THE GEOLOGY OF MOUNT DESERT ISLAND.

By F. BASCOM.

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Looking west along the line of glaciated mountain summits from crest of Jordan (Penobscot) Mountain. 1,080 feet above sea level. Erratics in the foreground. W. C. Alden, Photographer. U. S. Geol. Survey.

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Mount Desert, the largest island among several hundred on the New England coast and comprising the highest land on the Atlantic seaboard, is a region of superb natural charm and of no small physiographic and geologic interest.

The location of the island is such—at about 68° longitude and 44° latitude and open to the ocean only on the south—that the cool temperature normal to the latitude is modified by the sea, winds and moisture are tempered by the mainland, and an ideal summer climate is created. Nearly circular in outline, with a radius of about six miles, Mount Desert comprises approximately one hundred square miles.

The most obvious topographic feature of the island is a highland, trending nearly east and west, and sloping gently on the north side and more steeply on the south side. This ridge is cut into mountain peaks by nine transverse parallel valleys, which trend therefore nearly north and south. The highest summits are at the northeast end, where the altitudes range from 1,300 to 1,532 feet above the sea, declining in the southwest to altitudes between 970 and 1,000 feet.

These features record a somewhat extraordinary physiographic history which is involved in the geologic history of the island.

Geology.[1]—The great mass of Mount Desert is composed of granite. The highland ridge, its mountain peaks, and southeast and northwest flanks are granite rock. Clark Ridge, Southwest Harbor, and a narrow peripheral coastal margin are made up of other kinds of rock.

The granite is a handsome, medium-grained, pink and white rock, with three or four conspicuous mineral constituents: the colorless glassy constituent with a rough fracture is quartz, the pink mineral

[1] See Shaler, Nathaniel Southgate: Eighth Annual Report, United States Geological Survey, 1886–87. Part 2. "The Geology of the Island of Mount Desert," pp. 987–1060—with plates and 26 figures in the text.

The writer is indebted to W. C. Alden, of the U. S. Geological Survey, for the opportunity to read his unpublished notes on the glaciation of Mount Desert and for permission to use the prints which bear his name.

with lustrous smooth cleavage surfaces is feldspar (orthoclase and microcline), the opaque white mineral is also feldspar (chiefly oligoclase), and the dark-colored constituent is either a lustrous, easily cleavable, brownish black mica (biotite) or a less lustrous greenish black amphibole (hornblende). The rock is very uniform in character, varying only on the peripheral contacts, where it is finer grained and lighter colored owing to the absence of red iron oxide in the feldspar.

The United States Mint Building in Philadelphia and the Highway Bridge (abutments and piers) over the Potomac at Washington are built of this stone, obtained from large quarries on the west side of Somes Sound in the neighborhood of Hall Quarry P. O.

The granite has been described first, because it is the conspicuous and dominant rock of the island, but it is not the oldest rock. It is, on the contrary, with the exception of some trap dikes and unconsolidated sediments, the youngest formation of the island and has been injected into the older sedimentary and igneous rocks. The proof that the granite was a later intrusion into rocks earlier consolidated is found in three phenomena:

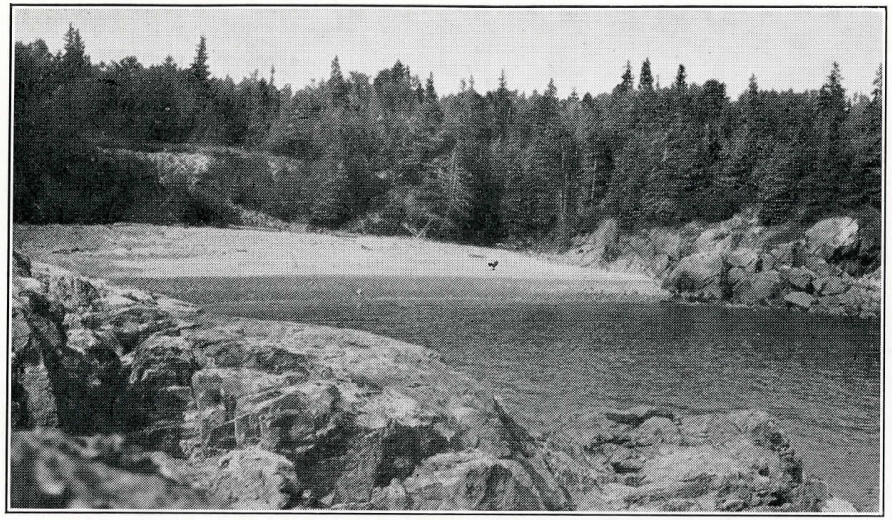
1. Dikes from the great mass of granite penetrate far into the surrounding rocks. Such dikes compose a large part of Sutton Island.

2. A breccia, which is made up of fragments of other igneous rocks imbedded in a granitic cement, occurs in some places along the contact of volcanics and granite. A breccia of this sort is a striking formation on the west side of Hunters Beach Cove. (Fig. 1.)

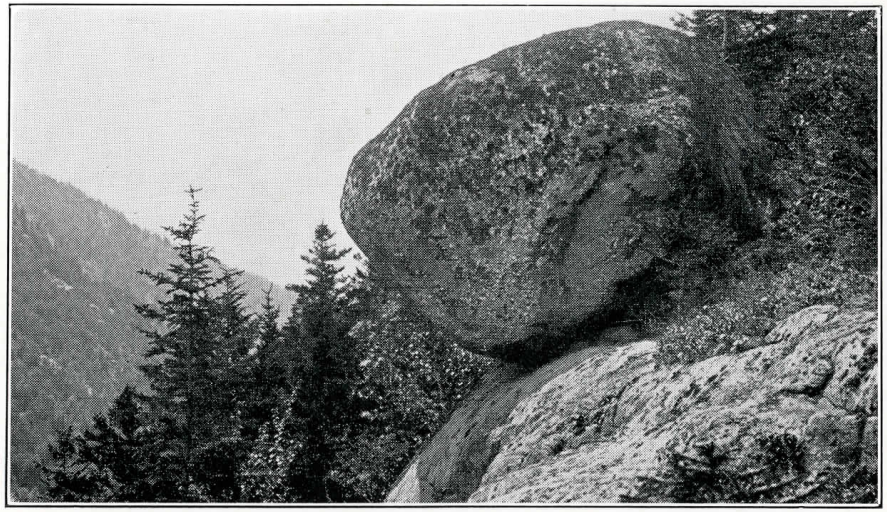
3. The granite is distinctly finer grained near the contacts with the intruded rocks wherever such contacts are exposed. This would be the case if the molten granite were chilled along the contact and in proximity to a cold wall rock. The more rapid cooling and solidification of the margin would not give sufficient time for the growth of crystals of the size prevalent in the main body of the rock.

Pre-granitic Rocks.—The oldest rocks of the island are a series, 2,000 feet or more in thickness, of green schists and quartzites, which fringe the west side of Mount Desert. Appearing at Dix Point, they trend north and northeast to Thomas Bay, dipping east and southeast. They compose the western two thirds of Bartlett Island and have therefore been called the *Bartlett Island series.*

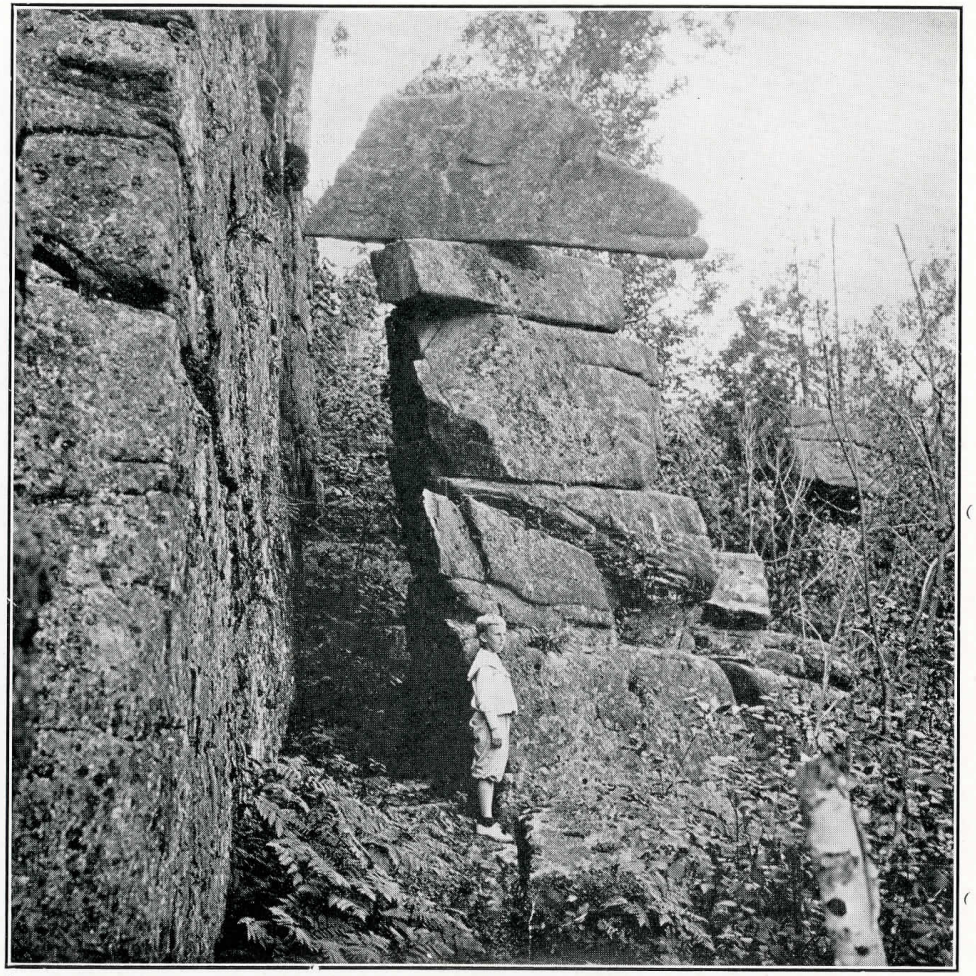
On the east side of Mount Desert, south of Bar Harbor and



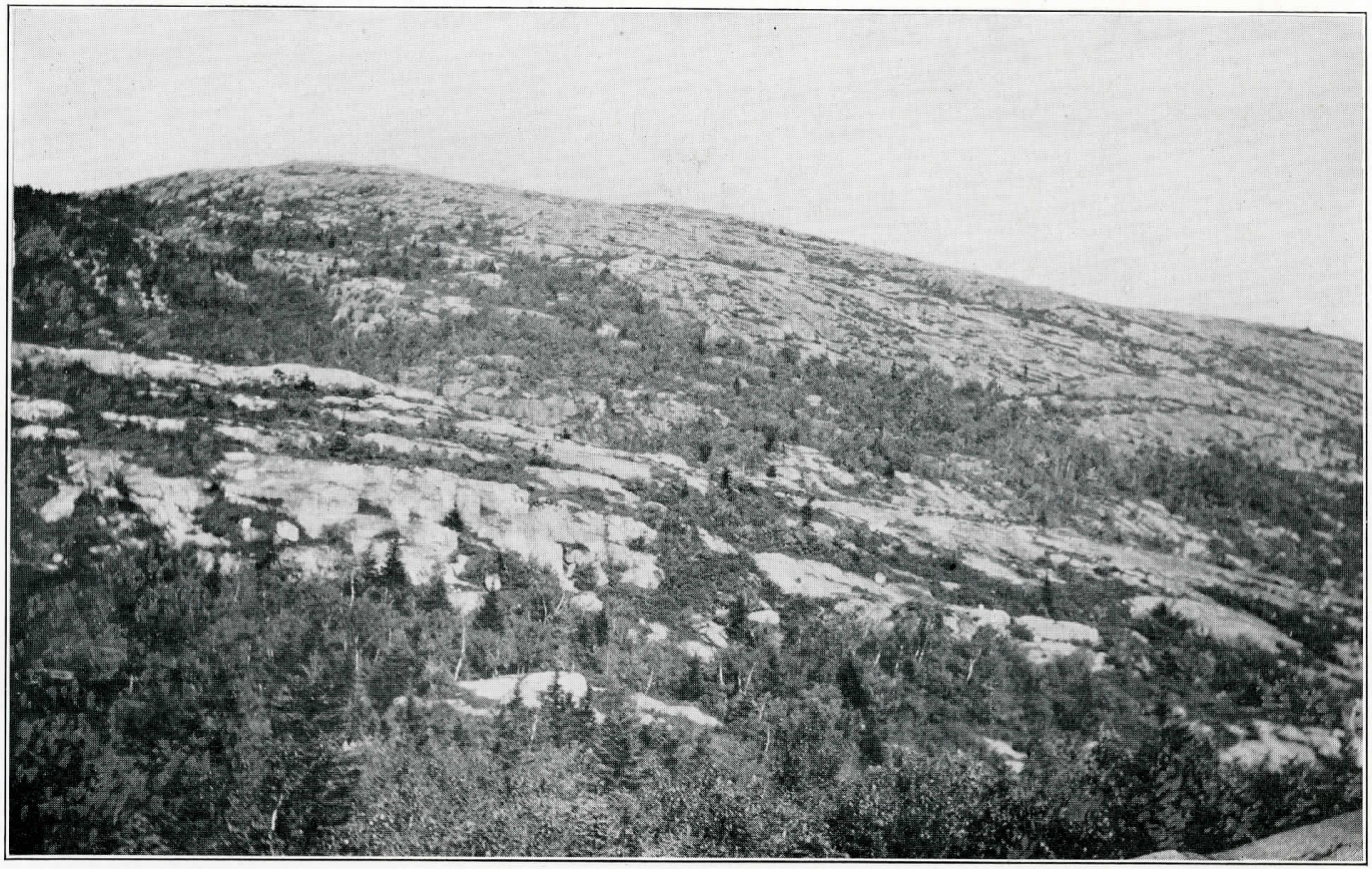
HUNTERS BEACH COVE, SOUTH SIDE MOUNT DESERT.
Breccia on left.
FIGURE 1.



BALANCED ROCK, SOUTH BUBBLE, MOUNT DESERT.
FIGURE 2.



CHIMNEY ROCK AT THE CLEFT.
FIGURE 3.



Looking northeast from the crest of Cedar Swamp Mountain to Ben Mountain col, or saddle, above which is Sargent Mountain Pond and below which is Sargent Mountain Amphitheatre. Note smooth surfaces and absence of benches. W. C. Alden, Photographer. U. S. Geol. Survey.

FIGURE 4.

extending from Cromwell Cove to Newport Cove, there is exposed a narrow belt of schists and slates which resemble the Bartlett Island series but are less metamorphosed. They trend nearly parallel to the coast line and dip away from it, thus offering the minimum resistance to wave action. They are presumably of the same age as the Bartlett Island series, but as this cannot be proven because of discontinuity and the absence of organic remains, they are given a different name, and are called the *Schooner Head series,* from the headland in which they are finely exposed.

Perhaps the next oldest formations of Mount Desert are the stratified rocks skirting the north and east shores of the island from Thomas Bay (east side) to Cromwell Cove at the southeast end of Bar Harbor. These are chiefly quartzites, slates, and flag-stones, red, purple, and green in color, 700 to 1,000 feet in thickness trending north and northeast with a gentle south dip. They are not very highly metamorphosed but no organic remains have as yet been found in them: it is possible that some of them under more thorough study might prove to be volcanics. They are well exposed at the Bar Harbor landing and have been named the *Bar Harbor series.* At the Ovens, just east of Sand Point, there appear massive fine-grained felsitic intrusives or volcanics which are exposed from the Ovens to Salisbury Cove.

Younger than the Bartlett Island and Schooner Head series, possibly contemporaneous with the Bar Harbor igneous rocks, and next in age to the granite, are the rocks that fringe Mount Desert on the south, known as the *Cranberry Island series.* They appear at Otter Creek Point, Hunters Beach (east side) Ingraham Point, East Point, Dodge Point, Pierce Head, Northeast Harbor, Southwest Harbor, where they cover a considerable area, and form Sutton Island and Little and Great Cranberry Islands. They consist of about 100 feet of flagstones underlying 2,000 feet of volcanics; quartz porphyries, amygdaloids, breccias, volcanic ash, etc. They dip steeply south and southeast or are nearly vertical.

Dikes.—(*a*) The oldest intrusive rocks are the dikes connected with the volcanics of the Bar Harbor and Cranberry Island series. These are porphyritic, are limited to the periphery of the island, are found only in the neighborhood of the lavas, and do not intrude the central granite mass.

(*b*) The great intrusive of the island is the granite mass which

has been described and which is essentially a short broad dome-like dike, cutting across the bedding of the sedimentaries and sending many offshoots into them. Baker Island granite is the largest of these offshoots from the main mass. Nutter and Dix points show another large offshoot. Smaller dikes from the central mass are plentiful everywhere along the contact between the granite and the adjacent sedimentaries.

(*c*) A third class of dikes shows the dark green color and fine-grained texture of the rock popularly known as trap. Such dikes are numerous, they cut indiscriminately all the formations, not excepting the granite, and are apparently the youngest consolidated material of the island. They traverse the granite parallel to joint planes, are less resistant to weathering than the granite, and their decay gives rise to narrow gorges or "chasms." Beech Hill road makes use of a gorge of this origin and others will be mentioned later. Dikes of this kind may be seen between Hunters Beach and the Champlain Monument.

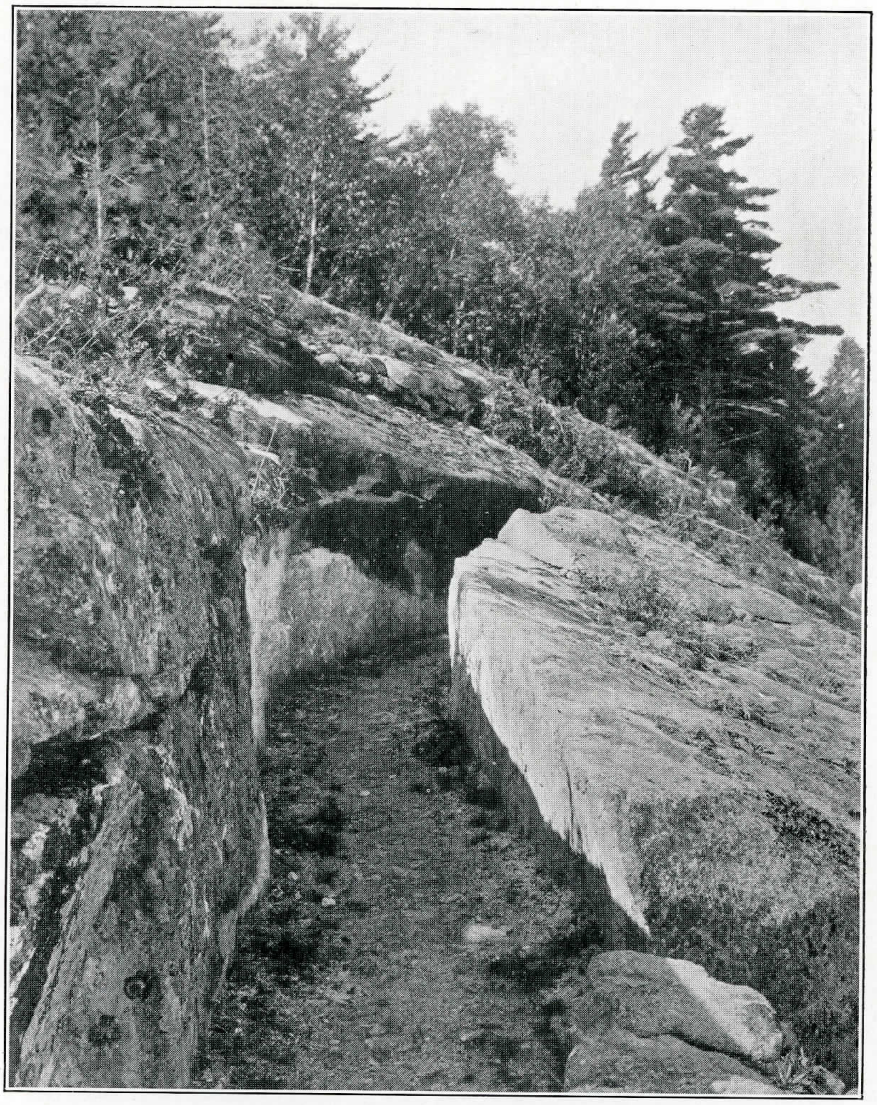
(*d*) Near the Champlain Monument a conspicuous white quartz vein strikes southeast toward the sea. Similar quartz veins occur elsewhere on the island, but they have not been studied with a view to age and origin.

In the pre-granitic sedimentary series, aggregating some six thousand (and presumably more) feet, the absence of limestone or calcareous deposits of any kind is noteworthy. No fossils have yet been found on the island and this non-calcareous character of the deposits is therefore the only clue to their age, and on this ground they have been referred to the base of the geologic column (Lower Cambrian or earlier).

The pre-granitic volcanics are somewhat younger and resemble similar volcanics to the south on Fox Island which have been referred to a later age (Silurian, Niagaran).

When the granitic intrusion occurred, there must have been a considerable thickness of sedimentary and volcanic rocks above the cooling granite. Thus only can the coarseness of the crystallization be accounted for. The fluid condition of the granite at the time of the intrusion is shown by the way in which it has penetrated in narrow dikes the fissures of the wall rock and by the way in which it has cemented fragments of the volcanics.

In addition to these hard (consolidated) rock formations there are unconsolidated sediments, *glacial, late glacial,* and *post-glacial* in age.



EMERY PATH, EAST SIDE OF DRY MOUNTAIN (THE FLYING SQUADRON), AND NORTH OF SIEUR DE MONTS SPRING. Print supplied by George R. Dorr, Superintendent of the Lafayette National Park.
FIGURE 5.

Stratified glacial sand and gravel, looking south one mile north of Asticou, Mount Desert, northeast of Lower Hadlock Pond. W. C. Alden, Photographer. U. S. Geol. Survey.

FIGURE 6.

Glaciation and Glacial Deposits.—Bare rock is exposed on Mount Desert near sea level between low tide and the highest level reached by high tide, and on the mountain summits and slopes above the general level of 600 to 700 feet. (Frontispiece and Fig. 4.) The very limited amount of rock-decay or of accumulated products of such decay on the mountain summits, the rounded contours, the roches moutonnées, the more or less perfectly preserved polishing, grooving, and striation of the granite, as well as its remarkably fresh character, are evidences of *glaciation* or ice erosion.

Elsewhere between these two levels, high tide and 600 feet, the rocks, except on cliffs and steep slopes, are covered by a mantle of loose material known as *drift,* mixed with a scanty soil composed of decayed rock and vegetal matter, or by compact laminated clay containing fossils and known as marine clays (Leda clays).

Drift comprises all the loose material not derived from the immediately underlying rock. It may be stratified, distributed along drainage lines, and relatively homogeneous, or it may be unstratified, irregularly distributed, and heterogeneous in the character and size of its components (*till*). This peculiar rock mantle owes its origin to *glacial deposition,* and is further evidence that an ice sheet once covered the island and left these deposits during its retreat.

Above 400 feet the drift is scanty and is characterized by numerous scattered *erratics* or glacial boulders of considerable size dropped by the ice. That these boulders were lodged by the melting of the ice is indicated by the altitude above stream valleys at which they are found, and by the unstable positions which some of them occupy and in which they would not be lodged by a flood sufficiently powerful to have transported them; that they were not formed by weathering, in place, of massive rock is indicated by their lithologic character which is usually unlike that of the rock upon which they rest and from which they could not therefore be derived by disintegration. "Balanced rock" on South Bubble is one of many such erratics (Fig. 2), and on the summit of Jordan (Penobscot) Mountain there is a conspicuous erratic of considerable size.

Between 400 and 200 feet altitude the coarser material is replaced by stratified sand and gravel in the valleys (Fig. 6) and below 200 feet by stratified clay (Leda clay) which extends in the coves to sea level and may be occasionally exposed in a roadside section. Wher-

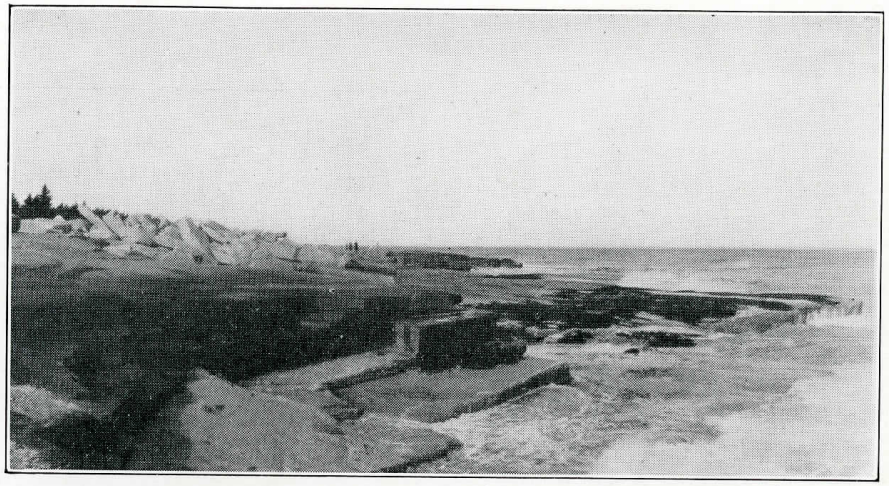
ever the clay is absent the lowland may be covered by till; an exposure of typical till, consisting of a blue clay mixed with subangular rock fragments ranging in size from sand grains to boulders, can be seen near the wharf at Northeast Harbor. At the south end of Jordan Pond, a rock-bound basin, a thin covering of till overlies the rock and is in turn overlaid to the south by stratified sand and clay, probably a late glacial delta deposit.

Of other glacial deposits there is scant evidence. The hummocky gravel hills which have been utilized for burial grounds, on the west side of the head of Bass Harbor, and also east of Quahaug Pond (Mill Cove) and northeast of Pretty Marsh Harbor, probably belong to that class of glacial stream deposits which are known as *kames*.

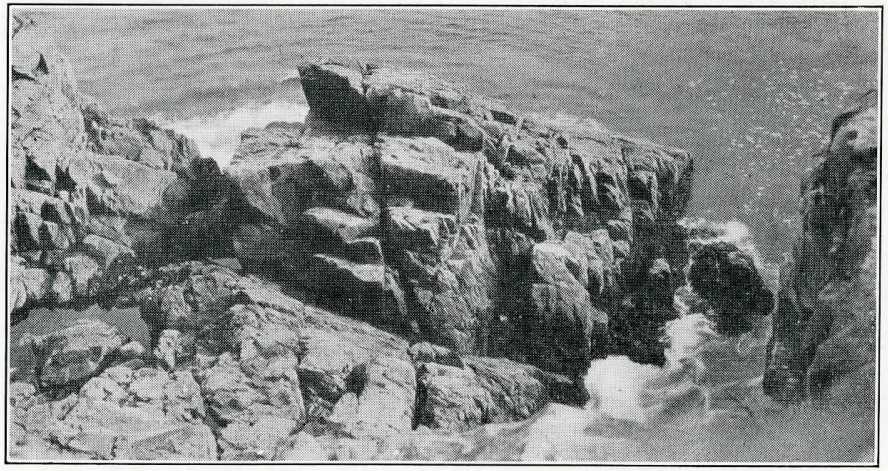
About two and one half miles north of Browns (Norumbega) Mountain is a low sinuous ridge (15–25 feet high). South of this and east of Seal Cove (Sargent Cove), on the east side of the road leading from Northeast Harbor to Somesville, there are irregular heaps of glacial boulders. Some of the material came from the northern end of the island and the accumulation may be morainic in character.

That the glacial ice covered the mountains to a considerable depth is indicated by the scouring of the mountain crests (Figs. 4 and 15); that the ice moved southward conforming in the main to pre-glacial drainage lines is shown by the erosion of the gorges (Figs. 13 and 19), as well as by the direction of the striation; that about the periphery of Mount Desert the ice diverged, advancing northeast and southwest, and again converged on the south side of the island, is also shown by the direction of the striæ, and that the partial submergence of the island began before the ice had disappeared from the mountain summit is indicated by the presence of marine clays (Leda clay) *overlaid* by stratified glacial clays.

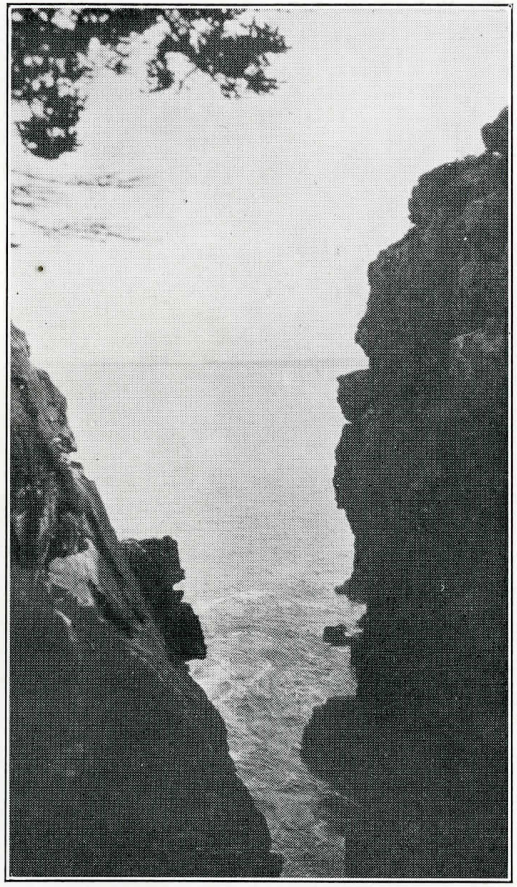
Physiography.—The contour and topography of Mount Desert are profoundly affected by a pronounced structure in the dominant rock of the island. This structure is known as jointing and consists in the presence of parallel planes of parting spaced a foot or more apart. There is a system of joint planes dipping gently southeast, and becoming nearly horizontal at the extreme southern exposures of the granite. Perpendicular to these joint planes are two systems of vertical joints trending in nearly north-south and east-west directions. Of these two systems the north-south joints are the more strongly



Seaward Side of Baker Island.
Figure 7.



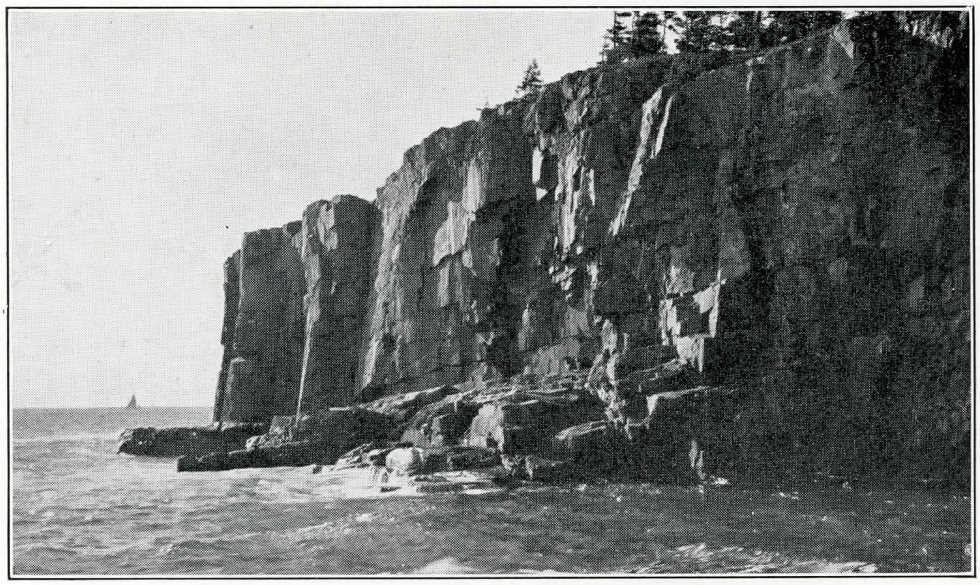
Joint Control of Sea Erosion.
Figure 8.



Chasm Due to Sea Erosion. At Otter Cliffs
Figure 9.

Cadillac Cliffs, Gorham Mountain.
Figure 10.

Entrance to Sea Cave at Base of Cadillac Cliffs, Gorham Mountain.
Figure 11.



Otter Cliffs at Present Sea Level, South of Cadillac Cliffs.
Figure 12.

developed. All three joint systems are magnificently developed in the granite of Baker Island, where they control the character of the sea erosion. By means of them the rock is readily split into gigantic cuboidal or parallelopiped blocks which are sucked out by storm and tidal waves and piled high on the shore like quarried stone. (Fig. 7.)

Because of the roughly circular form of the coast line the joint planes face the sea at varying angles and the character of the sea work is determined by this angle. Joint planes sloping toward the ocean resist wave action and are not easily cut back into high sea cliffs. In any other position, *i.e.*, sloping away from the sea, or vertical, or horizontal, jointing assists in the development of high sea cliffs. Vertical jointing at right angles to the shore line gives rise to deep indentations of the coast line parallel to these joint planes. (Figs. 8 and 9.)

On Mount Desert the nearly horizontal joint planes slope toward the open sea on the south, and north-south vertical joints are a dominant structure. Under these conditions an uncliffed, indented coast line has developed on the south and a cliffed, unindented coast line on the east. (Fig. 12.)

The causal association of dikes, joint planes, and valleys is also conspicuously illustrated in the nine remarkable transverse valleys already mentioned.

They are remarkable in their number and parallelism—nine parallel valleys in a distance of twelve miles. They are remarkable in their longitudinal profiles: some of them are lower in the middle than at their outlets; Somes Sound, Echo Lake, and Long Pond have such profiles. They are remarkable in their cross profiles, which are narrow and deep.

The location, number, and parallelism of these valleys are undoubtedly owing to the control of stream courses by vertical jointing and by dikes in the granite, and their remarkable profiles are owing to ice-work.

Joint planes offer lines of least resistance to drainage, and dikes intruding parallel to joint planes, which offer also lines of weakness to the intruding molten rock, are not only less resistant than the granite but they render the granite in their immediate neighborhood more accessible to disintegration, by their chemical action, by the multiplication of joint planes, and by their own disintegration. On the east side of Dry Mountain (The Flying Squadron) the trail leads

through a cleft about three feet wide parallel to a north-south vertical joint plane in the granite. This cleft, like many similar ones on the island, is a conspicuous illustration of joint plane erosion accomplished by the expansive power of frost, combined with the action of other agents of weathering introduced through the rift made by frost, and assisted in this instance by gravity. (Fig. 5.)

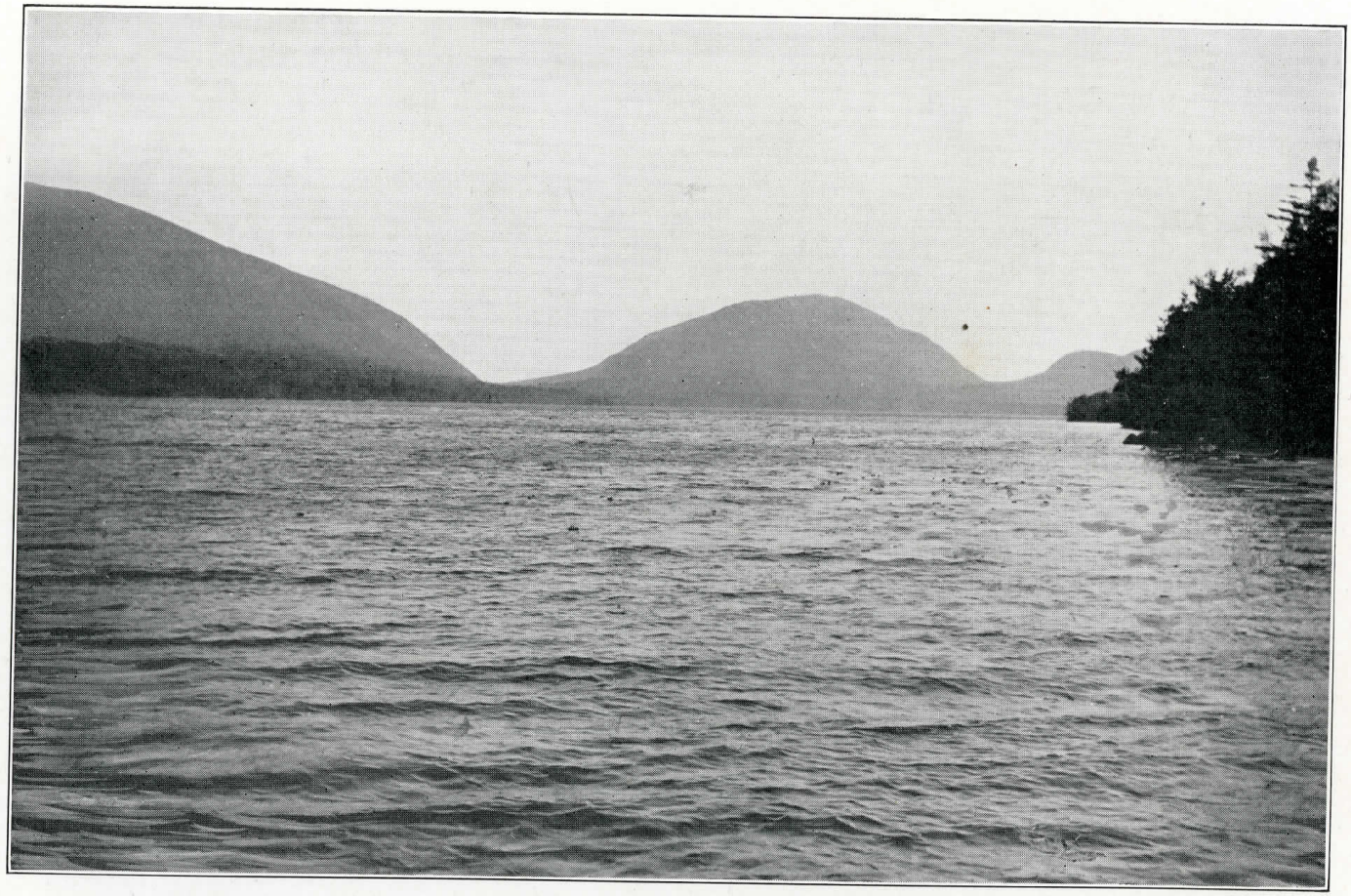
The valley between Beech Mountain and Canada Cliff (Echo Mountain) through which passes the road from Carter Nubble to Norwood Cove has its origin in the erosion of a dike which occupies the center of the depression. The dike is about 10 feet wide. The valley is more than 200 feet deep and owes its width to the easy access to weathering which the presence of the non-resistant dike gives to the adjoining much jointed and altered granite. This valley is an illustration of the conditions determining the erosion of other valleys, where similar phenomena exist but cannot be so readily observed.

In the erosion of a recently emerged land surface such as a coastal plain, the run-off is at first concentrated in *many roughly parallel* channels of which later one or more become, because of greater ease of corrosion or steeper slope, the master channels and capture by the more rapid deepening of their valleys the upper courses of the other originally parallel streams, thus developing normal dendritic (tree-like) drainage.

In the case of Mount Desert, rock structure and ice work combined to prevent the development of such normal dendritic drainage in the upper courses: owing to joint control the parallel valleys became firmly established and the highland was deeply notched by such valleys when the island was overridden by the ice, which, converging in these young valleys, over-deepened their upper courses, forming the rock-bound lake basins, and further deepened the lower courses.

The more gentle northern slope with post-glacial dendritic drainage lines has its origin in general ice erosion which obliterated the pre-glacial valley heads; the southern or lee side of the mountain suffered less scouring but a greater amount of plucking than the northern or shock side. Subsequent sea erosion and stream work have doubtless also been factors in steepening the southern slopes.

Post-Glacial Land Movements.—In order to read the record of land movements, it is necessary to observe the work of the sea on the present shore line. Characteristic features of a rocky coast, such as Mount Desert presents, are either (*a*) sea cliffs, sea caves, and a



Glacial gorges between Green (Cadillac) Mountain and the Bubbles, looking south from north end of Eagle Lake, two miles west of Bar Harbor. W. C. Alden, Photographer. U. S. Geol. Survey.

FIGURE 13.

Looking south along cliff face at south end of Jordan Mountain, toward south end of Jordan Pond, showing steps to Amphitheatre, 3 to 5 feet each, due to jointing and to glacial plucking. 450 to 500 feet above sea level. W. C. Alden, Photographer. U. S. Geol. Survey.

FIGURE 14.

bench bearing cliff debris on its outer slope, the region of relatively still water, or (*b*) chasms or coves of greater or less width bearing a sand and pebble beach in their reëntrant (*i.e.,* protected) angles; and (*c*) sand and clay deposits in the quiet water of protected coves or estuaries.

Whether cliff or beach is developed will be dependent chiefly—the rock remaining the same—upon the slope of the rock with reference to the sea and the position and number of the joint planes and dikes. With horizontal or vertical planes of parting and few or insignificant dikes, sea cliffs, sea caves, and benches, with cliff debris swept to the outer slope, will develop. Anemone Cave and the overhanging sea cliffs of the east coast of Mount Desert are examples of sea work under such conditions.

With the planes of parting in the rock dipping toward the sea, a structure offering maximum resistance to wave work, sea caves are not likely to form nor do high sea cliffs develop. The south shore of Baker Island facing the open ocean shows this condition. In general the south coast of Mount Desert, although facing the open sea, is notable for the absence of cliffs and caves, while the east coast is characterized by the presence of bold cliffs (Fig. 12) and deep caves, a difference due to the slope of the rock in relation to the sea.

Where dikes are numerous or wide with perhaps a concentration of vertical joint planes, hallways or "chasms" (Fig. 9) will develop, and where such chasms possess considerable breadth, a beach is formed in their protected angles. Hunters Beach Cove (Fig. 1) is a typical example of many such beaches on the Mount Desert coast, and of such nature and origin are the harbors on the south coast.

If at heights now above sea level such phenomena as these are found at fairly uniform elevations, and if clays containing marine fossils or similar but unfossiliferous clays are found above the present sea level, it is a fair inference that the sea at one time stood at higher levels and produced the features which are so characteristic of sea work at the present shore line and which are not known to be exactly imitated by any other agents. There are briefly such sea cliffs, sea caves, and terraces at the following levels, omitting the more faintly defined benches such as exist at the 20-foot, 40-foot, and 60-foot levels. It is noteworthy that these cliffs and caves face the east as do the cliffs and caves of the present shore.

1. *90 to 100 feet.* This bench is best seen on the east side of

Seal Harbor and at Newport Cove, where the slight cliff and slope of the old shore is very characteristic of sea work.

2. *165 to 200 feet.* Dodge's Ledge at Seal Harbor is a good example of the sea cliff at this level, with cavern-like recesses at its base retreating nearly 20 feet, fronting a smooth sloping rock terrace swept clear of glacial till and with an accumulation of sea-worn fragments below its edge.

3. *220 to 240 feet.* This bench and cliff are shown at the Cleft where the caves and "chimney rock" with "tilting rock" surmounting it, a stack probably detached by wave action, are conspicuous features. (Fig. 3.) Nature can produce very similar phenomena in very different ways: cliffs and stacks may originate through the action of the agents of weathering independently of wave work. In the case of the stack at the Cleft, its location, its association with other evidences of the presence of the sea, the removal of the upper joint blocks of the stack, and the disturbed position of the uppermost of the remaining blocks are indications of sea work. It is doubtful whether since the withdrawal of the sea there has been time enough for the production by weathering of such a stack.

4. *270 to 290 feet.* This bench and cliff are best seen on the east face of Gorham Mountain, where the well-known Cadillac Cliffs and sea cave mark this level (Figs. 10 and 11), and on the east face of the Beehive.

Well within the sea cave at the base of Cadillac Cliffs are spherical boulders of granite which look as if they had been wedged into their present position between joints in the granite by wave action. This, however, does not appear to have been their history. Disintegration, in place, of massive jointed rock will produce spherical boulders and this is the explanation of these boulders which are even yet not completely separated from the parent rock.

5. *300 to 340 feet.* A block of granite (7 feet by 4 feet), torn from its bed, turned over and lodged *above* its original bed, seems to be evidence of sea work at this level, and if the stratified clay containing marine fossils, which has been reported at this level, is actually to be found, it attests the presence of the sea.

There are at still higher levels (380–430 feet, 480–500 feet, and above 1,000 feet) ill-defined benches, the origin of which has been attributed to sea action. They do not, however, carry with them convincing evidence of such origin and can be as easily accounted for by the action of subaërial agents.

Sargent Mountain Pond, in a rock basin at 1,050 feet above sea level. Joints and plucked cliff in the foreground, glacially smoothed crest above. W. C. Alden, Photographer. U. S. Geol. Survey.

FIGURE 15.

Looking north through Green (Cadillac) Mountain gorge from point on east slope, showing joints permitting the development of the gorge by *plucking,* and a post-glacial talus the product of *frost action.* W. C. Alden, Photographer. U. S. Geol. Survey.

FIGURE 16.

Chasms, due to the erosion of dikes, with walls too steep and too sharply defined to have been produced by glacial action, are one of the features of the summit of Pemetic Mountain which has been thought to indicate sea action. These chasms, which trend nearly north and south, are from 20 to 40 feet wide and 20 or more feet deep. Such chasms and other gorges with a talus of angular blocks, the product of *frost action,* and with jointed walls which permit of glacial plucking, can also be easily accounted for by the action of subaërial agents. (Figs. 14, 15, 16.)

The question which naturally arises is, are these successive benches horizontal with reference to one another and to the present sea level? In other words, was the land-mass lifted successively *en bloc* to uniform heights or was it elevated with warping, bringing different portions to different heights?

A more detailed study of altitudes needs to be made before this question can be satisfactorily answered; it may be noted that the benches are, naturally, no more continuous than are the present benches now being developed at sea level, and that in these old sea cliffs, as in the present sea cliffs, there is a range of 10 to 15 feet in the positions of the bases of the cliff and a still greater range in the heights of the cliff. These facts must be taken into consideration in the correlation of the benches. Evidences of submergence and the extent of submergence elsewhere (350–400 feet on the mainland, increasing in amount toward interior and decreasing toward the coast) on the coast of Maine must be included in the investigation as well as a consideration of the competency of glacial plucking and joint erosion in cliff formation.

History of Mount Desert.—In very early geologic time (pre-Cambrian or early Palæozoic) sedimentation on the American continental shelf was going on in the area now occupied by Mount Desert Island. Sand and clay were being delivered at the coast and sandstones and shales were being formed in the quiet depths of the sea. This sedimentation did not take place without interruptions of various kinds. Land movements brought the sediments above the sea, subjecting them to erosion and removal and later to submergence when other sediments were deposited upon their remnants. Subsequent movements of uplift were accompanied by volcanic outbursts, the pouring out of great lava flows and the ejection of finely divided fragmental material.

Sedimentation was followed by a period of mountain growth when the sandstones and shale already indurated and altered by contact with lavas and intrusive dikes were uplifted, folded, and intruded by the granitic magma which, buried beneath a great thickness of sediment, cooled in a roughly dome-shaped mass. The compression, which folded the rocks, and the contact with the hot granitic magma further altered the sandstones and shales converting them into quartzites, slates, flagstones, and schists.

The mountain-making period was followed by a prolonged period of stability and erosion when not only the cover of the granite was removed, leaving merely the present peripheral remnants, but also the granite itself was deeply eroded and the whole area reduced possibly to an approximate plain, sloping to the sea. This long quiescent period was closed by the uplift of this low ridge or approximate plain with southward tilting and the initiation of a period of renewed erosion.

To this later erosion interval belongs the formation of many parallel valleys. The run-off flowing south to the sea concentrated in channels developed because of greater ease of erosion. Such lines of least resistance were furnished, as has been pointed out, by joints and dikes.

When the Labradoran ice-sheet advanced slowly upon the island, abrading the bare rock with tools plucked from the rock-bed, the present gentle north slope was developed by ice-erosion, the valleys on the present south slope were deepened and the lake-basins were carved. Upon the final disappearance of the ice, after prolonged and alternating advancing and melting, pre-glacial drainage had been considerably modified. The northern headwater valleys had disappeared in the erosion of the northern slope and young post-glacial streams, forced to make their own valleys, developed shallow meandering courses on this gentle slope uninfluenced by rock structures, which were concealed under a mantle of drift. On the southern slope, the glacial and later the post-glacial streams found ready-made, pre-glacial-stream-eroded, glacially-deepened valleys, heading in ice-eroded basins, and took possession of them, converting the basins into lakes.

Since glacial times, the southward-flowing streams have pushed their headwaters northward. Having the advantage over their rivals of a steeper descent to the sea and of older valleys, they are shifting the divide northward and in some cases have already captured the

Barrier beach at head of Bracys Cove enclosing Long Pond, west of Seal Harbor. W. C. Alden, Photographer. U. S. Geol. Survey.

FIGURE 17.

Rice Point, west end of Sutton Island, V-bar built of coarse cobblestones and beach gravel, 15 to 20 feet high. Inclosed lagoon is flooded at high tide. W. C. Alden, Photographer. U. S. Geol. Survey.

FIGURE 18.

headwaters of the northward-flowing streams. Northeastern Branch has in this way been robbed of its headwaters, Aunt Betty's Pond, which now drains south through Somes Sound. Hunters Beach Brook is working northward toward Bubble Pond which it is in time bound to capture, thus bringing about a drainage of the pond to the nearest base-level. Eagle Lake will continue to drain northward through Duck Brook to its nearest base-level.

During and following glaciation came the submergence of the island, when possibly the sea reached the present 340-foot contour line. The feeble character of the wave work at this level indicates that the island did not long remain submerged, but promptly began to emerge from the sea with a succession of uplifts and halts of varying duration.

At certain lower levels, such as have been indicated, the island remained stationary for periods of time sufficiently long to produce coast features as well defined as those marking the present coast line.

The history of Mount Desert does not close with emergence. There is good evidence elsewhere along the New England coast to show that emergence ceased long ago and that submergence involving Mount Desert has begun and is still going on. (Fig. 19.) The present seashore does not therefore mark the highest uplift of the island; lower levels have been submerged.

That all these movements have taken place quietly, that is, without violent earthquake shocks, must be inferred from the number of poised and balanced rocks (Fig. 2), which are found on the island and which could not have maintained their delicate adjustment if Mount Desert had been subjected to earthquake shocks.

Recent coast-building is found in the development of a sand bar barrier extending across Bracy Cove and enclosing a lagoon known as Long Pond (Fig. 17), in the formation of a bar (tombolo) tying Bar Island to Mount Desert and giving the name to Bar Harbor, and in the growth of beaches in the cove heads. At the west end of Sutton Island in an eddy between two opposing currents a perfect V-bar has developed. (Fig. 18.) The coast is notable on the whole, however, for a feeble development of spits, hooks, bars, loops, beaches, and similar coast features; a phenomenon which is owing to the relatively brief time during which sea and streams have been co-operating in the accumulation and deposit of shore material.

About 10,000 acres[1] of the most beautiful portion of this superb island have recently been made a national park. This domain, given to the nation for the perpetual benefit and enjoyment of the public through the patriotism and generosity of private owners, lies between Bar Harbor and Seal Harbor in a north-south direction and between Seal Cove Pond and Schooner Head in an east-west direction.

It is a commanding highland area, undisturbed in its natural beauty, surrounded by a summer population from all the United States on the coastal lowlands, and including within its boundaries no less than seven lakes and sixteen mountains. The lakes are: Long (Great) Pond, Echo Lake (Denning Pond), Sargent Mountain Pond, Jordan Pond, Eagle Lake, Bubble Pond, and the Bowl. The mountains are: the White Cap (925 feet), Green or *Cadillac*[2] Mountain (1,532 feet), Dry Mountain or *The Flying Squadron* (1,268 feet), Picket Mountain or *Huguenot Head* (720 feet), Newport or *Champlain* Mountain (1,260 feet), the Beehive (560 feet), Pemetic Mountain (1,262 feet), the Triad (688 feet, 720 feet, and 600 feet), Jordan or *Penobscot* Mountain (1,180 feet), the Bubbles (845 feet and 780 feet), Sargent Mountain (1,344 feet), Little Browns or *Parkman* Mountain, Browns or *Norumbega* Mountain (880 feet), Robinson or *Arcadia* Mountain (680 feet), Dog or *St. Sauveur* Mountain (670 feet), Beech Mountain (855 feet), and Western Mountain; East or *Mansell* Peak (971 feet), West or *Bernard* Peak (1,073 feet).

This new public domain is to be known as the Lafayette National Park. It is notable in being the only national park located east of the Mississippi River, and by its name it perpetuates anew the memory of the gallant Frenchman whose services to our country have been especially recalled in recent years. The appropriateness of the designation is emphasized, when it is borne in mind that the island was first explored by a compatriot of Lafayette—Samuel de Champlain, who, landing over three centuries ago (September 5, 1604) in the protected inlet now known as Bar Harbor, gazing south on the bare rock summits, gave the island the name it still bears.

Bryn Mawr College,
September, 1919.

[1] The 1922 edition of the U. S. Geol. Survey Map (Lafayette National Park) shows the boundaries only of the original acceptance by the Government for the Sieur de Monts National Monument.

[2] The italicized names are those proposed by the U. S. Geographic Board and accepted by the Publicity Committee of the town of Bar Harbor.

Sommes Sound, a fjord, looking north, Browns (Norumbega) Mountain on the right and Robinsons (Arcadia) Mountain on the left. Showing submerged coast-line. W. C. Alden, Photographer. U. S. Geol. Survey.

FIGURE 19.