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The Traveler Rhyolite and Its Devonian Setting, Traveler Mountain Area, Maine

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TRIP B-3

THE TRAVELER RHYOLITE AND ITS DEVONIAN SETTING, TRAVELER MOUNTAIN AREA, MAINE

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The stratigraphic and structural setting of the Traveler Rhyolite have been outlined by Neuman and Rankin in this guidebook. Before describing the field trip, I would like to discuss the Traveler Rhyolite in more detail.

The main body of the Traveler Rhyolite occupies at structurally depressed, roughly quadrilateral area about 13 by 19 km on the northwest limb of the Weeksboro-Lunksoos Lake anticline (see fig. 1 of Neuman and Rankin, this guidebook). The aggregate thickness of the volcanic pile within the depression is at least 3,200 m (10,500 ft). The main body of rhyolite is bounded by high-angle faults to the north and west and is intruded by the Katahdin Quartz Monzonite on the south. The depression is thought to be an ancient caldera called the Traveler caldera (Rankin, 1968).

The Traveler Rhyolite is typically a dark-greenish-gray or bluish-gray to nearly black aphanitic rock that breaks with a conchoidal fracture. A whitish weathering rind is common. The rhyolite is porphyritic and contains 3 to 30 percent (commonly 5 to 15 percent) small phenocrysts 1 to 3 mm across.

Many outcrops of the rhyolite offer little evidence about the type of volcanic activity that produced the rock. Thin sections help decipher some relevant features of these outcrops, but many rocks are too recrystallized to classify. Ash-flow tuff (both welded and nonwelded), tuff breccia, bedded air-fall(?) tuff and crystal tuff, lava, and tuffaceous sedimentary rock have been identified. Enough evidence is preserved, however, to establish that the great bulk of the Traveler Rhyolite consists of welded ash-flow sheets. Little sedimentary rock and no soil horizons have been identified within the volcanic pile, suggesting that the pile was erupted in a relatively short time. The dominance of welded tuff argues for subaerial eruptions. That the rhyolite welded ash-flow sheets overlie sedimentary rocks containing marine fossils (Seboomook Formation and Matagamon Sandstone) requires a change in the paleoenvironment from marine to terrestrial (Rankin, 1960).

Evidence that the bulk of the Traveler Rhyolite is welded ash-flow tuff comes from both outcrop and thin section. The features preserved include flattened pumice lumps, deformed (flattened) shards, columnar joints and massive units without obvious bedding. No glass remains in these Devonian rocks, and welding per se cannot be demonstrated, but flattening certainly can.

Collapsed pumice lumps, giving rise to a crude planar structure, are obvious in many outcrops but difficult to observe in others. Excellent examples of rhyolite containing collapsed pumice lumps will be seen along South Branch Ponds Brook, in loose pebbles on the shore of Lower South Branch Pond, and, to a lesser extent, in the rhyolite of Horse Mountain. Some difference in the average size of the pumice lumps is apparent from one part of the volcanic pile to another, or even from outcrop to outcrop. Detailed mapping eventually may demonstrate that individual flow units are traceable, but so far, tracing of flow units has not been attempted.

Columnar joints are obvious in many outcrops and cliff exposures. They range in diameter from about 2 cm to 2 m; the larger ones are as much as a few tens of meters long. Spectacular thin columns, averaging about 8 cm in diameter and a few meters in length, are exposed along Dry Brook. Even smaller columns, some of which are bent, are found on the North Ridge of North Traveler Mountain. We will not have time to visit either locality, but we will see well-developed larger columns at Horse Mountain and along South Branch Ponds Brook.

Some mountain slopes have a terraced appearance, suggesting the erosion of a layered sequence. Commonly, the rises of these terraces are zones of well-developed columnar joints, whereas the treads are zones of indistinct columns or no columns. In a few sequences, the size of the pumice lumps changes from one terrace rise to another suggesting that the rises represent different flow units of a welded tuff sequence. More commonly, flow units and cooling units cannot be distinguished from one another or mapped (for terminology, see Smith, 1960).

The compaction foliation (eutaxitic texture) caused by the flattening and welding of pumice lumps and shards is commonly roughly perpendicular to the axes of the columns. Where this relationship holds true, the direction of compaction was roughly perpendicular to the cooling surface, presumably a quasi-horizontal surface, and the present attitude of the compaction foliation is a measure of subsequent deformation. Columns having axes that are not perpendicular to the compaction foliation may indicate that the cooling surface was not horizontal or that the compaction foliation was rotated by strain during deformation.

Tilted benches and measured attitudes of compaction foliation on Black Cat Mountain, and on North Ridge, Center Ridge, and Pinnacle Ridge of Traveler Mountain indicate that the axis of an open north-plunging anticline runs through the South Branch Ponds. This fold is readily apparent from the south end of Upper South Branch Pond on the trail up Center Ridge. Compaction foliation dips of 20° to 40° are common. Excellent columnar joints can be seen on the basal cliff of Center Ridge at the northeast end of Upper South Branch Pond.

The Traveler Rhyolite is divided into the basal Pogy Member and the overlying Black Cat Member. As explained below, the upper part of the Black Cat Member probably could be mapped as a third member.

The Pogy Member is characterized by moderately compacted welded ash-flow tuff containing about 15 percent phenocrysts, of which about one-third are quartz and most of the rest are zoned plagioclase. Optical studies indicate that the average composition of the plagioclase is about An_{48} and zones range from An_{35} to An_{56} (Rankin, 1961). Sanidine (about Or_{67}) occurs with plagioclase and quartz in a few samples. Mafic silicate phenocrysts may be absent or may constitute as much as 10 percent of the phenocryst population. They are generally altered beyond recognition, but clinopyroxene was observed in one thin section, and the remnants of biotite phenocrysts were observed in a few thin sections. Garnet was seen in two samples. Lithic fragments, including rhyolite, diabase, sandstone, and shale, are present in most samples.

The Black Cat Member is characterized by highly compacted and welded ash-flow tuff containing about 10 percent phenocrysts. Typically, 75 percent of these are zoned plagioclase (An_{33} to An_{61}, bulk composition about Ab_{47}), 20 percent are augite (optically determined to be about Wo_{33} En_{28} Fs_{42}), and 5 percent are magnetite (Rankin, 1961). Quartz phenocrysts are typically not present but rarely constitute as much as 10 percent of the phenocrysts. Biotite phenocrysts coexist with augite in a number of samples, and rarely, hornblende is the only mafic silicate present. Fayalite coexisting with augite and biotite was observed in one thin section, and garnet phenocrysts were seen in two samples. Growth aggregates of phenocrysts, rare in the Pogy Member, are common in the Black Cat Member (fig. 1E).

An outlier of the Black Cat Member forms Soubunge Mountain about 14 km southwest of Strickland Mountain. The preserved thickness of rhyolite at Soubunge Mountain is about 250 m (800 ft), and it rests on a sandstone similar to the Matagamon (Andrew Griscom, written commun., 1966). In some of the Soubunge samples, hornblende phenocrysts are more abundant than augite.

The ash-flow tuff on the summit of Big Peaked Mountain (Traveler Mountain quadrangle), on Little Peaked Mountain, on Barrell Ridge, and along Dry Brook is currently included in the Black Cat Member; it may be a distinct unit at the top of the volcanic pile. In this tuff the pumice lumps tend to be smaller and less compacted and to form a smaller percentage of the rock than they do in the main part of the Black Cat Member. Phenocrysts make up about 5 percent of the rock and are thus less abundant than in the rest of the Black Cat. Plagioclase and augite are present. The rock is highly jointed; some jointing is almost a fracture cleavage.

The percentage of quartz phenocrysts is the only consistent difference observable in the field between the Pogy and Black Cat Members. The significance of the quartz phenocryst content was recognized after I completed most of the fieldwork. Limited field checking has shown that the subdivision is a valid one. It is, however, extremely difficult using a hand lens to identify small quartz phenocrysts that constitute 5 percent or less of the rock. For much of its length, the contact between the members is approximated between locations from which hand specimens had been collected previously.

From the evidence assembled, both the Pogy and Black Cat Members consist dominantly of welded ash-flow sheets. The phenocryst content of the Pogy is somewhat greater than that of the Black Cat and differs significantly in that quartz is ubiquitous and sanidine may be present. The Pogy Member is typically more altered than the Black Cat and more commonly contains lithic clasts. The pumice lumps in the Black Cat are characteristically more compacted than those of the Pogy. Length-to-thickness ratios of 10:1 to 20:1 are typical for the collapsed pumice lumps in the Black Cat. Ratios as high as 60:1 have been observed. In the Pogy Member, on the other hand, ratios of 2:1 to 4:1 are more common.

As of this writing, the bulk composition of the Traveler Rhyolite has not been well sampled. The three analyses published by E.S.C. Smith (1930 and 1933), the two analyses by Jun Ito, reported by Rankin (1961), and one analysis by the U.S. Geological Survey (Rankin, unpublished data) do not indicate significant difference in bulk chemistry between the Pogy and Black Cat Members. This apparent uniformity in bulk chemistry is consistent with trace-element data for several samples of the rhyolite analyzed by Rudolph Hon (oral commun., 1975) as part of his Ph.D. thesis study on the Katahdin batholith. In August 1979, I collected a suite of 19 samples, including 3 from the Pogy Member, 12 from the main body of the Black Cat Member, and 4 from the upper part of the Black Cat Member. The major-element analyses of these samples are not yet available.

The silica content of the available analyses ranges from 71.62 to 72.54 weight percent recalculated to 100 percent on a water-free basis) for two samples of the Pogy Member and from 70.50 to 75.06 percent for four samples of the Black Cat Member. The Differentiation Index of Thornton and Tuttle (1960) ranges from 82.6 to 84.5 for the two Pogy samples and from 79.9 to 88.7 for the four Black Cat samples. To a first approximation, the bulk compositions thus fall within the synthetic granite system. The normative constituents for both members plot in the vicinity of the minimum melting compositions in the steam-saturated system SiO_2 - $KAlSi_3O_8$ - $NaAlSi_3O_8$ (Tuttle and Bowen, 1958).

The model presented in 1968 (Rankin, 1968) to account for the observed differences between the Pogy and Black Cat Members still seems attractive. The arguments are summarized here from that paper. At the time of eruption, both quartz and feldspar were crystallizing from the magma that produced the Pogy Member, whereas liquids of the Black Cat Member were crystallizing only feldspar. The slightly higher phenocryst content of the Pogy further indicates that the Pogy was somewhat more crystallized at the time of the eruption. These observations are consistent with the hypothesis that the basal Pogy Member was erupted from the cooler upper part of the magma chamber and that the overlying Black Cat Member followed, probably relatively quickly, from deeper, hotter parts of the magma chamber.

Whether or not an ash flow will weld depends upon several variables, a major one of which is emplacement temperature (Smith, 1960, and Boyd, 1961). Calculations by Boyd (1961) show that a magma having a lower initial H_2O content will erupt an ash flow having a higher emplacement temperature than one erupted by a magma having a higher initial H_2O content. Other factors being equal, one would expect a drier magma to form a more highly compacted welded tuff than a wetter one. In fact, the emplacement and welding temperatures of the Black Cat Member were high enough so that the tuff locally flowed after or during welding, as judged by the rotated phenocrysts (fig. 1F) and microscopic to mesoscopic flow folds.

At equilibrium, the H_2O content of a magma should increase upward in the magma chamber (Kennedy, 1955). If the Pogy Member originated from higher in the magma chamber than the Black Cat, it may have been wetter as well as cooler. This suggested gradient in water content of the magma chamber is also consistent with the phenocryst assemblage of the two members. Tuttle and Bowen (1958) showed that at the liquidus, a decrease in water content (decrease in steam saturation pressure) shifts the quartz-feldspar field boundary toward the SiO_2 corner of the SiO_2 - $KAlSi_3O_8$ - $NaAlSi_3O_8$ system. That is, a liquid in equilibrium with quartz and feldspar crystals at a higher steam saturation pressure might be in equilibrium with only feldspar crystals at a lower steam saturation pressure even though the composition of the liquid may be otherwise unchanged. This relationship was incorrectly stated in the 1966 NEIGC guidebook.

Corroborative evidence that the H_2O content of the Pogy was higher than that of the Black Cat comes from the widespread alteration of the mafic silicate phenocrysts in the Pogy as well as the more commonly altered plagioclase phenocrysts in the Pogy. This alteration may be deuteric, caused by abundant volatiles rising through the Pogy ash flows after emplacement. That the emplacement temperature of the Black Cat was higher than that of the Pogy is indicated by the greater degree of flattening of the Black Cat pumice lumps and the evidence for postemplacement flowage of the Black Cat. The existing evidence is consistent with the Pogy Member having had a lower magma temperature and emplacement temperature and a higher H_2O content (steam saturation pressure) than the Black Cat Member. These suggestions can be related to gradients in temperature and H_2O content in the magma chamber.

Partial results from the analyses of the suite of 19 samples collected in August 1979 indicate that the Traveler magma chamber was compositionally zoned in components other than H_2O. As stated above, the major-element chemistry for these samples is not available at this time, the trace-element analyses are only partially completed, and the Pogy Member is poorly sampled. The work is continuing. Quantitative analyses of trace elements show that compositional gradients are most obvious in the main body of the Black Cat Member but that more subtle gradients exist in the pile as a whole. The results appear to confirm that the upper part of the Black Cat Member on Big Peaked Mountain, Little Peaked Mountain, and Barrell Ridge is a different unit. In summary, Sr and Zr (by x-ray fluorescence), Nb (by spectrophotometry), and Li (by atomic absorption spectroscopy) decrease upward through the volcanic pile, and U (by delayed neutron activation analysis) increases upward in the pile. Semiquantitative emission spectrographic analysis indicated that the boron content of the Pogy Member is higher than that of the Black Cat Member.

Except for the outlier of the Black Cat Member on Soubunge Mountain, nothing is preserved today of the Traveler Rhyolite outside the proposed

Traveler caldera. If we make a conservative estimate for the average thickness of the rhyolite within the caldera of 1600 m, the volume of rhyolite within the structural depression is about 400 km^3. A blanket of welded tuff 250 m thick (the thickness on Soubunge Mountain) surrounding the rim of the Traveler caldera to a distance as far as Soubunge Mountain would more than double the volume of material erupted. If the original volume of rhyolite was as much as 800 km^3, the Traveler rhyolite represents one of the larger pyroclastic flow fields of the world (see Smith, 1960). If the Katahdin pluton, which has an area of about 1,350 km^2 (Griscom, 1976), represents the subvolcanic magma chamber as both Hon (this guidebook) and I think, then 400-800 km^3 of rhyolite is not unreasonable.

The Traveler Rhyolite is the northeasternmost and by far the largest of a discontinuous belt of similar rhyolitic volcanic and shallow granophyric intrusive rocks of Early Devonian age that extends about 160 km across north-central Maine. They are collectively called the Piscataquis volcanic belt (Rankin, 1968). Five major volcanic centers have been identified in the belt. Coeval mafic rocks, with the possible exception of the Moxie pluton, are conspicuously absent from the Piscataquis volcanic belt. Much of the rhyolite from these centers is peraluminous as evidenced by normative corundum in the available major-element analyses and garnet phenocrysts in the rocks. The Traveler Rhyolite appears to be the least peraluminous (that is, to have the lowest percentage of normative corundum) of the rhyolites, but garnet phenocrysts are present in a few samples of the Traveler. Garnet phenocrysts from the rhyolite of the Piscataquis volcanic belt range in composition from about 80 to 90 percent almandine; most of the remaining component is pyrope (Rankin, unpublished probe data).

I previously suggested that the Piscataquis volcanic belt was an island arc (Rankin, 1968). The observations that the volcanic centers overlie Lower Devonian marine sandstones, a shallower water facies than that of the surrounding Seboomook turbidites, and that many of the rhyolites must have been erupted subaerially are still valid. That is, the Early Devonian rhyolitic volcanism took place along a welt or ridge within a deeper water marine basin. That this volcanism was in any way related to the subduction of oceanic crust now seems unlikely.

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Itinerary, Trip B-3

Topographic quadrangle maps:

15-minute	2-degree
Shin Pond	Presque Isle
Traveler Mountain	

Assemble at site of the former Shin Pond House, Maine Route 159, 9.5 miles northwest of Patten and 0.2 miles west of bridge over Shin Pond's thoroughfare. The departure time is 8:30 a.m., Saturday, October 11, 1980. Be sure to attach yourself to the correct trip; more than one trip will assemble here. Cars may be used on this trip but please be sure that each vehicle carries at least four people, has a full tank of gas, and has a useable spare tire fully inflated. Bring your own lunch. Note that pets, including dogs, are not permitted in Baxter State Park. The trip includes a 200-foot climb over a steep, forested scree slope and a 3-mile trailless walk down South Branch Ponds Brook. Stout walking shoes are essential; wet feet guaranteed for all but the most agile. Please stay with the leader and in as compact a group as possible.

Mileage

0.0	Site of Shin Pond House, facing northwest along Grand Lake Road. Trip B-4 also follows Grand Lake Road as far as the East Branch of the Penobscot River. Some of Neuman's road log for that trip as far as the Bowlin Pond Road is repeated here. You should refer to that road log (this guidebook) for more detail.
0.3	Roadside ledges are thin-bedded, crossbedded quartzite of the Grand Pitch Formation and porphyritic Rockabema Quartz Diorite.
0.4	Roadside ledges are medium- and dark-gray slate and quartzite of the Grand Pitch Formation.
0.5	Very light colored and fine-grained phase of the Rockabema Quartz Diorite and Grand Pitch slate.
1.5	T6R7 town line.
1.6	Road on right to Snowshoe and White Horse Lakes.
1.9	View of Sugarloaf Mountain straight ahead. The mountain is capped by a metadiabase sill. The fossiliferous Shin Brook Formation crops out on the slopes of the mountain beneath the sill.
2.6	Crommet Spring lunch ground.
3.1	Ledges to left of road are of the fossiliferous Shin Brook Formation.
3.6	Ledges on left are metadiabase sill that overlies the Shin Brook Formation.
5.7	Ledges on left are quartzite of the Grand Pitch Formation.
5.9	Bridge over Seboeis River.

6.7 Road on right to Scraggly Lake.

7.1 Beginning of long straight stretch of road with view down road of North Traveler and Bald Mountains, both held up by the Traveler Rhyolite.

10.4 Side road right to Hay Lake.

10.7 Side road left to Bowlin Pond.

11.1 T5R8 town line. Gradational contact betwen Seboomook Formation and Matagamon Sandstone crosses road near here.

11.8 Roadside ledges are of Matagamon Sandstone, as are all roadside ledges as far as the shore of Grand Lake Matagamon.

13.1 STOP 1. "Hurricane Deck." Overlook and exposures of Matagamon Sandstone. The Matagamon Sandstone here is in a northeast-trending structural basin, the Hay Mountain basin (Rankin, 1965). These exposures are very nearly on the axis of the basin, and the sandstone dips gently northeast. In good weather, one can obtain a fine view here of the mountains to the west and south. To the southwest, Mt. Katahdin is visible between Turner Mountain on the left and Traveler Mountain on the right. The long mass of Traveler Mountain is across the valley of the East Branch. Although The Traveler (the highest point of Traveler Mountain) is only 3,541 feet high, it rises 3,000 feet above the river. The bare conical peak of Bald Mountain is set against North Traveler Mountain. The last mountain to the right, barely visible from here, is Horse Mountain on the shore of Grand Lake Matagamon. C.H. Hitchcock (1861) referred to this as the mountain with the inelegant name. Turner and Katahdin are composed of Katahdin Quartz Monzonite, the others, of the Traveler Rhyolite.

14.7 Bridge over East Branch of the Penobscot River, a favorite for white-water canoeists. H.D. Thoreau (1950) extolled the joys of the East Branch after his 1857 trip down it. The store on the east side of the bridge was not there at the time of my last pre-1979 visit, that is, at the time of the 1966 NEIGC trip. Civilization creepeth into the Maine Woods. Road right on west side of bridge leads 0.5 mile upriver to Grand Lake Dam at foot of Grand Lake Matagamon. Good exposures of Matagamon Sandstone form east abutment of dam.

15.7 Baxter State Park Boundary. This is the largest State park in Maine and has an area of nearly 200,000 acres. 180-m cliffs of rhyolite forming Horse Mountain on left.

15.9 STOP 2. Park as close to the edge of the road as you can. Climb about 200 ft up steep slope to the base of cliffs. Be extremely careful in crossing scree slope. Remember others are behind you. The Pogy Member of the Traveler Rhyolite forms the cliffs above. The Matagamon Sandstone underlies the scree slope over which we climb. The contact, defined as the sharp change in lithology from underlying obviously stratified rocks to rhyolite above, is more or less exposed at the top of the scree slope and dips 20^{o} W. The top 6 m or so of the Matagamon contain scattered pebbles of felsite and beds of tuffaceous sandstone, indicating that some volcanic activity preceded the main body of rhyolite.

The basal 0.6 or 1.2 m of the massive rhyolite are composed of nonwelded tuff in which devitrified shards are clearly visible (fig. 1A). This nonwelded tuff grades up into welded ash-flow tuff that appears to make up most of the rhyolite of the Horse Mountain cliffs. Fragments of collapsed pumice are visible in the rhyolite about a meter above the base. Deformed and flattened shards are visible in a thin section (fig. 1B) collected from this locality 1.5 m above the base. Columnar joints may be seen in the cliff face. These are most obvious in the main part of the cliff to the south and are perhaps most easily seen from the road. Some are as much as 1.2 m in diameter and at least 12 m long.

If one traces the contact along the base of the cliffs, it is seen to be an irregular surface having relief of as much as 5 or 6 m. This irregularity may be due to scouring by ash flows, although in other places in the world, ash flows are known to have crossed unconsolidated material without disturbing that material.

16.3 STOP 3. Canoe landing on right opposite Maine Forest Service Camp. Known locally as Eastern Landing. Walk 0.1 mile ahead (north) along road. Roadcut in Pogy Member showing thin anastomosing dikes of sandstone from the underlying Matagamon Sandstone. Thicker clastic dikes have been found at the base of the cliffs on Horse Mountain and on the shore of Grand Lake Matagamon just ahead of us on the point. The largest clastic dike is about 6 m thick and at least 10 m long (as viewed from the bottom of the cliff). The clastic dikes provide evidence that the ash flows overrode unconsolidated sand of the Matagamon.

16.4 Gate house, Baxter State Park.

16.8 Road turns left away from lake and crosses ledges of rhyolite of the Pogy Member.

17.9 Cross unexposed, high-angle fault between Traveler Rhyolite and Seboomook Formation.

19.0 Trout Brook Farm, first cleared in 1837, is now a Baxter State Park campground. It produced hay for horses used in logging operations until the 1940's. C.H. Hitchcock stayed here in 1861. Rough side road, right, passes through farm

Figure 1. Photomicrographs of the Traveler Rhyolite. All are in plane-polarized light. A., B., and C. are of the Pogy Member and are in stratigraphic order from bottom to top. D., E., and F. are of the Black Cat Member and do not represent a stratigraphic succession.

A. Nonwelded tuff, Pogy Member. Sample KT-153. Devitrified shards showing axiolitic texture and unruptured "bubbles" are visible. Stop 2 of field trip; altitude of about 900 feet at base of cliff on Horse Mountain about 0.5 m above the Matagamon Sandstone.

B. Welded ash-flow tuff, Pogy Member. Sample KR-73. Phenocrysts are quartz and plagioclase. Flattened devitrified shards are visible; some are deformed around phenocrysts. Clast of siltstone is in upper right. Same locality as sample in figure 1-A about 1.5 m above the Matagamon Sandstone.

C. Welded ash-flow tuff, Pogy Member. Sample KR-65. Texture suggests vague outlines of highly compacted devitrified shards. The dark mineral in the shards is probably celadonite. Altitude about 1,420 feet at top of cliff on Horse Mountain.

D. Welded ash-flow tuff, Black Cat Member. Sample Kt-499. Phenocrysts of zoned plagioclase and altered augite. Highly compacted and devitrified pumice lumps impart the eutaxitic texture. The same texture on a larger scale is visible in the outcrop. From second unit above stream about 30 m downstream from Station 3 of traverse down South Branch Pond Brook.

E. Welded ash-flow tuff, Black Cat Member. Sample KT-297. Highly compacted. Phenocrysts of plagioclase, augite, and opaque minerals. Growth aggregates of phenocrysts are visible. From ledges at an altitude of 1,160 feet on east bank of stream flowing north from Black Brook Mountains (Traveler Mountain quadrangle). This is about 2.8 miles west of South Branch Ponds campground.

F. Welded ash-flow tuff, Black Cat Member. Sample KT-208. Phenocrysts of zoned plagioclase, augite, biotite, and opaque minerals. Fayalite is also present in the thin section. Extreme compaction of pumice lumps. Rotated phenocrysts indicate that the material flowed after compaction and welding so that texture resembles that of a lava. From outcrop at an altitude of about 2,240 feet along an unnamed stream that flows east from The Traveler toward Haskill Deadwater of the East Branch.

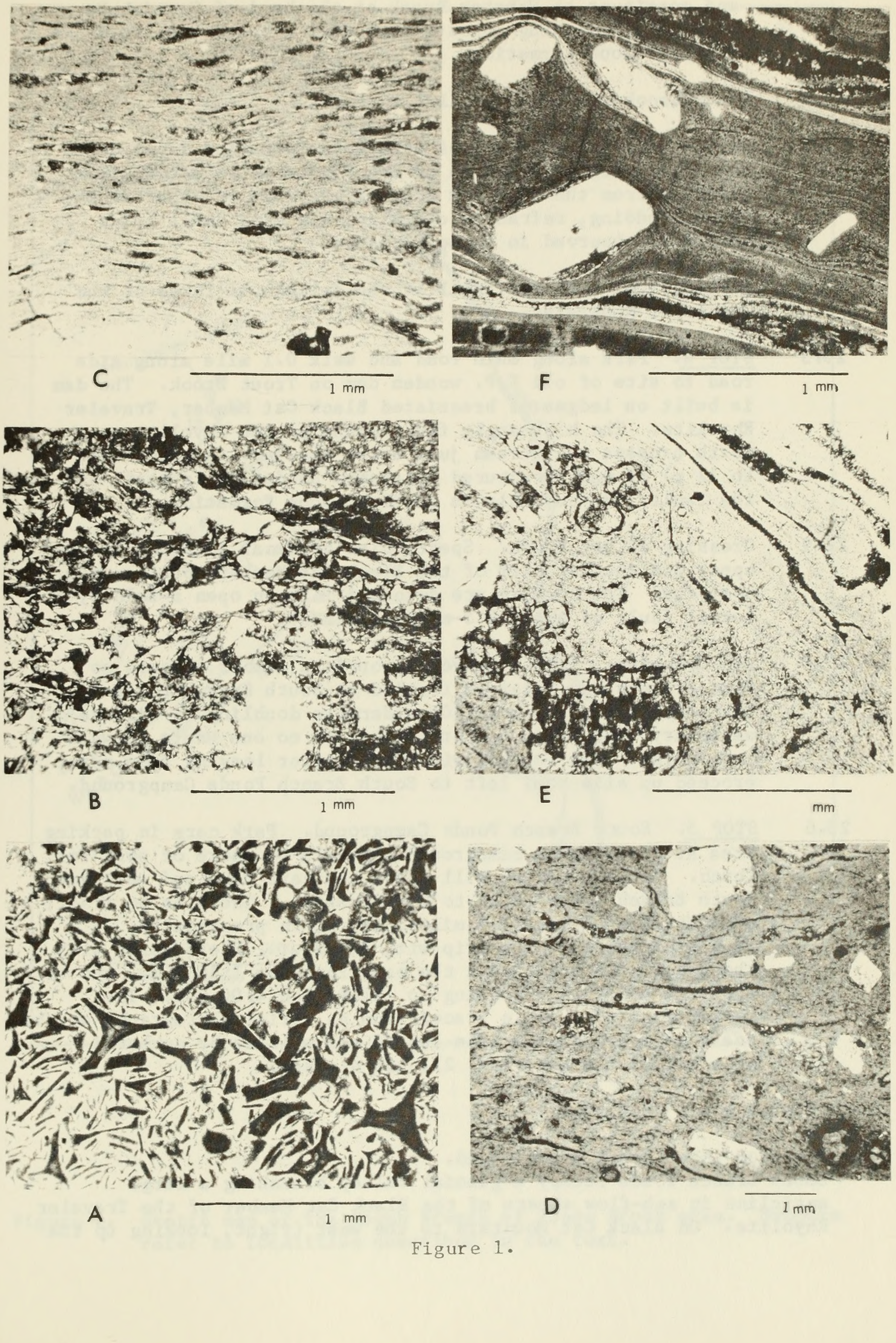

Figure 1.

and continues to Webster Brook at the head of Grand Lake Matagamon, crossing enroute some well-exposed open folds in the Seboomook Formation.

19.5 Trout Brook on right parallel to road.

20.0 Sharp turn left. Ledges of Seboomook Formation in woods to left. Excellent exposures of the Seboomook Formation just upstream from the adjacent right-angle turn of Trout Brook. Graded bedding, refracted cleavage, and many small folds have been observed in these exposures.

20.2 Parking area left for trail to the delightful lakes of the Deadwater Mountains.

20.5 STOP 4. Park along main road and walk 0.1 mile along side road to site of old K.P. wooden dam on Trout Brook. The dam is built on ledges of brecciated Black Cat Member, Traveler Rhyolite. The high-angle fault bounding the rhyolite on the north crosses the stream just below the dam. A thin wedge (9 to 12 m) of much fractured Matagamon Sandstone is north of the fault. Beyond this is the Seboomook Formation.

22.9 Crossing of Dry Brook. Spectacular columnar jointing in the upper distinctive part of the Black Cat Member about a mile upstream. The columns are deformed into an open z-fold by a normal fault of about 0.5-m displacement.

23.4 The Crossing. STOP. Leave appropriate number of cars so that drivers may later be ferried to South Branch Ponds to retrieve remaining cars. Considerable doubling up will be necessary, but it is a short drive and no one wants to walk both ways. Take lunches with you. After leaving some cars, proceed up side road left to South Branch Ponds Campground.

25.6 STOP 5. South Branch Ponds Campground. Park cars in parking area at entrance to campground and walk to shore of pond for lunch. After lunch we will leave the cars here and walk down South Branch Ponds Brook to The Crossing. There is no trail, the distance is nearly 3 miles, and it is practically impossible to make the trip with dry feet. Please stay with the group. We must leave the campground by 1:30 p.m., and we must all be at The Crossing no later than 4:00 p.m. The sketch map (fig. 2) is traced from an aerial photograph, so the scale is approximate. The log of the walk is by numbered stations on the map (fig. 2), not distance.

South Branch Ponds Brook Wade.

1. Shore of Lower South Branch Pond.
South Branch Ponds occupy a glacial valley breaching a large anticline in ash-flow sheets of the Black Cat Member of the Traveler Rhyolite. On Black Cat Mountain to the west (right, looking up the

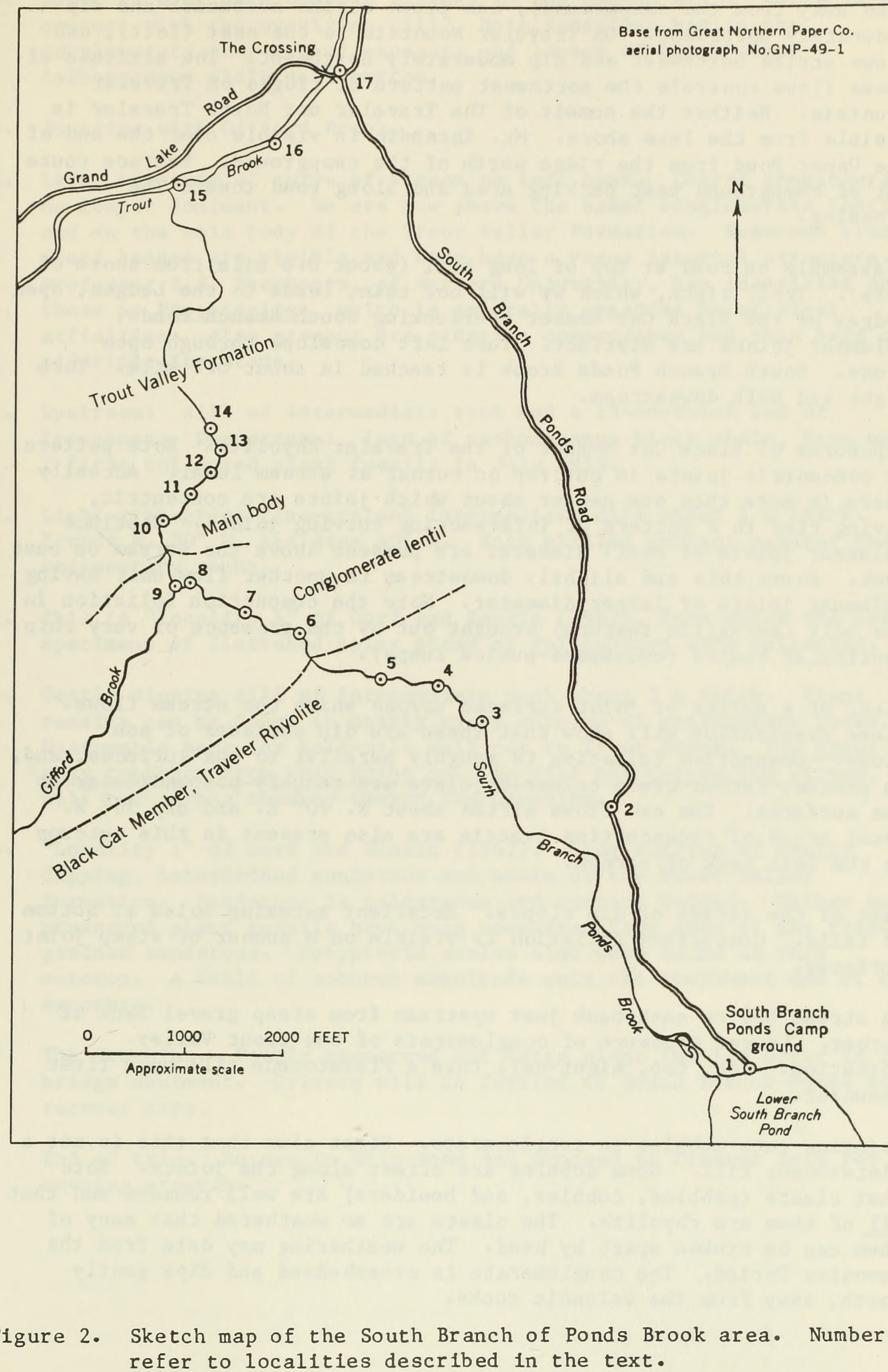

Figure 2. Sketch map of the South Branch of Ponds Brook area. Numbers refer to localities described in the text.

lake away from the campground), ash flows strike northeast and dip moderately northwest. On Traveler Mountain to the east (left), ash flows strike northwest and dip moderately northeast. The attitude of these flows controls the northwest pattern of ridges on Traveler Mountain. Neither the summit of The Traveler nor North Traveler is visible from the lake shore. Mt. Katahdin is visible over the end of the Upper Pond from the ridge north of the campground. Retrace route out of campground past parking area and along road toward The Crossing.

2. Reassemble on road at top of long hill (about 0.6 mile from shore of lake). Trail right, which we will not take, leads to the Ledges, open ledges of the Black Cat Member overlooking South Branch Ponds. Columnar joints are distinct. Turn left downslope through open woods. South Branch Ponds Brook is reached in about 0.2 mile. Turn right and walk downstream.

3. Exposures of Black Cat Member of the Traveler Rhyolite. Note pattern of concentric joints in outcrop on corner at stream level. Actually there is more than one center about which joints are concentric, giving rise to a pattern of intersecting curving joints. Distinct columnar joints of small diameter are present above the stream on east bank. Above this and slightly downstream is another flow unit having columnar joints of larger diameter. Note the compaction foliation in the unit (eutaxitic texture) brought out by the presence of very thin lenticular bodies (collapsed pumice lumps).

4. First of a series of joint surfaces across which the stream flows. Close examination will show that these are dip surfaces of ash flows. Compaction foliation is roughly parallel to the surfaces, and, in places, rather crude columnar joints are roughly perpendicular to the surfaces. The ash flows strike about N. 70° E. and dip 30° N. Local areas of crosscutting breccia are also present in this outcrop on the left bank of stream.

5. Last of the series of dip slopes. Excellent swimming holes at bottom of falls. Compaction foliation is visible on a number of steep joint surfaces.

6. In stream bed on east bank just upstream from steep gravel bank at corner. Lowest exposure of conglomerate of the Trout Valley Formation. You, too, might call this a Pleistocene till upon first enounter.

7. Jointing cuts cobbles in conglomerate. First clue that this is not a Pleistocene till. Some cobbles are offset along the joints. Note that clasts (pebbles, cobbles, and boulders) are well rounded and that all of them are rhyolite. The clasts are so weathered that many of them can be broken apart by hand. The weathering may date from the Devonian Period. The conglomerate is crossbedded and dips gently north, away from the volcanic rocks.

8. About 10 m of conglomerate exposed in the canyon wall. Where is the contact with the overlying till? Note sandstone bed in the conglomerate near top of exposure and lenses of black sandy carbonaceous shale near bottom.

9. Junction with Gifford Brook.

10. Large exposure at curve of stream on left bank. Coarse conglomerate no longer dominant. We are now above the basal conglomerate lentil and in the main body of the Trout Valley Formation. Numerous black chert lenses are visible and some have a vague internal structure. Professor E.S. Barghoorn, of Harvard University, has identified one of these as Prototaxites, which is generally regarded as of algal affinities. Also present are siderite concretions and thin beds of sideritic ironstone.

11. Upstream: sill of intermediate rock and a 15-cm-thick bed of ironstone. Downstream: lens of carbonaceous black shale, from which I first collected plant fossils in July 1955.

12. Light-gray-green fine-grained intermediate dike about 1 m thick. Trends N. 30° W. and dips 40° N. Note chilled contact against the sedimentary rocks.

13. This is "locality 4" of Dorf and Rankin (1962), from which the best specimens of flattened spiny stems of Psilophyton were collected.

14. Gently dipping sill of intermediate rock about 3 m thick. Plant remains can be found in nearly every outcrop of sedimentary rocks. Reassemble here for half-mile walk out to Trout Brook. The group must stay together from this point on. We will not follow the stream, but will cut across country toward The Crossing.

16. "Locality 1" of Dorf and Rankin (1962). Long outcrop of gently dipping, interbedded sandstone and shale of the Trout Valley Formation. Sandstone is calcareous and current bedded. Rather well preserved plant fossils have been recovered from some of the fine-grained sandstone. Eurypterid scales also were found at this outcrop. A fault of unknown magnitude cuts the southwest end of the exposure.

17. The Crossing. Poorly preserved but large plant fossils occur in the bridge abutment. Drivers will be ferried to South Branch Ponds to recover cars.

End of trip. Return to Shin Pond and proceed to Presque Isle for evening program.