GEOLOGY OF MOUNT DESERT ISLAND, MAINE.

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(With a map.)

ABSTRACT OF NEW VIEWPOINTS. The granite mass of Mount Desert (of Carboniferous age) is but recently unroofed and exhibits closely the original conformation of its roof. The cross-valleys in its mountain range are preglacial and were determined by roof-pendants and by keystone faults. The rim rocks of the island fall into three groups, of later ages than formerly assigned, namely a Cambro-Ordovician schist, unconformably superposed late Silurian sediments and volcanics, and a fragmented later Devonian dioritic batholith. Sheet-jointing of the granite is concentric with its surface of cooling and confirms the inferences from inclusions as to the roof form. Elevated beaches not hitherto recognized occur in the north part of the island. For through-going intermontane glacial troughs of the Somes Sound and Jordan Pond type a new term is proposed.

MOUNT DESERT ISLAND, the site of Acadia National Park, with its entourage of Bartlett's Island, the Cranberry Islands and lesser satellites, constitutes a perfect small unit, geographically and geologically. The larger geologic features of this unit have been described by Shaler (1889), Bascom (1919) and Raisz (1929). But when National Park Service desired to include a geological map in the Acadia Park leaflet, the four existing maps (Shaler 1889, Stose 1932, Keith 1933, Perkins 1933) were found to present irreconcilable disagreements. Rapid restudy of the island, with the timely assistance of Mr. George B. Dorr (founder and superintendent of the Park) and his entire staff, particularly Park Naturalist Maurice Sullivan with Paul Favour and other ranger-naturalists, of Ralph Lewis of the Museum division, and of Capt. Charles Parker, resulted in a new map herewith presented, and in some new interpretations. Hearty acknowledgment is due also to Messrs. Earl A. Trager and Howard E. Rothrock, my superiors in National Park Service, for aid and encouragement in this work and for permission to publish; and to Dr. H. L. Alling of Rochester for petrographic examination of rocks.

The general outline of the island, with the distribution of its rock masses, is shown by the map; its location by the key map.

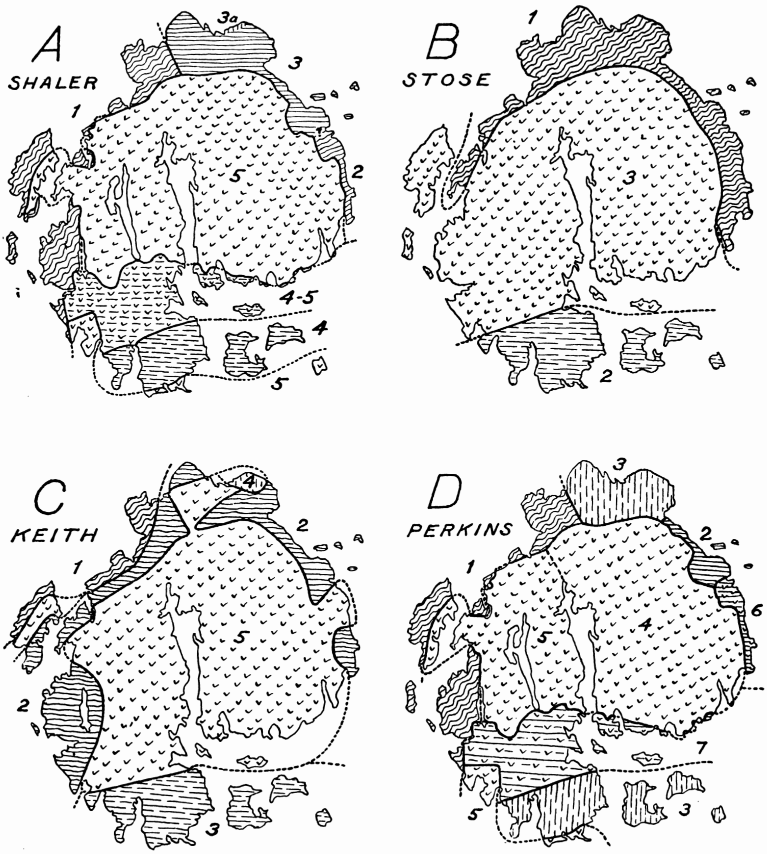

Plate I.

The Prior Maps of Mount Desert Island, showing lack of agreement as to limits, classification, age and composition of the rocks.

(A.) *N. S. Shaler 1889* (much reduced): 1. Bartlett Island series. 2. Schooner Head series. 3. Bar Harbor series (Cambrian). (3a. Felsite in Bar Harbor series.) 4. Cranberry Island series. 4-5. Sutton Island series (preceding invaded by next). 5. Granite (generally then assigned to the Devonian).

(B.) *G. W. Stose 1932* (much enlarged): 1. Younger sedimentary schists (Algonkian?). 2. Early Paleozoic volcanic rocks (Cambrian? and Silurian). 3. Late Paleozoic intrusives (Carboniferous and Silurian).

(C.) *A. Keith 1933* (enlarged): 1. Gneisses and schists (Precambrian). 2. Greenstone schist (metadiabase), (mainly Silurian but some Devonian). 3. Rhyolite breccia, etc. (Devonian). 4. Rhyolite (Devonian). 5. Biotite granite (mainly Carboniferous, some Devonian in S. E. Maine).

(D.) *E. H. Perkins 1933* (reduced): 1. Greenish schists (probably Precambrian). 2. Bar Harbor sediments (Early Paleozoic). 3. Felsitic lavas

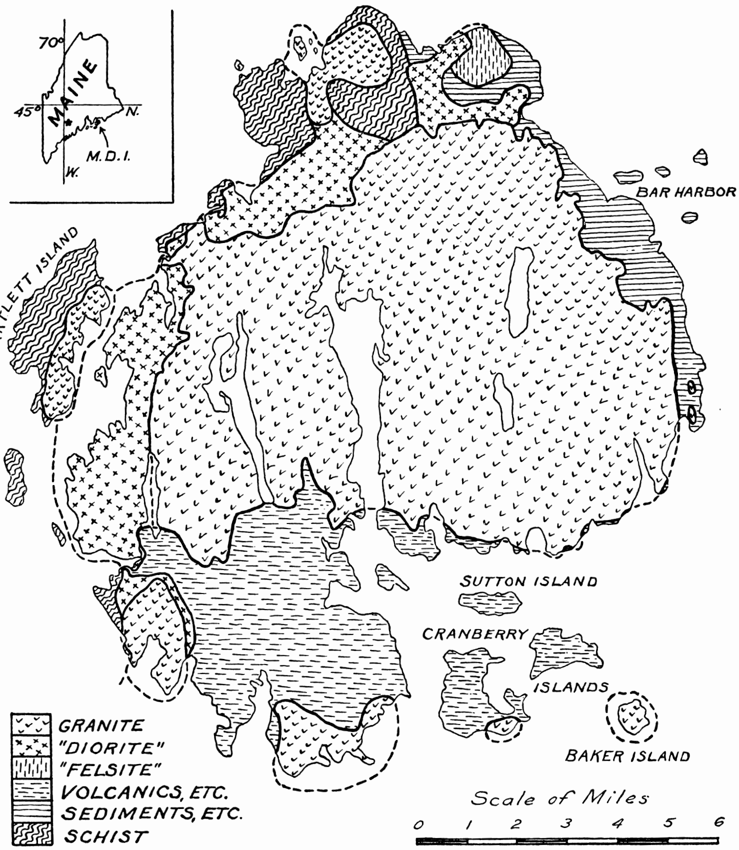

Plate II.

Preliminary Geologic Map of Mount Desert Island, showing the limits of the central mass of (unmixed) granite with its outlying circle of six larger and two tiny granite "cupolas"; the areas of "diorite" (largely invaded by the granite except at northeast) and of the three types of old rocks (also much invaded by "felsite," "diorite" and granite) with the largest mass of pure "felsite."

(Post-Bar Harbor). 4. Hornblende granite (Late Paleozoic). 5. Biotite granite (Late Paleozoic). 6. [= 2-3-4]. Intrusive breccia—sediments intruded by felsite, diorite and granite. 7. [= 2-3-5]. Complex of sedimentary rocks, volcanics and granite.

Perkins interprets the (6) Schooner Head and (7) Sutton Island series as we do, but numbers them as if younger. His map is based on Shaler's.

A range of mountains limited to the southern half of the main granite area extends across the island in a direction about N. 60° E. from its most westerly point to its most easterly, though it does not reach either coast. In these bald mountains surrounded by the sea lies the peculiar charm of Mount Desert. North of this range the elevation is moderate except for some outlying granite hills in the northeast quarter. South of it is also lower ground, much invaded by the sea in the southeast quarter isolating the Cranberry Islands. But the low ground as well as the high is hilly, and all the shores are rocky, surf-battered, indescribably picturesque.

The granite is the youngest rock shown on the map. Its dikes and apophyses penetrate all the others. Its freshness, with coarse, uncrushed texture, indicates that it has suffered no great compression and fixes its date as late Paleozoic (Carboniferous), for it is cut by Triassic trap. It forms a broad, low dome rising (in some places very steeply) up into the older rocks that once roofed it over. Its failure to disturb notably these older rocks, where they rest against it, is evidence that the molten granite melted or engulfed the rock it has replaced. It is a batholith (one of a family of such).

From the concealed fringe or base of the granite batholith, extending outward under the skirting sediments, volcanics and diorite, arise on all sides smaller granite knobs or cupolas, in a nearly complete circle. The map shows four on the south coast, one (on Bartlett's Island) at the west, one at the north, and two tiny ones on the east, total eight actually exposed. But the plexus of granite dikes in Strawberry, Great Meadow and other hills on the east, and also on Sutton's Island, show these to be unexposed cupolas. Prediction ahead from these and from an exposed cupola (at the Bear Brook auto campground) not fully disconnected from the main mass of granite led to discovery of the granite ledges cresting the hill at Great Head, in the woods, and a similar mass in the hill to north, both heretofore unmapped. In both, the granite core must have much steeper side-walls than the hill inclosing it.

The lower north half of the granite area, formerly attributed to deep erosion of the granite (peneplanation or glaciation), is so filled with inclusions of the older rocks for a long way back from its mapped boundary line as to make the drawing of that line often a matter of the personal equation. Thus this lower ground is merely the original roof of the batholith, from which the weaker rocks have been denuded. The mountain range represents an originally higher portion; but there are two lines of proof that it too preserves nearly the primitive outline of the roof except as the peaks have been lowered by longer exposure.

(a) The sheet-jointing so persistently concentric with the present surface, as in the quarry on north end of Champlain Mountain, and ranging thus from vertical along the Precipice Trail to flat on Baker's Island, was found (in cross-section) to conform to the roof where the granite goes under the schist on the southeast shore of Bartlett's Island and so to be a product of cooling, not of weathering.

(b) Glaciation has been charged with the parallel valleys that slice this range into peaks with a base three or four miles long, across the range, but only a mile wide lengthwise of it, not merely for their present depth and U-shape but for their very initiation. The latter is not a faculty of the continental ice-sheet except in situations where selective stream erosion would have operated long before the ice. Tracing of the northern contact revealed that the older rocks extend not only up into the mapped embayments but also as included fragments far into the valleys toward the mountains, making the physiographic features again those of the granite roof, lately uncovered. This proved to be the case with the largest of the cross-valleys, Somes's Sound, that nearly divides the Island at its middle.

The combined evidence of contact phenomena and of sheet-jointing points therefore to roof-pendants of weaker rock as the cause of most or all of the valleys. All the south shore bays, including Somes's Sound and the bottoms of at least all the larger ponds, may still hold these weaker rocks, though for simplicity the outline of the granite region has been carried square across them on the map. But that recent discovery of the Crosbys (1925), keystone faults, is also in evidence, especially in the finer and more rigid lines such as the Gulf (not the road pass of Echo Notch, more lately so called) east of Green or Cadillac Mountain. Why the pendants and the keystone joints had like orientation is a question to which time could not be given in the field.

New to the maps, though recognized by Raisz, is the discrimination from the granite of the older, finer-grained rock designated "diorite." (Shaler, and Stose, here mapped sedimentary schist and granite, but with unlike boundaries; Keith has granite and metadiabase-schist; Perkins put schist, two granites and felsite. A part of the discrepancy is due to interpenetration by the igneous rocks, so that each maps what seems to him dominant.) Time may refine upon the line now drawn, and always the personal equation will enter. The age of this diorite is not fully determined, save that it is older than, extensively invaded by, and included in the granite; and that it invades the Bar Harbor sediments. At Seal Cove, in the southwest, it seems to cut across the Silurian volcanics. One gains the impression that it is later Devonian, emplaced under some depth of Devonian sediments.

The comparatively undisturbed mass of felsite forming Ireson's Hill and the Ovens Cliff on the northeast corner of the Island appears younger than the upturned volcanics of Cranberry Island on the southwest promontory. It is clearly later than and intrusively related to the Bar Harbor sediments, yet is cut by the diorite along the shore east of Salisbury's Cove. Clearly it cooled nearer the surface than did the diorite, and the latter much nearer the surface than did the granite, as though marking successive steps in subsidence and sedimentation such as that of the later Devonian and Carboniferous strata preserved to the northeast.

Shaler (map "A") distinguished four "series" of stratified rocks on the north, east and south shores of Mount Desert, namely the Bar Harbor series from Thomas's Bay (an error) around to Rodick's (Cromwell's) Cove south of the village, the Schooner Head series thence to Great Head (Shaler's map draws no line between these two), the Sutton Island and Cranberry Island series on the south side not clearly discriminated from each other and generally reunited by later writers.

Our work, though time was insufficient, showed no age differences in these four but the same volcanics fingering out northward, as on Burnt Porcupine Island, and the same sediments fingering out southward, as on Sutton's Island, indicating southward sources for the volcanic increment. From Great Head to Schooner Head the interbedded sediments and volcanics are embroiled in felsitic invasions, well shown at Anemone Cave, possibly synchronous with the felsite of the Ovens. Schooner Head was visited in company with the owner, Mr. Richard Hale, to whom thanks are due. If there is anything on this east shore to resemble the schist of the northwest shore, as claimed, we did not find it.

The extent and variety of igneous intrusions, chiefly dikes, that have cut to pieces this rim of ancient bedded rocks from Leland's Point around east and south sides to Seal Cove cannot be depicted on the map nor enumerated in this brief summary. Felsite, diorite and granite have been mentioned. Dikes and sills of old trap (camptonite?) with rough and vein-welted surface are rather widespread; rhyolite is seen at Otter Cliffs, aplites are common on the southwest promontory, the Triassic trap dikes cut everything but are not numerous. Painstaking study is needed.

This rim shows least disturbance of bedding at the north, where the dips are low, but on the south the beds stand on edge with approximate east-west strike, which is also the average strike of low folds on the north. This folding is believed to be early Devonian (Acadian), as the volcanics of neighboring areas are Silurian.

On the west and north sides of the Island appears an intensely plicated greenish-gray metasediment, known on the mainland as the Ellsworth schist but here by the prior name Bartlett Island. This schist occupies more ground at the north than previous maps have given it (the exposures being covered at high tide), and comes so nearly into contact with the Bar Harbor sediments at Leland's Cove as to leave no doubt of their widely different ages and totally unconformable relations. The average trend of the schist is north-northeast. Quartzite layers in it, especially at Seal Cove on the south end of Bartlett's Island, show its sedimentary origin, but it also contains igneous injections. Like most New England "Precambrian" it is probably of (early) Paleozoic age and owes its metamorphism to the Taconic mountain-folding, to which its strike would assign it.

The presumed history is (1) schist (Eopaleozoic), (2) orogeny (Taconic), (3) erosion (early Silurian), (4) sediments and volcanics (middle and late Silurian), (5) orogeny (first Acadian), both preceded and followed (Ireson felsite) by igneous intrusions, (6) sedimentation (Devonian), (7) diorite, (8) further sedimentation (Carboniferous), (9) Cadillac granite,

(10) uplift (Appalachian) and erosion, (11) trap dikes (Triassic), (12) epidote veins and quartz dikes.

To the dubious evidence of marine cliffing upon which others relied is now added positive proof of marine submergence in wave-built beaches up to about 200 feet above tide at and northwest of Hull's Cove. The cemetery west of route 3 above the cove stands on a bar (at 110 feet) running southwesterly to the nearly destroyed top of a drumlin, with lower levels down the wave-concaved slope. (Shaler figured the lower terracings but missed the fine bar at the summit.) At the big gravel pit on the southeast slope of Ireson's Hill the clean-washed beach gravels (of felsite) formerly exhibited perfect beach forms, according to the men who have worked them out; and these gravels continue up practically to the highway summit, at 220 feet.

Like many Adirondack lakes, the lakes of Mount Desert lie largely in glacial troughs carved like bath-tubs in the mountain passes. With these, Somes's Sound and the pass of the Hudson through the Highlands are genetically identical. Shaler correctly described, with diagram, their mode of origin through over-deepening by the crowding of the ice through the pass. To the world, the word fiord connotes a trough heading in high ground. The accident of submergence is emphasized, obscuring kindred origins. For glacial troughs opening both ways out of a mountain range, regardless of submergence, a term is needed, and for this there is here proposed the name, *dorr*. Somes's Sound is a dorr, and the type of a dorr that is submerged. Great Pond is an unsubmerged dorr.

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