BEDROCK GEOLOGY OF THE SHIN POND-TRAVELER MOUNTAIN REGION

by

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From 1980 NEIGC Guidebook (Roy and Naylor, eds, 1980) with minor deletions [...] and [additions from later work].

INTRODUCTION

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

The region affords the longest and most complete stratigraphic section in the State; it contains many fossil localities including an unusual occurrence of well -preserved Early Devonian terrestrial plants ..., 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 route of the trips are only random and incomplete samples of the information upon which the understanding of the geology of this area is based.

The geology of the quadrangles to be visited was mapped at a scale of 1:62,500. Neuman (1967) mapped the Shin Pond and Stacyville quadrangles for the U. S. Geological Survey. Rankin (1961) mapped the Traveler Mountain quadrangle, with special emphasis on the volcanic rocks of Traveler Mountain, for a dissertation at Harvard University; he was supported in part by the Maine Geological Survey. The Island Falls quadrangle, east of the Shin Pond quadrangle, was mapped by E. B. Ekren and [the late] F. C. Frischknecht of the U. S. Geological Survey, using electromagnetic equipment to supplement surface observations. [The Katahdin Granite, a major component of the Katahdin-Traveler Igneous Suite, mostly south of Figure 1, is not visited in trips B4 or B5; it was studied by Griscom (1976) and Hon (1976) for dissetations at Harvard University and M.I.T., respectively.] In addition to these reports, more than a dozen papers by these geologists on one or another aspect of their work have been published. Further, all but the mountainous area is covered by aeromagnetc maps of the U. S. Geological Survey. [Recently detailed geologic studies of the northern part of the Traveler Mountain quadrangle have been conducted by J. P. Hibbard and Stephen Hall (1993, 1994).]

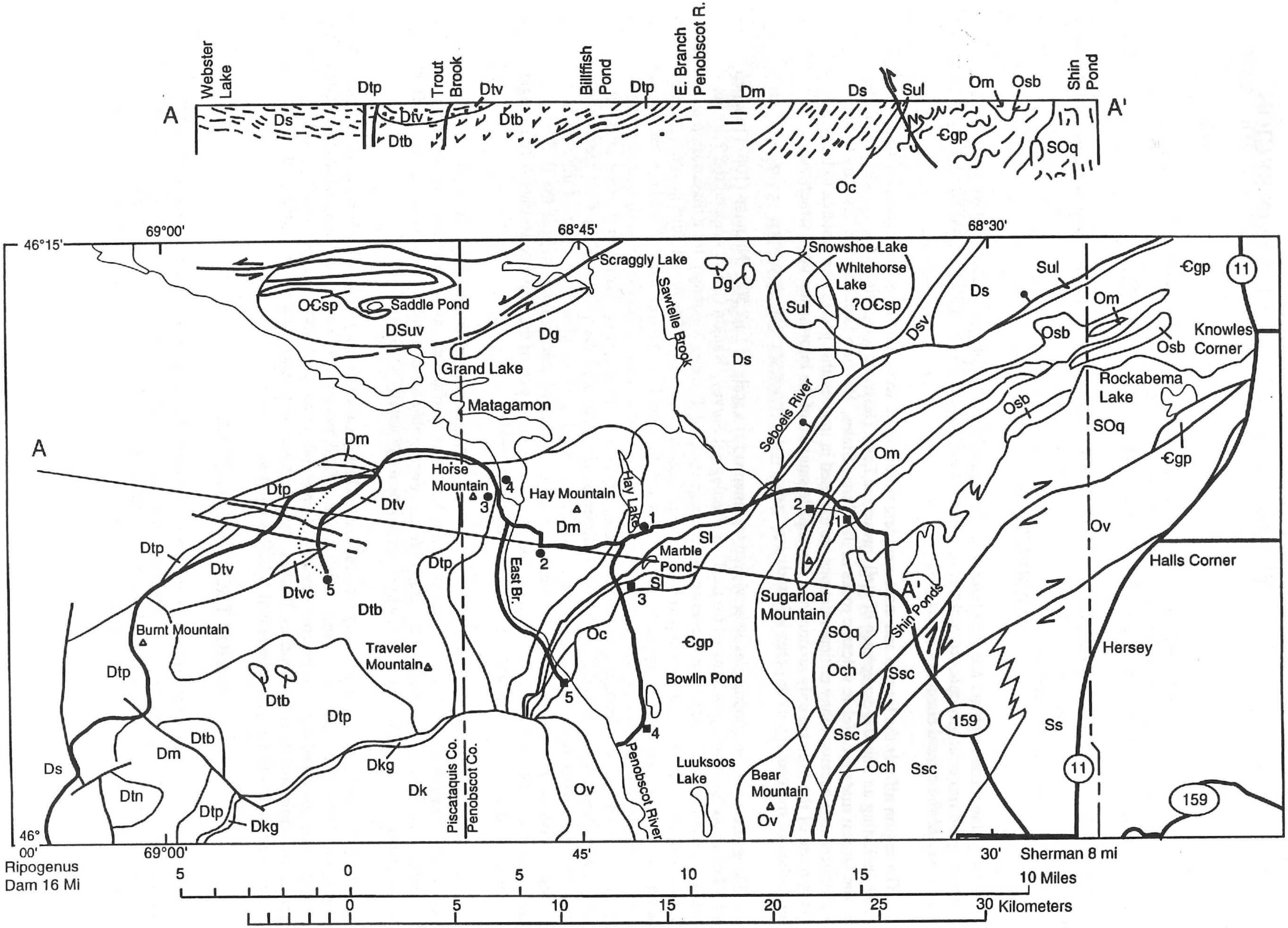
We wish to acknowledge the essential role of Arthur J. Boucot, now of Oregon State University, in identifying and interpreting the many Silurian and Early Devonian brachiopods, and thus in establishing the relative ages of many of the units mapped. Graptolites in considerably fewer numbers were identified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

The 1966 [and 1980] New England Intercollegiate Geological conference in the Mount Katahdin Region (Caldwell, ed., 1966) [Roy and Naylor, eds., 1980] included field trips led by Neuman and Rankin through much of the same area discussed here. Although relevant [...] [materials of the 1966 and 1980 guidebooks] [...] is repeated here, additional work by Neuman, Rankin, and others has been added, and the itineraries of the trips have been modified to fit the [...] [schedule of the 1994 program].

MAJOR TECTONIC FEATURES

The major structures of the region are the large anticline that extends northeastward from the Stacyville quadrangle across the southern half of the Sin Pond quadrangle (the southwestern end of the Weeksboro-Lunksoos Lake anticline of Pavlides and others, 1964; Lunksoos anticlinorium of Boone and Boudette, 1989) and the complementary synclines to the northwest and southeast (fig. 1). Lower Cambrian(?) and Lower Ordovician rocks are exposed in the

Neuman, R.B. and Rankin, D.W., 1994, Bedrock geology of the Shin Pond-Traveler Mountain region (trip B4/B5), in, Hanson, L.S., ed., and Caldwell, D.W., co-organizer, Guidebook to Field Trips in North-Central Maine, New England Intercollegiate Geological Conference, Wm. C. Brown Publishers, Debuque, Iowa, p. 123-133.


A
A'
Webster Lake
Dtp
Trout Brook
Dtv
Billfish Pond
E. Branch Penobscot R.
Dm
Ds
Sul
Om
Osb
Shin Pond
Dtb
€gp
SOq
Oc
69°00'
68°45'
68°30'
46°15'
Scraggly Lake
Snowshoe Lake
Whitehorse Lake
?O€sp
O€sp
Saddle Pond
DSuv
Dg
Grand Lake
Matagamon
Sawtelle Brook
Seboeis River
Dsv
Knowles Corner
Rockabema Lake
Horse Mountain
Hay Mountain
Hay Lake
Marble Pond
Sl
Dtvc
Burnt Mountain
Traveler Mountain
East Br.
Sugarloaf Mountain
Shin Ponds
Och
Ssc
Halls Corner
Hersey
Ov
Ss
Bowlin Pond
Luuksoos Lake
Bear Mountain
Penobscot River
Piscataquis Co.
Penobscot Co.
Dkg
Dk
Dtn
159
11
46° 00'
45'
30'
Sherman 8 mi
Ripogenus Dam 16 Mi
10 Miles
30 Kilometers

EXPLANATION

SEDIMENTARY AND EXTRUSIVE ROCKS

SOUTHEAST OF ANTICLINE

Lower & Upper Silurian

Ss / Ssc — Allsbury Formation
Ss - Slate, siltstone, minor sandstone
Ssc - Sandstone, conglomerate, minor slate

NORTHEAST OF ANTICLINE

Middle Devonian

Dtv / Dtvc — Trout Valley Formation
Dtvc - Conglomerate

Lower Devonian

Dtb / Dtp — Traveler Rhyolite
Dtb - Black Cat Member
Dtp - Pogy Member

Dm — Matagamon Sandstone

Ds — Seboomook Formation

Silurian or Devonian

DSv — Mafic volcanic rocks

DSuv — Volcanic and sedimentary units of Hibbard & Hall, 1993

Lower & Upper Silurian

Suv / Sul — Unnamed formations
Suv-Mafic volcanic rocks and conglomerate
Sul-Calcareous siltstone, limestone, and conglomerate

Sl — Unnamed formation
Conglomerate, sandstone, noncalcareous siltstone

Upper Ordovician

Oc — Unnamed formation
Conglomerate, sandstone, siltstone, and basalt

CORE OF ANTICLINE

Lower Middle Ordovician

Och — Wassataquoik Chert

Ov — Unnamed mafic volcanic rocks (greenstone)

Osb — Shin Brook Formation

Lower Cambrian?

Ꞓgp — Grand Pitch Formation

NORTH OF ANTICLINE

Cambrian?

OꞒsp — Saddle Pond Formation of Hibbard & Hall, 1993

INTRUSIVE ROCKS

DEVONIAN

Dkg / Dk — Katahdin [Granite]
Dkg - Granophyric rocks

Dg — Granophyre

ORDOVICIAN OR SILURIAN

SOq — Rockabema Quartz Diorite

ORDOVICIAN

Om — Metadiabase

Contact, presumed stratigraphic

Fault; ball and bar on downbrown side of those of dominantly vertical displacement; arrows show relative diplacement of those of dominantly horizontal displacement.

● Stops of trip B4

■ Stops of trip B5

core of the anticline. On the northwest flank of the anticline are Upper Ordovician rocks and a Silurian sequence of distinctive calcareous sedimentary rocks, conglomerate, and volcanic rocks that are overlain by Lower Devonian siltstone, sandstoneand volcanic rocks of Traveler Mountain, and the overlying sedimentary rocks that were derived from them. On the southeast flank of the anticline, 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 Rhyolite and the overlying Trout Valley Formation, 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 the 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 the cleavage folds the earlier cleavage is cut by a second one. Argillaceous rocks and interbedded sandstone at the base of the overlying Ordovician Shin Brook Formation at a few places 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 clasts of the conglomerate indicate that a tectonic event separated the deposition of these formations. Deformation contrasts between the 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 a regional extent at some time between the Early Cambrian and the Early Ordovician; the term Penobscot disturbance was coined for this event (Neuman and Rankin *in* Caldwell (ed.), 1966, p. 9; [see also Neuman, 1967. The relation of the penecontemporaneous Taconic and Penobscot orogenies seems now to be that the Taconic effected the Laurentian margin of the Iapetus ocean basin whereas the Penobscot took place on its opposite side (Neuman and Max, 1989; Colman-Sadd and others, 1992)].

The effect of the Taconic orogeny in this area is indicated by several features. For example, the absence of Ordovician rocks beneath the Silurian in most places along the northwest flank of the Lunksoos 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 Lunksoos anticlinorium indicate that an ancestral form of [this structure] developed during the Taconic and remained to separate the Silurian basins of deposition. Fragments of the Rockabema Quartz Diorite in Lower Silurian conglomerate on the southeast flank of the anticline were probably locally derived and indicate the minimum age of that intrusive.

The Acadian orogeny was the last major deformation 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 Weeksboro-Lunksoos Lake anticline, and faults are important features in some places. On the southeast flank of the anticline most beds as well as cleavage stand nearly vertical; axes of minor folds and cleavage-bedding 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 east of Traveler Mountain, minor folds plunge northeast, whereas major folds plunge southwest.

The age of the Acadian orogeny relative to the age of the Traveler Rhyolite and Trout Valley Formation poses some difficult questions. The Katahdin [Granite] lacks a tectonic fabric and clearly intrudes folded Lower Devonian rocks; it is a post-orogenic pluton. The structurally competent Matagamon Sandstone and Traveler Rhyolite are part of these folds, but these competent rocks show the effect of deformation less than the underlying rocks. The ash flows of the Pogy Member of the Traveler Rhyolite overrode unconsolidated sediments of Matagamon as evidenced by sandstone dikes in the basal Pogy [tuffs] and possibly channeling of the Matagamon by the ash flows (Rankin, this guidebook). Pebbles of felsite in the upper few meters of the Matagamon provide further evidence that volcanism began before the end of the deposition of the Matagamon Sandstone. On the other hand, [Rankin and Hon (1987) concluded that the Katahdin [Granite] is a subvolcanic pluton of the Traveler caldera.] Thus, there can be no great interval of time between the deposition of the Matagamon Sandstone, folding by the Acadian orogeny, and the intrusion of the post-orogenic Katahdin pluton [whose isotopic age is about 400my (Denning and Lux, 1989)]. These observations lend further support to the suggestions by Naylor (1971) that the Acadian orogeny was a short-lived event.

The Trout Valley Formation [was deposited across long wave-length folds in the Traveler Rhyolite (Rankin and Hon, 1987). Its Middle Devonian age determined from plant fossils (Kasper and Forbes, 1979) is probably post-Acadian, slightly younger than the Katahdin Granite that is closely related to the Traveler Rhyolite.]

STRATIGRAPHY

Description of mapped units of Figure 1

Core of anticline

Grand Pitch Formation (Neuman, 1962) Cgp: Gray, green, and red slate and siltstone and about equal amounts of vitreous quartzite and lesser amounts of graywacke [...]. Contains the trace fossil Oldhamia smithi Ruedemann in red slate at several places along [and near] the East Branch of the Penobscot River. [... For discussion of Oldhamia and its stratigraphic significance see Hofmann and Cecile, 1981.] Minimum thickness, 1,500 m (5,000 ft). [Rocks similar to the Hurricane Mountain mélange occupy a large part of the outcrop area of the Grand Pitch Formation (Boone and Boudette, 1989); these are gray and dark-gray slate and medium- to coarse grained sandstone, lacking the red slate and thick-bedded quartzite of the typical Grand Pitch.]

[Saddle Pond Formation of Hibbard & Hall, 1993 OCsp: Black phyllite and quartzwacke, intensely deformed.]

Shin Brook Formation (Neuman, 1964) Osb: [Lava], tuff, tuffaceous sandstone and conglomerate, and breccia. [Lava], the most common rock, is massive, greenish-gray, and porphyritic; contains saussuritized, stubby to anhedral plagioclase phenocrysts as much as 2mm 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. Paleontological studies of these and related fossils from New Brunswick, Newfoundland, and Wales indicate a late Early Ordovician age (e. g. Neuman, 1964, 1976, Neuman and Bates, 1973, Nowlan, 1981) [and an environment of cool-waters at middle paleolatitudes (Neuman, 1984, Neuman and Harper, 1992]. Thickness variable, 100 to 750m (300 to 2,500 ft).

Ordovician mafic volcanic rocks (greenstone) Ov: Largely massive, dark greenish-gray, locally pillow lava and flow breccia. Petrology summarized from Hynes (1976, p. 1216): Some rocks are highly porphyritic and contain both feldspar and pyroxene phenocrysts in fine fluidal groundmass. Alteration of some feldspars varies from core to margin suggesting that feldspars originally were zoned. Some pyroxene phenocrysts have good oscillatory zoning. Pyroxene commonly less than 20 percent of mode. These observations indicate that the rocks are probably meta-andesites. Many coarse-grained rocks have ophitic texture; fine-grained vesicular rocks that have almost 40 percent pyroxene were probably originally basalts. The presence of basalts and andesites is supported by bulk chemistry which ranges from 50 to 60 wt percent silica. [Referred to as Stacyville Volcanics by Wellensiek and others (1990) and by Winchester and Van Staal (1994); the former reported their probable primary magnetization at 20° S latitude; geochemical studies by the latter show them to be of within-plate or mid-ocean ridge origin.] Thickness where present, 300 to 750m (1,000 to 2,500 ft).

Wassataquoik Chert (Neuman, 1967) Och: 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, 100 to 450m (300 to 1,500 ft).

Northwest flank of anticline

Ordovician conglomerate, sandstone, siltstone and basalt Oc: Polymict boulder to pebble conglomerate containing fragments of volcanic rocks, slate, quartzite and quartz pebbles, with interbedded siltstone, ankeritic near the top; basalts at the base and near middle are dark greenish-gray, very fine grained, with phenocrysts of plagioclase, pyroxene, and olivine; some pillow structures (Rankin, 1961, p. 41). Exposed principally along the East Branch of the Penobscot River (including Haskell Rock Pitch), presumably overlain by Lower Silurian conglomerate; wedges out northeastward. Contains brachiopods, trilobites, and corals of Late Ordovician (Ashgill) age. [The rugose corals are described, illustrated, and assigned a paleogeographic context by Elias, 1982]. Maximum thickness about 1,200m (4,000 ft), but wedges out quickly. [See Fig. 4 of Itinerary for Trip 5, this Guidebook.]

Lower Silurian conglomerate, sandstone, and siltstone Sl: Thick-bedded, polymict quartzose pebble conglomerate, micaceous sandstone, and gray and red siltstone and slate; wedges out northeastward. Conglomerate contains large, thick-shelled brachiopods, such as Pentamerus sp. and Stricklandia lens ultima Williams. As much as 250m (800 ft) thick.

Upper Silurian calcareous siltstone, limestone, and conglomerate Sul: Light-gray calcareous siltstone and fine-grained sandstone containing thin beds and lenses of silty limestone; includes some reefal limestone at Marble Pond and elsewhere, and coarser grained sandstone and conglomerate in the northeast corner of the Shin Pond quadrangle. Fossils, especially brachiopods, corals, and stromatoporoids locally abundant. Some assemblages dated as Early or Late Silurian (Wenlock or early Ludlow) age. Probable minimum thickness, 150m (500 ft).

Upper Silurian mafic volcanic rocks (apparently a thick volcanic equivalent of the calcareous siltstone sequence described above) Suv: Massive metamorphosed mafic volcanic rocks including pyroclastics, interlayered with green tuffaceous slate and siltstone, conglomerate with red and green matrix and muddy sandstone; also minor amounts of reefal limestone, some containing basalt clasts. Scattered fossils in green tuffaceous slate, green matrix conglomerate, reefal limestone and debris derived therefrom; some assemblages dated no more precisely than Silurian or Devonian. [...] Thickness a thousand meters or more (several thousand feet).

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

Devonian and/or Silurian sedimentary and volcanic rocks DSuv: Volcanic and sedimentary rocks; Ireland Pond and Grand Lake Seboeis informal units of Hibbard & Hall, 1993, 1994.

Seboomook Formation (Boucot, 1961) Ds: Graded beds of fine-grained, cross-bedded sandstone, dark-gray siltstone, slate, and a few thick beds of fine-grained feldspathic sandstone like that of the Matagamon Sandstone. One exposure of gray sandy siltstone at the base contains a few Early Devonian brachiopods. Primarily a submarine-slope and prodelta deposit according to Hall and Stanley (1973). Thickness variable: 1,200m (4,000 ft) on East Branch of the Penobscot River.

Matagamon Sandstone (Rankin, 1965) Dm: 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 of scour-and-fill structure. Load casts of sandstone in siltstone ("pseudonodules") rare. The Matagamon is a sandstone facies of the Seboomook. Fossils are scarce except in occasional shell beds where Early Devonian (Becraft-Oriskany) brachiopods are abundant. Primarily delta-top and delta-front deposits of a westerly prograded delta (Hall and Stanley, 1973). Thickness, 1,200 to 1,500m (4,000 to 5,000 ft).

Traveler Rhyolite (Rankin, 1968): Flinty aphanitic rhyolite that breaks with a conchoidal fracture and contains 10 to 15 percent of small (1 to 3mm) phenocrysts. Color ranges from light gray through various shades of greenish, greenish-gray and bluish gray to nearly black. In general, the darkest rocks contain the least altered phenocrysts and the best preserved primary textures. Largely welded ash-flow tuff, minor breccia, and rare airfall tuff and sandstone and shale. Columnar jointing characteristic of the welded tuff. Younger than the Matagamon

Sandstone of Becraft-Oriskany age and older than the Trout Valley Formation of late Early or Middle Devonian age. Youngest stratigraphic unit intruded by the Katahdin [Granite which is interpreted to be the subvolcanic pluton to the Traveler Rhyolite volcanic carapace].

[The 360 m.y. ± 10 m.y. [...] isotopic age for the Traveler Rhyolite by Bottino and others (1966) is now considered obsolete in view of the 374 my dates for the Katahdin Granite that were recently determined (Denning and Lux, 1989)].

The Traveler Rhyolite is composed of two members:
Pogy Member Dtp: Lower member. Moderately compacted welded ash-flow tuff containing about 15 percent phenocrysts of quartz, plagioclase, and completely altered minerals; estimated thickness, 900m (3,000 ft).
Black Cat Member Dtb: Upper member. Highly compacted welded ash-flow tuff containing about 10 percent phenocrysts of plagioclase and augite; estimated thickness, 2,300m (7,500 ft).

Trout Valley Formation (Dorf and Rankin, 1962) Dtv: Light blue-gray to black shale, siltstone, sandstone, conglomerate, and and minor amounts of sideritic sandstone and black sideritic ironstone. A massive conglomerate lentil (Dtvc), probably a deltaic deposit, is present at the base along South Branch Ponds Brook - the route traversed by Trip B4. 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 fragmennts other than felsite have been observed in the conglomerate.

[Well preserved plant fossils include several species of leafless plants formerly referred to as Psilophyton, now considered to be an artificial taxon (Kasper, 1980). A Middle Devonian (Hamilton or Givetian) age is indicatated by the lycopod Leclercqia complexa (Kasper and Forbes, 1979)]. Exposed thickness about 450m (1,500 ft).

Southeast flank of anticline

Allsbury Formation (Ekren and Frischknecht, 1967):
Sandstone, conglomerate and minor slate (Ssc) - Feldspathic sandstone, polymict pebble and cobble conglomerate, and gray slate and siltstone. The coarser conglomerate contains cobbles of porphyritic quartz diorite like the Rockabema, greenstone, quartzite, and other rocks, occurs in the fault slices of the southeastern flank of the anticline; at one place interbedded sandstone yielded Early Silurian (late Llandoverian) fossils (Estimated minimum thickness, 1,500m (5,000 ft).
Slate, siltstone, and minor sandstone (Ss) - 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 Llandoverian to Ludlovian forms. Estimated thickness, about 3,000m (10,000 ft).

Intrusive rocks

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

Rockabema Quartz Diorite (Ekren and Frischknecht, 1967) SOq: Fine- to coarse-grained, gray to greenish-gray, sheared and altered porphyritic quartz diorite to 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 that quartz. Chlorite and epidote pseudomorphic after biotite; calcite abundant in patches and veinlets. Locally contains large xenoliths of greenstone and quartzite.

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

Katahdin Granite [Rankin and Hon (1987): The major intrusive component of the Katahdin-Traveler Igneous Complex.

The interior of the pluton (Dk) is a massive, medium- to fine-grained biotite granite with remarkably constant mineralogy: 34 percent alkali feldspar (Or_{70}), 26 percent normally zoned plagioclase (An_{34} to An_{25}),, 34 percent quartz, 6 percent biotite, and accessories of apatitie, allanite, zircon, tourmaline, opaques, epidote, and rare fluorite and fayalite. Muscovite and titanite are notably absent. The granite shows large textural, although not mineralogical or chemical, variations from a "normal" granite in the interior of the pluton to a granophyric and miarolitic granite near the summit of Mt. Katahdin. At first appearance the miarolitic cavities are small and entirely filled with tourmaline, epidote, and rarely fluorite. At the highest elevations the cavities are large (one to several centimeters) and open.
Granophyric phase, Dkg: Vuggy, pink, containing phenocrysts of biotite. Vugs contain epidote, tourmaline, quartz, and potassic feldspar. Border phase (included with granophyric phase on fig. 1) on the east is fine-grained and contains abundant fragments of thermally altered and partially assimilated sedimentary rocks.
The border facies of the granite (Dkg) adjacent to the Traveler Rhyolite is also granophyric and vuggy. The border phase on the east (not shown separately on fig. 1) is fine grained and contains fragments of thermally altered and partially assimilated sedimentary rocks.

Although the Katahdin Granite has not yet proved amenable to isotopic dating, its age of 400 my is estimated from $^{40}Ar/^{39}Ar$ dating of the Horserace Quartz Diorite that was intruded into it (Denning and Lux, 1989)].

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