1-1-1980

Ordovician and Silurian Stratigraphy of the Ashland Synclinorium and Adjacent Terraine

Roy, David C.

TRIPS B-7 and C-2

BEDROCK GEOLOGY OF THE PRESQUE ISLE AREA

Richard S. Naylor*

Northeastern University, Boston, Massachusetts

INTRODUCTION

This trip includes stops in the Presque Isle, Caribou, and Ashaland 15-minute quadrangles. The author mapped the north-central part of the Presque Isle quadrangle in 1960 as an undergraduate thesis at the Massachusetts Institute of Technology and returned in the summers of 1961 and 1962 to extend reconnaissance bedrock mapping to the west and north.* Although maintaining an active interest in the area and visiting it annually, the author must stress that nearly twenty years have passed since he last mapped in this area.

The bedrock geology of the Presque Isle Quadrangle was published by Boucot, Field, Fletcher, Forbes, Naylor, and Pavlides (1964). That paper outlines the previous history of geologic mapping locally. Briefly, the area has long been known for its rich and abundant fossil localities and many notable paleontologists have published articles about the area. Bedrock mapping lagged however. The pioneering work of H.E. Gregory (Williams and Gregory, 1960) produced a useful lithologic map, but the work was not stratigraphically or structurally oriented. Geologists from the Maine and United States Geological Surveys mapped parts of the area in the 1940's but were concerned chiefly with the so-called Aroostook County manganese deposits and their immediate geologic setting. The project on which the author and others worked in the early 1960's under the supervision of A.J. Boucot was thus the first general purpose stratigraphic and structural mapping of this interesting area.

D.C. Roy, Ely Mencher, and co-workers began their extensive mapping project immediately after the end of the phase of work described above. Their results, mostly in areas to the north and west of the Presque Isle quadrangle are summarized in the introduction to this Guidebook and in the articles by Roy and are not repeated here. Their stratigraphic nomenclature is followed in this article.

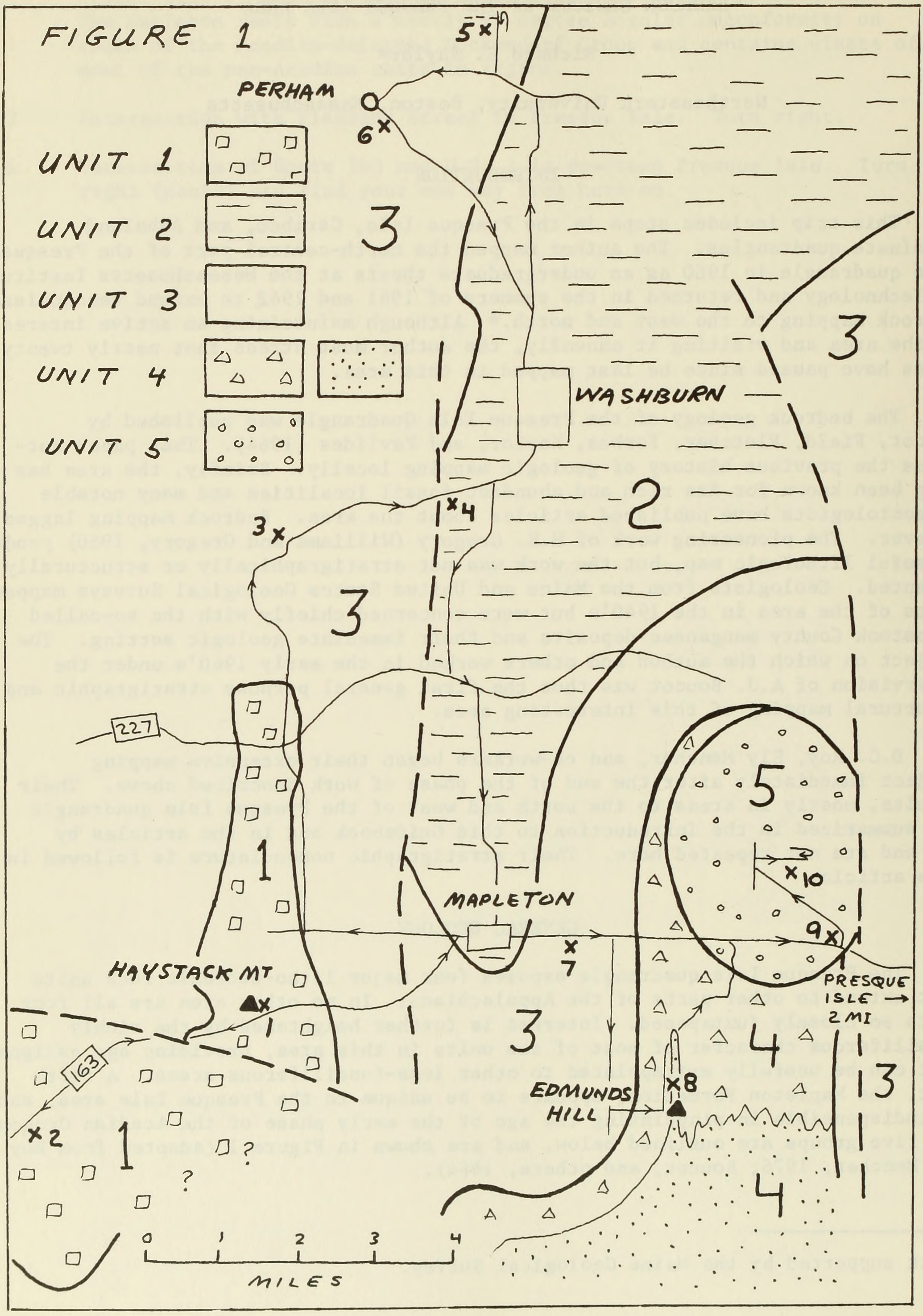
GENERAL GEOLOGY

The Presque Isle quadrangle exposes four major litho-tectonic rock units that extend to other parts of the Appalachians. In no other area are all four units so closely juxtaposed. Interest is further heightened by the richly fossiliferous character of most of the units in this area, providing age assignments that can be usefully extrapolated to other less-fossiliferous areas. A fifth unit, the Mapleton Formation, appears to be unique to the Presque Isle area, and is indispensible in pinpointing the age of the early phase of the Acadian Orogeny. The five groups are outlined below, and are shown in Figure 1 (adapted from Roy and Mencher, 1976; Boucot, and others, 1964).

---

*Work supported by the Maine Geological Survey.

Geology of the Presque Isle area showing lithotectonic units described in text, with field trip route and stops.



Unit 1 comprises volcanic and sedimentary rocks exposed in the Castle Hill Anticline in the northwest corner of the Presque Isle quadrangle and in the Ashland quadrangle to the west (stops 1 and 2). The volcanic rocks are a bimodal suite comprised mainly of greenstone (spilite) and sodium-rich felsite (Keratophyre). These are closely associated with sulfidic, graptolite-bearing shale, red or black chert, and green argillite. These rocks are of Middle and Upper Ordovician age. This belt of rocks extends (with some gaps) for hundreds of kilometers to the southwest and probably links with the Ordovician metavolcanic and metasedimentary rocks of the Bronson Hill Anticlinorium. Exposures die out only a few kilometers to the north, but the belt is postulated to continue some distance further north below the surface (Hamilton-Smith, 1970). The author and others have speculated that this belt is one of perhaps half a dozen volcanic arcs significant in the evolution of the Northern Appalachians.

Unit 2 is the Carys Mills Formation containing interlayered argillaceous micrite, calcareous slate, and calcareous quartzo-feldspathic gray wacke. Locally known to geologists as "the ribbon-rock," Unit 2 is part of the Aroostook-Matapedia litho-tectonic unit. The unit extends northeastward from Presque Isle to the tip of the Gaspe Peninsula, but to the southwest, exposures die out in about 50 kilometers. These sparingly folliliferous rocks are mostly Early Silurian (Llandoverian) but are locally as old as Upper Ordovician (Ashgillian) and possibly older.

Rast and Stringer (1974) have suggested that Unit 2 was deposited on the floor of a small ocean basin whose eastern margin was subducted under the volcanic are of the Tetagouche belt in New Brunswick. At the time of the authors work, the relationship between Units 1 and 2 was unkown. Although closely juxta-posed in the Presque Isle area they are everywhere separated by exposures of Unit 3. Field relationships to the north and west indicate that Unit 2 was deposited conformably on the Madawaska Lake Formation, which in turn was deposited on the rocks of Unit 1 (Roy and Mencher, 1976).

Unit 3 is a complex of Silurian clastic formations. These range in age from late Early Silurian (Late Llandoverian) to Upper Silurian (Wenlockian, Ludlovian and locally Pridolian). D.C. Roy (see Introduction) has worked out the complex facies relationships within this Unit. He interprets it as representing a series of submarine fans derived substantially from a source-area developed on Unit 1 and deposited in a basin opening eastward. The contact between Unit 1 and Unit 3 is an angular unconformity with a hiatus spanning much of the Early Silurian. The contact between Unit 2 and Unit 3 is gradationally conformable with no discernable structural break. The stratigraphic relationships demonstrate the Units 1 and 2 were juxtaposed in their present position no later than the Late Landoverian. Rocks more or less comparable to those of Unit 3 are exposed for hundreds of Kilometers southwest of Presque Isle as the formations comprising the western flank of the Merrimack Synclinoriu.

Unit 4 comprises volcanic and sedimentary rocks of Early Devonian (Upper Gedinnian) age. The volcanic rocks (Hedgehog and Edmunds Hill Formations) are distinctly more felsic than those of Unit 1. The Edmunds Hill is one of the few andesite units described in New England, although this assignment should be verified by modern chemical analyses. The volcanic rocks of the Hedgehog Formation are described as andesite, trachyte, and rhyolite (Boucot, and others, 1964). The volcanic rocks are overlain by and interfinger with the Chapman Sandstone which is also Upper Gedinnian.

The interfingering is especially well-displayed at Edmunds Hill (Stop 8), where a thin tongue of Chapman Sandstone is underlain by Hedgehog Volcanics and overlain by Edmunds Hill Andesite. Fossils in the Chapman are a mixture of plants and coarse-ribbed shells suggestive of a high-energy, near-shore beach environment. At the Grindstone locality 9km south of Edmunds Hill, the Chapman contains more delicate, fine-ribbed shells of the same age as the fauna at Edmunds Hill, but suggestive of a low-energy depositional environment. There too the water also must have been shallow because a rich assemblage of plant fossils is also found. Further south, The Chapman Sandstone grades into the fine-grained Swanback Slate which may be a deeper water deposit. The relationships suggest a volcanic island in the Mapleton area, with a beach at Edmunds Hill, and a basin deepening to the south. (A visit to the Grindstone locality is highly recommended as part of a tour of the Presque Isle area, but would be too time consuming to include in the present trip. The locality is named on the topographic sheet and may be approached from the East Chapman Road).

Units 3 and 4 are separated by a disconformity (attributed to the Salinic Disturbance; Boucot, and others, 1964) with a hiatus spanning the Latest Silurian and Earliest Devonian.

Unit 4 is part of a belt of similar Early Devonian (Upper Gedinnian) volcanic and sedimentary rocks extending from the west end of Chaleur Bay to the The Forks (south of Jackman) in western Maine (Boucot, and others, 1964). From Jackman to north of Mt. Katahdin this same belt is the locus of a series of cauldera complexes containing thick deposits of rhyolite ignimbrite dated as Late Early Devonian (Early Emsian). These include the Traveler Rhyolite described by D.W. Rankin elsewhere in this Guidebook.

Unit 4 is thus part of a volcanic belt of substantial magnitude and considerable lateral extent. The rocks are distinctly more felsic than the earlier volcanics of Unit 1. One interpretation is that the Unit 4 volcanics evolved on a block with at least partly-developed continental affinities, whereas the Unit 1 volcanics were developed in a more oceanic environment.

Brown (1979) determined paleomagnetic pole positions for samples of the Unit 4 volcanics and noted their similarity with pole positions from volcanics of the Late Devonian Perry Formation on either side of Passamaquoddy Bay in coastal Maine and New Brunswick. Despite the significant difference in age between Early and Late Devonian she deduced in effect that the eastern and western flanks of the Merimack Synclinorium were part of a coherent block* by Devonian time. She further noted that the poles for this block differ significantly from those of Catskill and other Late Devonian units deposited on certain North-American basement. She argued from these data that the Presque Isle area was not part of North American plate in Early Devonian time.

---

* The author considers her designation of this block as Avalonian to be a serious misnomer. None of her samples come from the Avalon Province proper and the autho has argued elsewhere that the term "Avalonian" should not be applied west of the Dover (Nfld.) and Bloody Bluff - Lake Char (SE Mass. and Ct.) Faults

The present author notes that the youngest marine Devonian rocks (including the Middle Devonian Mountain House Wharf Limestone of the Memphremagog area, southern Quebec) in the Northern Appalachians occur in the Connecticut Valley - Gaspe Synclinorium west of the Presque Isle area. It is possible that a true ocean basin persisted there in the Late Early and Early Middle Devonian. It is further possible that subduction of this block eastward beneath the rocks of Unit 1 played some role in the evolution of the volcanic rocks of Unit 4.

Unit 5 contains red, arkosic sandstone and conglomerate of the Mapleton Formation yielding plant fossils dated as late Middle Devonian (Early Givetian). These rocks (Stops 9 and 10) rest with angular unconformity on Unit 4 and contain clasts of Unit 4 and older rocks. This demonstrates that an early phase of the Acadian Orogeny occurred between Mid-Early and late-Middle Devonian time (Boucot, and others, 1964). The Presque Isle area is currently the only locality in the Northern Appalachians where a significant Acadian unconformity can be bracketed so closely.

It is noteworthy that the Mapleton Formation is itself folded, and faulted, with dips up to 50 degress (part of which, but not all, may be original dip of the coarser sediments). Boucot and others (1964) noted that Carboniferous rocks at Plaster Rock, New Brunswick (about 80km east of Presque Isle) are flat-lying and tentatively cited. This as evidence for the presence of later phases of the Acadian Orogeny.

MISCELLANEOUS OBSERVATIONS

The work-a-day exposures in the Presque Isle area are those occurring in the ditches along farm-roads and highways. They provide the most continuous sections for describing the units and working out stratigraphic relationships. Unfortunately they come and go depending on the industriousness of the road-maintenance folk and the severity of cloudbursts. Stop 5 is an exposure of this type. It was very well exposed in 1961 when used as the type section for what now the New Sweden and Lower Jemptland Formations. It was only moderately exposed when the road-log was prepared in August, 1979.

The potato economy of Aroostook County depends significantly on the calcareous rocks of Unit 2. Where a single farm spans the boundary between Unit 2 and Unit 3 the land underlain by Unit 2 is planted in potatoes and the remainder is used as pasture land, chicken yards, and woodlots. Potatoes can be grown on other units, but apparently with greater difficulty, as witnessed by the much greater proportion of uncleared land. The field trip route crosses this boundary on several occasions, and the participants are invited to be on the lookout for this interesting phenomenon as a relief from the tedium of driving.

Despite the extensive glacial transport of the regolith, it is interesting to note that the chemistry of the soil closely reflects the underlying bedrock. This was noted by D. Smith, who was engaged by the Maine Geological Survey in 1962, to reconnoiter the Unit 2 - Unit 3 contact from Washburn to the Canadian border. He found that the cruptic soil-chemistry codes on the Soil and Conservation Service photomosaics could be used to rough in the contact to within an accuracy of about 1/4 mile as confirmed by his subsequent bedrock mapping.

REFERENCES

Boucot, A.J., Field, M.T., Fletcher, R., Forbes, W.H., Naylor, R.S., and Pavlides, R., 1964, Reco-naissance Bedrock Geology of the Presque Isle Quadrangle Maine: Maine Geol. Survey, Quadrangle Mapping Series no. 2, 123p.

Brown, L., 1979, Paleomagnetic Results from Northern Maine and the Western Limit of "Avalon" in the Mid Paleozoic: Geophysical Res. Letters, Vol. g, pp 821-824.

Hamilton-Smith, T., 1970, Stratigraphy and Structure of the Ordovician and Silurian Rocks of the Seigas Area, New Brunswick: New Brunswick Dept. of Natural Resources, Mineral Resources Branch, Report of Investigation No. 12.

Rast, N. and Stringer, N., 1974, Recent Advances and the Interpretation of Geological Structure of New Brunswick: Geosicence Canada, Vol. 1, pp 15-25.

Roy, D.C., and Mencher, Ely, 1976, Ordovician and Silurian Stratigraphy of Northeastern Aroostook County, Maine: Geol. Soc. America, Memoir 148, pp 25-52.

Williams, H. S. and Gregory, H. E., 1900, Contributions to the Geology of Maine: U. S. Geol. Survey Bull. 165, 212 p.

ITINERARY

ASSEMBLY POINT - HAYSTACK MT. Maine Rt 163 (Ashland Rd.) approximately 10 miles west of Presque Isle. (Rt 163 is a left-turn off U.S. 1 about a mile north of the college.) You will see Haystack as an obvious feature on the western horizon shortly after leaving town. Park where the highway crests at the southern flank of the mountain. On the left is a gravel strip for car parking (face for departure to west); higher-slung vehicles can negotiate the road that turns right from the highway crest, crossing a small meadow to the base of the mountain.

The official trip will leave this stop at 9:00 AM. Climb as high as ambition and time permit. If you do not have time for the climb note road-cut exposures 50 m. east of the parking area, but watch traffic.

00.0 STOP 1 Felsic volcanic rocks of the Winterville Formation.

00.7 Castle Hill Picnic grounds on left

03.2 Left off Rt. 163 on dirt track leading into abandoned gravel pit. (100 yards beyond turn, Rt 163 crests a low rise, drops, then climbs steeply beyond. If you overshoot, there is a wide gravel shoulder on right for turning about 0.1 mi beyond the low crest. Drivers of low-slung cars may wish to turn here and park on south shoulder of Rt. 163. Cars will depart to east.)

STOP 2 At first sight, this appears to be a gravel pit with glacial boulders of basalt breccia, but on closer inspection one can see that the operation has scraped down to bedrock at several places near the back of the quarry. One exposure is of richly fossiliferous mafic tuff. The fossils are considered Ashgillian (Late Ordovician: R.B. Newman, oral communication, 1980).

05.8 Castle Hill Picnic ground on right.

06.5 Rt. 163 crests at Haystack Mtn.

09.6 Left off Rt 163 on paved cutoff behind Exxon Station where Rt 163 curves to right.

09.7 Left (West) on paved road

09.9 Straight (West) at jct.

10.6 Straight (West.) Dudley Farm both sides of road. Site of early 1940's test pits exploring low-grade manganese deposits in the New Sweden Fm (lower Perham) and limestone-breccia "reefs" at the base of the Jemptland Fm (upper Perham). Note paucity of potato-fields to west in land to west underlain by non-calcareous rocks below the Jemptland Formation.

11.7 Left turn (North) onto Turner Road near site of former Pyle School.

12.3 Small gravel pit on right exposes red shale of New Sweden Fm (Lower Perham).

14.4 Straight (North) at stop sign crossing Maine Rt. 227

14.5 Veer left (North) on gravel road

15.8 Straight (North) Summit of Richardson Hill. Site of good section through Castle Hill Volcanics and overlying units before "improvements" raised road.

17.8 Park on right at bottom of hill before road curves right (East). Walk (North) to base of field on left to Aroostook River (beware furrows and holes hidden by over growth); west about 0.1 mile along river to prominent outcrop.

STOP 3 The exposure displays a gentle anticline in the sandstone and shale member of the Frenchville Formation. Note also the graded bedding. This is the most northerly exposure of the unit on the Castle Hill anticline.

Return to cars and continue eastbound.

20.1 Park by low cuts on right in broad right curve in road

STOP 4 The roadcut exposes micrite and slate of the Carys Mills Formation. Further east in outcrops along the Aroostook River (the first of which is just around the bend and down the steep bank) the percentage of micrite is higher, and the unit has the characteristic appearance to which the name "ribbon-rock" was given. The roadcut was was one of the first exposures to yield fossils. They are very small graptolites, which are best seen on slabs pulled from the cut and washed by the rain. The fossils here are probably Ashgillian. The discovery of younger fossils in the river bank exposure demonstrates that the rocks locally face eastward. A fault is used to explain why the next outcrop westward is also younger (New Sweden Formation).

20.8 Veer left at junction with better road.

21.3 Straight at jct across bridge.

21.6 Left (Northwest) on Maine Rt. 164 into Washburn.

22.5 Left (West) on Maine Rt. 228 towards Perham.

23.8 Straight on paved secondary road as Rt. 228 curves to left.

26.5 Left (West) at junction.

27.1 Right (North) at junction.

27.4 Hedgerows on left (West) with field-road on north side. Make U-turn leaving room for other drivers to maneuver. Park on right facing south. Rocks for this stop exposed along field road: cars will depart to south the way they came in.

STOP 5 Boucot and others (1964) designated the section along the farm road as the type section of the Perham Formation. Roy later elevated the Perham to Group status and named the Jemptland (poorly exposed at the top of the hill) and New Sweden Formations (most of the section on the east flank). Redefinition of the gradational contact at the base of the New Sweden Formation places the lower part of the section (approximately 100 meters) in the Carys Mills Formation.

27.7 Right (West) at jct.

28.6 Veer left (West) at jct.

29.1 Left (southwest) on Maine Rt. 228.
Stay with Rt. 228 as it curves left then right through Perham.

29.4 Park on right opposite white house beyond white church at low road cut.

STOP 6 Typical siltstone of the New Sweden Formation. This is a good outcrop for working out cleavage - bedding relationships, but be cautious about what you call bedding here.

33.6 Stay on Rt. 228 through Washburn. Avail yourself of grocery store here if you need "fixins" for dinner (see below: in the County, "dinner" is the noon meal even if eaten out of a pail.)

33.8 Right (South) on Maine Rt. 164 through Washburn.

34.8 Right (West) off Rt. 164 across tracks and bridge.

34.9 Straight (West) at jct.

35.6 Curve left (South) with better road at jct.

38.5 Left (East) at jct with Maine Rt. 227.

38.8 Right (South) at jct taking road to Mapleton.

39.6 Left into Town of Mapleton Picnic Area for LUNCH STOP.

42.3 Left (East) on Maine Rt. 163 at jct in Mapleton.

43.6 Park on right at crest of hill at roadcut.

STOP 7 SPRAGUEVILLE FORMATION.
Fine calcareous siltstone characteristically showing pervasive bio-turbation. (in good exposures the latter feature is useful in separating this unit from the underlying Carys Mills Formation.) The rocks are cut by teschenite (analcime-bearing, mafic) dikes that are better exposed on the hill to the south.

43.9 Right off Rt. 163 (South) on Pelke Rd.

44.1 Straight. Teschenite dikes exposed in low cuts on right.

44.4 Veer left (South) at jct with better road.

46.1 Left (East) on road towards base of Edmunds Hill.

46.7 Left (North) at jct. Loose blocks of fossiliferous Chapman Sandstone in rockpiles on right.

47.1 Park on right at gate to Trombley Quarry. Don't block entry road.

47.1 STOP 8 CHAPMAN SANDSTONE AND EDMUNDS HILL ANDESITE.
The best exposures are in the cleared pavement above the quarry face. In May, 1978, the interfingering of the sandstone with the volcanics was well-displayed, but the face may be expected to change for better or for worse as the quarry is worked. The two units are superficially similar (the Chapman being rich in volcanic clasts), so the eye must be attuned to the differences in texture between the igneous and sedimentary units. All of the rock types may be seen in the boulder-pile at the junction (46.7) if you cannot get into the quarry. The quarry was opened in the late 1970's.

47.6 Stay with main road. Low cut exposing andesite breccia. Fossiliferous pyroclastic rocks exposed in field reached by road to south.

48.4 Curve left (North) with main road.

49.5 Right (East) onto Maine Rt. 163.

51.1 Left (North) off Rt. 163. Park on right without blocking dump entrance. (Departure to north). Walk back to Rt. 163 and uphill (West) to small cut.

STOP 9 Conglomeratic facies of the Mapleton Formation. PLEASE DO NOT HAMMER ON THIS CUT, and please refrain from prying clasts loose; this is the only exposure the conglomerate conveniently situated for field trips. Note the rounding of the clasts and their variety, including both sedimentary and volcanic materials. Fossiliferous clasts of Chapman sandstone have been reported. It is uncertain whether clasts of the nearby Munson's Granite have been identified; a possible candidate shown to the author by D.C. Roy about 1965 may have been a porphyritic rhyolite.

52.7 Curve right (North) at jct.

52.8 Right (East) at crossroads.

53.1 Park on right. Walk south into woods to small quarries.

STOP 10 MAPLETON SANDSTONE plant fossils. This locality at the crest of Winslow's Hill lies near the axis of the syncline that folds the Mapleton formation. The woods to the south of the road contain numerous small quarry-pits, and plant fossils are abundant at and near several of these. Plant micro-fossils are also abundant in these rocks.

Additional exposures of Mapleton Congl. about 1 mi. further along road.

Turn back. Retrace Route to Presque Isle Dump (see 51.1)
Left (East) onto Maine Rt. 163 into Presque Isle.