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Boudette, Eugene L.

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THE CHAIN LAKES MASSIF AND ITS CONTACT WITH A CAMBRIAN OPHIOLITE AND A CARADOCIAN GRANITE

Eugene L. Boudette[1], Gary M. Boone[2], and Richard Goldsmith[3]

[1]State Geologist, New Hampshire Geological Survey; [2]Department of Geology, Syracuse University; [3]U.S. Geological Survey (Ret.)

INTRODUCTION

The Boundary Mountains along the Maine — Québec border form the height of land and watershed between drainage northward to the St. Lawrence River and southeastward to the New England part of the Atlantic coast. Along this part of the international boundary the highest peaks attain elevations of 3500 to 4000 feet (~1070-1220 m), and are held up by resistant rocks of the Chain Lakes Massif and the western part of the Boil Mountain ophiolitic complex (Boudette, 1982). The Boundary Mountains constitute the massif and the principal exposure of this distinctive basement, but exotic blocks of Chain Lakes granofels are found in the St. Daniel mélange in southeastern Québec and in its equivalent, the Mélange ophiolitique du Ruisseau Nadeau, in the southeastern part of Gaspé peninsula (de Broucker, 1987), as detailed in Boone and Boudette (1989), and references therein. Inasmuch as the type locality of the Chain Lakes granofelsic basement is in the Boundary Mountains, we have termed the tectonic terrane underlain by sialic basement that is bounded by the two ophiolite and mélange belts — the St. Daniel, along the Baie Verte Brompton line, and the Hurricane Mountain belt to the southeast — the Boundary Mountains terrane (fig. 1). The Boundary Mountains terrane was progressively covered by forearc turbiditic flysch of Late Cambrian to Early Ordovician age, followed by Mid- to Late Ordovician felsic and mafic volcanics and an unconformable northwest-transgressive shoreline-shelf, cyclic turbidite succession beginning in the Silurian. These rocks range in age up to Lower Devonian, immediately preceding the Acadian orogeny. Rocks of the Boundary Mountains terrane are intruded by calc-alkalic granitic rocks. Their ages range from Late Ordovician to Middle Devonian (fig. 2; table 1).

The principal purpose of this trip is, first, to examine several lithologic and structural variants of Precambrian metamorphosed diamictite constituting perhaps the major rock type as seen in outcrops of the Chain Lakes Massif (Boudette and Boone, 1976), and second, to examine a part of the Hurricane Mountain Belt, where (1) the Boil Mountain ophiolitic complex is combined within a tectonostratigraphic succession with (2) metamorphosed volcanics and volcanogenic metasedimentary rocks (Jim Pond Fm.) and mélange (Hurricane Mountain sequence), both probably of Middle to Late Cambrian age (table 1), and (3) a forearc basin flysch sequence (Dead River Fm.) of Late Cambrian to Early Ordovician age, which overlies the mélange. The volcanics - mélange - flysch succession is almost entirely unfossiliferous.

The Hurricane Mountain mélange is separated from the Chain Lakes Massif (CLM) by the Boil Mountain complex (Boudette, 1982). The Boil Mountain ophiolite lies in tectonic contact with the Chain Lakes Massif. The fault pattern (figs. 2a and 2b) is complicated by numerous normal and transverse faults, but the initial juxtaposition is best interpreted as

FIGURE 1. Index map showing the accretionary configuration of major lithotectonic terranes in the northern Appalachian orogen. **CLM,** Chain Lakes massif; **TPF,** Thrasher Peaks fault. Modified from Boone and Boudette (1988, Fig. 4A).

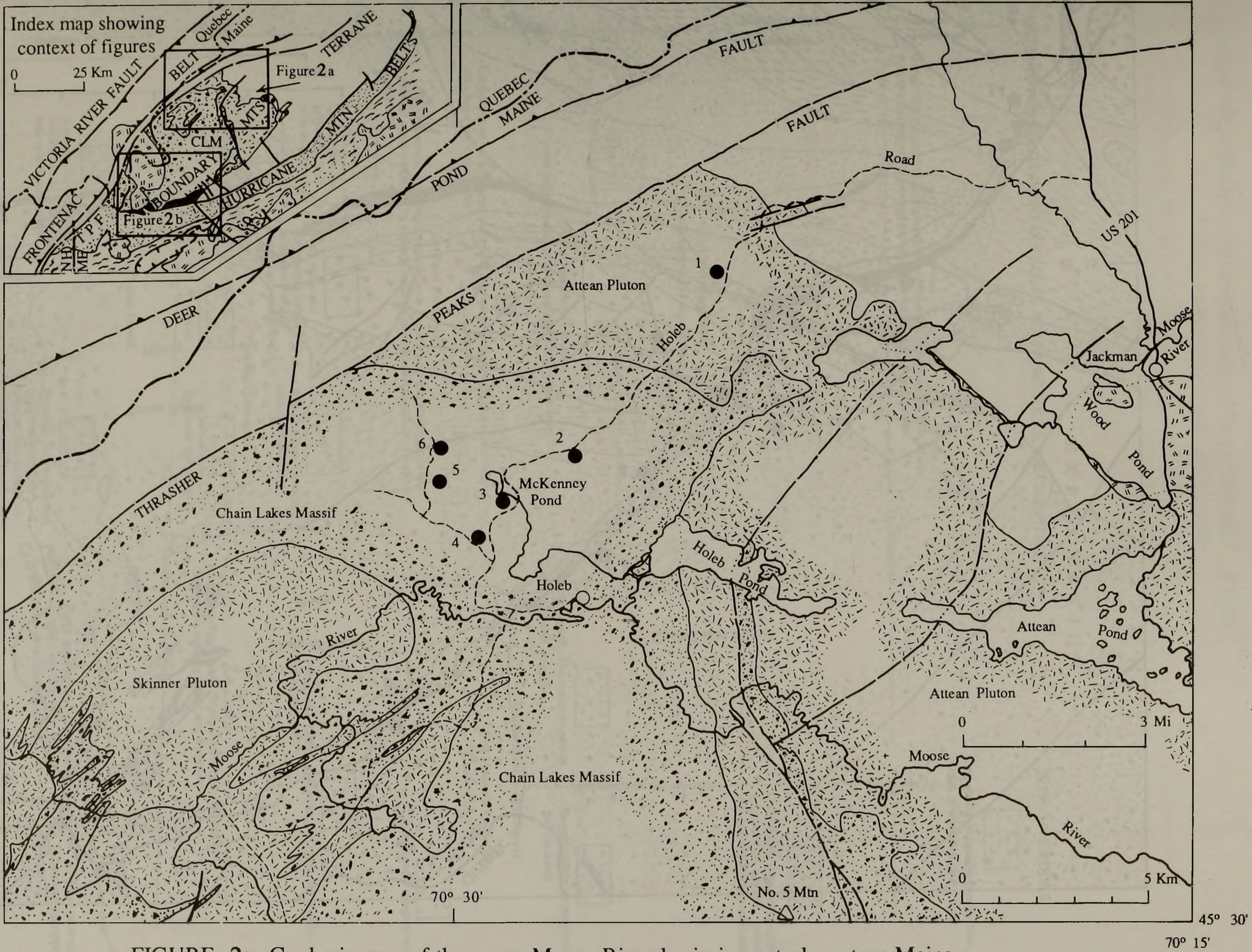

FIGURE 2a. Geologic map of the upper Moose River basin in central western Maine.

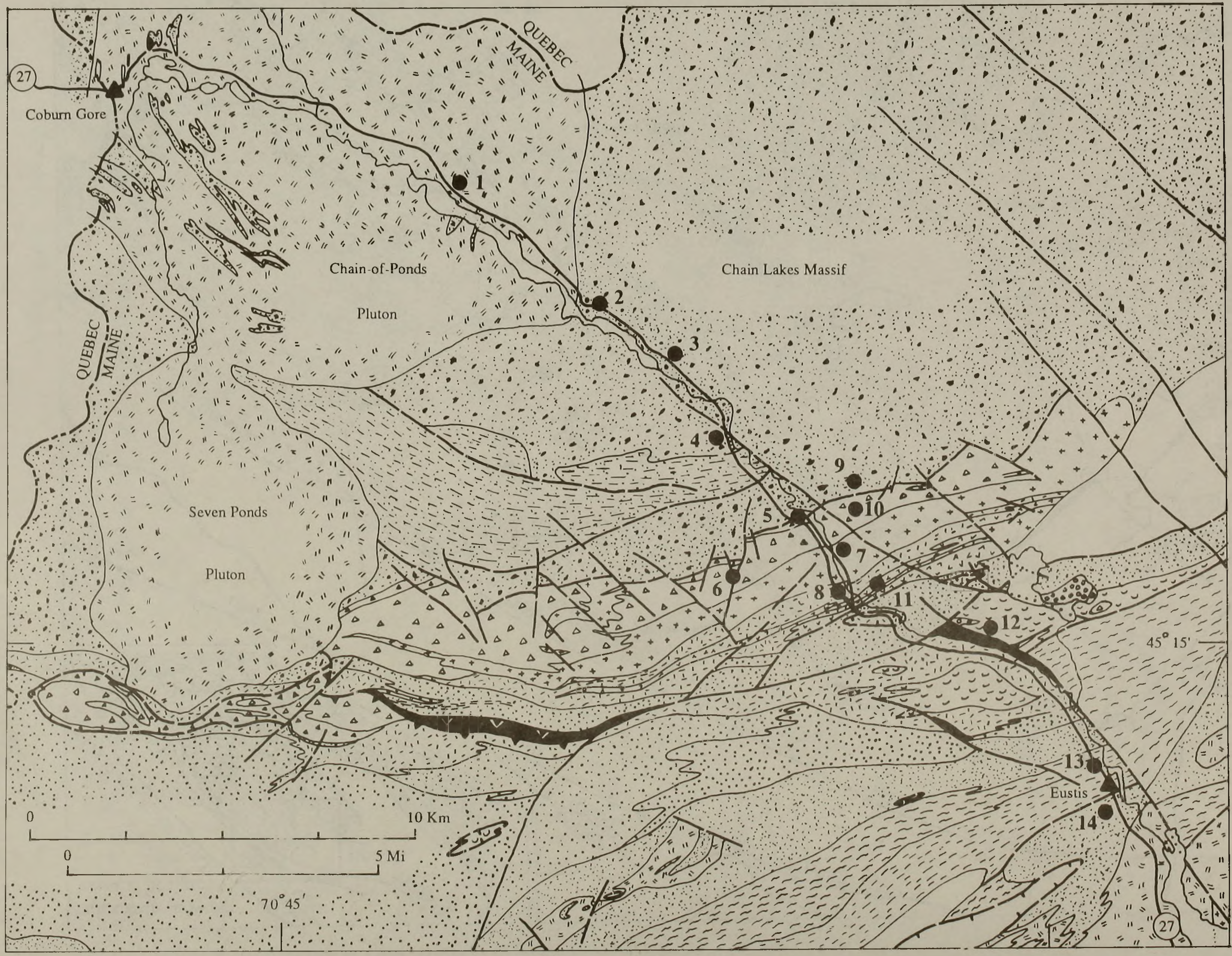

FIGURE 2b. Geologic map of a highway transect from Coburn Gore to Eustis in central western Maine.

E X P L A N A T I O N

METAMORPHOSED SEDIMENTARY ROCKS, VOLCANIC ROCKS, AND SUEVITE(?)

Ludlovian - Gedinnian

▨ Clastic and chemical sedimentsof shelf and shoreline environments, with minor bimodal volcanic rocks grading up into cyclic turbidite of deeper regimes

Unconformity

Middle to Upper Ordovician

Dead River Formation

(Flysch carapace of oceanic layer 1)

▨ Pelitic member

▨ Sandy, calcareous member

Hurricane Mountain Formation

(Trench mélange of an accretionary prism -- oceanic layer 1)

▨ Carbonaceous, sulfidic scaly pelite and greywacke charged with blocks and rafts of autoclastic and exotic rocks

Middle to Upper Cambrian

Jim Pond Formation

(Boil Mountain ophiolite of oceanic layer 2 grading up into keratophyric and silicic rocks succeeded by a clastic mélange-olistostromal sequence of oceanic layer 1)

▨ Quartzwacke and greywacke with rafts of greenstone

▨ Scaly pelite and greywacke charged with blocks and rafts of clastic and exotic rocks

▨ Siliceous iron formation and laminated chert

▨ Felsic flows and epiclastic rocks with vent facies

Tholeiitic Greenstone

▨ Pillowed

▨ Epiclastic and pillowed

Obduction zone

Helekian (?)

Chain Lakes Massif

▨ Aquagene bimodal volcanic rocks grading up into arkosic sandstone

▨ Massive, locally gneissic, granofels (diamictite) charged with exotic rock clasts, locally a polycyclic breccia, sillimanite schist and metadiorite

PRECAMBRIAN

INTRUSIVE ROCKS

SILURIAN - DEVONIAN

▨ Calc-alkalic (magnetite-type) gabbro, diorite, granodiorite, and granite

ORDOVICIAN

▨ Calc-alkalic (magnetite-type) granodiorite, granite, granophyre, and quartz porphyry undivided

(emplacement age uncertain)

▨ Magnesite-quartz-chromium muscovite -chromite rock (virginite)

▨ Clinochrysotile serpentinite, talc, and blackwall

(Emplacement as cold diapirs)

CAMBRIAN

Boil Mountain Ophiolite

(Oceanic layer 3)

▨ Trondhjemite (plagiogranite)

▨ Pyroxenite, gabbro, epidiorite, and epidiorite breccia, (mostly layered)

▨ Antigorite serpentinite (altered harzburgite, websterite, chromitic cumulate dunite, and troctolite)

Major Faults

Early gravity or slide blocks (barbs on downthrown side)

Unclassified

Thrust or reverse (sawteeth on upper plate)

● 7 Field Stops

Table 1. Chronology of tectonometamorphic events in the region containing the Chain Lakes massif.

ISOTOPIC AGE* (Ma)	TIME-STRATIGRAPHIC INTERVAL	EVENT	INTERPRETATION
367.6 ± 1.3	Middle Devonian	Intrusion of Lac des Arraignées Granite	Prograde contact metamorphism produced aureoles <1 km wide; high-T assemblage: Bio + Staur + sillimanite ± garnet
373.3 ± 2.0		Intrusion of Chain of Ponds Pluton	
367.7 ± 1.3		Intrusion of Big Island Pond Pluton	
397 ± 10	Early Devonian	post-Acadian intrusion of Lexington Batholith	
		Acadian Orogeny	Transposed foliation, SE margin of Chain Lakes Massif
418 ± 14			Retrograde metamorphism of Attean and Chain Lakes rocks to biotite + chlorite grade
443 ± 4	Late Ordovician	Intrusion of Attean batholith	Prograde contact metamorphism, ca. 200 - 300 m wide aureole, biotite + sillimanite ± garnet hematite-bearing assemblages
ca. 455 - 475	*NO EVIDENCE OF TACONIAN OROGENY*		
520 ± 12	Late Cambrian		Post-obduction plagiogranite, Boil Mtn Complex
540> t >484	Late Cambrian (extending to Early Ordovician ?)	Penobscottian Orogeny	Obduction of Boil Mtn ophiolitic Complex; accretion of Hurricane Mtn. mélange; thrust and fold tectonics of accretionary complex & forearc basin deposits
ca. 570	Early Cambrian	Rift to drift, passive margin	Cooling through Ar blocking -T of hornblende, Chain Lakes granofels
ca. 770	Late Proterozoic (Hadrynian)	Crustal thinning & rifting	High T/P thermal metamorphism development of fleck gneiss in volcanogenic granofels
1534 ± 60	Mid-Proterozoic (Helikian)	?	Age of Chain Lakes protolith: formation of diamictite; impact metamorphism in northern part of Chain Lakes Massif ?

Middle Devonian 40Ar/39Ar cooling ages of hornblende granitic plutons for Heizler, Lux, and Decker (1988).

Minimum age of Acadian orogeny in western Maine (Rb/Sr mineral and whole rock) from Gaudette and Boone (1985), and Boone and Gaudette (unpub. data)

ca. 418 Ma (Rb/Sr) age of retrograde metamorphism of Chain Lakes granofels, from Cheatham (1985).

U/Pb zircon age of Attean batholith, from Lyons and others (1986). U/Pb zircon age of Boil Mtn. plagiogranite, from Eisenberg (1982) and John N. Aleinikoff (pers. commun., 1988).

Preliminary 40Ar/39Ar age bracket (amphiboles in meta-basites) of Penobscottian orogeny, from Boone and others (in press).

40Ar/39Ar cooling age of hornblende, Chain Lakes granofels from Biederman (1984).

Rb/Sr average age of high T/low P metamorphism of Chain Lakes rocks, from Cheatham (1985).

U/Pb zircon age of Chain Lakes granofels protolith, Naylor and others, 1973.

obduction of the ophiolite along a consuming plate boundary. In the area shown by fig. 2 and elsewhere along strike to the northeast, we interpret the mafic and ultramafic rock fragments in the mélange as derived from obduction and fragmentation of oceanic crust, (presumably early Paleozoic Iapetus oceanic lithosphere), along a suture zone between adjacent suspect accreted terranes. The Boundary Mountains Terrane, lying northwest of this suture zone, is floored by the mainly sialic Chain Lakes granofels and gneiss, and stands within the orthotectonic part of the northern Appalachians of Maine and Québec. It lies between the southeasternmost surface exposures of Laurentian (Grenvillian) crust, in southeastern Québec, and the northwesternmost exposures of Avalonian basement, southeast of the Kearsarge - Central Maine synclinorium (KCMS; see Lyons and others, 1982). Beneath the overlapping Late Ordovician to Early Devonian strata of the KCMS, a third suspect terrane, inferred to be the Gander (Boone and Boudette, 1989) separates the Boundary Mountains Terrane from those identified as Avalonian (fig. 1).

The deformation within the Hurricane Mountain belt is inferred to have been caused by suture zone collision resulting in the amalgamation of two sial-floored terranes: the Boundary Mountains and Gander. This early accretionary event is termed the Penobscottian orogeny (after the "Penobscottian disturbance" of Neuman; see Neuman and Rankin, 1966). It is separated in space, and probably largely in time, from the Taconian orogeny which followed it (table 1).

The second part of the trip, along and near State Hwy. 27, lies along the western Maine seismic reflection/refraction profile (see Stewart, 1989, for a summary and an interpretation of the data). Extrapolation of the surface geology of the Chain Lakes massif and surrounding tectonostratigraphic units down dip of reflectors along this profile is convincing in the interpretation that the Boundary Mountains terrane, with its Chain Lakes basement, was thrust upon the Grenvillian basement of the early Cambrian continental margin, in this western Maine part of the northern Appalachians.

CHAIN LAKES MASSIF

Regional Context

The CLM (fig. 1) is bounded by faults and contacts with intrusive rocks. Along its northwestern margin, slate-grade Devonian strata are juxtaposed against the CLM along the Thrasher Peaks fault. To the north and east of the transect, the massif is bounded by intrusive contact with the Late Ordovicain Attean batholith (table 1). Locally along its eastern margin, the CLM is overlain unconformably by late Silurian and early Devonian strata . Along its southeastern and southern margins, the massif is fault-bounded by the ophiolitic rocks of the Boil Mountain Complex, and by metafelsite of the Jim Pond Formation. The strike of these units and the fault which separates them diverges sharply from the regional northeasterly trend, to northwesterly, around the southwest margin of the CLM in the southwest (figs. 1 and 2b).

Approximately 3,000 m of exposed structural thickness is estimated for the polymetamorphosed granofels, gneiss, and minor amphibolite and metasandstone of the CLM. This estimation is derived from an interpretation that the overall structure is an elongated foliation dome with principal plunge to the southwest, along the regional strike (Boudette and Boone, 1976). According to this interpretation the structurally lowest rocks are in the northeastern part of the massif. There, the rocks, which may lie structurally above well layered, quartzofeldspathic to pelitic gneiss, are characterized by a relict fragmental fabric which led Boudette and Boone (1982) to propose an exometamorphic, impact origin to account for a suevite-like, relict micro- and meso-structure, prior to regional metamorphism. Rocks containing this fabric are the subject of the first part of this field trip. The structurally highest 1000 m, in the southern part of the massif, is composed of layered metavolcanic and interspersed meta-arkosic rocks.

Much of the massif (~2000 m), as exposed in the valley of the Chain of Ponds and North Branch of the Dead River transected by State Highway 27 (fig. 2b), is characterized by massive to weakly layered granofels of approximately dacitic composition. Gneissic variants are common locally. Variations in composition are marked by modest changes in the ratios of minerals comprising the stable assemblage of biotite, chlorite, muscovite, plagioclase, epidote, alkali feldspar and quartz. Different ratios of alkali feldspar and plagioclase are the most notable. Magnetite and hematite are common oxide accessories. Relict almandine-rich garnet, cordierite and sillimanite (fibrolite), occurring singly or in pairs with the stable greenschist assemblage in semipelitic rocks, can be found in many localities scattered throughout the massif. Relict AFM phases, however, have not yielded consistent or meaningful thermobarometric results. The polymetamorphic history of the CLM, moreover, spans a period of 800 Ma or more and records a generalized PTt path of prograde and retrograde events terminating in the Devonian.

The most distinctive feature of most rocks of the massif is the occurrence of relict boulders and pebbly fragments distributed sparsely to commonly throughout the granofelsic or gneissic matrix, and readily visible in most outcrops. Their sizes range from a few centimeters to as much as a meter in long dimension, but most are 2 to 15 cm in length. Thus much of the massif consists of polymict, originally matrix-supported diamictite. Many of the fragments are of foliated, semipelitic and semicalcic schists and fine-grained, thinly laminated gneiss. Randomized orientations of their foliations with respect to layering or foliation of host granofels or gneiss indicates derivation from source areas of pre-existing metamorphic rock. Granitic rock, diorite, gabbro and felsic volcanic rock clasts are dispersed throughout the diamictite, but nowhere known to be abundant. Less common fragments that are also foliated, consist of banded amphibolite. Some may be exotic, but others appear to be tectonic inclusions which originated by boudinage of thin amphibolite layers followed by separation and rotation of the boudinaged fragments. Most of the fragments of presumed exotic origin are commonly rounded, but may also be angular and blocky. Well-rounded clasts are commonly ellipsoidal with long axes paralleling their internal structures but not necessarily parallel to the layering or foliation of the enclosing matrix. Rotation of clasts, apparently synmetamorphic, is common. At the hand-specimen and thin section scales, angular to rounded nodules of quartz, with or without cores of epidote and sulfide minerals, are quite common. Their origin (clasts vs. metamorphic segregations) has often provoked debate at the outcrop. Amphibolite is a sparse lithologic component of the structurally highest parts of the massif, where gneissic structure, parallel to compositional layering, is more common.

The structurally (and probably stratigraphically) lowest sequence of the CLM is subdivided into three facies: (1) the Twin Bridges semi-pelitic gneiss; (2) the Appleton epidiorite; and (3) the Barrett Brook polycyclic epidiorite breccia. We propose that this sub-diamictite sequence comprises the vestiges of a target-rock succession if the impact hypothesis (Boudette and Boone, 1982) is valid. The principal diamictite sequence is presently subdivided into four distinct facies, each with internal variants of structure, texture, and clastic components. These facies are: (1) the McKenney Pond chaotic rheomorphic granofels; (2) the Coburn Gore semi-pelitic gneissic granofels; (3) the Kibby Mountain flecky gneiss, and (4) the Sarampus Falls massive to layered granofels. The structurally (and probably stratigraphically) highest sequence is the Bag Pond Mountain bimodal metavolcanic section and feldspathic meta-arenite. The sequence is well-layered and upright as indicated by depositional structures. The Bag Pond Mountain rocks are interpreted to represent a return to sedimentation and volcanism in a passive margin or epicontinental setting following impact metamorphism and deformation.

Structure, Petrology, and Genesis

Biederman (1984, p. 32 - 53) has contributed a uniquely relevant and detailed discussion of the petrography and structure of the Chain Lakes rocks along Route #27. Within the transect of the trip, the Chain Lakes is disposed as a broad arch in which foliation and bedding parallel. The rocks are typically dark gray to gray-green and medium- to coarse-grained. Layering, clast population and the distribution of metamorphic minerals provide the only distinction between lithic types.

The rocks along the transect are composed principally of quartz, sericitized plagioclase, chlorite and chloritized biotite, muscovite, and K-feldspar. Subordinate sillimanite (fibrolite), garnet, apatite, allanite, sphene, zircon, epidote, calcite, and opaque minerals (hematite, magnetite and sulfides are found) (table 2). These minerals are arranged in a variety of granoblastic textures. Biederman (1984, p. 38) recognized two distinct modal assemblages attributable to metamorphic overprint. One assemblage (sillimanite + biotite + quartz + plagioclase + K-feldspar + garnet) is attributable to a high-grade event. The second assemblage (quartz + muscovite + epidote + chlorite + calcite) is interpreted to be related to Paleozoic low-grade events.

One of the distinctive lithic types to be seen in the Chain Lakes is flecky gneiss (Stop 3) in which fibrolite-oxide-rich clots, which characterize the rock, appear to have been produced by the breakdown of cordierite or garnet. Another (Stops 6 and 9) is the tectonite produced along the boundary with the Boil Mountain ophiolite in the Sarampus Falls facies.

Metamorphism

The CLM is characterized throughout by chlorite + muscovite + brown or green biotite-bearing assemblages that overprint relict high amphibolite to low (biotite-bearing) granulite facies assemblages imposed upon thickly bedded to massive protoliths, most, to varying degrees, diamictic. The relict high grade assemblages constitute massive granofelsic to well-foliated gneissic meso- and microstructures. Intermediate between these structural extremes are relict flecky gneisses, localized patches of agmatitic rock, and breccia, in which a relict foliation is variously poorly to well developed. The present chlorite-biotite grade assemblages are for the most part mimetic after these earlier-formed structures.

Within the central part of the massif, through which the route of the field trip lies, the varied degrees of fleck-gneiss abundance and structure are impressive. This is probably the reason for Rankin and others (1983) reference to the rocks of the massif as "gneiss and migmatite of Chain Lakes" in the correlation chart for Precambrian rocks of the Eastern United States. Our view, gained over several years of mapping within the massif, is that a massif-wide application of the term migmatite is misleading.

The polymetamorphic history of the CLM spans a period of 800 m.y. or more and records a pressure-temperature-time path of prograde and retrograde events terminating with the emplacement of the Late Ordovician Attean batholith (table 1). We believe that the high-grade regional metamorphism(s) took place in the Proterozoic. It is doubtful that the high-grade aspects of the massif could be ascribed to Grenville tectonometamorphic events. Even if an early phase of the high-T metamorphism was coeval with the Grenville rocks, it was followed by a period of relatively static, widespread high temperature production of

Table 2. Chemical and modal analyses of rocks from the Chain Lakes massif and Boil Mountain ophiolite.

Major oxide composition (weight percent)

	Chain Lakes massif(1)						Boil Mountain ophiolite(2)		
Sample No.	1	2	3	4	5	6	7	8	9
Field No.	CL-38	CL-40	CL-42	CL-34	S-38	BP-13	784a	115a	267a
SiO_2	67.2	69.9	69.2	68.8	68.4	65.8	43.8	50.7	34.0
Al_2O_3	15.0	14.7	15.3	13.7	15.4	16.7	15.9	15.7	14.8
Fe_2O_3	2.8	2.3	1.3	3.5	1.3	2.2	3.6	1.5	2.3
FeO	2.9	2.4	4.0	1.9	3.2	3.5	7.3	5.1	3.3
MgO	1.6	1.2	1.3	1.3	1.2	1.7	10.4	10.1	32.5
CaO	1.5	1.8	1.3	1.5	1.6	1.6	15.6	11.7	0.8
Na_2O	2.7	2.6	1.5	2.5	2.6	2.0	0.18	2.2	0.04
K_2O	2.4	3.1	3.1	2.9	2.6	2.9	0.14	0.46	0.02
H_2O+	1.9	1.4	2.5	2.9	2.5	2.5	2.1	2.5	12.1
H_2O-	0.07	0.01	0.04	0.01	0.01	0.07	0.02	0.06	0.35
TiO_2	1.0	0.90	0.81	1.0	0.78	0.93	0.21	0.36	0.24
P_2O_5	0.17	0.18	0.13	0.19	0.16	0.16	0.01	0.04	0.01
MnO	0.09	0.07	0.08	0.07	0.08	0.10	0.12	0.10	0.02
CO_2	0.41	0.26	0.10	0.27	0.03	0.10	0.02	0.04	0.02
Total	99.74	99.82	100.66	99.14	99.66	100.26	99	101	101

	Normative mineral composition (weight percent)						CIPW norm			
q	38.3	37.5	43.0	40.2	37.9	37.2		0	0	0
c	6.7	4.9	7.8	4.9	6.0	8.1		0	0	15.2
or	14.8	18.6	18.7	17.6	15.8	17.6		0.85	2.78	0.1
ab	23.3	22.3	12.9	21.6	22.6	17.3		1.6	19.0	0.4
an	3.8	6.2	5.1	4.7	6.9	6.5		43.5	32.3	4.3
en	4.1	3.0	3.3	3.3	3.1	4.2	cp	29.6	21.4	0
fs	1.6	1.2	5.2	0.0	3.8	3.3	op	2.0	14.6	22.3
mt	4.1	3.4	1.9	3.5	1.9	3.3	ol	22.0	9.0	57.3
hm	0.0	0.0	0.0	1.1	0.0	0.0				
il	1.9	1.7	1.5	1.9	1.5	1.8		0.4	0.7	0.5
ap	0.4	0.4	0.3	0.0	0.4	0.4		0.02	0.1	0.03
ca	0.9	0.6	0.0	0.6	0.1	0.2		0.1	0.1	0.1
Total	99.9	99.8	99.7	99.5	99.8	100.0		100.7	100.0	100.1
DI	87	89	87.5	89	89	87		2	24	1

(continued)

Table 2 (continued)

Modal analyses

Points counted	1234	1040	1052	1083	1056	1155			
Sample No.	1	2	3	4	5	6	7	8	9
Quartz	33	38	46	42	42	36	tr	x	--
K-feldspar	1	0.4	0.6	0.5	5	2	--	--	--
Plagioclase	37	28	15	34	22	24	--	x	--
Biotite	9	7	6	0	0	0	--	--	--
Muscovite	12	21	22	17	19	23	--	--	--
Chlorite	5	1	10	4	10	13	(20)	x	(5)
Epidote	1	1	0.1	0	0.3	0.3	(35)	x	--
Iron oxide	1	2	0.6	2	1	1	(5)	x	(5)
Apatite	0.3	0.4	0.2	0.1	0.3	0.1	--	--	--
Calcite	0	1	0.1	0.6	tr	0.2	--	--	--
Zircon	tr	tr	0	tr	tr	0	--	--	--
Allanite	tr	0	0	0	0	0	--	--	--
Sillimanite	tr	0	0	0	0	0	--	--	--
Leucoxene	tr	0.4	0	0.4	0.2	tr	--	--	--
Sphene	0	0	0	0	0	tr	--	--	--
Amphibole?	0	0	0	0	0	0	--	--	--
Actinolite							--	x	--
Green hornblende							(45)	x	--
Clinochysotile & Mg-chlorite							--	--	(90)

(1)Rapid rock analysis, H. Smith, 1984

(2)Rapid rock analysis, H. Smith, 1969-70

-	Not observed
tr	Trace
x	Present in major amounts
(35)	Thin section estimate

1. Sarampus Falls facies, Chain Lakes massif; gray, plicated gneissic diamictite containing short discontinuous streaks of mica and scattered clasts of quartz in quartzo-feldspathic matrix. Outcrops on Rte. 27, 2.1 km NW of junction with Beaudry Road, Chain of Ponds quadrangle. Lat. 45° 19' 30", Long. 70° 38' 45".

2. Kibby Mountain facies, Chain Lakes massif; gray, faintly gneissic diamictite containing scattered clasts of quartz of different sizes and elongate lenses in which clusters of biotite as much as a centimeter in diameter give a spotted appearance to the rock, matrix is quartzo-feldspathic. Chain of Ponds quadrangle, Rte. 27, 0.9 km NW of junction with Baudry Road. Lat. 45° 19' 10", Long. 70° 37' 50".

3. Bug Eye Pond facies, Chain Lakes massif; dark gray, massive diamictite containing different size clasts of quartz and biotitic metamorphic rock scattered in a quartzo-feldspathic matrix. Road cut Rte. 27, 600 m NW of Sarampus Falls, Jim Pond quadrangle. Lat. 45° 18' 20", Long. 70° 36' 50".

(continued)

Table 2 (continued)

4. Bag Pond facies, Chain Lakes massif; light gray, white-weathering, even-grained, fine-grained, faintly pin-striped gneiss. Quartz clasts rare. Outcrops on trail at 1800 ft contour, 800 m N of Round Mountain Pond, Chain of Ponds quadrangle. Lat. 45° 16' 45", Long. 70° 38' 50".

5. Bug Eye Pond facies, Chain Lakes massif; gray, massive diamictite containing scattered clasts of quartz of different sizes and numerous mafic-rich clasts as much as 1 cm in diameter in quartzo-feldspathic matrix. Ledges at bridge over Bog Brook, Skinner quadrangle, Lat. 45° 31' 30", Long. 70° 32' 25".

6. Bug Eye Pond facies, Chain Lakes massif; dark gray, massive diamictite containing scattered clasts of quartz and mafic-rich rock in quartzo-feldspathic matrix. Cuts along railroad, 1.7 km NE of Lowelltown, Boundary Pond quadrangle, Lat. 45° 31' 20", Long. 70° 37' 35".

7. Troctolite, massive, equigranular with bladed hornblende up to 3 mm long, western Toe Nail Ridge, Black Mountain quadrangle, Lat. 45° 14' 49", Long. 70° 40' 20".

8. Gabbro, massive, medium- to coarse-grained intergrown plagioclase and ferromagnesian minerals producing a diabasic to graphic texture, east of Greenbush Pond on east side of North Branch, Dead River, Tim Mountain quadrangle, Lat. 45° 14' 59", Long. 70° 30' 19".

9. Serpentinite, diapiric type, waxy, sheared with cross-fiber veins up to 1 cm wide, along south Tea Pond road, Tim Mountain quadrangle, Lat. 45° 14' 06", Long. 70° 31' 26".

In CLM rocks most plagioclase is altered all or in part to sericite; muscovite includes both sericite not recognizably from alternation of plagioclase and discrete flakes; chlorite and iron oxide derived primarily from alteration of biotite; some sericite in Samples 1 and 2 from former fibrolite.

granofels, flecky granofels, and flecky gneiss, prior to the earliest Phanerozoic tectonothermal events.

Exposures of the contact to be visited (Stops 5 and 6), preserve a thin tectonic lens of amphibolite at the base of the Boil Mountain Complex. The amphibolite shows a range of texture of the constituent amphiboles, ranging up to coarse-grained patches of hornblende prisms, which define the foliation that parallels the contact. Other matrix minerals are sphene, epidote, opaque oxide(s), and sparse chlorite, which are fine-grained. Chlorite is confined to small patches, presumably having replaced actinolite or hornblende. The amphiboles show a range of composition. The largest grains are euhedral to subhedral, very fresh hornblende, showing here and there a sharp zonation to, or mantling by actinolite at their margins. Actinolite also occurs as small single grains and clusters amid medium- to fine-grained hornblende lenses adjacent to the patches of coarse-grained hornblende.

Oft-cited in favor of obduction-related metamorphism is the observation of coarser-grained muscovite in the common quartzofeldspathic rocks of the Chain Lakes along its southeastern and southern perimeter at Stop 6 (Boudette, 1970, 1978, and 1982). Although this hypothesis has not been investigated or tested with respect to microstructural change, it still stands as viable. One consequence of this possibility is the requirement of H_2O mobility at elevated temperature within an inferred structural thickness of about half a kilometer below the obduction contact. Coarse muscovite, however, is not everywhere present within this zone.

THE BOIL MOUNTAIN COMPLEX AND JIM POND FORMATION

Boudette (1982, p. 212) and Coish and Rogers (1987; p. 51) have described the illogical practice of dividing the plutonic from the volcanic and sedimentary components of the ophiolite. For descriptive purposes alone, the ophiolite-mélange-flysch carapace succession retains herein the subdivision used by Boudette (1970, 1978, and 1982) and Boudette and Boone (1976), and Boone and Boudette (1989). Coish and Rogers (1987) have established the geochemical context of the Boil Mountain Complex (Boudette, 1982) combined with the volcanic components of the Jim Pond Formation. According to Coish and Rogers (1987) the Boil Mountain ophiolitic complex is probably best correlated in the Appalachians with the Dunnage Zone ophiolite of Newfoundland. They also furnish support for realistic comparisons of the Boil Mountain with other world-wide ophiolite complexes.

Boil Mountain Complex

Lithologic units include serpentinite, pyroxenite, gabbro, trondhjemite, and epidiorite of oceanic layer 3 (see table 2). Rocks of the Boil Mountain Complex are extensively altered, but relatively pristine examples may be found in the northeast. Deformation and dislocation of the rocks of the complex increase toward the southwest along with alteration, especially in the serpentinite. This effect becomes especially notable where faults on the southeast become tangential to the ophiolite. Extreme tectonism and metamorphism is believed to have remobilized segments of the serpentinite of the complex to produce the diapiric variety. The serpentinite of the Boil Mountain Complex contains antigorite and is moderately hydrated; diapiric serpentinite described in a later section, in contrast, is more hydrated. Antigorite and clinochrysotile do not coexist in these rocks.

The distribution of rock types within the Boil Mountain Complex is relatively uneven and, to some degree, they are mixed. The two-fold subdivision of the ultramafic and mafic components shown on figure 2b is generalized and reflects the dominant rock types in each. The northeastern part of the complex has a stratigraphy wherein the rocks are part of a sequence as much as 1.6 km thick facing southeast and are relatively enriched in Mg at their base along the northwestern margin. The lower zone is represented by the principal occurrence of the antigorite serpentinite (altered harzburgite and dunite) and pyroxenite. The Mg-rich rocks (Stops 5 and 6) are generally overlain by massive epidiorite which in turn grades into gabbro, epidiorite autobreccia (Stop 10; epidiorite and subordinate trondhjemite), and minor clinopyroxenite. Greenstone septa (or possibly dikes) are common in the trondhjemite facies (Stop 7). Repetition of lithologies is common near the base, where distinctive igneous layering is also seen (Stops 5 and 6).

The base of the Boil Mountain Complex is exposed at Stops 5 and 6 where epidiorite, gabbro, or serpentinite of the ophiolite are in sharp, tectonic contact with rocks of the Chain Lakes massif. The latter appear as discrete septa within the ophiolitic rocks and show subtle effects of thermal recrystallization. Thus the basal contact is difficult to characterize at the scale of outcrops, but some protoclasis of the ophiolitic rocks suggest that ductile faulting accompanied their emplacement and is the pre-eminent relationship. Moderately well-foliated amphibolite shows partial to extensive retrogradation of hornblende to actinolite. Elsewhere along the base of the complex, the contrast in mechanical competence between the rocks of the Chain Lakes massif and those of the Boil Mountain Complex has resulted in the localization of post-intrusion fault dislocations (Stop 6) characterized by brittle deformation, and relationships are usually obscure.

Diapiric serpentinite, soapstone, and virginite

Discordant bodies of dominantly strongly-sheared serpentinite (see #10, table 2) associated with subordinate, but variable amounts of soapstone and virginite (carbonate-quartz-chromium muscovite-chromite rock) intrude rocks of the Jim Pond Formation along faults (Stop 12). The diapiric serpentinite is notably hydrated and is composed of clinochrysotile and magnesian chlorite. The diapiric serpentinite has apparently detached itself from the parent complex and has migrated as much as 7 km from source areas.

Exposures of the bodies are nowhere sufficient to observe any consistent geometric arrangement of the serpentinite, talc rock, and virginite. In most cases, the arrangement appears to be unique with each of the rocks successively in contact with country rock which is strongly sheared. In most cases where all lithologies are present, the talc rock tends to envelop the serpentinite and the virginite envelops the other rocks. Both serpentinite and virginite have been found to occur singly.

Jim Pond Formation

The Jim Pond Formation is a combined bimodal volcanic, and aquagene volcanic - olistostromal sequence representing oceanic layers 1 and 2. On the northwest the Jim Pond is composed essentially of chlorite-albite-epidote-actinolite greenstone (Stop 8) with minor amounts of mafic-rich metagraywacke, metamorphosed dacite, maroon phyllite, and hematitic chert (jasper).

In the southeast the greenstone constitutes all but about 150 m of the Jim Pond section in the east, and gives way by short-ranged facies change to metaquartzwacke toward the west. Greenstone is present as slide blocks within the metaquartzwacke member. The greenstone is thickly layered with lenses throughout characterized by uniformly- and well-developed pillows. The thick units are provably individual flows that are 15 m or more thick. Mafic lapillite, in layers 1-20 cm thick, and volcanic breccia compose less than 10 per cent of the greenstone member and are found throughout interlayered with pillowed and massive flows.

In addition to metamorphosed dacite, the Jim Pond Formation contains sodic quartz-latite flow rock and related ash-flow rock, breccia, and epiclastic rock (Stop 11). The thickness of the metadacite member varies from 0 to more than 500 m. The metadacite occurs in layers that are about 15 m thick or more. Ash-flow deposits are finely laminated in beds 1 to 10 mm thick. The boundary between the greenstone of the mafic member and the metadacite is sharp. Repetitive sequences of the two volcanic rocks occur with individual flows averaging about 30 m in thickness. The metadacite and iron-formation members are almost everywhere closely associated. In the northeast on regional strike, the main belt of metadacite is succeeded (toward the southeast) by iron formation with interlayered metaquartzwacke and metagraywacke.

HURRICANE MOUNTAIN FORMATION

The Hurricane Mountain mélange (Boone, 1989, and references therein) represents part of an accreted wedge of carbonaceous, sulfidic scaly metapelite and metasiltstone which is charged with blocks and rafts of autoclastic and exotic rocks. If the Hurricane is accreted within a zone of orthogonal subduction, high-pressure mineral assemblages apparently were not formed. Localized occurrences of different exotic lighologies along the strike of the Hurricane suggest that subduction may have been oblique, and that concommitant strike-slip faulting, within the forearc environment or arcward of it, brought different provenances into the zone of active fragmentation where gravity-driven submarine slides were incorporated into the growing accretionary wedge.

The Hurricane retains a rather consistent structural thickness of 900 to 1000 m throughout the Lobster Mountain anticlinorium; this thickness probably is largely a product of Penobscottian, rather than Acadian deformation. The structural relationship of the Hurricane to the underlying, less deformed, aquagene volcanic Jim Pond Formation is essentially a fault contact, involving break-up and olistostromal emplacement of Jim Pond greenwacke, quartzite and volcanogenic rocks in a matrix which is increasingly composed of siltstone protolith structurally upward into the Hurricane in the southwest part of the Hurricane Mountain Belt (Fig 1; Boudette, 1978). We recognize the base of the Hurricane here as defined by matrix that is predominantly metasiltstone, commonly rusty, owing to disseminated pyrite and pyrrhotite (Stop 14). Farther along strike to the northeast, the Hurricane is in sharp structural discontinuity with felsic volcanics, or with graded beds of wacke and volcanogenic, bedded pseudochert and lenses of ferromanganese oxide of the upper part (estimated to be the upper one-third) of the Jim Pond Formation. A predominant axial planar cleavage in metasedimentary and metavolcaniclastic rocks of the Jim Pond is locally folded and weakly overprinted by a second, presumably Acadian cleavage.

DEAD RIVER FORMATION

The Dead River Formation (Boone, 1973) is interpreted to have accumulated as a coeval flysh carapace over the Hurricane Mountain mélange seaward from the accretionary margin. The sediments of the Dead River were apparently transported into place by turbidity currents, and also reworked thereafter by bottom currents. An upward increasing abundance of poorly-sorted metasandstone beds composed both of immature and unstable detritus in the Dead River indicates a gradual change into a higher energy sedimentologic environment.

The Dead River is subdivided into a lower metapelite member and an upper metasandstone member (Stop 13). The metapelite member consists dominantly of green, red, and variegated red and green phyllite and slate with minor amounts of calcareous metagraywacke in beds 5-10 cm thick. A few thin metalimestone lenses occur at the base of the member. The lower member is transitional into the upper member with the amount of metagraywacke and thickness of beds gradually increasing upward. The upper half contains up to 50 percent or more of metagraywacke and arkosic metasandstone, with metaquartzwacke beds ranging from 2 to 30 cm thick. The balance of the lithology is similar to the metapelites of the lower member. The contact between the lower and upper member is arbitrarily taken to be the horizon where the metasandstone beds comprise at least 50 percent of the lithology.

The rocks of the Dead River are associated in a variety of depositional structures ranging from parallel lamination to wavy and flaser-bedding to thickly bedded, graded sets. In general, parallel bedding and uninterrupted graded bedding are more common in the lower half of the unit, becoming less common in the upper half because of the increase in abundance of zones of small-scale chaotic structure, convolute structure, and other well-preserved soft-sediment deformational features. Despite the wide variety of bedding, a characteristic feature of metapelites throughout the unit is a pinstriped appearance produce by quartz- and quartz-feldspar-rich laminae parallel to cleavage and relict bedding. Metagraywacke and metaquartzwacke beds also commonly contain quartz-rich laminae developed along fracture-cleavage and slip-cleavage surfaces. These pin-stripe structures persist through a wide range of metamorphic conditions. The average regional stratigraphic thickness of the Dead River present is estimated to be 760 m (Boone, 1973), but as much as 1200 m could be present in places.

REFERENCES

Biederman, J.L., 1984, Petrology of the Chain Lakes massif along Route 27 in central western Maine: A Precambrian high grade terrane; unpubl. M.S. thesis, University of Maine, 125 p.

Boone, G.M., 1973, Metamorphic stratigraphy, petrology, and structural geology of the Little Bigelow Mountain map area, western Maine: Maine Geological Survey Bulletin 24, 136 p.

Boone, G.M. (with contributions by M.T. Heizler and D.T. Doty), 1989, (in press), Hurricane Mountain Formation mélange: Description and tectonic significance of a Penobscottian accretionary complex, in, Marvinney, R.G. and Tucker, R.D., eds., Geology of Maine: Sesquicentennial Volumes, Maine Geol. Survey: v. 2.

Boone, G.M. and Boudette, E.L., 1989, Accretion of the Boundary Mountains Terrane with the northern Appalachian orthotectonic zone: in Horton, J.W. and Rast, N., eds. Mélanges and olistostromes of the U.S. Appalachians: Geol. Soc. America Spec. Paper 228, p. 17-42.

Boudette, E.L., 1970, Pre-Silurian rocks in the Boundary Mountains anticlinorium, northwestern Maine: in Boone, G.M., ed., Guidebook for field trips in the Rangeley Lakes - Dead River Basin region, western Maine: New England Intercollegiate Geol. Conference, 62nd Ann. Mtg., p. C1 - C21.

_______, 1978, Stratigraphy and Structure of the Kennebago Lake Quadrangle, central western Maine: unpubl. Ph.D. thesis, Dartmouth College; 342 p.

_______, 1982, Ophiolite assemblage of early Paleozoic age in central western Maine: in St-Julien, Pierre and Béland, Jacques, eds., Major structural zones and faults of the northern Appalachians: Geol. Assoc. Canada Spec. Paper 24, p. 209 - 230.

Boudette E.L. and Boone, G.M., 1976, Pre-Silurian stratigraphic succession in central western Maine: in Page, L.R., ed., Contributions to the stratigraphy of New England: Geol. Soc. America Mem. 148, p. 79 - 96.

_______, 1982, Diamictite of the Chain Lakes Massif of Maine: a possible metasuevite: Geol. Soc. America Abstracts with Programs, v. 14, no. 7, p. 448.

Cheatham, M.M., 1985, An isotopic study of the Chain Lakes Massif, Maine: unpubl. M.S. thesis, University of New Hampshire, 163 p.

Coish, R.A. and Rogers, N.W., 1987, Geochemistry of the Boil Mountain ophiolitic complex, northwest Maine, and tectonic implications: Contrib. Mineral. Petrol., 97, 51-65.

Eisenberg, R.A., ms.,1982, Chronostratigraphy and lithogeochemsitry of Lower Paleozoic rocks from the Boundary Mountains, west-central Maine: unpubl. Ph.D. thesis, Univ. of California, Berkeley, 180 p.

Gaudette, H.E. and Boone, G.M., 1985, Isotopic age of the Lexington Batholith: Constraints on timing of intrusion and Acadian metamorphism in western Maine: Geol. Soc. America Abstracts with Programs, v. 17, no. 1, p. 19 - 20.

Goldsmith, Richard, 1985, Reconnaissance geologic map of the Skinner - Lowelltown area, Somerset and Franklin Counties, Maine: U. S. Geol. Survey, Open File Report, OF - 85 - 136, 2 sheets, scale: 1:24,000.

Heizler, M.T., Lux, D.R., and Decker, E.R., 1988, The age and cooling history of the Chain of Ponds and Big Island plutons and the Spider Lake Granite, west-central Maine and Quebec: Am. Jour. Sci., v. 288, p.925 - 952.

Luetgert, J., Doll, W.E., and Murphy, J., (*in press*), Seismic refraction profiles in northwestern Maine:

Lyons, J.B., Boudette, E.L., and Aleinikoff, J.N., 1982, The Avalonian and Gander zones in central eastern New England, in Major Structural Zones and Faults of the Northern Appalachians edited by P. St. Julien and J. Beland: Geol Assoc. Canada Spec. Paper 24, 43-66.

Naylor, R.S., Boone, G.M., Boudette, E.L., Ashenden, D.O. and Robinson, P., 1973,Pre-Ordovician rocks in the Bronson Hill and Boundary Mountains anticlinoria, New England, USA : EOS, Am. Geophys. Union Trans., v. 54, no.4, p.495.

Neuman, R.B. and Rankin, D.W.,1966, Bedrock geology of the Shin Pond region: in Caldwell, D.W., ed., Guidebook for field trips in the Katahdin region; New England Intercoll. Geol. Conference, 58th Ann. Mtg., p. 8 17.

Rankin, D.W., Stern, T.W., McClellan, James, Zartman, R.A., and Odom, A.L., 1983, Correlation chart for Precambrian rocks of the eastern United States: U. S. Geol. Survey Prof. Paper 1242-e, 18 p.

Robertson, P.B. and Plant, A.G., 1988, Shock metamorphism in sillimanite from the Haughton impact structure, Devon Island, Canada: Contr. Mineral. and Petrology, v. 78, p. 12 - 20.

Stewart, D.B., 1989, Crustal processes in Maine: Amer. Mineralogist, v. 74, p. 698-714.

Trumbull, 1988, Petrology of flecked gneisses in the northern Wet Mountains, Fremont County, Colorado: Geol. Soc. America Bull., 100, p. 247 - 256.

TRIP A-4 and B-4

(ROCKS OF THE CHAIN LAKES MASSIF AND BOIL MOUNTAIN COMPLEX)

This two-day trip will traverse a combination of federal and state highways and privately maintained lumbering roads. The latter present appropriate hazards, but are navigable by ordinary vehicles in wet or dry weather. USGS quadrangle maps that may be helpful include the following:

Day #1

Attean	15'
Spencer Lake	15'
Skinner NE	7 1/2'
Skinner SE	7 1/2'

Day #2

Chain -of -Ponds	7 1/2'
Jim Ponds	7 1/2'
Spencer Lake	15'
Stratton	15'

The De Lorme Maine Atlas and Gazeteer (De Lorme Publishing Company, Freeport, ME - - available at most Maine bookstores and sports outlets) is also recommended. Background geology for the trip is provided in the references.

Day #1 will be directed toward roadside outcrops in the Moose River headwaters in the vicinity of Holeb and mainly concerned with the rocks of the northern part of the Chain Lakes massif. Woodland access, always at the discretion of nature and human whimsy will require a return to Jackman and regrouping for the second day along ME Rte. #27 because of the demolition of the bridge over the Moose River at Holeb. Otherwise, we could enjoy a scenic, instructive and exciting route through the heart of the Chain Lakes massif via the Beaudry and Gold Brook lumbering roads to the Stratton/Eustis area. If time allows, two optional stops near Parlin Pond, south of Jackman off Rte. U.S. 201, will be added to look at Ordovician (?) and Devonian (?) igneous rocks of the Jackman region.

Day #2 will traverse Maine Rte. #27 from north to south where we will see rocks at the roadside or on short walks into the forest. This transect is coincidently along the North Branch of the Dead River and will emphasize rocks of the southwestern part of the Chain Lakes massif and rocks of the Boil Mountain ophiolite ramped upon it. The selection of stops on day #2 will be flexible combining the influence of time, interest, and weather. The timing of the trip will be planned to allow participants adequate time to reach Farmington for the annual banquet and formal part of the meeting.

DAY #1
Friday 10/13/89

TRIP A-4 ROAD LOG

Mileage	
0.0	ASSEMBLY POINT 9:00 AM "Attean View" scenic rest stop located 6.0 miles south of the Moose River bridge between Jackman and Moose River. The overlook is about 85 miles from Farmington. No camping is allowed here. The overlook is on rocks of the Attean batholith (ca. 445 Ma), mostly granite and granodiorite, situated on the west side of Owls Head. A panorama of the Boundary Mountains and the upper Moose River basin is seen from here. The Boundary Mountains are underlain either by metagreywacke and greenstone of the Silurian Frontenac assemblage intruded by diorite sills (probably also of Silurian age); or Helekian granofels diamictite of the Chain Lakes massif. The lowlands are underlain mostly by rocks of the Attean batholith or the Lower Devonian Seboomook Formation which is mostly composed of cyclic turbidite. Depart at 9:00 - - North on US #201.
6.0	Moose River bridge.
9.0	Intersection of Holeb Road (unmarked) in Dennistown - - turn left toward the west.
15.4	N. Branch, Wood Stream.
16.6	Wood Stream STOP #1 - - Rocks of the Attean batholith near Smith Pond.
21.1	Mud Pond Road Jct. STOP #2 - - Rocks of the Chain Lakes massif; Burnt Jacket Mtn. type.
22.3	Road Jct. (Turner Ponds) - - Keep left.
23.0	McKenney Pond STOP #3 - - Rocks of the Chain Lakes massif; McKenney Ponds type.
27.9	Road Jct. (Gulf Stream) Turn right.
28.3	Pavements in road STOP #4 - - Rocks of the Chain Lakes massif with segmented ribbon magnetite.
29.5	Fork in Gulf Stream Road - - Turn right.
30.1	Barren Ridge to South STOP # 5 - -Rocks of the Chain Lakes massif with amphibolite and other clasts.
30.6	Pavements along road STOP #6 - - Rocks of the Chain Lakes massif with combination of "facies types". Retrace route to Jackman

An announcement will be made at STOP #6 about two optional stops to be added between Jackman and points south. If these stops are added we will regroup at the starting point (Attean View rest stop) at a time that will allow for refreshment and fuel in Jackman. The optional rod log is as follows:

0.0	Assembly Point (Attean View)
(10.8)	Scott Paper Company Appleton Road (unmarked) near the south end of Parlin Pond - - turn right.
(15.0)	STOP #7 - - Lower Devonian (undated) garnet porphyry of the Moose River synclinorium.
(18.6)	STOP #8 - - Rocks of the Attean batholith - - "gray facies".

End of Day #1, Trip A-4 - - retrace route and proceed south. Participants continuing on the second day of the trip may wish to follow the leaders (who are familiar with time/mileage-saving short cuts) to Stratton.

DAY #2
Saturday 10/14/89

TRIP B-4 ROAD LOG

Mileage

0.0 ASSEMBLY POINT 8:30 AM

Turnout southwest side of ME Rt. #27 about 500 feet northwest of access road to Natanis Point Campground.

Early arrivals and campers will enjoy the view to the southeast from Natanis Beach which displays a geologic transect from Lower Devonian (373 and 368 Ma) plutonic rocks intruding Helekian Chain Lakes diamictite, over Cambrian ophiolite and related rocks passing upward into Siluro-Devonian rocks as young as Gedinian intruded by Lower Devonian gabbro and granitic rocks. This transect has the additonal intrigue of being, in part, coincident with the MERQ/USGS Maine vibroseis/refraction geophyiscal line.

The leaders caution the participants that Rte. #27 presents us with special traffic dangers because of curves, narrow shoulders and traffic that mostly ignores speed limits. We have chosen turnouts with safety in mind, but still need your vigilance and care.

Stop locations can be identified on the (1) Chain-of-Ponds, (2) Jim Pond, and (3) Tim Mountain USGS 7.5-minute quadrangles; and (4) the Stratton 15-minute quadrangle. Quadrangle numbers are given in stop description.

1.0 STOP #1 - - Cliffs along east side of highway midway along Natanis Pond (1). Middle Devonian porphyritic granite of the Chain-of-Ponds pluton intruded by a Triassic(?) lamprophyre dike.

3.4 STOP #2 - - Cliffs on east side of highway opposite Bag Pond (1). Matrix-dominant massive granofels of the Chain Lakes diamictite about 1000 ft (300 m) from the contact with rocks of Stop 1.

4.8 STOP #3 - - Outcrops of east side of highway north of maintenance sheds near outlet of Lower Pond (1). Flecky gneiss of the Kibby Mountain facies of the Chain Lakes diamictite with abundant clasts.

6.3 STOP #4a - - Outcrop on east side of highway south of North Branch bridge (1). Massive, quartz clast variant of the Sarampus Falls facies which has been dated.

6.6 STOP #4b - - CLM (Sarampus Falls). Park Here.

Roadside and stream outcrops at Sarampus Falls Roadside Park (2). Typical Chain Lakes of diamictite facies, rheomorphic and partially layered showing anatectic leucosomes. The outcrop is northeast of a major zone of late brittle deformation.

8.8 STOP #5 - - Outcrops about 250 ft (75 m) east of highway, along indistinct fisherman's trail that leads to North Branch of the Dead River, opposite outlet of Viles Brook (2). Fault contact between Chain Lakes diamictite and ultramafic to epidiorite lens of the Boil Mountain ophiolite; includes, in part, a cumulate facies.

For STOP #6, see below (Optional)

10.1 STOP #7 - - Exploration pit (gold) about 100 ft (30 m) east of highway, at south intersection of a bypass road segment; about 1800 ft (550 m) north-northwest of Shadagee Falls (2). Cataclastic, altered trondhjemite of the ophiolitic Boil Mountain Complex.

Park between stops near Poison Pond

10.5 STOP #8- - Road cuts on both sides of highway; 600 ft (180 m) southeast of Poison Pond (2). Pillowed tholeiitic greenstone of the lower part of the Jim Pond Formation, where pillow facing direction is southeast.

Optional: Return to STOP #6 (Optional) *Special navigational instructions and map to be furnished.

Cliff and ravine escarpment 1000 ft (300 m) west-southwest of the south end of Blanchard Pond (2). Same as Stop 5, with well-displayed fault relationships and chromite cumulate layers.

14.9 Jct. ME Rte. #27/CCC Road (unmarked)

NOTE #1: The following stops (9 through 12) will not be visited, but navigational directions are given for those who would like to pursue additional details on their own within the rocks of the Chain Lakes massif, Boil Mountain ophiolite, and Jim Pond Formation.

0.0 [14.9] Jct., CCC Road (unmarked) and ME Rte. #27 - - Turn left (Reset mileage to 0.0)

0.3 [15.2] Cross-roads - - Keep left.

0.7 [15.6] Jct. Keep left.

3.3 [18.2] Jct. Keep left. - - Jim Pond road (unmarked)

4.2 [19.1] Jct. at bridge ruins -- Keep right.

7.6 [22.5] STOP #9 - - Knoll (el. about 1290 ft) east of North Branch of Dead River, azimuth 320°, 1000 ft (300 m) from outlet of Viles Brook (2). Tectonite within the Sarampus Falls facies of the Chain Lakes diamictite formed by transposition and cataclasis.

(Turn and return)

8.1 [23.0] STOP #10 - - Cliff east of North Branch, Dead River, 1100 ft (330 m), azimuth 115° from outlet of Viles Brook. Epidiorite autobreccia of the Boil Mountain ophiolite.

9.7 [24.6] STOP #11 - - Outcrops east of North Branch, Dead River, 800 ft (240 m) north of Chase Pond along abandoned logging road on the southwest flank of Chase Pond Mountain (2). Keratophyric volcaniclastic rocks of the Jim Pond Formation, including vent facies breccia.

11.7 [26.6] STOP #12 - - Hill (el. 1291 ft) east of North Branch Dead River, 1600 ft (480 m), azimuth 100° from outlet of Shallow Pond along abandoned logging road

(2). Virginite associated with diapiric serpentinite along faults in uppermost greenstone of the Jim Pond Formation.

(Return to ME Rte. #27)

15.2 [30.1] ME Rte. #27/CCC Road - - Keep left.

NOTE #2: The following stop (13) and a diversion of about one mile on Eustis Ridge Road to the overlook and a pavement outcrop of the Hurricane Mountain mélange (same rocks as STOP #14) may be made depending on time available or if weather does not allow the traverse to STOP #6. Continue mileage from STOP #8.

15.8 STOP #13 - - A. Roadside outcrop at benchmark 1190, 0.1 mi (0.16 km) north of Eustis village, near north bypass road intersection (4). Pelitic member of the Dead River Formation. B. Dam at Eustis village (4). Calcareous graywacke member of the Dead River Formation.

16.9 STOP #14 - - Gravel pits 1800 ft (540 m), azimuth 115 m from Welhern Pond, about 0.5 mi (0.8 km) southwest of Eustis village (4). Scaly carbonaceous, sulfidic melange of the Hurricane Mountain Formation.

18.4 Jct., Me Rte. #27/Eustis Ridge Road

(End of Day #2, Trip B-4)