extreme northwest corner of the sedimentary area. I am now satisfied that the small outcrops of sandstone shown on the map near the border of the melaphyr really are melaphyr; and the boundary line should be carried far enough to the east to include them. The actual gap between the two rocks at this point, measured across the strike, is probably not more than 150 feet.

Although there are no reversed dips, a general view of this series of strata suggests that the main band of slate marks a synclinal axis, the beds on the west appearing to be, so far as they go, a repetition in reverse order of those on the east. This is the explanation which I proposed twelve years ago, in my "Contributions to the geology of eastern Massachusetts," and it is expressed in the section accompanying the special map. This section shows an inverted syncline, on the east side of which the beds, as they recede from the axis, round over to a nearly horizontal position, as indicated by the observations in the northern part of Melville Garden, west of the avenue: while on the west they maintain a high inclination until cut off by a fault against the melaphyr. But few dips have been observed west of the slate, and none so high as the section represents. Hence the syncline, if it really exists, is probably more completely inverted than it has been drawn. Then, again, the repetition of the strata, as the map shows, is by no means perfect; and we note especially that it is impossible to find on the west side as many beds of slate as are clearly exposed on the east. Of the three beds which the map shows on the west side, the second is based upon a single outcrop and the third upon none; while the conglomerate and sandstone prevent the extension of either of these far to the north. In the construction of the map, it will be noticed, that the interpretation was preferred in each case which, without doing violence to the actual observations, is most favorable to the synclinal theory. It can not be denied, however, that an equally strong or stronger case can be made out for a monoclinal structure; and the latter appears to me now the more probable view.

Although this section, as a whole, bears a general resemblance to the Village and Beal's Cove sections, the precise correlation of the beds is a puzzling problem. The much gentler dips and consequent broader outcrops must be borne in mind; for it may very well be that what in the other sections is reckoned as a single bed appears here, through the expansion of its outcrop, as two or more distinct beds. Great allowance must also be made for the undoubted lateral changes in the character of the strata. In fact, this consideration renders the independent correlation of any of the coarser beds extremely hazardous; and I am fully persuaded that the only reasonably safe clue is afforded by the main belt of slate. This bed, if not folded upon itself, is about 150 feet thick; and if it is the equivalent of anything in the Village section, it must be the bed of red and gray slate near the middle of the section (6) which passes downward (south) into sandstone and upward (north) into conglomerate and has a thickness on Hersey Street of 130 feet. Assuming this correlation to be substantially correct, the importance of the lateral changes in the strata becomes apparent when we turn to the coarser and more variable parts of the section, and especially when we attempt to find in beds 3, 4, and 5 beneath the slate in the Village section the extended series of strata north and east of, *i. e.*, below, the slate in the Melville Garden section. This point of view makes it almost necessary to postulate the transverse fault previously referred to as possibly crossing Downer Avenue obliquely between the two ponds. Supposing the downthrow to be to the east, as with the faults east and west of Ragged Island, the series of outcrops in the center and eastern part of Melville Garden become the equivalent of those in the extreme western part of the garden and extending from Downer Avenue along the north side of the main slate. Even then a satisfactory detailed correlation is scarcely possible, perhaps on account of imperfect outcrops, and especially are we at a loss to assign a place to the beds of Langlee Island, without the further assumption of a profound east-west or strike-fault, with the downthrow to the north, between Langlee and Sarah Islands, the beds of Langlee Island being, approximately, or in part, a repetition of those of Sarah Island. This hypothetical strike-fault may or may not be supposed to cross the north-south fault between Ragged and Sarah Islands. In the former case, Crow Point and the extreme northern part of Hingham Harbor are probably underlain by the conglomerate series. While in the absence of strike-faults this concealed area may be regarded, with much probability, as melaphyr, an oblong and approximately horizontal block with the conglomerate series dipping gently away from it on the south and west. It is important to notice, however, that if the very low dip west of Walton's Cove be regarded as normal, the conglomerate series would naturally reach across Crow Point and cover the melaphyr; and since this view is most distinctly indicated by the actual observations, it has been followed in the construction of the map and sections. The eastward extension of the beds of Langlee and Sarah Islands would carry them beneath Pine and Planter's Hills; and in the absence of evidence to the contrary the conglomerate series is represented on the general map as ending in this direction against the great fault separating the Hingham and Nantasket areas.

The Huit's Cove Area.

This area embraces all that remains of the third special map (Plate 9), including the large quadrangular body of melaphyr east of Huit's Cove and the sedimentary rocks which border the melaphyr on the north and west and form the immediate shores of the cove. It is a moderately elevated and ledgy tract, with comparatively little swampy ground. The east and southeast borders of the melaphyr, as previously noticed, are not exposed at any point; and it is possible to determine neither the exact position nor the nature of the contact with the sedimentary rocks. But on the north and west the conditions are much more favorable, and the boundary is drawn with substantial accuracy at most points. This melaphyr is, for the most part, a compact to imperfectly crystalline dark gray rock. The color varies, according to the condition of the iron oxide, from gray or greenish to reddish or purplish tints.



HUIT'S COVE.

E. Meisel, lith.

In texture it most resembles the melaphyr of the Village area, but is more slaty in some parts and, apparently, more crystalline in others, the crystallization being, perhaps, most marked in the least altered dark or gray variety. A finely porphyritic variety resembling porphyrite has also been observed. It is especially contrasted with the melaphyr bordering the granite axis by the comparative absence of the amygdaloidal and scoriaceous characters. Amygdules are often present, usually in small patches, but are mainly small and indistinct, although occasionally very large and conspicuous. They consist partly, as elsewhere, of epidote or epidote and quartz, but chiefly of a pure. dark green chlorite; more rarely of cleavable calcite. The calcite amygdules have been, superficially, very generally removed through solution, leaving the original steam-holes essentially intact. Chlorite is decidedly the most abundant and characteristic secondary mineral, and epidote, whether diffused or segregated is of subordinate importance.

The melaphyr area, as a whole, may be fairly described as quite uniform in character; and no reasons are apparent for drawing geological boundaries through it. No intrusive contacts have been observed; but this point will be referred to again in describing the slate. Neither are there any known facts requiring us to refer the melaphyr to different periods of eruption; although it is, perhaps, doubtful whether so large a body should be regarded as belonging to a single flow. In attempting to settle this point, I have searched without success for some development of the flow structure sufficiently marked to show whether the melaphyr still retains in the main, as I suppose it does, an approximately horizontal position. Of course, if still horizontal, the thickness is not necessarily great. The only facts which I have observed that seem to have any bearing upon this point are as follows: (1) At the extreme northeast corner of the melaphyr, not only are the ledges marked as sandstone just east of the boundary, on the map, all melaphyr, but the ledge immediately within the boundary marked as partly sandstone is also all melaphyr; so that there is no evidence, as once supposed, of sandstone overlying the melaphyr. (2) Directly north of these ledges, about half way between there and the shore, in the area colored as slate, is a ledge which appears on the map as sandstone and slate; but I am now satisfied that it is really fine-grained granite and felsite overlain by compact, slaty, and chloritic melaphyr. The boundary of the melaphyr at this point should thus be carried a hundred feet farther north as well as east. But the special significance of this outcrop seems to be that it shows us the actual base of the melaphyr, and that the northeast corner of this great block of melaphyr is tilted up a little higher, at least, than any other part.

That the contacts between the melaphyr and the sedimentary rocks bounding it on the west and north are lines of profound displacement is unquestionable, unless we are prepared to regard the melaphyr as intrusive in the slate and conglomerate, that is, as forming a vast dike or laccolite; a view which, it may be stated once more, finds no support whatever in the petrographic characters of the melaphyr, nor in any facts now exposed to our observation. The slate forming the shores of Huit's Cove and extending around the northern end of the melaphyr is undoubtedly, as previously explained, the great slate (14) of the Beal's Cove section, and in its normal position, or stratigraphically, it must be separated from the melaphyr by more than a thousand feet in thickness of the conglomerate series; yet here it lies directly against the melaphyr or separated from it only by the single bed of conglomerate, which, as the detailed observations will show, is clearly the highest member of the conglomerate series. We thus see that, simply as a measure of erosion, the melaphyr is impressive, since there must have been removed from its surface, not only the entire conglomerate series of Hingham, but also the still greater volume of the overlying slate series; and the bordering displacements, although they have barely sufficed to bring the bottom of the slate down to the top of the melaphyr, can, taking the high inclination of the beds into account, scarcely measure less than 2,000 feet. The main strike-fault is broken, as the map shows, by several transverse faults, which add much to the complexity of the contact.[1]

At the southeast angle of the cove, the slate is exposed almost continuously for a distance, measured at right angles to the strike, of about 90 feet. The contact with the melaphyr can not be observed, the nearest outcrops of the two rocks at this point being 30 feet apart. It is probable, however, that the real contact is near the most easterly exposure of slate, since a hundred feet to the north the outcrops of melaphyr advance nearly to this line. The strike of the slate is about N. 20° E.; and it dips away from the melaphyr, the inclination diminishing westward from 65° or 70° to 60°. For the first 20 feet it is quite massive and of a very dark gray color, although weathering whitish; but beyond this, or upwards, it becomes gradually much lighter gray and distinctly banded or laminated. It is well jointed throughout, but shows no distinct cleavage. The lower, massive portion of the slate, which, fortunately, has been quarried to a limited extent and thus affords a clean, fresh exposure, exhibits within the first five to eight feet of the base, several distinct zones coinciding in direction with the bedding of what appear at first glance to be simply black spots or blotches in the rock. More careful inspection, however, shows that they are really sharply outlined inclusions of a nearly compact and evidently igneous rock, in other words, pebbles. They are, as a rule, somewhat rounded or water-worn. They vary from a small fraction of an inch to several inches in diameter; and their longer axes usually coincide, after the

[1] During the three years since the colored map of this district was drawn, the discovery of additional outcrops of slate along the east shore of Huit's Cove has led me to a somewhat different view of the relations of the slate and conglomerate, the conglomerate appearing now as a limited bed in the slate. Consequently a new map of this interesting shore has been drawn (Pl. 11), which will be found to agree much better than the colored map with the following description of the ledges.

manner of pebbles, with the stratification. The most remarkable feature of these inclusions is that they are all of the same lithological character: very dark gray to nearly black in color, finely and imperfectly crystalline to almost compact in texture, and entirely massive in structure. The resemblance to the dark gray melaphyr of the Huit's Cove area is very marked, the main point of difference being that the inclusions or pebbles are blacker. They are seen, however, on close examination, to contain threads and amygdules of chlorite and calcite; while the fact, which has been observed repeatedly, that steam-holes on the original surface of a pebble are now filled, not with chlorite, etc., but with the fine greenish gray slate and minute fragments of the melaphyr itself, points to the conclusion that these secondary minerals have been developed in the pebbles subsequently to their inclusion in the slate, the melaphyr having been comparatively fresh and unaltered at the time of its enclosure. The pebbles, although scattered to some extent through the slate, are distributed chiefly, as stated, in several zones or layers from three to six or eight inches in thickness. Under the lens, however, the fragments of melaphyr are seen to be of all sizes down to the finest sand and dust; and this almost impalpable débris of the melaphyr, which really forms a considerable fraction of the whole, is not limited to the pebbly layers, but pervades the entire thickness of the dark gray slate and is, obviously, a sufficient explanation of its darker color.

Following the shore southwest from this little quarry, we find from 40 to 50 feet higher up in the slate several other pebbly layers from a few inches to a foot in thickness. These, however, are strongly contrasted with the preceding, in being made up of the normal variety of pebbles, different kinds of granite and felsite chiefly; but including, also, an occasional pebble of precisely the same black melaphyr. This circumstance alone proves almost beyond the possibility of a doubt that the enclosed fragments of the lower layers are genuine pebbles, and not due in any way to the alteration of the slate. Again, these melaphyr pebbles, although they have not been exactly identified with any mass of melaphyr now exposed to observation, lend some support to the view that there is or has been in this vicinity a body of melaphyr of more recent date than the great bed which, as we have seen, belongs near the base of the conglomerate series: for certainly it is not easy to see how melaphyr covered by a thousand feet of conglomerate, sandstone, and shale, could have yielded these pebbles to a still higher part of the same conformable series of strata; but a limited eruption — dike, laccolite, or surface flow — at the close of the conglomerate series would explain the phenomena. It should be added that the outcrops of melaphyr nearest to the pebbly slate and upon or against which it seems to rest, are of wholly different character from the enclosed fragments, being greenish and profusely amygdaloidal.

The outcrop of slate is almost continuous northward across the outlet of the swamp to the ledge of beautifully jointed slate which projects somewhat into the cove. The breadth of the slate here is fully 100 feet; but the dip is lower, varying from 60° near the melaphyr to 55° at the top of the bed. The lower half of the bed is very imperfectly exposed; but it is clear now that the conglomerate layers near the middle of the bed are as limited in this section as in the first, and that there is no appreciable break or displacement, and hence that the compensating faults bounding this ledge on the colored map are not needed. The jointing of the slate in this ledge is exceptionally perfect, yielding many flat-surfaced, sharp-edged, crystal-like blocks; and certain layers contain scattering cubic crystals of pyrite.

A short beach now interrupts the slate, but the background of melaphyr continues without deviation; and toward the north end of the beach the slate, reappearing, presents an interesting contact with what appears to be a north-south dike. The melaphyr along this beach, which has been well exposed by quarrying, is the dark gray, semi-crystalline, and sparingly but very coarsely amygdaloidal variety, many of the larger steam-holes, especially, being filled with cleavable calcite, and others with chlorite. The eruptive rock in contact with the slate, although bearing some resemblance to this melaphyr, is probably a true diabase, or, at least, intrusive in the melaphyr as well as in the slate. The contact, which is exposed for about twelve feet, is somewhat undulating or wavy; but the plainly marked lamination of the slate is quite closely conformable with the curving contact, so that where two convex curves meet a very sharp fold of the slate projects a foot or more into the trap. Occasionally, however, the contact breaks across the bedding; and, although it is a conceivable fault-fracture, it appears best, for the reasons stated, to regard the strike-fault between the slate and melaphyr as followed, in this instance, by a dike younger than either but lithologically somewhat similar to the melaphyr.

On attempting to follow the slate northward along this contact we encounter an undoubted transverse fault, for we pass at once to melaphyr, and the contact is shifted abruptly to the westward or toward the outer edge of the beach about 40 feet, equal to a vertical slip of nearly 60 feet, with the down-throw, evidently, to the south. North of the displacement the contact-dike appears to be wanting; and the slate and melaphyr are seen in actual contact. The exposure, however, is unsatisfactory; and the evidence is still inconclusive as to the true relations of these two rocks. The displacement is proved also by the conglomerate layers in the slate, previously mentioned; for these reappear, essentially unchanged, on the point at the end of the beach. The westerly dip of the slate is very constant, being 55° on this part of the shore.

About 120 feet north of this beach and the small quarry, the transverse fault is repeated in the reverse direction, the two displacements being approximately compensating. The contact between the slate and melaphyr, unchanged in direction, is now in the woods from 130 to 170 feet back from the shore;

and, although the ledges on either side locate it closely enough for mapping, it is nowhere exactly or satisfactorily exposed. We now learn for the first time that the full breadth of this bed of slate does not exceed 100 feet, equal to a thickness of about 80 feet, and also that it is conformably overlain on the west by a heavy bed of conglomerate, which forms the shore for a distance of 400 feet. The exposed breadth of the conglomerate is, at first, only 30 feet; but it increases northward to a maximum of 70 feet, equal to a thickness of nearly 60 feet. This is probably not the entire thickness of the conglomerate; at any rate there are no indications on this part of the shore of its being overlain by slate. It is, for the most part, a rusty and readily disintegrating rock. At some points it is quite ochery in appearance; and it is, doubtless, owing to the lack of an efficient cement and its consequent friable or crumbling character that it fails to outcrop farther south on the shore. Although mainly of medium and uniform texture, a portion of the bed, as exposed on the shore, is extremely coarse and irregular. The pebbles are of all sizes up to a yard or more in diameter, the largest observed being a bowlder of coarse granite over five feet in length. Furthermore, the various sizes are jumbled together promiscuously, without evident assorting or stratification, looking not unlike an indurated till or bowlder clay.

On account of its relations to the slate, the composition of this conglomerate possesses unusual interest. The conglomerate is not only underlain, but, as will be seen later, it is overlain by slate, the overlying bed embracing a thickness of a thousand feet or more. It is clear that, in the absence of fossils in the slate, the key to its geological age is to be sought in this intercalated conglomerate, proceeding on the principle that every rock of this region represented among the pebbles of the conglomerate must be older than both the conglomerate and the great overlying slate. We are able to prove in this way that the slate is newer than most, at least, of the granites and felsites, as well as some of the melaphyrs and porphyrites; and since some of these rocks, and especially the granite, are clearly eruptive at many points through the Lower and Middle Cambrian slates of the Boston Basin, it follows that the Hingham slate should be referred to a higher horizon. I have also observed in this conglomerate frequent pebbles of slate, a further confirmation of the view that there is an older slate in this region. Of especial interest in this connection, however, are the calcareous portions of the conglomerate. The most casual observer would be likely to notice that limited portions of the coarse conglomerate have an etched appearance, weathering in the smooth and cavernous manner peculiar to calcareous rocks, and the test with acid at these points shows an abundant calcareous cement, the solution of which allows the pebbles to fall apart. This calcareous conglomerate is chiefly in the form of irregular but rounded and sharply defined masses or patches from a foot to a yard or so across; and elsewhere in the bed the calcareous cement is wholly wanting. This is analogous to what may sometimes be observed in the modified drift of limestone districts, such as western New England, beds of loose sand and gravel enclosing irregularly rounded but often extremely graceful masses of firm sandstone and conglomerate due to the solution and segregation of limestone débris. The source of the calcareous material in the Hingham conglomerate is an interesting question. Does it indicate contemporaneous shells and corals—fossils belonging to the same geological age as the conglomerate, or is it, as in the more modern examples just cited, limestone débris from some older formation, which, after its enclosure in the conglomerate, has undergone segregation—solution and deposition—so as to assume a concentrated form in limited portions of the rock? The latter is undoubtedly the true view; for there still remain undissolved fragments of the limestone, well-rounded distinct pebbles of all sizes up to a foot or more in diameter, some of them beautifully stratified in directions entirely at variance with the bedding of the conglomerate. The pebbles of limestone are of quite uniform character; and are to be recognized especially by the mode of weathering and the behavior with acid. The rock is dull gray, finely and imperfectly crystalline, evidently impure, and leaves a large insoluble residue when treated with acid. Where the segregation of the calcareous débris has occurred in the finer—sandy or slaty—portions of the conglomerate, the resulting forms are sometimes difficult to distinguish from the original pebbles. The further consideration of the source of these fragments and of the light which they throw upon the age of the enclosing rocks may most profitably be reserved for the general discussion of the age and relations of the Hingham strata.

On following the conglomerate north it is found to end abruptly, as shown on the map, against the slate. The contact, which is clearly exposed and can be traced over the cliff, is transverse to the strike of both rocks and a very obvious fault. The fault-plane strikes N. 80° E. and hades to the north 10°, and parallel with it the slate shows a very marked cleavage. On account of the cleavage, and the consequent shaly character of the slate near the surface, the true bedding is difficult to make out. It can be proved, however, that the dip has the normal westerly direction for this shore, but is somewhat steeper than usual. Along the fault-line, for a thickness of a foot or so, the slate is distinctly comminuted, having, evidently, experienced unusual compression and friction; and in the conglomerate, parallel with the fault, may be observed several more or less distinct planes of either cleavage or shearing. The marked cleavage of the slate is evidently a local feature, for along the north side of the cove, 400 feet distant, it is scarcely noticeable, being quite subordinate to the joint-structure. We may, therefore, find a sufficient explanation of the cleavage in the fact that the slate, as the result of the faulting, has been dropped down along side of the massive conglomerate and then squeezed up against it.

This slate is not that which we have previously observed underlying the conglomerate; for on ascending the slope north of the fault it is found, as shown on the map, to rest upon the conglomerate, which has been shifted laterally a little more than its own breadth, equivalent to a vertical slip of nearly 200 feet. From this point the conglomerate can be traced across the fields in frequent outcrops, approximately as mapped, for nearly a quarter of a mile, closely bordered by the outcrops of slate on the west and of melaphyr on the east, the termination of the conglomerate being marked by a large bowlder of coarse conglomerate resting upon a ledge of melaphyr. We look in vain here for any trace of the slate which we have found along the eastern shore of the cove separating the melaphyr and conglomerate. Apparently, the throw of the transverse fault, added to the strike-fault bounding the melaphyr, has been sufficient to conceal the lower slate; and we thus reach the conclusion that, as shown on the new map, the transverse fault probably breaks but does not necessarily cross the strike-fault. The transverse fault marked as crossing the conglomerate northeast of the cove is clearly indicated by the jogging of both the upper and lower contacts of the conglomerate; and the change of strike on crossing this line is obvious. At the point where the conglomerate is mapped as coming to an abrupt termination it evidently shares the fate of the lower slate. A transverse fault is almost a necessity here; and its relations to the strike-fault and the strata are the same as before. The contact between the conglomerate and melaphyr is exposed at several points, but not sufficiently to reveal clearly their true relations. The contact is, apparently, an irregular surface and is broken by minor faults as well as by the principal displacements already described.

Undoubtedly the best section of the slate series of Hingham is that along the north side of Huit's Cove. From the conglomerate west across the strike the slate is exposed almost continuously for about 1,100 feet. The dip is constantly to the west, varying from 45° to 60° or more as we approach the conglomerate, the actual exposed thickness of the slate being, probably, about 900 feet. In one ledge only on the northeast shore of the cove, a few scattering pebbles have been observed in the slate. It resembles the lower slate in the fine and perfect jointing, which is particularly well developed on the point, yielding prismatic blocks which are sometimes remarkably slender, less than a square inch in section, and several feet in length — monolithic columns in miniature. For the most part, at least, it is of a darker gray color than the lower slate, and somewhat darker, also, than the slate of the Beal's Cove section. In following the slate north from Huit's Cove, the strike seems to change gradually with the conglomerate, and the dip becomes more variable; but on crossing the fault terminating the conglomerate the strike changes abruptly to N. 65°-70° E., and holds that general direction across the north end of the melaphyr; while the dip between the melaphyr and the north shore is extremely inconstant. This mass of slate is, in fact, highly contorted, being contrasted in that respect with all the other outcrops of Hingham. The slate shows no special alteration in the vicinity of either the melaphyr or the great masses of diabase which break through it. In general it is a soft, thin-bedded, dark gray slate, showing in some of the ledges a good lamination cleavage; although the true slaty cleavage, which holds a nearly constant attitude throughout this district, is usually transverse to the bedding. In spite of the fact that the dip of the slate is extremely variable, it is easily seen that, as the map shows, the prevailing or true dip is north near the melaphyr and south near the shore, indicating an irregular synclinal fold east of the transverse fault, the axis of which is roughly marked by the great dike. It does not appear, however, that the dike has materially influenced the character of the folding. The contortions are, of course, a normal feature of an open syncline; but whether either the fold or the contortions are connected genetically with the great strike-fault supposed to separate the slate and melaphyr, we can only conjecture.

The extreme northwest corner of this area is low and devoid of outcrops; but the ledges on the south and east are evidently sufficient to justify mapping the whole as slate. Eastward, on the contrary, the ledges, alike of melaphyr, slate, and diabase, end at the western edge of the meadow and its barrier beach: and the band of slate represented as crossing the meadow and the northern end of Pleasant Hill is based largely upon theoretic considerations. In the way of direct evidence we have the important fact that this north shore, including the beach and the section of till above it, is made up almost wholly of débris of the gray slate, many of the fragments being large and angular. There are, of course, occasional bowlders of granite and felsite, glacial erratics from the hills north of Boston Harbor; and more rarely, also, a stray block of conglomerate or sandstone. But it is perfectly obvious that we find here no adequate representation of the great development of the conglomerate series — conglomerate, sandstone, and red slate — outcropping immediately south of this shore and striking directly toward it. Considering the extremely local origin of the main part of the drift, we have no alternative but to conclude that this shore is underlain by the gray slate and not by either the conglomerate series or the melaphyr. This prolongation of the slate series directly across the strike of the conglomerate series implies, of course, an eastward extension of the fault between the slate and melaphyr. At the northeast corner of the melaphyr, as already explained, this fault should be carried a little nearer the shore than the map shows it; but there is, on the whole, no theoretical part of the map which I am able to regard with greater satisfaction. According to this view, the Melville Garden and Planter's Fields area of the conglomerate series is bounded on the west by a profound upthrow fault, and on the north by an equally profound downthrow fault.

The Islands North of Hingham.

Slate Island and Grape Island, although belonging politically the one to Hull and the other to Weymouth, are geologically a part of Hingham; and at extreme low tide they are topographically almost joined to the main land. These two islands are contrasted in their topographic features. Slate Island, the name of which is unusually appropriate, is almost bare of drift; and with the exception of some unimportant beach deposits on its southern shore, the ledges of slate are exposed over, virtually, its entire surface, or would be but for the exceedingly dense growth of sumach, raspberry, and other shrubs. The island rises abruptly on the north shore in a low cliff from 15 to 25 feet high, and descends thence in one long gentle slope to the low southern shore. Grape Island, on the other hand, although clearly underlain by slate, is heavily drift-clad, bearing two distinct drumlins, with a broad depression holding a small pond between them.

Slate Island, especially, is, geologically, essentially a continuation of the northwest shore of Hingham. With the exception of the numerous rusty gray dikes of diabase, the rock is all the same soft, dark gray, thin-bedded slate with which we have become familiar north and northeast of Huit's Cove, the chief difference being that on the island the slate is less contorted, and has a higher and more constant dip; and the cleavage and bedding are in constant instead of only occasional agreement. The strike is usually N. 65°–70° E., the extreme range, however, being N. 55°–75°. The dip is almost vertical over the whole surface of the island, varying usually between S. 85° and 90°, although at one point, where influenced by a large dike, it is N. 85°. The stratification is everywhere very thin, even, and regular; and many of the exposures are exceedingly beautiful examples of the upturned leaves of the geological record. Smooth, glaciated surfaces present a remarkably perfect striping or lining; while on the beach, where the waves and frost have fully developed the cleavage, the appearance is suggestive of gigantic crystals of mica set on edge and undergoing exfoliation. The cleavage, which, as stated, is everywhere sensibly parallel with the bedding planes, is, perhaps, the most perfect to be observed anywhere in the Boston Basin ; and it is a noteworthy illustration of the principle that when the bedding planes nearly coincide with the normal direction of the cleavage, the latter is deflected so as to make the agreement perfect, the normal inclination of the cleavage in this part of the Boston Basin being N. 70°–80°. The fissile character of the slate is seen also in the fact that with few exceptions the numerous dikes follow the bedding planes and the cleavage.

Although we do not observe on Slate Island the minor plications or contortions, the strongly marked wrinklings of the slate which characterize the north shore of Hingham, there is abundant evidence of local stresses and deformation. The indications are that during the powerful compression of the slate evidenced by its high dip and perfect cleavage it experienced intense but very local torsional and shearing strains, resulting in the development of (1) numerous small monoclinal bendings, along the axes of which the slate is often pinched to half its normal thickness ; (2) innumerable parallel and overlapping or *en échelon*, oblique rifts or cracks from an inch to a foot or more in length. The rifts are invariably attended by slight displacements of the layers, thus affording most complete and instructive examples of normal faults ; the slate, without exception, being bent or compressed in such a way that the hanging wall of each rift or fracture is depressed with reference to the foot-wall. The displacement dies out gradually from the middle toward the ends of each fault ; and the cases are frequent where monoclines can be seen passing into normal faults, a simple plication changing within a few inches to an actual break and slip. In many of the fault cracks, also, calcite has been deposited from solution, forming miniature veins, which have thus faulted walls and many of the normal features of more important examples. Slate Island is, indeed, a fine field for the student of structural geology; and it is interesting to observe in this connection that the conditions are unusually favorable for obtaining cabinet specimens of the slate exhibiting its various structural features; for besides the débris which naturally encumbers the shore, we have that afforded by the numerous small quarries scattered over the island, the slate having been extensively quarried in the past for ballast.

The half-tide ledge southwest of Slate Island is composed of slate precisely similar to that on the island, with a nearly vertical southerly dip. The bed rock of Grape Island is exposed at only two points, on the north and south shores, near the eastern end of the island. The southern ledge, which is in the line of strike of the north shore of Slate Island, is a dark gray to black, thin-bedded, and fissile slate. The cleavage conforms perfectly with the bedding, and the slate is well jointed. The strike is N. 75° E. and the dip S. 80°–90°. The slate is somewhat contorted in places, and it is traversed by several small irregular gray dikes similar to those of Slate Island. The northern ledge, which is on the extreme northeast corner of the island, is quite extensive at low tide. It, also, is all slate; but mostly a coarse, gritty, gray variety, and not, as a rule, very distinctly bedded. Toward the northern end of the ledge, however, it is darker and softer, and more like the slate on the south shore. The strike is N. 70° E.; and the dip S. 70°–75°.

Beyond these islands there are no outcrops of any kind nearer than Raccoon Island on the west, the village of Hull on the north, and Rocky Neck on the east. Hence we can only speculate as to the extension and probable relations of the newer slates in those directions; but southward there can be no reasonable doubt that they are continuous with the similar slates forming the north shore of Hingham. Unfortunately, however, the vertical position is a very equivocal one; and it is quite impossible to say with certainty whether in looking south from Slate Island we are facing a syncline or an anticline. The former is, of course, indicated by the beds on the island, and the latter by those on the shore, and it may very well be that several axes intervene.

THE DIKES OF HINGHAM.

It is intended, of course, to include here only those intrusive masses which are either contemporaneous with or newer than the sedimentary rocks; and the granitic rocks — diorite, granite, and felsite — are thus wholly excluded. No dikes of porphyrite have been certainly identified in Hingham; but, as previously stated, the dikes associated with the slate and conglomerate are all of more basic character and are certainly nearly all true diabase. It is possible, however, that several of the dikes which have been observed should be classed as melaphyr. One of these, which is colored as melaphyr on the map, crosses the small field in the angle between Downer and Grove Avenues, south of the pond. The rock has the texture and general appearance of melaphyr; but the outcrops are insufficient to show clearly its width, exact trend, or relations to other rocks, except that it appears to be cut, as mapped, by a dike of normal diabase. It is, however, probably intrusive in the conglomerate; and hence suggests a flow of melaphyr much higher up in the stratigraphic scale than any that we have recognized. A dike of similar lithological character, and possibly a continuation of this, although it has been inadvertently colored as diabase, breaks through the conglomerate near Otis Street, in the south part of Melville Garden. It is about 15 feet wide, irregular in outline, and hades to the north.

A glance at the maps suffices to show that the diabase dikes, which we may suppose are wholly subsequent to the sedimentary deposits, dating from the period of disturbance when the strata were folded and faulted, have, with few exceptions, a general east-west trend; and it is highly probable that the two east-west systems of the Nantasket area are represented here, but there are no clearly exposed intersections fully to prove it. The dikes of the south-of-east or newer system evidently predominate; but the maps render it unnecessary to specify more particularly those belonging to the different systems. The newest or north-south system of the Nantasket area is, possibly, wholly unrepresented. Certainly no typical examples of it have been observed. No attention has been given to the numerous dikes of diabase traversing the granitic areas, further than to observe that they also show a general agreement in trend with the east-west systems of Nantasket; and hence are probably mainly if not wholly of post-Cambrian age. In other words, on account of the great difficulty of tracing and correlating the dikes, no attempt has been made to map them outside of the sedimentary areas; and within these areas it is probable that a large proportion of the dikes are wholly concealed by drift, while many others are so imperfectly exposed as to preclude their delineation. The maps show the trend and, in most cases, the width in feet of each dike. The prevailing hade, as at Nantasket, is to the north.

Dikes of the Village Area.

Beginning at the east, we have first the short dike, from 50 to 70 feet in width, in the granite between Elm Street and Lafayette Avenue. This is of special interest as helping to prove the faults which limit it on the east and west, and as showing that in this case at least the dike probably antedates the faults. The large masses of trap in the granite on and near Hersey Street present no points of special interest. They are, possibly, connected with each other and also with the large dike in the conglomerate series which crosses Hersey Street at the junction with the lane. The southward extension of this dike is, however, quite problematical; but the east-west branching portion has been quite clearly traced out, varying in width from less than three feet to more than thirty feet on Hersey Street. In the end of the lane the outcrop of diabase measures 100 feet north and south; and the southern extension appears the best explanation of this fact. The east-west branches are, possibly, independent and intersecting dikes. Certainly the main or more southerly branch east of Hersey Street presents striking characters not observed in the others. Its eastern outcrops in the sandstone, where it is from 6 to 7 feet wide, are very distinctly and quite coarsely porphyritic, enclosing feldspars one fourth of an inch long. It is also very highly magnetic, containing a large amount of magnetite in grains up to half an inch or more in diameter. Farther north Hersey Street is crossed by two parallel dikes 3 feet and 8 feet in width; but east of the street they are smaller and appear to unite and then divide again; while west of the street they seem to be offshoots from a large mass of trap of undetermined form. The other dikes call for no special comment. Where the width is not given on the map, it means that the outcrop is unsatisfactory; and several dikes have been omitted for this reason. Evidently, the dikes of this area are especially characterized by their irregular, branching forms, which makes it unsafe to map them beyond their outcrops.

Dikes of the Beal's Cove Area.

This part of Hingham appears to be comparatively free from dikes; the only one distinctly represented on the map being the irregular ten-foot dike at the mouth of Beal's Cove. This appears to belong to the south-of-east system; but its trend may mean nothing more than a natural tendency to follow the bedding of the slate. About 1,000 feet directly east of the northern arm of the cove, on the south side of Tucker's Swamp, a large mass of trap breaks through the conglomerate and sandstone, which was inadvertently omitted from the map. It is impossible to be sure of its size or trend, but it is probably a dike at least fifty feet wide, having a general north-south direction. Obscure outcrops of several large dikes have also been observed on the line of Beal Street, in the granite and melaphyr.

Dikes in the Area North of Lincoln Street.

This is the area of the third special map (Pl. 9), embracing also the islands of the harbor. We naturally notice first the great masses of coarsely crystalline diabase which are such conspicuous features of the map. The actual outcrops, as may be seen on referring to the map, are quite insufficient for the accurate delineation of these immense dikes. But, although the outlines, as engraved, are largely hypothetical, they serve to show their approximate extent and probable relations to the enclosing strata. The long branch extending southward from the western end of the broad dike which crosses Planter's Fields Lane has certainly a very slender basis of facts; but still it correlates the scattering outcrops and is inconsistent with no actual observation. The same is true of the western part of the large dike north of Huit's Cove. If it has not exactly that form, it probably has some similar form. The boundaries of all the dikes are represented by continuous lines where they are reasonably well determined, and broken lines where they are hypothetical. The slate separating the two branches of the large dike between the melaphyr and the north shore extends at least 150 feet farther east than represented; and it is by no means certain that these two are really united on the land. The clearest exposure of the contact with the stratified rocks is on the north side of the southern dike, where it breaks through a bed of reddish brown slate. The slate is somewhat warped, the dip and strike being appreciably affected; but there is no marked lithological change; and this is the general fact, the slate and sandstone appearing rarely to be sensibly altered by the proximity of the trap. No clear intersections of these large masses of diabase by the smaller dikes of the district have been observed; and perhaps the most probable view is, that some of the smaller and more typical dikes are offshoots from these great intrusive masses. One thing is certainly very clear; *viz.*, that the latter occur where the stratified rocks show exceptional disturbance, and hence probably date, like the smaller dikes, from the period when the strata were folded and faulted.

The three dikes on Langlee Island appear to agree in hading N. 10°–15°, but while the north dike and the south dike are parallel with the strike of the conglomerate, trending a little north of east, the middle dike is oblique to the strike, trending a little south of east. The latter dike is highly altered, appearing to be made up very largely of secondary minerals — epidote and quartz. These dikes can not be identified on the main land, passing, probably, beneath the drift of Crow Point. The numerous dikes in Melville Garden and Planter's Field and on the shores of Huit's Cove evidently belong mainly to the south-of-east system, but the outcrops are not easily connected, with the single exception of the large dike which follows the general course of Grove Avenue, and can be traced in frequent outcrops for 1,800 feet. The very unusual trend of this and one or two other dikes may, perhaps, be due in some way to the northerly strike of the strata. The nearly north-south dike in the main belt of slate appears, at first glance, to belong to the third or newest system of Nantasket. Lithologically, however, it does not agree with that system; and it seems best to regard it as, normally, an east-west dike which has been influenced in its trend by the bedding of the slate.

Dikes of Slate and Grape Islands.

About twenty dikes from 2 to 8 feet wide have been observed on Slate Island. Fully two thirds of these are exactly parallel with the slate; and the remainder, which are extremely irregular in form, break across the slate approximately at right angles. Although two systems of dikes may thus be recognized, as regards mere direction, they are undoubtedly all of the same age; for while they are somewhat peculiar in lithological aspect, they are all extremely alike in this respect. The trap is, without an important exception, a finely and indistinctly crystalline, almost compact, light brownish gray variety, of a dull, ashen luster. Trap of this general character and evidently highly altered, has been observed repeatedly in the thin-bedded slates of this district, and is, perhaps, somewhat peculiar to them. On the north shore some very small dikes (from 1 to 6 inches) not included in the previous enumeration have been altered to impure epidote. The small gray dikes in the slate on the south side of Grape Island are precisely similar to those on Slate Island.

Dikes in the Granitic Rocks.

Mr. Bouvé has carefully traced out the dikes of the granitic area, so far as they are exposed on or near the streets, and the following notes are condensed from his paper.

On Meeting House Hill, Main Street, South Hingham, a few steps north from the church, a dike from 5 to 6 feet wide is exposed in the granite for about 70 feet, trending west-northwest. The bold ledge of granite in the angle between Leavitt and Jones Streets is divided by three prominent east-west dikes. They are readily found by proceeding 700 feet along Leavitt Street on the left side from Weir River to the house of Mr. Alanson Crosby, and then passing to the rear of the house about 300 feet from the road. The most northerly of the three dikes is from 2 to 3 feet in width; the second, 18 feet from the first, is 10 feet wide, and exposed for 75 feet; and the third, 40 feet from the second, is from 3 to 4 feet wide. On Leavitt Street about a mile and a half from Leavitt's

Bridge, going east, and less than a quarter of a mile before reaching the town line, a porphyritic dike 6 feet wide crosses the road diagonally, trending about east-west. On the east side of Lazell Street, 740 feet south of Free Street, the high ledge of granite is cut by a very similar east-west porphyritic dike 6 feet wide. About 50 feet south of it is a parallel dike 32 inches wide. At the granite quarry on Long Bridge Lane may be seen two east-west dikes about 30 feet apart, one about a foot and the other 22 inches in width.

On Friend Street, near Main Street, two east-west dikes cut through the granite of the roadway. The first is 330 feet from Main Street, from 4 to 6 feet wide, and has been traced from the road east about 100 feet and west across the meadows about 1,000 feet. The second is about 40 feet beyond the first, 2 feet wide, and has been traced 120 feet or more. In a ledge of granite on Union Street, about 360 feet from Lazell Street, an east-west dike can be traced about 100 feet. It varies in width from 15 inches to 2 feet, and is quite irregular. About 2,000 feet beyond this, going from Lazell Street, another east-west dike, from 3 to 4 feet wide, crosses the street diagonally, and has been traced 75 feet into the field on the left.

A dike at least 12 feet in maximum width crosses the junction of Rockland and Summer Streets, on Old Colony Hill, and has been traced east across the adjoining field a total distance of 815 feet. On the east side of the harbor, about 275 feet north of the steamboat landing, is an east-west dike 9 feet wide, with veinlets of epidote. About 80 feet farther north is a more irregular but similar and parallel dike about 2 feet wide. Beyond this, about 150 feet, a third dike encloses a large mass of granite. A fourth dike of the system, 6 feet wide, is exposed, 125 feet farther along the shore, at the entrance of Mansfield's Cove. At the north end of Martin's Lane, an east-west dike, 6 feet wide, can be traced 100 feet in the granite; and in the outcrops of granite about 500 feet in length along the east bank of Weymouth Back River, from 800 to 1,300 feet south of Beal's Cove, are three dikes from 5 to 10 feet or more in width and trending approximately east-west.

AGE OF THE HINGHAM STRATA.

The principal facts bearing upon this problem have been presented in the preceding pages, and it remains now simply to marshal the scanty evidence and note its collective value. Paleontological evidence is, at present, wholly wanting; although we may reasonably entertain the hope that fossils will yet be found in the slates or sandstones of Hingham. The lithological evidence, although it might be said to point to the correlation of the Hingham slates with those of Weymouth and Braintree, is certainly very unreliable in a case like this; and, furthermore, it is entirely at variance with the plain indications of stratigraphy. But the stratigraphic evidence, again, is far from direct or satisfactory, since the deposits of Hingham are completely isolated by the drift formations and the sea,—cut off, alike from the stratified rocks of Nantasket on the east and those of Weymouth and the Blue Hills on the west. Notwithstanding these difficulties, however, we have two clues which are satisfactory, so far as they go, although they are, unfortunately, not of such a nature as to lead to a definite determination of the geological horizon. These are (1) the relations to the older eruptives—the granitic rocks; (2) the composition of the conglomerate.

The Paradoxides beds of Braintree and the Blue Hills, which Walcott now regards as of Middle Cambrian age, are clearly intersected by, and therefore older than, the different varieties of granite and felsite of that district. We have no reason to doubt that these granitic rocks are the same for the entire South Shore, from Scituate and Cohasset westward; and therefore it follows that the conglomerates of Nantasket and Hingham, which are so largely composed of the débris of these eruptives and are seen in several sections to rest directly upon them, must represent an horizon above the Paradoxides beds. The conglomerate series is overlain conformably by the great slate series of Hingham, with some interstratification or blending of the two series. We are thus obliged to recognize in the Boston Basin a thousand feet or more of argillaceous strata above the Paradoxides or Middle Cambrian zone and separated from it by a corresponding or greater thickness of coarser sediments and lavas—the conglomerate series—with a probable unconformity at the base of the latter. This unconformity between the Paradoxides beds and the conglomerate series is proved, not alone by the extensive erosion of the granitic rocks, but we also find in the conglomerate, at Huit's Cove and elsewhere, pebbles of slate similar to that of the Paradoxides beds. Of special interest in this connection, as already explained, are the pebbles of limestone in the conglomerate of Huit's Cove. Limestone is a rare rock in eastern Massachusetts; and the only beds now known that can be regarded as a probable source of these pebbles are the limited and impure layers in the Cambrian slates of Nahant and Weymouth, and, possibly of Stoneham and other points outside of the Boston Basin.

It is apparent from the foregoing that, although we may fairly regard the stratified rocks of Hingham as forming one conformable series from the lowest conglomerate to the highest slate, and this series, which is quite certainly 2,000 and probably, including the Nantasket beds, 3,000 feet in thickness, is newer than the Middle Cambrian beds and separated from them by an important unconformity, we are still wholly at sea as regards the precise horizon of the Hingham and Nantasket strata. We might, consistently with the facts so far examined, refer them to any horizon between the Middle Cambrian and the top of the Carboniferous. It remains to be noted, however, that but for the contemporaneous lavas and the intersecting dikes, the conglomerate series of Nantasket and Hingham, including the conglomerate proper and the red and green sandstones and shales, bears a marked resemblance to the undoubted Carboniferous strata of the Norfolk Basin, extending from Braintree south of the Blue Hills to Wrentham, where it joins the Narragansett Basin. The conglomerate series of the Norfolk and Narragansett Basins underlies the true Coal Measures, and has been referred with much probability to the horizon of the Millstone Grit. Now, since it is the nature of volcanic phenomena to be localized, there appears to be no serious obstacle in the way of referring the conglomerate series of the Boston Basin, with the associated igneous rocks, to the same horizon; and we may reasonably suppose that, in consequence of the more yielding nature of the crust indicated by the igneous phenomena, while the formation of the conglomerate series was followed in the southern basins by conditions favorable to the formation of beds of coal and the enclosing shales and sandstones, a marked local depression made the site of the Boston Basin a deep-water area over which were deposited the barren slates which now overlie the conglomerate series. It is desired to simply suggest this correlation here, and the various facts which support it will be more fully set forth in Part III.

THE SURFACE GEOLOGY OF HINGHAM.

For the general outlines of this last chapter in the geology of Hingham the reader is referred to the corresponding section of Part I. These two areas (Nantasket and Cohasset, and Hingham) are not only contiguous, but, so far as the surface geology is concerned, they are actually continuous; and the only notable contrast which they present is this: the modified drift (sandplains and eskers), which is so scantily developed in Nantasket and Cohasset, is a very prominent feature of Hingham.

DRUMLINS, GLACIAL STRIAE, AND BOWLDERS.

As in Nantasket and Cohasset, the unmodified drift or till, so far as it is exposed at the surface, exists almost wholly in the form of drumlins; and, relatively to the area, they are quite as numerous and important in this district as in the other. The latter statement would, perhaps, be more than justified, but for the vast accumulations of modified drift from which the drumlins south of the railroad immediately arise and in which, no doubt, some of the smaller ones are wholly concealed. All the drumlins observed in Hingham are shown on the map in precisely the same way as those of Nantasket and Cohasset, with the exception of Prospect Hill (218 feet), which lies just beyond the southern limit of the map, on the east side of Beechwood River. Prospect Hill is probably about equal in size to the main Turkey Hill, and it is easily one of the largest and most imposing drumlins in the Boston Basin. The elevations refer to sea level (mean tide). This is the topographic height; and in the case of the inland drumlins it is considerably in excess of the true geologic height; for the height of a drumlin, regarded simply as a mound of bowlder-clay, should, evidently, be measured from the rocky base on which it stands. This is a partial explanation of the fact that so many inland drumlins have elevations incommensurate with their limited areas and overlooking the large drumlins near the shore. But it must be borne in mind, also, that some of the inland drumlins are much larger than they appear, only their summits protruding from the sandplains.

As the map shows, there is a noticeable difference in trend of the drumlins in the northern and southern parts of the town, the contrast being almost as marked here as in Nantasket and Cohasset. North of the railroad the prevailing trend is south-east or between that and east-southeast, while south of this line it is between southeast and south-southeast. The Turkey Hills belong in the northern division. Undoubtedly the correct explanation of this contrast is that proposed in Part I; *viz.*, that the ice-sheet, at least during the period when the drumlins were forming, was deflected to the east-ward by Boston Harbor, but the portion of the ice which overcame the southern wall of the harbor regained very nearly its south-southeast trend. Although it can be said that a general agreement exists between the trends of the drumlins and the glacial striae on the adjacent ledges, yet this agreement is by no means perfect in all cases. The striae, as the following table shows, depart, as a rule, less widely than the drumlins from the normal direction of glacial movement; indicating, apparently, that they were formed chiefly during the period of maximum glaciation, when the ice-sheet was less influenced by the subjacent topography and had power to move the entire thickness of the ground moraine and abrade the solid ledges; while the drumlins, it is generally conceded, must have been formed, or at least finally shaped, during the waning of the ice-sheet, when it was easily turned from its course and no longer an efficient agent of erosion, but, partly slipping over the ground moraine and partly dragging it along, banked it up against the ledges. This change in the direction of the ice-movement over the harbor area is proved, also, by a corresponding variation in the striae observable sometimes on the same ledge and often on adjacent ledges; and the fact that the later striae have been superimposed upon the earlier, without entirely obliterating the latter, testifies to the feebly erosive character of the later movement.

Directions of Glacial Striae.

Grape Island, on slate . . . . , ...	S. 60° E.
Huit's Cove, on a dike	S. 40° E.
Planter's Fields, on slate	S. 25° E.
Beal Street, on coarse conglomerate	S. 23°–25° E.
" " " melaphyr	S. 32°–35° E.
Beal's Cove, on slate	S. 30°–35° E.
West Hingham (Fort Hill), on diorite	S. 25°–35° E.
" " (near the Station), on melaphyr . .	S. 23°–25° E.
Weir River Street, on granite	S. 23°–26° E.
Corner Union Street and Long Bridge Lane, on granite	S. 22°–25° E.
Lazell Street, 1,000 feet south of Free Street . .	S. 23°–25° E.
Rockland Street, corner of Summer Street . . .	S. 25°–30° E.
Granite quarry near Abington Street	S. 25° E.

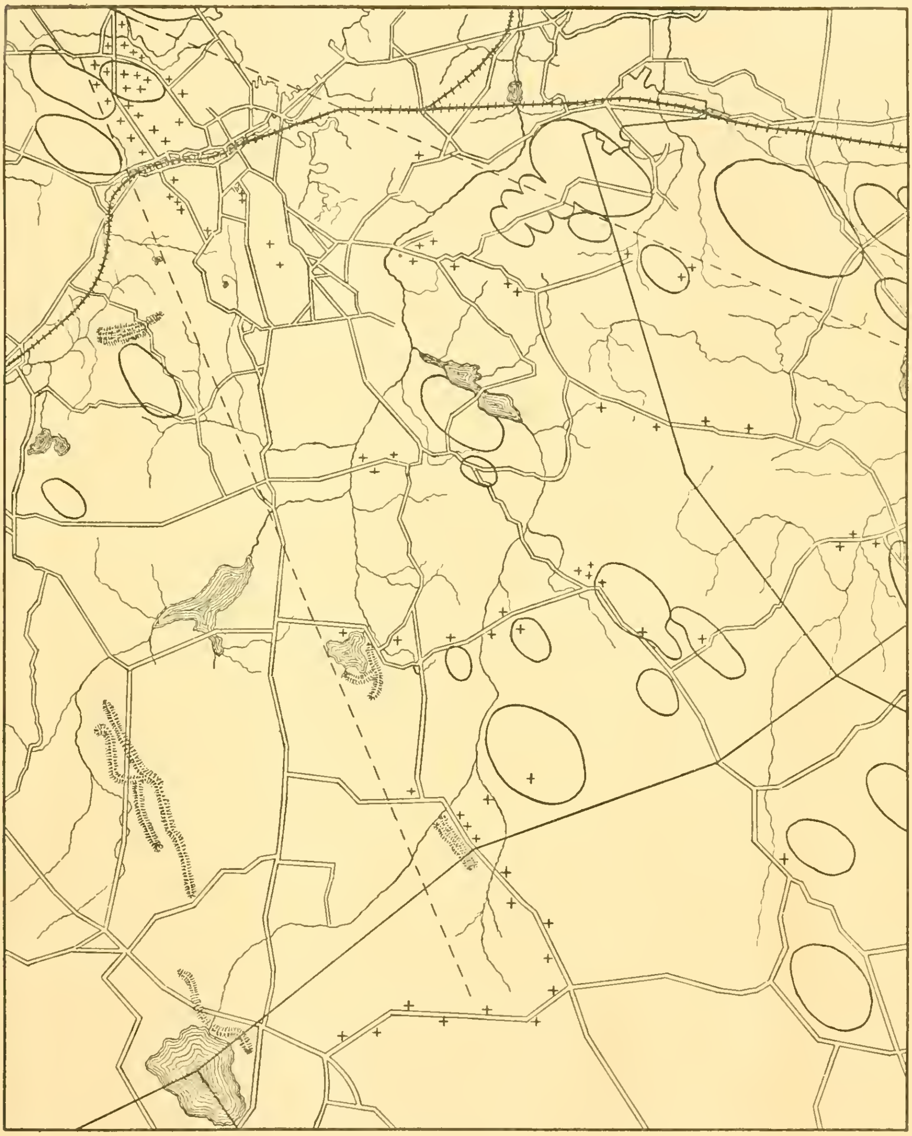
The fragments of marine shells forming an integral part of the till in several of the Nantasket drumlins and testifying to the preglacial existence of Boston Harbor, appear, so far, to be wholly wanting in the Hingham drumlins. This negative evidence is probably, however, of little value; for the discovery of the shells has been found to require, in every instance, a deep fresh section of the till, the shells having been removed by solution from the superficial portion of the till. Such a section is afforded by only one drumlin in Hingham — Crow Point Hill. On the north side, this drumlin is exposed to several miles of open water; and the waves have cut away, as the map shows, at least one fourth of the whole mass, forming a fresh scarp from 30 to 40 feet in height. A careful examination of this section on several different occasions has failed to reveal the slightest trace of enclosed or preglacial shells. It should be stated, however, that the lower part of this section is, unfortunately, concealed by the roadway and the retaining wall, and the greatest accessible depth below the original surface is probably not over 25 feet. Pleasant Hill presents on the same shore a long low section which, although not so satisfactory as the other, might, perhaps, be expected to disclose the shells if they were at all abundant in the hill. But this can not be said of the very low and imperfect sections afforded by the shores of the World's End, Planter's Hill, and Pine Hill. Turkey Hill, Otis Hill, and perhaps one or two other drumlins, present shallow roadside sections; but on none of the inland drumlins are there clear sections, natural or artificial, extending below the superficial and highly oxidized till. The insufficiency of this purely negative evidence is obvious, especially in view of the fact that shells have been found in well-sections in the inland drumlins of Cohasset (p. 143) and Braintree; and it may be safely predicted that fossil shells would be found in some of the drumlins of Hingham if the blue or unoxidized till were exposed to our observation.

The extremely local origin of the main part of the till becomes very obvious immediately on passing southward from the sedimentary rocks of Hingham to the broad area of granite. For the first mile or two fragments of conglomerate, slate, and melaphyr are fairly abundant; but beyond a distance of three or four miles from the boundary they are rather rarely met with. I have elsewhere[1] pointed out that the ice-sheet probably slid over the subglacial till or ground moraine, the latter moving very much less rapidly than the ice itself: just as the stones in the bed of a river move less rapidly than the water flowing over them. The englacial fragments only, like floating objects in a river, are far-travelled or measure the actual movement of the ice; and these form but a very small fraction of the till.

[1] Proc. B. S. N. H., v. 25, 134.

There is one rock in Hingham which is so unique and striking in its lithological character and so restricted in its distribution *in situ* as to give its distribution in bowlders or glacial erratics a special interest. This is the red felsite in the vicinity of Bradley Hill, on Lincoln and Thaxter Streets. The accompanying map (Pl. 12) shows the distribution of this beautiful rock in the drift, so far as it has been traced out. The bowlders of red felsite are of frequent occurrence north of the railroad; but beyond a mile from Bradley Hill they are few and far between, as indicated by a careful scrutiny of the stone walls, and every observed example has been noted on the map. The bowlders undoubtedly extend farther to the southeast than I have traced them; but their lateral limits are indicated at least approximately by the two lines on the map diverging southward from Bradley Hill. The directions of these lines are approximately S. 23° E. and S. 67° E. The initial breadth of the included area measures the probable east-west extent of the red felsite *in situ;* but the constantly increasing breadth southward must be attributed to the natural fanning-out or radial dispersion which has been noted in other cases of the derivation of glacial erratics from a limited area. The mean of the two lateral limits stated above (S. 45° E.) may be regarded as an approximation to the normal direction of glacial movement in Hingham; or, perhaps it would be better to say the average direction, since it is probable that the trend of the ice-sheet was not at any point constant in direction.

The fact, that, although the red felsite erratics have been found near the southern end of Main Street, none could be found on the line of or west of this street, is an indication that the movement of the ice was not rectilinear; but, as shown by the drumlins and glacial striae, it was first east-southeast, changing gradually southward to south-southeast, and describing a curve of which Main Street is the chord. Probably, also, the movement was, as previously explained, more easterly during the earlier and later stages of glaciation, when the ice-sheet was



+ + *Felsite Bowlders.* ◯ *Outlines of Drumlins.* *Eskers.*

MAP SHOWING THE DISTRIBUTION OF THE BOWLDERS OF RED FELSITE IN HINGHAM, COHASSET, AND NORWELL. SCALE, ONE INCH = 4800 FEET.

comparatively thin and easily diverted, and more southerly during the long intervening period of maximum glaciation.

Of the local origin of the larger fragments, at least, in the till, we have an impressive illustration in the numerous bowlders on Prospect Hill. This large drumlin is something like Booth Hill in Scituate in being well sprinkled with bowlders over a large part of its surface; but owing, perhaps, to aqueous erosion which has swept away the finer material, they are especially abundant on the southwest and south sides of the hill, these slopes being the most remarkable bowlder-fields observed in the South Shore district and recalling the bowlder-clad areas of Cape Ann. But among these thousands of bowlders, of all sizes from six inches to six feet or more in diameter, Mr. Bouvé and I have observed very few that are not granite; and certainly the sedimentary and volcanic rocks of northern Hingham are very sparingly represented. Still, in a walk along the shore between Crow Point and Huit's Cove, where the detritus is nearly all slate or slate and conglomerate, one meets quite frequent bowlders of granite and felsite, which must have crossed Boston Harbor. The most impressive example of this sort which I have observed is afforded by the two large bowlders of granite lying on the north side of Otis Hill. They are coarsely crystalline, subangular, and from 10 to 12 feet in maximum diameter. Underlying this end of Otis Hill and extending thence to the north shore of Hingham we have quite certainly only the sedimentary rocks and intersecting dikes of diabase; and the nearest visible source of these bowlders is the granite ledges of Saugus, 16 miles distant.

The most notable bowlder in Hingham, so far as mere size is concerned, is the large mass of granite on the north side of Rockland Street, near the base of Old Colony Hill. It lies on top of the ground and quite close to the road, but is partly concealed by the young trees growing about it. It is an irregularly angular block of granite 19 feet long, 16 feet wide, and 17 feet high; and was probably derived from one of the ledges in the vicinity of Martin's Lane or Planter's Hill. Another large bowlder of granite, almost concealed by young trees and vines, is partly buried in the swamp, close to the north side of Pleasant Street and immediately west of Beechwood River.

Two bowlders of conglomerate are large enough to merit special mention. One of these lies on the shore at the north end of Crow Point Hill and is partly submerged at high tide. It was originally from 12 to 15 feet in diameter, but has been ruthlessly broken by blasting into three unequal masses. It is a very firm, distinct, and coarse conglomerate, with many pebbles of reddish granite one foot or more in diameter; quite distinct from any conglomerate observed in Hingham, but resembling the coarse conglomerate of the Green Hill ledge at Nantasket. The other conglomerate bowlder is in the northwest part of Planter's Fields, northeast of Huit's Cove and about midway between the nearest water of the cove and the north shore. It rests on a ledge of melaphyr sloping northward, within a few feet of the northwestern extremity of the belt of conglomerate shown on the map, and measures 15 feet in length, 8 feet in width, and 9 feet in height. It is also a firm and rather coarse rock, the pebbles ranging mostly from 2 to 6 inches in diameter.

MODIFIED DRIFT AND TERRACES.

The modified drift, in its various forms, is a very prominent feature of Hingham geology; and it is here that we find the strongest contrast between the geology of Hingham and that of Cohasset and Nantasket. The sandplains, except the low plains immediately bordering the streams, are, to a large extent at least, indicative of standing water; and, except possibly for the very lowest plain, we must, as explained in Part I, postulate fresh rather than salt water. It appears probable, therefore, that the slight development of sandplains in Cohasset and their almost complete absence in the Nantasket peninsula is due to the general absence of barriers capable, especially at the higher levels, of retaining the water from the melting ice-sheet. The temporary lakes indicated by the sand-plains of the South Shore must, however, have owed their existence in every instance to a wall of ice on the north — the front of the retreating ice-sheet. During the recession of the ice the imprisoned waters north of the water-parting found outlets at successively lower levels, and it is undoubtedly to the somewhat abrupt changes of level in the lakes thus determined that we owe the broadly terrace or step-like arrangement of the sandplains which is observed on passing up from the Coastal Plain across the Lower and Glad Tidings Plains to Liberty Plain. It follows from this that, as in the case of ordinary terraces, the upper plains are the oldest and the lowest were formed last. At each level the glacial lakes received the natural drainage of the low water-shed on the south and of the ice-sheet itself, with its superficial rivers, on the north. The detritus deposited in the lakes, like the water, must have had a double origin, coming partly from the washing of ordinary till from which the ice had retreated and partly from the englacial till of the ice-sheet. The glacial streams had undoubtedly, in many cases, deeply grooved and divided the marginal portion of the ice, and in these grooves or channels was accumulated, after the manner of rivers, the narrow deposit of sand and gravel, which, when the ice melted away, became the steep, winding ridges which we call kames and eskers. At the mouths of these glacial rivers, delta-plains were formed in the lakes, adjacent deltas often becoming confluent. The plains are thus naturally coincident in height with the eskers, and often appear as expansions of the latter. The remarkably steep marginal slopes presented by the plains at some points are believed not to be the free, growing front — the foresets — of the deltas, but to indicate supporting walls of ice, the melting of which, as with the kames, allowed the material to assume the maximum angle of stability. In a similar manner, isolated masses of ice gave rise to the kettles and larger depressions or basins of the plains; and the valleys occupied by the modern drainage, although, doubtless, the product, in part, of erosion, especially of erosion during the formation of the lower plains, were probably outlined, at least in their wider parts, by stationary masses of ice, and since such remnants of the ice-sheet would naturally linger longest in the valleys, we have here a cause determining an approximate coincidence of the ancient and modern — the preglacial and postglacial — drainage lines.

Extending south from the railroad along the boundary between Hingham and Cohasset, and forming the water-parting between Weir River and Bound Brook, is a broad and nearly continuous remnant of the ancient peneplain, bearing several accumulations of till, among which the Turkey Hills and Prospect Hill are most prominent. South of Prospect Hill and Accord Pond this high land separates the basins of Weir River and Bound Brook from the much larger basin of North River. This broad divide is diversified in its eastern half by several large drumlins—Mt. Blue, Black Pond Hill, Otis Hill, Simons Hill, etc.—and many smaller ones, and a remarkable series of elevated swamps; but west of the meridian of Prospect Hill the surface deposits are almost wholly modified drift; and southwest of Union Street in Hingham there is no pass out of the Weir River basin below the 120 feet contour-line.

When, during the retreat of the ice-sheet, its front rested against the high land to the eastward, the water from the ablation of a large area of ice must have flowed across the divide west of Prospect Hill, forming the broadly extended sandplains which enclose Accord Pond (Accord Plain), with a height of from 160 to 180 feet, and slope gently southward for several miles; and when the ice-front had finally withdrawn from the summit of this divide, the northward drainage was obstructed by the ice itself and the lake formed in which were deposited the beds of sand and gravel forming Liberty Plain. During the maximum development of this lake the ice-front must have joined the divide near the junction of Union and Pleasant Streets and extended thence southwest and west along the northern edge of Liberty Plain across Main, Cushing, and Whiting Streets into Weymouth, as far at least as Old Swamp River, the valley of which may have been occupied by a long lobe of ice. This embayment of the ice-sheet holding Liberty Lake was thus from 3 to 4 miles in length and from 1 to 2 miles in breadth; and the waters probably found an outlet in the direct line of Beechwood River, along the west side of Prospect Hill, through Valley Swamp, and so over the divide into the basin of North River.

The valleys occupied by Beechwood River, the small streams draining into Fulling Mill and Cushing Ponds, and the branches of Plymouth River, dividing Liberty Plain or indenting its northern edge, probably correspond in a large degree to irregularities of the ice-front; for where this lobate character of the plain is best developed, the abruptness and steepness of the marginal slopes clearly indicate that they are not the free and natural forms or frontal slopes of deltas, and their relations to the streams and to the internal structure of the plain forbid us to regard them as the product of erosion. The hypothesis that these lobes are deltas pure and simple, unmodified by erosion or retaining walls of ice, requires us to postulate streams flowing from the south of improbable magnitude. Breakneck Hill, extending north from Whiting Street between two branches of Plymouth River, is a remarkably perfect lobe of Liberty Plain. It rises abruptly from the bordering streams, and its surface, save where dimpled with kettles, is approximately level for a breadth of 1,000 feet, being much too broad and plateau-like to be classed as a kame. Beyond Whiting Street, Liberty and Accord Plains, with occasional ledges of granite protruding through them, embrace almost the entire southwest corner of Hingham and the adjacent parts of

Weymouth and Rockland, the various parts being known locally as Huckleberry Plain, Mosquito Plain, Farm Hills, Smooth Hills, etc.

Some of the finest and most extensive eskers in Hingham are connected with Liberty and Accord Plains. On the east side of Accord Pond, in the vicinity of Pond Street in Norwell, Accord Plain has a very perfect development with a height of about 160 feet; and branching off from it is a typical esker which runs north and northwest to the outlet of the pond, where it is interrupted by an erosion-gap which has been widened by artificial excavation. West of the stream (Beechwood River) it follows a somewhat serpentine course towards and across Whiting Street, being traceable nearly 500 feet beyond the street. Accord Pond is due to the obstruction of the valley of Beechwood River by the plain and especially by this esker. What is virtually a somewhat detached branch of this esker runs north from Whiting Street east of the river. Continuing in a general north-northwest direction from these eskers for nearly half a mile to and across Gardner Street, we reach the southern end of the remarkable esker which extends thence for nearly a mile in the same direction to and across Cushing Street, showing a general agreement in height with Liberty Plain. It is throughout a prominent and sharply defined ridge of gravel; and can be traced about 1,100 feet west of Cushing Street. About 200 feet south of this esker Cushing Street cuts through a second and similar esker which has in its western half a curving course convex to the south, joins the first esker 600 feet east of the street, and then branches off and runs approximately parallel with it, as a high sharp ridge (Mullein Hill), nearly half way to Gardner Street.

Although the eskers of Cushing Street, which are known together as the High Hills, are such prominent and important features in the surface geology of Hingham, they are not more typical or beautiful than those next to be described. These are on the west side of the valley which is the direct continuation southward past the west side of Prospect Hill of the valley of Beechwood River, and through which, it seems probable, the waters of Liberty Lake found an outlet. The eskers form two adjacent and approximately parallel ridges from 20 to 40 feet high immediately west of and parallel with Prospect Street, commencing at the bend in the street south of Beechwood River and extending in a south-southeast direction across the town-line into Norwell as far as Valley Swamp, the extreme length being nearly half a mile. The western ridge reaches a little farther north than the other, and both are somewhat serpentine, being separated by shallow kettles, and uniting at one point to form for a few rods a single ridge.

That these eskers are connected in origin with a glacial river flowing southward through this valley there can be but little doubt. The whole appearance of the valley, east of Prospect Street, indicates that it has been swept by such a current. The very broad, low hill of till extending from Prospect Hill southwest to Valley Swamp is thickly strewn with bowlders, the finer portion of the till having been washed away; and on the lower western and southwestern slopes of Prospect Hill, as previously noticed, the ground is literally covered with bowlders, especially on the erosion terraces, which are a conspicuous feature of this drumlin. The most prominent bench or terrace is from 45 to 50 feet below the summit. It is strongly marked and continuous along the entire southwest side of the hill. About 30 feet below this is a second terrace; and 20 feet below that a third, the latter agreeing approximately in elevation with the kames and Liberty Plain. The upper terraces, at least, must antedate Liberty Plain, requiring the same explanation as the similar terraces on the drumlins of Cohasset and Nantasket; and thus dating from a time when the ice-sheet filled this valley, with the top of the drumlin protruding and a glacial river running between the slope of till and the edge of the ice.

The distinctly double or duplicate character of the Prospect Street eskers is very suggestive of the material having been deposited in a channel having a bottom as well as walls of ice. When the bordering ice melted away, it allowed the sand and gravel to fall down on either side of a ridge of ice; and the subsequent melting of this core or nucleus of ice caused the crest of the ridge to fall in, dividing the single ridge into two, with kettles between. In the same direct line with the Accord Pond and Cushing Street eskers is the splendid series on the west side of Weymouth Back River, in Weymouth; and it is in the highest degree probable that they were formed in succession by the same great glacial river.

Between Union Street and Leavitt Street there is a transverse depression or gap in the water-parting separating Weir River and Bound Brook which does not, apparently, rise above the 80 feet contour-line; and we may suppose that, when the ice-front had retreated from the high land at this point, the imprisoned waters found an outlet here, and Liberty Lake was drained, the overflow being now into Bound Brook instead of into North River. The continued recession and embayment of the ice, while the waters discharged at this level, formed the temporary lake in which were deposited the sands and gravels of Glad Tidings Plain, the normal height of which is from 65 to 70 feet. This plain has a very perfect development in the vicinity of Glad Tidings Rock, between Free and Pleasant Streets, and also west of Cushing Pond and Plymouth River, between High and Ward Streets, and the Weymouth boundary, and north of High Street, between Hemlock Swamp and French Street, surrounding and partially burying the drumlin of Nutty Hill, and also west of French Street. The little plateau known as Pigeon Plain, south of Hobart Street and southwest of Great Hill, is an isolated but singularly perfect portion of this plain. Liberty Plain does not rise directly from Glad Tidings Plain, but a marked depression separates them at nearly all points. The basins of Fulling Mill and Cushing Ponds are a part of this depression; but even on the line of Main Street, where there is neither pond nor stream, it is very noticeable. The northwestern part especially of Glad Tidings Plain is indented by many beautiful kettles and basins, some of which are ponds; but the only well-developed or typical esker, so far as I have observed, connected with this plain, is that skirting the east side of Fulling Mill Pond. This esker formerly terminated on the line of Pleasant Street, but it has been dug away for 50 or 60 feet. Its maximum height is above 40 feet, and it is nearly 2,000 feet long. It is somewhat winding, but the general course, as shown on the map, is approximately north-south. Somewhat less than 1,500 feet south from its northerly termination it divides, the western branch following the shore of the pond westward 750 feet farther, with an elevation of 25 feet.

South of Turkey Hill, the basins of Weir River and Bound Brook are connected by one or more gaps less than 60 feet in height through which the water probably passed during the formation of the principal and higher part of Lower Plain (from 50 to 55 feet). But later the overflow appears to have gained the still lower passage north of Turkey Hill, following the present course of the railroad (Weir River Bay being, presumably, occupied by ice) to Cohasset Harbor; thus explaining the sand deposits along this line and the very typical sandplain of Cohasset Village, Little Harbor being still occupied by ice, as indicated by the abrupt slopes of the plain on that side.

Although Lower Plain is only from 10 to 20 feet lower than Glad Tidings Plain, they are easily distinguished at nearly all points on account of the line of depression which separates them. Lower Plain has no important development east of Weir River, but its inland boundary is approximately defined by the valley of this stream and the small tributary stream crossing Main Street north of Free Street and draining Hemlock Swamp. From the north end of this swamp the line passes along Hobart Street between Great Hill and Pigeon Plain, which we have already recognized as an outlier of Glad

Tidings Plain, to French Street and the Weymouth line. This southern and highest part of the plain has its best development along the lines of Main, East, and Central Streets, its elevation here varying but slightly from 50 feet. West of Hersey and Main Streets it is more fragmentary, divided by swamps and meadows and the branches of Town Brook and Fresh River. It closely invests Great Hill, greatly diminishing the apparent height of this drumlin ; and some of these isolated portions are very typical in form, though more commonly presenting the forms of rounded hills and hillocks or kame-like spurs and ridges.

Undoubtedly the most interesting feature of the Lower Plain, south of the railroad, is the tongue or lobe of it which extends northeast along East Street from the vicinity of Main Street to Andrew Heights. This ridge of gravel and sand rises abruptly 50 feet from the salt marsh (Home Meadows) on the north and slopes gently down to Weir River on the south. It was evidently formed at a time when the basin of the Home Meadows was occupied by a lobe of the ice-sheet, the sand drifting, probably, from the main part of the plain on the west and accumulating against the edge of the ice, the subsequent melting of which gave the bank its steep northern slope. The special interest of this deposit is, of course, that it forms, as previously stated, a natural dam directly across the original course of Weir River, causing it to turn at a right angle, flow up the valley of what was once a small tributary, over the water-parting north of Turkey Hill, and thence down through Foundry Pond and a straight narrow valley to Weir River Bay, the drainage of almost the entire area of Hingham south of the railroad becoming, in consequence of this geological accident, tributary to Nantasket Harbor instead of Hingham Harbor. South of the glacial barrier, the valley of the main stream and its principal tributaries is broad, open, smooth, and unbroken by ledges, the streams meandering through extensive meadows and swamps ; and north of the barrier the valley is

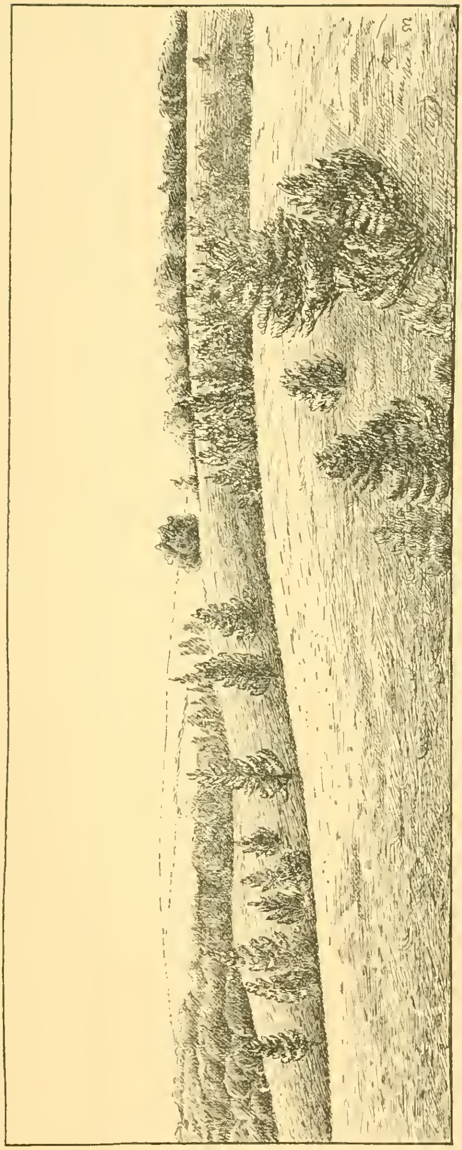


Fig. 24. — Great Hill Kames.

continued with the same character in Home Meadows; while the modern character of the present valley of Weir River below this point is seen in its contracted form, its rapid descent north of the railroad, and the fact that the actual channel of the river is frequently bordered by the massive granite ledges.

When the ice had retreated some distance north of the railroad, but still filled the valleys of Weymouth Back River and Hingham Harbor, and rested against the high rocky land extending from Old Colony Hill eastward to Little Harbor, the water finding an outlet along the line of the railroad into Cohasset Harbor, the part of the Lower Plain north of the railroad, and separated by the valleys of Town Brook and Fresh River from the higher southern part of the plain, was formed. It is most perfectly developed, with a normal elevation of from 40 to 45 feet, in the area south of Broad Cove and across the southern end of the harbor, this eastern extension almost repeating the barrier along East Street which has diverted the drainage of the Weir River Basin. Its most interesting development, however, is west of the drumlins, in the Hockley District, which embraces the triangular area between Fort Hill Street, Hockley Lane, and Weymouth Back River. The typical plain is almost wholly wanting here; but the deposit is of a distinctly tumultuous character, gracefully undulating, with rounded knolls, short ridges or kames, and kettles. It is to the smoothly hummocky character of this district that it owes its name. The highest part is a ridge from 60 to 80 feet high which should, perhaps, be referred to the Glad Tidings Plain.

Several groups of eskers may be referred to the Lower Plain, although only one of these is actually included within its area. This is the beautiful double esker at the north end of Great Hill. As shown on the map, these ridges trend east-west, the southern one just touching the extreme north end of Great Hill, from the slope of which the view (Fig. 24) is taken, the large drumlin which looms up in the distance being Baker's Hill. The ridges are approximately straight, parallel, of nearly equal height — from 30 to 50 feet — and so near together as to make it reasonable to suppose that they are the product of one glacial stream, as explained on page 279. The northern ridge is about 1,800 feet long, extending nearly 600 feet east of New Bridge Street; while the southern ridge begins at the street: and about 900 feet west of the street and 350 feet from their western terminations they are connected by a cross ridge, the beautiful, elongated basin between this and the street being known as the "dry dock." The unusual trend of these eskers is not readily accounted for, but we risk little in saying that their relation to Great Hill was probably a determining cause.

Passing the Hockley district, which is largely kame-like in character, the next group embraces three parallel ridges north of Beal's Cove, from 400 to 600 feet long and trending about west-northwest. Still farther northwest, at the re-entrant angle in the east shore of Weymouth Back River, about 1,600 feet south of Lincoln Street, we have the beginning of one of the finest and most extensive groups of eskers in Hingham. It skirts the shore without an appreciable break across Lincoln Street to the northern end of Stoddard's Neck, a total distance of fully two thirds of a mile, the general trend being quite normal, south-southeast. In detail, however, it is curving, winding, and branching, sometimes single and sometimes double, enclosing kettles and a pond, as shown on the map. The height varies from 25 to 50 feet, except on the west side of Stoddard's Neck, where it exceeds 60 feet.

Taking a general view, it is readily seen that all the eskers of Hingham may be referred to two slightly diverging lines or systems. The western system has already been traced, beginning in the magnificent series on the west side of Weymouth Back River, in Weymouth, and including the eskers of Cushing Street and Accord Pond. The eastern system begins on Stoddard's Neck, and includes the kames and eskers of Beal's Cove, Great Hill, Fulling Mill Pond, and Prospect Street.

On both sides of Great Hill are distinct erosion terraces corresponding in height to Glad Tidings Plain. Similar benches, but agreeing in elevation with the Lower Plain, are strongly marked on the southwest sides of Otis and Baker's Hills, prominent features of these great drumlins and the work, probably, of glacial streams tributary to the lake in which the Lower Plain was formed.

When the ice-sheet had retreated from the northwest corner of Hingham, but yet lingered in Weymouth Back River, the prominent line of ledges extending from Huit's Cove across Lincoln and Beal Streets to Beal's Cove, with the drumlins back of it, formed a barrier northwest of which was spread a very perfect sandplain having a normal elevation of from 25 to 30 feet and designated in the preceding pages as the Coastal Plain. Traces of it may be observed all through the northern part of Hingham, and corresponding to it are more or less distinct erosion terraces on the southwestern side of Pleasant Hill and the northeastern side of Squirrel Hill.

So far as known, there are no deposits of stratified clay in Hingham, above sea-level. This finest part of the modified drift was probably carried far beyond the limits of the town by the overflow waters from the glacial lakes. We may reasonably suppose, however, that beneath the argillaceous silt now depositing in Hingham Harbor and exposed to view at low-tide, there is a considerable thickness of true glacial clay.

POSTGLACIAL DEPOSITS AND CHANGES.

The evidences of postglacial changes of level observed in Nantasket are not repeated with equal distinctness, if at all, in the Hingham area; but above the present level of the sea there are, so far as observed, no traces of marine erosion or marine deposits, or any proofs of a postglacial elevation of the land. The lowest or coastal sandplain, like the higher plains, is, as already stated, best explained as the product of glacial lakes and streams during the departure of the ice-sheet. Beneath some of the lower bogs and marshes there are, possibly, layers of marine silt and shells, but nothing of the kind appears to have been observed. On the other hand, it is in the highest degree probable that sections of the salt marshes would present, in the form of buried peat beds, if not otherwise, evidence of a moderate postglacial subsidence of the land. But even if such facts were shown to be wanting, we need not doubt that Hingham has participated in the slight downward movement of which we have satisfactory evidence in other parts of the Boston Basin. All the evidence now at hand indicates that the land has been nearly if not quite stationary for a long period; and if, as has been supposed, a subsidence is still in progress, it must be extremely slow.

The erosive action of the streams of Hingham during post-glacial time has been insignificant. The almost entire absence of rapids indicates that the streams have to a very large extent regained the preglacial drainage lines; and in consequence we rarely find them now eroding the hard rocks. Weir River, below Leavitt Street, is, of course, a notable instance of diverted drainage, and the artificial fall where the river issues from Foundry Pond is almost the only suggestion of a cascade character observed in any of the streams of Hingham. The general absence of ledges in the valleys is, obviously, explained by the strong preglacial elevation of the land, during which the valleys were, in many cases, cut down below the present level of the sea. Marine erosion in postglacial times is practically limited to the drumlins about the harbor and the sand-plains and kames bordering Weymouth Back River.

The principal salt marshes of Hingham are the Home Meadows, and those bordering Broad Cove and the tidal portion of Weymouth Back River between the railroad and the barrier due to the jutting out from either shore of a kame-like ridge of modified drift. Several of the smaller marshes, as previously stated, were reclaimed during the early settlement of the country by means of dikes. A large part of Hingham Harbor has advanced, in the process of silting up, to the eel-grass stage. Weymouth Back River is much less advanced simply because it is a long narrow basin and the tidal-scour is more concentrated and efficient.

Besides the growth of peat on the salt marshes, there are extensive deposits in the fresh-water swamps and meadows;

and in the past some of these have been dug for fuel. This is especially true of Tucker's Swamp, west of Beal Street and Hockley Lane, where the digging of peat was at one time an important industry. In connection with the peat-bogs I have learned of no deposits of diatomaceous earth; but it is very probable that such exist. Bog-iron ore is forming in many places, the most important occurrence that I have happened to notice being on the farm of David Breen, in the meadows west of Downer Avenue and north of Lincoln Street. It forms a layer from one to two feet thick beneath a similar thickness of peat. A beautiful orange sand, that is, a sand strongly impregnated with limonite, was exposed in a ditch dug to drain the swamp on Lincoln Street west of Squirrel Hill.

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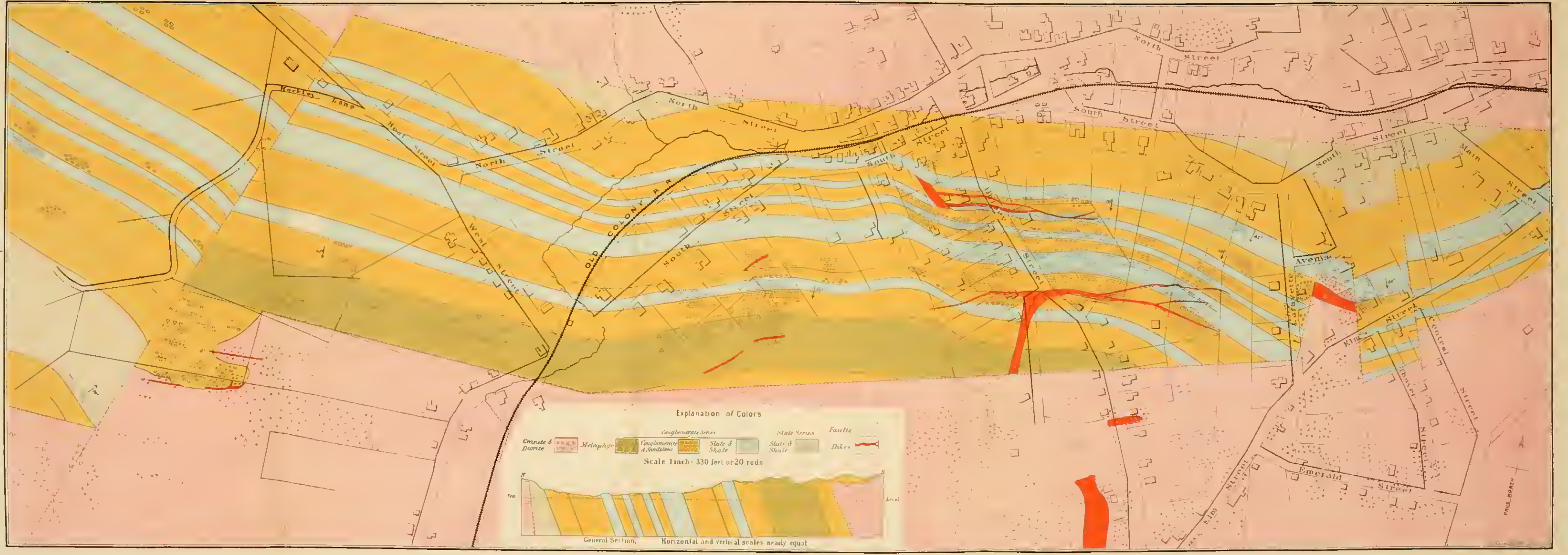
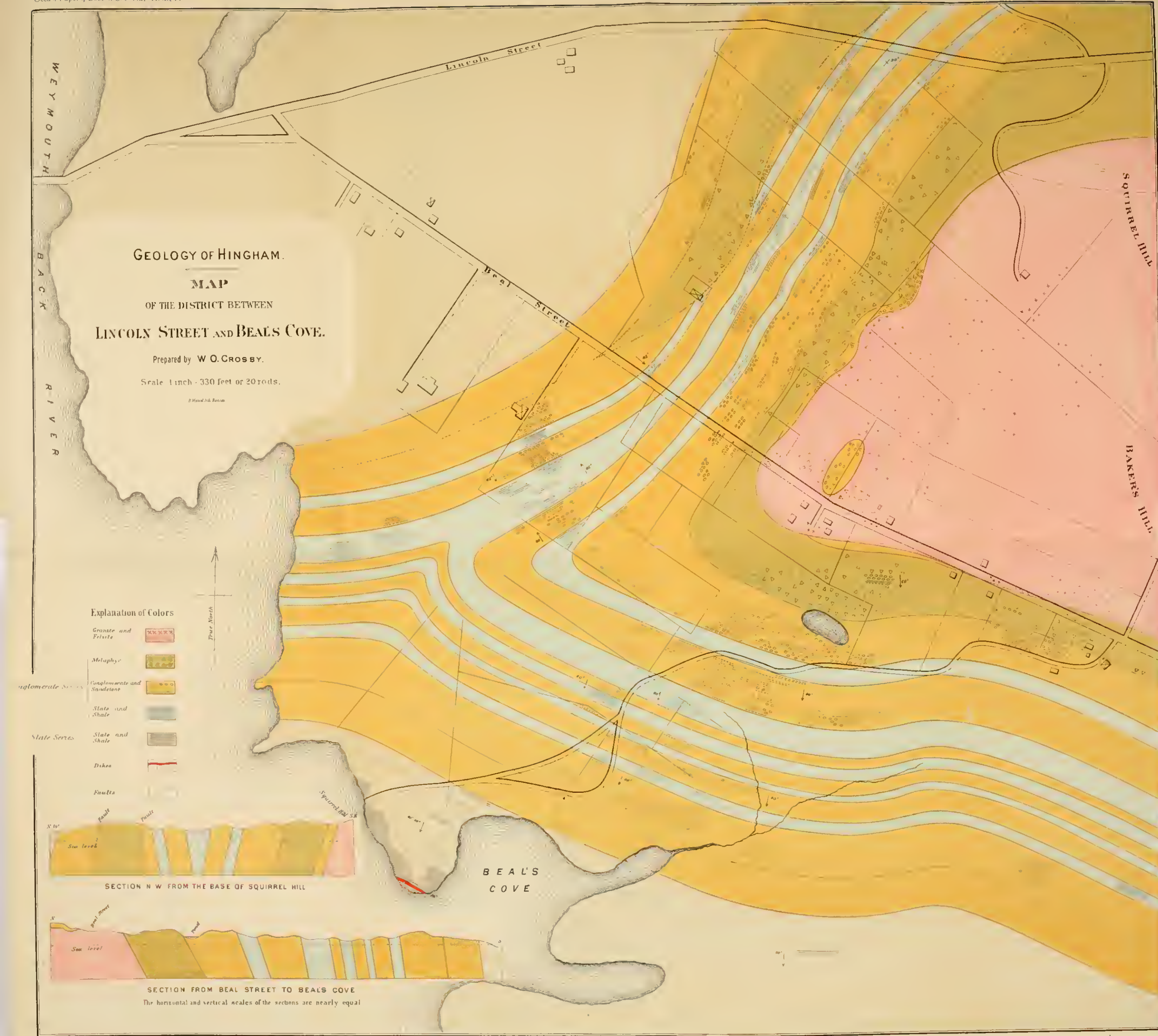
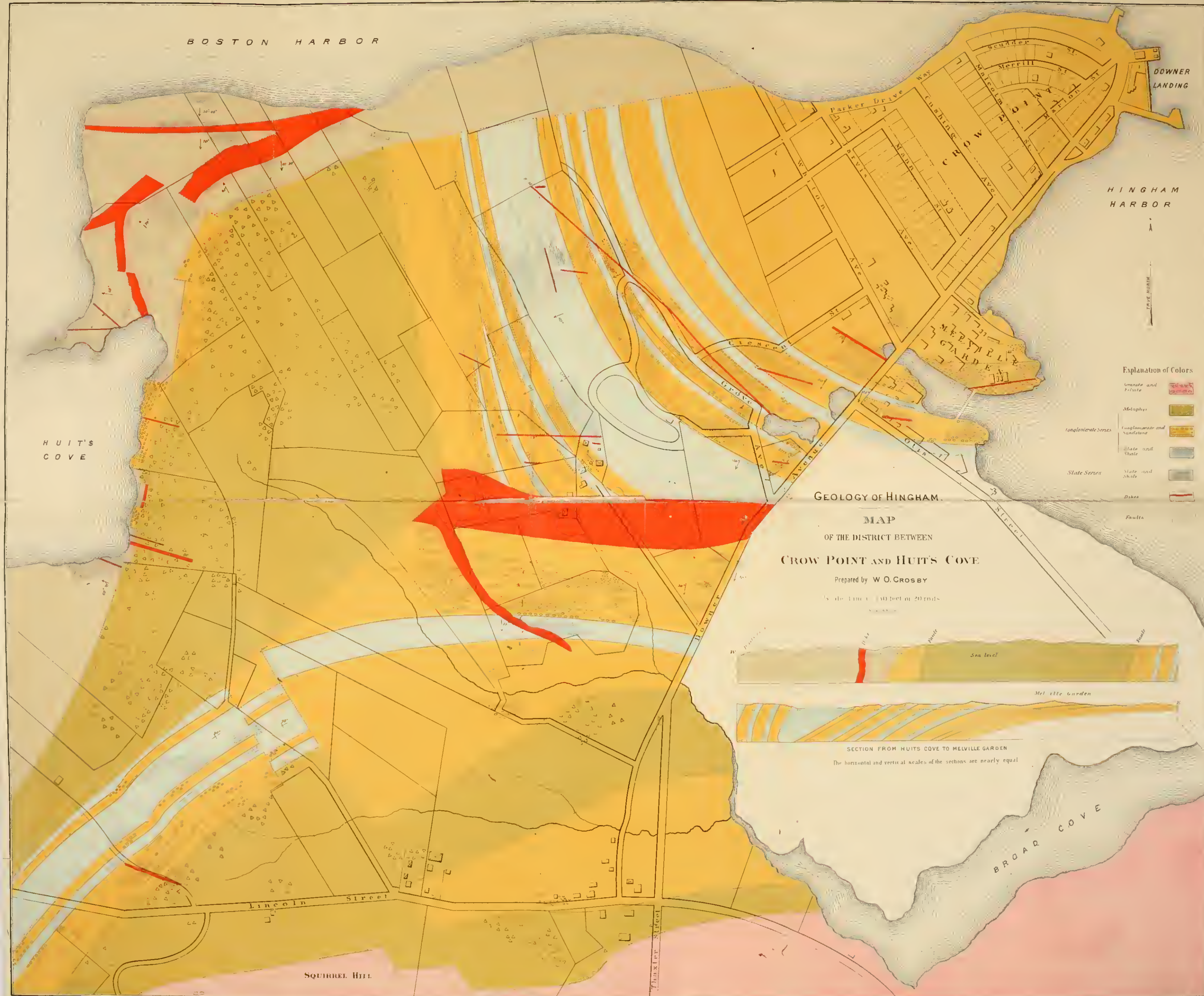
Plates 7, 8, 9,

GEOLOGY OF HINGHAM MAP OF HINGHAM VILLAGE AND WEST HINGHAM. Prepared by W O CROSBY




GEOLOGY OF HINGHAM.
MAP
OF THE DISTRICT BETWEEN
LINCOLN STREET AND BEAL'S COVE.
Prepared by W. O. CROSBY.
Scale 1 inch - 330 feet or 20 rods.
Lincoln Street
Beal Street
WEYMOUTH BACK RIVER
SQUIRREL HILL
BAKER'S HILL
BEAL'S COVE
True North
Explanation of Colors
Granite and Felsite
Melaphyre
Conglomerate and Sandstone
Slate and Shale
Slate Series
Slate and Shale
Dikes
Faults
N W
Fault
Fault
Sea level
Squirrel Hill S.E.
SECTION N W FROM THE BASE OF SQUIRREL HILL
N
Beal Street
Pond
Sea level
SECTION FROM BEAL STREET TO BEALS COVE
The horizontal and vertical scales of the sections are nearly equal


GEOLOGY OF HINGHAM.
MAP
OF THE DISTRICT BETWEEN
CROW POINT AND HUIT'S COVE
Prepared by W. O. CROSBY
BOSTON HARBOR
HINGHAM HARBOR
HUIT'S COVE
BROAD COVE
DOWNER LANDING
CROW POINT
MELVILLE GARDEN
SQUIRREL HILL
Lincoln Street
Thaxter Street
Downer Avenue
Otis Street
Parker Drive Way
Scudder St
Merrill St
Cushing Ave
Crescent
Grove Ave
Explanation of Colors
Slate Series
Dikes
Faults
Sea level
SECTION FROM HUITS COVE TO MELVILLE GARDEN
The horizontal and vertical scales of the sections are nearly equal