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Early Ascents and Geologic Exploration of Katahdin in the Nineteenth Century; Bedrock Geology of the Shin Pond Region

Griscom, Andrew

Neuman, Robert B.

Rankin, Douglas W.

NEW ENGLAND INTERCOLLEGIATE GEOLOGICAL CONFERENCE

PL. VII.

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KATAHDIN

1966

NEW ENGLAND INTERCOLLEGIATE GEOLOGICAL CONFERENCE.

The New England Intercollegiate Geological Conference is perhaps the oldest continuous "organization" on the continent whose sole aim is geological field trips. It began with an informal field trip in 1901, run by William Morris Davis in the Connecticut Valley of western Massachusetts, and gradually extended itself (Connecticut, 1903; eastern Massachusetts, 1905; Rhode Island, 1907; New Hampshire, 1910) over New England and eventually outside to such foreign parts as Montreal and New York City. Attendance at the early meetings is unknown but was probably small; nowadays it runs to 250 or better. The length of the group's name is equalled only by the looseness of its organization. Its purpose remains to arrange for field trips in areas where geological work has recently been done, and to bring together in the field geologists interested in current problems of New England geology.

John Rodgers, Secretary, N.E.I.G.C.

Cover Illustration:

MOUNT KTAADN from W. BUTTERFIELD'S *(Oct. 8th, 1836)*

Near the GRAND SCHOODIC LAKE

Plate VII of Atlas of 24 plates, separately bound, which accompanies Jackson, Charles T., First report on the geology of the State of Maine, Augusta, Maine, 1837.

NEW ENGLAND INTERCOLLEGIATE GEOLOGICAL CONFERENCE

GUIDEBOOK

for field trips in

THE MOUNT KATAHDIN REGION, MAINE

Field Trip Leaders

D. W. Caldwell, Department of Geology, Boston University, Boston, Massachusetts.
Andrew Griscom, United States Geological Survey, Menlo Park, California.
Bradford A. Hall, Department of Geology, University of Maine, Orono, Maine.
Robert B. Neuman, United States Geological Survey, Washington, D. C.
Douglas W. Rankin, United States Geological Survey, Washington, D. C.

58th Annual Meeting
September 29, 30, October 1, 1966

TABLE OF CONTENTS

INTRODUCTION AND ACKNOWLEDGEMENTS.

Members of the N.E.I.G.C. are welcomed to the Mt. Katahdin region, not by an institution, but by the several geologists who are very glad to share with the conference the results of their recent studies here. We are also happy to demonstrate, particularly to the younger members of the Conference, that, in this electronic age, many significant contributions to geologic knowledge can still be made using the time-honored tools of the geologist; his legs and his hammer.

For the first time in a number of years, the Conference is without an official host. Also missing this year will be the elaborate banquets, the comfortable surroundings, the efficient bus trips and the high-rank metamorphic rocks to which attendees of Conferences in recent years have become accustomed. In their stead we can offer outdoor cooking, tents, leantos and rustic cabins, long hikes and fossiliferous sedimentary rocks.

The modern, detailed geologic investigation of the Mt. Katahdin region began in the middle 1950's when Caldwell, Griscom and Rankin, then graduate students at Harvard University started their field studies. In the late 1950's and early 1960's, Neuman of the U. S. Geological Survey mapped the geology of the Shin Pond and Staceyville Quadrangles to the east and northeast of Katahdin. Griscom and Rankin subsequently joined the U. S. Geological Survey, which has published many of the results of their studies. In 1961 Hall, then a graduate student at Yale University, began mapping in the Chamberlain Lake region northwest of Katahdin. The recent studies of both Hall and Caldwell in this area have been supported by the Maine Geological Survey.

During the previous winter and spring months, Brad Hall took over the many chores associated with the organization of this conference and I gratefully acknowledge his very considerable contributions. The Department of Geological Sciences, University of Maine made available its facilities to Dr. Hall in his organizational labors. The Maine Geological Survey provided welcome assistance in the processing of registration forms and the distribution of guidebooks. John R. Rand, Freeport, Maine and Linwood Partridge, Maine Department of Economic Development aided in the design and layout of the guidebook cover. The contributions of each of the field trip leaders are so obvious and at the same time so vital, that it is impossible for me to acknowledge them adequately.

D. W. Caldwell, guidebook editor

EARLY ASCENTS AND GEOLOGIC EXPLORATION OF KATAHDIN IN THE NINETEENTH CENTURY[1]

By Andrew Griscom, U. S. Geological Survey

About 90 miles upstream from Penobscot Bay, the Penobscot River divides into the West Branch and the East Branch. Between these two branches are located the highest mountains in Maine. In the past, the mountains, especially Katahdin, provided impressive changing views to the Indians, who used the rivers, in particular the West Branch, as highways to the interior. John Giles saw Katahdin while a captive of the Indians a few years before 1700, and wrote in 1736:

> "I have heard an Indian say that he lived by the River at the Foot of the Teddon, and in his Wigwam, seeing the top of it thro' the Hole left in the top of the Wigwam for the passing of Smoke, he was tempted to travel to it; accordingly he set out early on a Summer's Morning, and laboured hard in ascending the Hill all Day, and the Top seem'd as distant from the Place where he lodged at Night, as from the Wigwam whence he began his Journey; and concluding that Spirits were there, never dare make a second Attempt.
>
> "I have been credibly inform'd that several others have failed in the same Attempt; particularly, that three young Men towr'd the Teddon three days and an half, and then began to be strangely disoredered & delirious, and when their Imagination was clear, and they could recollect where they were, and been, they found themselves return'd one Days Journey; how they came down so far, and they can't guess, unless the Genii of the Place conveyed them."

The earliest Survey in the Katahdin region of which we have record is described in the journal of Joseph Chadwick, who probably made a partial ascent of Katahdin in 1764 while returning from Quebec via the Penobscot West Branch. The name he uses for the mountain is a variant of Nesowadnehunk (usually pronounced "Sowdyhunk"), the deadwater on the West Branch from which the pyramidal outline of Katahdin is visible:

> "SATINHUNGEMOSS HILL
>
> Lays in the Latitude of 45° 43′ and from Fort Pownal 184 miles as we travel and 116 miles by Computation.
>
> Being a remarkable Hill for highteth & figr The Indines say that this Hill is the highest in the country. That they can ascend so high as any Greens Grow & no higher. That one Indine attempted to go higher but he never returned.
>
> The hight of Vegetation is as a Horizontal Line about halfe the perpendiciler hight of the Hill & intersects the tops of Sundrey other mountines. The hight of this Hill was very apperent to ous as we had a Sight of it at Sundre places Easterly & Westerly at 60 or 70 Miles Distance—It is Curious to See—Elevated above a rude mass of Rocke large Mountins—So Lofty a Pyramid—On which is another Rarity.
>
> From a. Descendes a Stream of water.—If the observer places himselfe at such a place that the Rays of water as it falls from the hill will appear in as grate a Voriety of Collers as may be Viewd in a Prism glass."

Eckstorm (1926) interprets Chadwick's descriptions of the waterfall rainbow and the superstitions of the Indians as indications of an attempted ascent that was discouraged at the timberline by the Indian guides. The locality of the waterfall is uncertain, but Katahdin Falls on Katahdin Stream is a reasonable possibility.

On August 13, 1804, Charles Turner, Jr., a surveyor from Scituate, Massachusetts, and later a member of Congress, ascended Katahdin with a group of surveyors who were engaged in locating the grants of Eastern Lands. Turner's account is generally considered to be that of the first ascent, although his description implies earlier explorations by the English of which there are no known records. The route of ascent was the Hunt Trail spur, the great southwest slide not yet having occurred, and the party with pardonable enthusiasm estimated the height of the mountain as 13,000 feet.

[1] Publication authorized by the Director, U. S. Geological Survey.

Efforts to settle the boundary controversy between Maine and New Brunswick led to the next two ascents of Katahdin by official government surveyors in order to establish whether or not the mountain was situated on a major drainage divide. Major Colin Campbell, a surveyor for Great Britain, ascended the mountain in 1819 and again in 1820, this time in the company of a joint party of British and United States surveyors. The major demonstrated a certain bias in his report by stating (Greenleaf, 1829, p. 29-31) that the view indicated a chain of mountains or divide extending from Katahdin northeast to Mars Hill in Aroostook County, thus laying claim to all land northwest of this divide for England. A detailed account of the ascent was not found until 1958, when a manuscript by Daniel Rose, last mentioned in 1883 by J. D. Elder, was located and acquired by the Bangor Public Library. The British surveyor William F. Odell was the only man whose glass barometer tube survived the 1820 ascent and the party jointly arrived at a rather accurate figure of 5,335 feet for the summit elevation. These two successive climbs were made via the great southwest slide which formed either in 1816 or a few years before and was over 4 miles long. The present Abol Trail follows the upper portion of this slide, now mostly reforested.

The surveying in 1825 of the Monument Line, an east-west base line for the location of townships in the northern part of the state (Avery, 1928), resulted in the first ascent of Katahdin from the East Branch. Joseph C. Norris and his surveying party began working west from the New Brunswick border in the summer of 1825 and discovered that by misfortune their chosen line led directly over the Tableland of Katahdin. Norris finally on November 10, in bitter winter weather and out of supplies, abandoned his survey for that season on the west side of the Tableland above the cliffs of Northwest Basin. The following day the surveyors ascended Katahdin from the north, and after circling down to the southwest, encountered the southwest slide and descended to the West Branch, where a boatload of supplies was waiting for them. They barely managed to canoe down the West Branch to Bangor before the river froze for the winter. In 1826 Norris completed the Monument Line from Chesuncook Lake west, but he left a gap between the lake and Katahdin. The gap was not surveyed until 1833, when Edwin Rose, a surveyor for the State, made the sixth recorded ascent of the mountain. The half-mile offset of the Monument Line near Doubletop Mountain represents the error in Norris' 1826 estimate of where the Line would intersect Chesuncook Lake.

The fifth ascent of Katahdin, by a survey party from Waldo County, is briefly mentioned by Greenleaf (1829). This party computed the height of Katahdin as 5,623 feet.

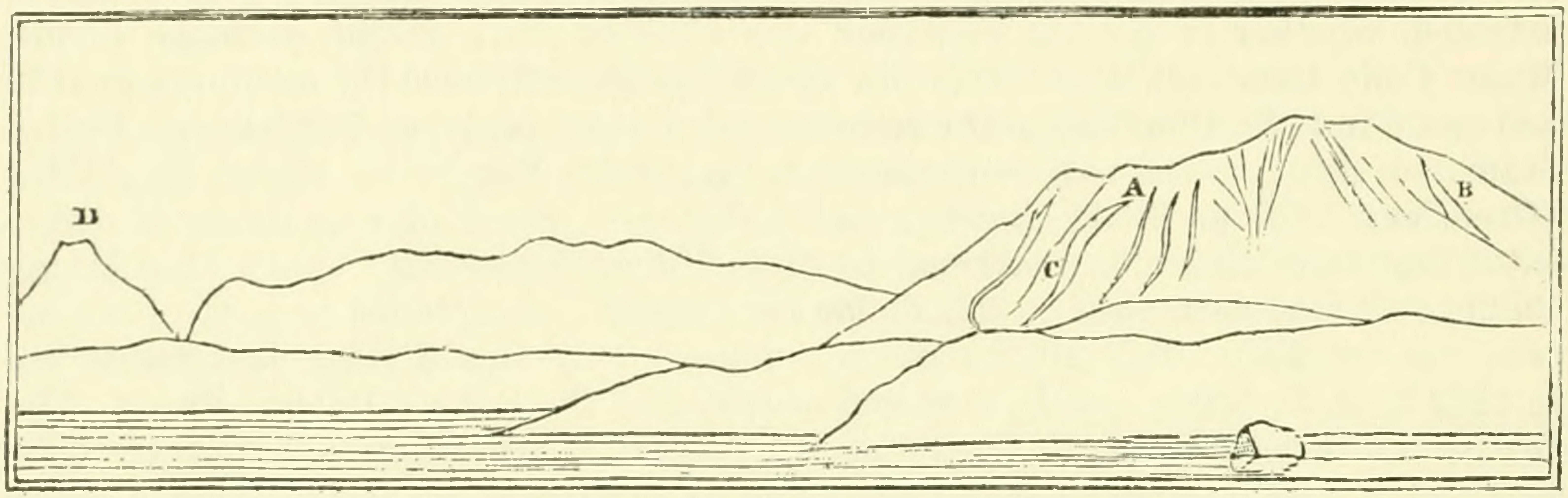
In 1836 Professor Jacob W. Bailey of West Point visited Katahdin in order to make geologic observations concerning the mountain, being unaware of the geological survey of the state proposed for the following year.[2] He described the southwest slide (his "West Slide," Bailey, 1837, p. 28) as follows:

> "Here a scene of wild confusion presented itself; masses of granite, shivered by their fall from above, lay scattered over the path of the slide; all traces of the original soil and vegetation were swept away, so that the denuded ledges of granite appeared in some places, while in others they were covered with great quantities of a coarse gravel, evidently produced by crumbling of some of the coarse varieties of granite, much of which was seen in a state of partial disintegration."

[2] In Figure 1 is shown a sketch of Mt. Katahdin which appeared in Bailey's account (Bailey, 1837) of his expedition. According to Griscom (personal communication), this sketch is ". . . perhaps the earliest published view . . ." (of Mt. Katahdin). Ed.

Figure 1

Outline of Mount Katahdin, as seen from Debskoneegan Lake.



A, West Slide.—B, East Slide.—C, Camp.—D, Sugar Loaf.

Bailey ascribed the occurrence of fossiliferous limestone, graywacke, and amygdaloidal fragments in the slide to diluvial action and noted that the summit was composed of red granite.

Subsequent to Bailey's ascent, visits to Katahdin were made more frequently; in what follows, the discussion will emphasize only nineteenth century expeditions which have some relevance to the geology of the mountain. It can be noted in passing that one of the earliest mentions of the geology of the region is found in Greenleaf (1829, p. 116), who states somewhat optimistically concerning the sandy limestone beds at Ripogenus Gorge: ". . . an extensive bed of fine statuary marble forms a part of the bed of the west branch of the Penobscot, a little below the Chesuncook."

Dr. Charles T. Jackson (during the first geological survey of Maine) reached the top of Katahdin, via the southwest slide, on September 23, 1837, in a snowstorm and short of provisions. He observed that the mountain was composed entirely of biotite granite (Jackson, 1838) and stated his belief, based on erratic boulders in the upper part of the slide, that the drift had passed over the top of the mountain. The cause of the drift was not to be understood for many years.

In 1846 the Rev. Marcus R. Keep opened up the route from the east, clearing a trail to be known as the Keep Path; he later explored the eastern cirques of the mountain.

Henry David Thoreau described in The Maine Woods (1864) a partial ascent of Katahdin on September 8, 1846. He quoted Jackson concerning the geology of the mountain and, like Jackson, was greeted at the edge of the Tableland by a mountain capped with clouds (ibid., p. 63-64):

". . . I was deep within the hostile ranks of clouds, and all objects were obscured by them. Now the wind would blow me out a yard of clear sunlight, wherein I stood; then a gray dawning light was all it could accomplish, the cloud-line ever rising and falling with the wind's intensity. Sometimes it seemed as if the summit would be cleared in a few moments, and smile in sunshine: but what was gained on one side was lost on another. It was like sitting in a chimney and waiting for the smoke to blow away. It was, in fact, a cloud-factory,—these were the cloud-works, and the wind turned them off done from the cool, bare rocks."

In 1861 Charles H. Hitchcock, in the course of a geological survey of the state, ascended Katahdin by way of Avalanche Brook, the East Slide, and the Knife Edge (in one of the last groups guided by the Rev. Mr. Keep). Hitchcock observed the red granite at the summit, capping the white granite found at lower elevations. He doubted that the drift had completely passed over Katahdin because of the sharp outline of the Knife Edge.

John K. De Laski, who visited the mountain with the Young botanical expedition in 1847 and again in 1871, believed that the continental ice sheet overrode the summit of Katahdin (De Laski, 1872). Alpheus S. Packard, entomologist with the Hitchcock party and later professor of geology at Brown University, also supported the concept of a continental ice sheet as the cause of the drift (Packard, 1867).

A great advance in Katahdin geology was marked by the paper of Charles E. Hamlin (1881) describing the results of his visits to Katahdin in 1869, 1871, 1879, and 1880. Here are found the first thin-section descriptions of the red and gray granites (by M. E. Wadsworth, then assistant to N. S. Shaler at Harvard University and a pioneer in microscopic petrography), mention of the gradational contact between the two color varieties, and a discussion of the abundant biotitic inclusions. Finding glacial erratic boulders only up to an elevation of 4,615 feet, Hamlin felt the evidence left unsettled the question as to whether the drift passed over Katahdin, but he did recognize that local valley glaciers had been present and had deposited terminal moraines at the exits of the basins.

The problem of the ice sheet overtopping Katahdin was finally settled by Ralph S. Tarr (1900), who, during expeditions to Katahdin in 1897 and 1899, found foreign rock fragments at the summit. He also provided a more complete description of the effects of the local valley glaciation on the east side of Katahdin and explained that this local glaciation occurred subsequent to the continental ice sheet.

With the publication of Tarr's results, the preliminary investigations of Katahdin geology were complete. Little more information was obtained during the next half century. Interested readers are referred to the splendid annotated bibliography of Katahdin by Smith and Avery (1936).

Geologic research during the twentieth century, begun by graduate students of Harvard University in the 1950's, is discussed by other papers.

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BEDROCK GEOLOGY OF THE SHIN POND REGION[1]

By Robert B. Neuman and Douglas W. Rankin
U. S. Geological Survey, Washington, D. C.

Introduction

Low-rank metamorphism and the presence of fossils make the geology of northeastern Maine a key to the understanding of the more metamorphosed rocks of southern New England. The Shin Pond region, consisting of the Shin Pond and surrounding quadrangles, contains many of the critical elements of that key.

The region affords the longest, most nearly complete, and most accessible section in the State, and it contains one of the largest masses of felsic volcanic rocks in the United States. Because facies change abruptly within short distances and because many critical relations are exposed in inaccessible places, the features to be seen along the routes of the trips are but random and incomplete samples of the information upon which the understanding of the geology of this area is based.

The geology of the four contiguous quadrangles to be visited has been mapped at a scale of 1:62,500 in recent years. Neuman mapped the Shin Pond and Stacyville quadrangles for the U. S. Geological Survey in 6 summer field seasons ending in 1963; he has been especially interested in Ordovician stratigraphy and paleontology. Rankin mapped the Traveler Mountain quadrangle, with special emphasis on the volcanic rocks of Traveler Mountain, for a dissertation at Harvard University, supported in part by the Maine Geological Survey, in 5 seasons ending in 1961. The Island Falls quadrangle, east of the Shin Pond quadrangle, was mapped in 1958-1962 by E. B. Ekren and F. C. Frischknecht of the U. S. Geological Survey, using electromagnetic equipment as a supplement to surface observations. More than a dozen papers by these geologists on one or another aspect of their work have been published. Professional Papers and accompanying geologic maps on the U. S. Geological Survey work have been prepared and are now being processed for publication. Further, all but the mountainous area is covered by recent aeromagnetic maps of the U. S. Geological Survey.

We wish here to acknowledge the essential role of Arthur J. Boucot, now of the California Institute of Technology, in determining and interpreting Silurian and Lower Devonian brachiopods, and thus in establishing the relative ages of many of the units mapped. Graptolites in considerably fewer numbers were identified by W. B. N. Berry (University of California, Berkeley) whose assistance we also gratefully acknowledge.

Major tectonic features

The major structures of the region are the large anticlinorium that extends northeastward from the Stacyville quadrangle across the southern half of the Shin Pond quadrangle (the southwestern end of the Weeksboro-Lunksoos Lake anticline of Pavlides and others, 1964) and the complementary synclines to the northwest and southeast (figs. 1 and 2). Lower Cambrian(?) and Ordovician rocks are exposed in the core of the anticlinorium. On the northwest flank of the anticlinorium the Silurian sequence includes distinctive calcareous sedimentary rocks, conglomerate, and volcanic rocks that are overlain by Lower Devonian siltstone, sandstone, the volcanic rocks of Traveler Mountain, and the overlying sedimentary rocks that

[1] Publication authorized by the Director, U. S. Geological Survey.

were derived from them. On the southeast flank of the anticlinorium, by contrast, the Silurian rocks are largely a monotonous assemblage of slate, siltstone, and fine-grained sandstone, without volcanic rocks, and with little limestone or conglomerate; in this region, no sedimentary rocks of Devonian age have been identified.

Most of the rocks are deformed and metamorphosed to the chlorite grade of regional metamorphism. Metamorphism and deformation are least in the Traveler Mountain volcanic rocks and the overlying Trout Valley Formation of Dorf and Rankin (1962), the latter being remarkably little disturbed.

The rocks of the Lower Cambrian(?) Grand Pitch Formation are intricately folded and faulted and are more deformed than those of overlying formations. Argillaceous rocks of the Grand Pitch possess a well-developed cleavage, and sandstones are commonly sheared. In many places cleavage is folded; in some of these cleavage folds the earlier cleavage is cut by a second one. Argillaceous rocks with interbedded sandstone also occur at the base of the overlying Ordovician Shin Brook Formation at a few places, but they are not as complexly deformed as those of the Grand Pitch. At other places the lower part of the Shin Brook contains conglomerate composed of fragments of slate and quartzite almost certainly derived from the Grand Pitch.

Both the deformation contrast and the composition of the conglomerate indicate that a tectonic event separated the deposition of these formations. Deformation contrasts between rocks that may be correlative with the Grand Pitch and overlying Ordovician rocks have been described elsewhere in the northern Appalachians (Cooke, 1955; Riordon, 1957; Larrabee and others, 1965, p. E-8). Such a contrast through this large an area suggests tectonic activity of regional extent at some time between the Early Cambrian and the Early Ordovician; the term Penobscot disturbance is proposed for this event.

If the contrast of deformation between the Grand Pitch and younger formations is ascribed to the Penobscot disturbance, the effect of the younger Taconic orogeny in this area is seen largely in, (1) the distribution of Ordovician rocks, (2) the facies pattern of the Silurian rocks, and (3) the occurrence of a pre-Lower Silurian porphyritic quartz diorite. The absence of Ordovician rocks beneath the Silurian in most places along the northwest flank of the anticlinorium might be attributed to Taconic uplift and erosion. This event may also be responsible for the apparent wedge-out of Ordovician rocks at the southwestern end of this outcrop belt. The contrasting facies of contemporaneously deposited Silurian rocks on opposite sides of the anticlinorium indicate that an ancestral form of this anticlinorium developed during the Taconic and remained to separate the Silurian basins of deposition. Fragments of the porphyritic quartz diorite in Lower Silurian conglomerate on the southeast flank of the anticlinorium were probably locally derived and indicate the minimum age of that intrusive.

The Acadian orogeny was the last to affect the area. Through most of the region, Acadian structure is characterized by nearly vertical, well-developed slaty cleavage and shear surfaces; folds are the dominant major structures, but there are significant contrasts in the style of folding on opposite sides of the anticlinorium, and faults are important features in some places. On the southeast flank of the anticlinorium most beds as well as cleavage stand nearly vertically; axes of minor folds and bedding-cleavage intersections are generally vertical. By contrast, on the northwest flank, bedding over wide areas dips moderately, and major as well as minor folds have moderate plunges. Curiously, over a considerable area, minor folds plunge

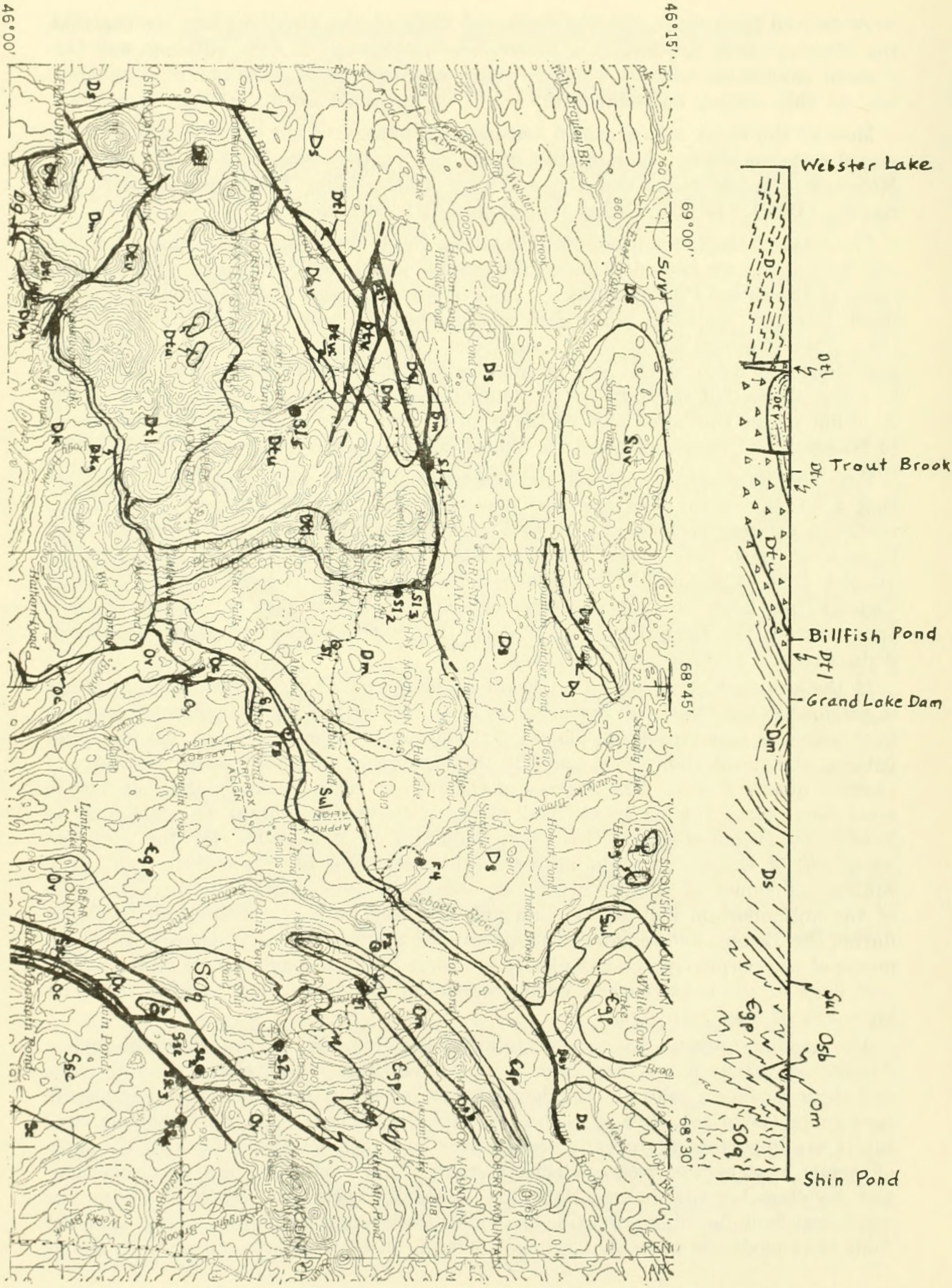

Figure 1. Geologic map of the Traveler Mountain and Shin Pond quadrangles, and structure section approximately parallel to route of excursion.

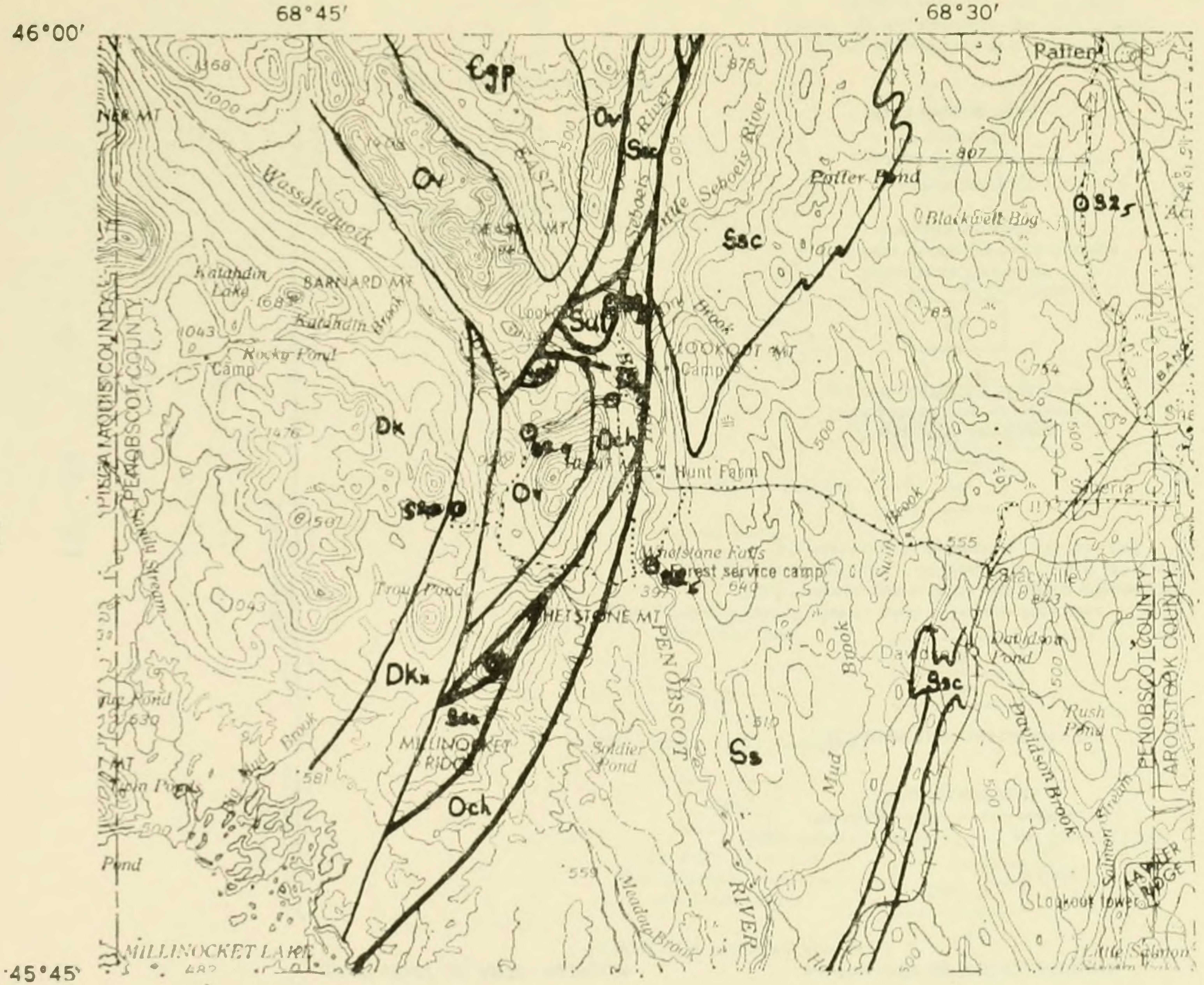

Figure 2. Geologic map of the Stacyville quadrangle

EXPLANATION

Contact

Fault

Route of excursions

Stops: F1-F4, Friday, Sept. 30

$S1_1$-$S1_5$, Trip 1, Saturday, Oct. 1

$S2_1$-$S2_{10}$, Trip 2, Saturday, Oct. 1

0 — 10 MILES

EXPLANATION

SEDIMENTARY AND EXTRUSIVE ROCKS

SOUTHEAST OF ANTICLINORIUM

NORTHWEST OF ANTICLINORIUM

Lower Devonian

Dtv — Dtvc

Trout Valley Formation of Dorf and Rankin (1962)
Dtv-Shale, siltstone, and sandstone;
Dtvc-conglomerate

ACADIAN UNCONFORMITY(?)

Dtu
Dtl

Quartz latite of Traveler Mountain
Dtu-Porphyritic quartz latite with quartz phenocrysts rare or absent; lava. Dtl-Porphyritic quartz latite with abundant quartz phenocrysts; ash flow tuff

Dm

Matagamon Sandstone
Thick-bedded, fine- to medium-grained feldspathic sandstone

Ds

Seboomook Formation
Graded beds of fine-grained sandstone and dark siltstone

DSv

Mafic volcanic rocks

INTRUSIVE ROCKS

Dkg — Dk — Dkx

Quartz monzonite of Mt. Katahdin
Dk-granoblastic rocks; Dkg-granophyric rocks; Dkx-border phase with abundant xenoliths

Dg

Granophyre
May be equivalent to volcanic rocks of Traveler Mountain

DEVONIAN

SILURIAN OR DEVONIAN

SILURIAN

Lower and Upper Silurian

Ss

Slate, siltstone, and minor sandstone

Ssc

Sandstone and conglomerate with minor slate

Suv / Sul

Suv-mafic volcanic rocks, including flows, tuff, and conglomerate; Sul-calcareous siltstone, limestone and conglomerate

Sl

Conglomerate, sandstone, and non-calcareous siltstone

TACONIC UNCONFORMITY

SOq

Porphyritic quartz diorite

ORDOVICIAN

Upper Ordovician

Oc

Conglomerate, sandstone, and calcareous siltstone

CORE OF ANTICLINORIUM

Middle Ordovician

Och

Chert with subordinate felsic pyroclastic rocks

Ov

Mafic volcanic rocks (greenstone)

Om

Metadiabase

Lower or Middle Ordovician

Osb

Shin Brook Formation
Tuff, tuffaceous sandstone, and conglomerate

PENOBSCOT UNCONFORMITY

CAMBRIAN(?)

Lower Cambrian(?)

Cgp

Grand Pitch Formation
Gray, green, and red slate, quartzite, and graywacke

northeast whereas major folds plunge southwest. The structurally competent Matagamon Sandstone and the quartz latite of Traveler Mountain are folded together with the beds below, but these competent rocks show the effects of deformation or metamorphism less. The Trout Valley Formation is so little deformed that it may postdate the Acadian orogeny.

More certainly younger than Acadian folding is the quartz monzonite of Mount Katahdin and its bordering breccia.

Stratigraphy

Only those formal stratigraphic names that are unequivocally in good standing are used in this guidebook; nomenclatorial revision or clarification is deferred to other more appropriate publication, as is the introduction of the new names that will be used in the forthcoming U. S. Geological Survey publications.

CORE OF ANTICLINORIUM

Grand Pitch Formation (Neuman, 1962): Gray, green, and red slate and siltstone, and about equal amounts of vitreous quartzite and lesser amounts of graywacke and tuff. Contains the trace fossil *Oldhamia smithi* Ruedemann in red slate at several places along the East Branch of the Penobscot River. *Oldhamia* occurs with Early Cambrian body fossils in the Weymouth Formation in Massachusetts (Howell, 1922), but it is the only fossil in such formations as the "Nassau Beds" of Ruedemann (*in* Cushing and Ruedemann, 1914, p. 70) in New York, and the Bray Slate in Eire (Tremlett, 1959, p. 62) for which a late Precambrian age cannot be excluded. Minimum thickness, 5,000 feet.

Shin Brook Formation (Neuman, 1964): Tuff, tuffaceous sandstone and conglomerate, breccia, and flows. Tuff, the most common rock, is massive, greenish-gray, and porphyritic; contains altered stubby to anhedral altered plagioclase phenocrysts up to 2 mm in cross section; it is of intermediate composition, in the andesite-dacite range. Fossils, mostly brachiopods, and fewer trilobites, bryozoans, gastropods, and sponges, occur in the sandstone and tuff at different levels from place to place. Study of the brachiopods by Neuman (1964), and of the trilobites by Whittington (*in* Neuman, 1964) indicated a late Early or earliest Middle Ordovician age. Thickness variable, 300 to 2,500 feet.

Ordovician mafic volcanic rocks (greenstone): Largely massive metamorphosed basalt, andesite, and dacite; locally pillow lava and flow breccia. Thickness where present, 1,000 to 2,500 feet.

Chert with subordinate felsic and mafic pyroclastic rocks: Thin-bedded, medium-to dark-gray, greenish-gray, and red chert; tuff and tuff breccia interbedded locally. Siliceous shale interbeds contain graptolites of the *Climacograptus bicornis* and *Orthograptus truncatus* var. *intermedius* Zones, and conodonts and inarticulate brachiopods. Estimated thickness, 300-1,500 feet.

Ordovician conglomerate, sandstone, and calcareous siltstone: Polymict boulder to pebble conglomerate containing fragments of volcanic rocks, slate, quartzite, and quartz pebbles, and gray sandstone and calcareous siltstone. Exposed principally along the East Branch of the Penobscot River (including Haskell Rock Pitch), where it overlies mafic volcanic rocks and is presumably overlain by Lower Silurian conglomerate; wedges out northeastward. Contains brachiopods, trilobites, and corals of Late Ordovician (Ashgill) age. Maximum thickness about 1,500 feet, but thins abruptly to extinction.

NORTHWEST FLANK OF ANTICLINORIUM

Lower Silurian conglomerate, sandstone, and siltstone: Thick-bedded polymict quartzose pebble conglomerate, micaceous sandstone, and gray and red siltstone and slate; wedges out northeastward along outcrop belt. Conglomerate contains large thick-shelled brachiopods, such as *Pentamerus* sp. and *Stricklandia lens ultima* Williams. As much as 800 feet thick, but thins to extinction.

Upper Silurian calcareous siltstone, limestone, and conglomerate: Light-gray calcareous siltstone and fine-grained sandstone with thin beds and lenses of silty limestone; includes some reefal limestone at Marble Pond and elsewhere, and coarser grained sandstone and conglomerate in the northwest corner of the Shin Pond quadrangle. Fossils, especially brachiopods, corals, and stromatoporoids locally abundant. Some assemblages dated as Early or Late Silurian (late Llandovery or Wenlock) age; others are more certainly Late Silurian (Wenlock or early Ludlow) age. Probable minimum thickness, 500 feet.

Upper Silurian sedimentary and mafic volcanic rocks (apparently the thickened volcanic equivalent of the calcareous siltstone sequence described above): Massive metamorphosed mafic volcanic rocks including pyroclastics, interfingered and interbedded with green tuffaceous slate and siltstone, conglomerate with red and green matrix, and muddy sandstone; also minor amounts of reefal limestone, some with basaltic clasts. Scattered fossils in green tuffaceous slate, green matrix conglomerate, reefal limestone and debris derived therefrom; some assemblages dated as Late Silurian (lower Ludlow), others no more precisely than Silurian or Devonian. Some pre-Silurian rocks may be included. Thickness several thousand feet.

Devonian or Silurian mafic volcanic rocks: Tuff, breccia with scoriaceous fragments, and probably some flows. Possibly the same as Upper Silurian volcanic unit, but lacks fossils.

Seboomook Formation (Boucot, 1961, p. 169): Graded beds of fine-grained, crossbedded sandstone, dark-gray siltstone, and slate, and a few thick beds of finegrained feldspathic sandstone like that of the Matagamon Sandstone. One exposure of gray sandy siltstone at the base contains a few Lower Devonian brachiopods. Thickness variable: 4,000 feet on East Branch of the Penobscot.

Matagamon Sandstone (Rankin, 1965): Thick-bedded, fine- to medium-grained feldspathic sandstone and subordinate amounts of siltstone and slate like that of the Seboomook. Sandstone commonly well laminated and crossbedded; some displays scour-and-fill structure. Load casts of sandstone in siltstone ("pseudonodules") rare. The Matagamon is a sandstone facies of the Seboomook. Fossils scarce except in occasional shell beds where Lower Devonian (Becraft-Oriskany) brachiopods are abundant. Thickness: 4,000 to 5,000 feet.

Quartz latite of Traveler Mountain (The name "Traveler Rhyolite" is generally attributed to "Toppan, 1932," an unpublished Master's thesis at Union College, Schenectady, New York; inasmuch as this thesis cannot be considered a publication and the rock is now considered to be a quartz latite, the unit remains without a formal name.): Dark dense aphanitic quartz latite that breaks with a conchoidol fracture and contains a few percent of small (1 to 3 mm) phenocrysts. Lava, ash-flow tuff, airfall tuff, and breccia have been recognized. Little sedimentary rock is interbedded, and no fossils have been recognized. The quartz latite must be younger than the Matagamon Sandstone which is of Becraft-Oriskany age and older than the Trout Valley Formation of Early or Middle Devonian age. It is the youngest stratigraphic unit intruded by the quartz monzonite of Mt. Katahdin. The quartz latite is described in more detail in a separate section of this guidebook.

Trout Valley Formation of Dorf and Rankin (1962) : Light blue-gray to black shale, siltstone, sandstone and conglomerate, and minor amounts of sideritic sandstone and black sideritic ironstone. A massive conglomerate lentil, probably a deltaic deposit, occurs at the base along South Branch Ponds Brook—the route traversed by Field Trip AS_1. Although pebble and granule conglomerate is scattered throughout, conglomerate lenses are less common in the upper part; boulder and cobble conglomerate is largely restricted to the basal conglomerate lentil. No rock fragments other than felsite have been observed in the conglomerate.

Fossils include plants (in some places so abundant that the rock resembles a low-grade coal), ostracodes, estherids(?) and eurypterid scales. Well-preserved impressions of terrestrial plants were characterized by Dorf and Rankin (1962) as a *Psilophyton* flora and interpreted by them to indicate an Early Devonian (Onesquethaw-late Coblenzian) age; however, they may be somewhat younger (Schopf, 1964, p. D49). The relatively undeformed condition of the Trout Valley may be due to its post-tectonic age if it proves to be equivalent to the post-Acadian Middle Devonian Mapleton Sandstone of Aroostook County; on the other hand it may be due to its shielded tectonic position above the thick competent quartz latite of Traveler Mountain. Exposed thickness about 1,500 feet.

SOUTHEAST FLANK OF ANTICLINORIUM

Silurian sandstone and conglomerate with minor slate: Feldspathic sandstone, polymict pebble and cobble conglomerate, and gray slate and siltstone. The coarser conglomerate, containing cobbles of porphyritic quartz diorite, greenstone, quartzite, and other rocks, occurs in the fault slices of the southeast flank of the anticlinorium; at one place interbedded sandstone yielded Lower Silurian (upper Llandovery) fossils. Pebble conglomerate and sandstone without dateable fossils lies in the core of an anticline to the southeast. Sandstone with subordinate conglomerate, like the Frenchville Formation in the Presque Isle quadrangle (Boucot and others, 1964), and also with Lower Silurian fossils, lies in the core of a second anticline still farther southeast in the Stacyville quadrangle. Estimated minimum thickness, 5,000 feet.

Silurian slate, siltstone, and minor sandstone: Medium- to dark-gray, greenish-gray, and red slate and siltstone, and a few beds of fine- to medium-grained sandstone. Monograptid graptolites rare, including late Llandovery to early Ludlow forms. Estimated thickness, about 10,000 feet.

INTRUSIVE ROCKS

Ordovician metadiabase: Gray and greenish-gray, fine- to coarse-grained metadiabase forming massive ledges. Occurs as a sill above Shin Brook Formation.

Silurian or Ordovician porphyritic quartz diorite: Fine- to coarse-grained, gray to greenish-gray, sheared and altered porphyritic quartz diorite and granodiorite, characterized by phenocrysts of quartz and feldspar as much as half an inch in cross section. Potassic feldspar, some slightly perthitic, constitutes as much as one-third of the feldspar. Total feldspar somewhat more abundant than quartz. Chlorite and epidote pseudomorphic after biotite; calcite abundant in patches and veinlets. Locally contains abundant large xenoliths of greenstone and quartzite.

Devonian granophyre: Light-gray granophyre containing about 5 percent phenocrysts of quartz, plagioclase, and biotite. Plagioclase phenocrysts commonly in rosettes 2 to 3 mm in diameter. Groundmass granophyric or spherulitic.

Devonian (post-tectonic) quartz monzonite of Mount Katahdin (= "Katahdin Granite" of authors): Granoblastic phase is massive medium-gray, medium-grained, and consists of two-thirds feldspar (about three-fifths perthite and two-fifths zoned plagioclase), one-third quartz, and 5 to 10 percent biotite. Where altered, potassic feldspar is pink, plagioclase is greenish, and chlorite replaces biotite. The quartz monzonite is porphyritic locally, and contains pink-weathering perthite phenocrysts 5 mm long in a groundmass somewhat finer grained than the granoblastic phase. The granophyric phase is vuggy, pink, and contains phenocrysts of biotite. Vugs contain epidote, tourmaline, quartz, and potassic feldspar. Border phase on the east is fine grained and contains abundant fragments of thermally altered and partially assimilated sedimentary rocks.

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