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Geologic field report for the Scraggly Lake and Grand Lake Seboeis areas, north-central Maine: 1992 field update

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Geologic Field Report for the Scraggly Lake and Grand Lake Seboeis Areas, North-Central Maine: 1992 Field Update

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INTRODUCTION

Systematic, 1:24,000 scale geologic mapping of the Grand Lake Seboeis region in north-central Maine continued in the summer of 1992 as part of an ongoing project that started in 1990. The general lithostratigraphic units and structural geology in the region were outlined during the 1990 and 1991 field seasons, and these results have been previously summarized (Hibbard & Hall, 1992). During the summer of 1992, our field efforts addressed the following questions that arose as a result of our previous field mapping in the region:

- what is the northeastward extent and nature of the Millinocket Lake volcanic belt and what is its relationship to the Irleand Pond volcanics?
- what is the nature of a phyllite unit, originally assigned to the Ireland Pond volcanics and what implications does it have for the northern Maine 'gnarlstone' problem?
- what is the eastward extent and internal stratigraphy of the Silurian-Devonian Grand Lake Seboeis Group?
- what is the structure of the latest Silurian-Devonian Millimagassett Lake formation, that overlies all other strata in the region?

The following report summarizes the progress made in 1992 towards answering these questions and serves as an addendum to the more comprehensive report of 1992 (Hibbard & Hall, 1992). Most of the areas mapped in 1992 and reported on here lie within the Trout Brook Mtn., Millinocket Lake East, Grand Lake Seboeis, and LaPomkeag Lake NTS 7.5′ quadrangles.

EXTENT AND NATURE OF THE MILLINOCKET LAKE VOLCANIC BELT

The Millinocket Lake volcanic belt was first described by Hall (in Hibbard & Hall, 1992) as a belt of primarily mafic volcanic rocks and associated volcaniclastic rocks that extend along the south side of Millinocket Lake. During the 1992 field season, the belt was traced eastwards from Millinocket Lake to the area of Boody Pond

(Grand Lake Seboeis 7.5′ quad.) where it forks. The NE trending fork has been traced to the hills just east of Isthmus Pond, whereas the SE trending fork appears to extend continuously through the Jones Pond area, onward through the area northeast of Sawtelle Pond, and may well link up with volcanic rocks previously mapped in The Narrows of Grand Lake Seboeis (Hibbard & Hall, 1992). The assignment of all of these volcanic rocks to the Millinocket Lake volcanic belt is based mainly on the apparent continuity of the volcanic rocks across the area.

Volcanic rocks between Jones Pond and The Narrows on Grand Lake Seboeis were originally included in the Grand Lake Seboeis Group (Hibbard & Hall, 1992). These volcanics formed the bulk of the volcanic rocks described as Grand Lake Seboeis Group volcanics in our 1992 report. Our 1992 mapping has forced us to reconsider this assessment; on the basis of their continuity with the Millinocket Lake volcanic belt, these volcanics are tentatively assigned herein to that belt.

In the area between Millinocket Stream and Boody Pond, the belt is predominantly characterized by mafic pillow lava and associated volcaniclastics. However, to the east of Boody Pond, both of the forks of the belt contain basalts intermixed with subordinate intermediate and probable dacitic volcanic rocks (field classification). S. Hall (in Hibbard & Hall, 1992) has reported a similar compositional variation in the area south of Millinocket Lake, where more felsic compositions are encountered in the belt towards its southeast flank. It is possible that the more intermediate- and felsic-bearing volcanic sections constitute a unit distinct from the dominantly basaltic sections; however, no significant structural or stratigraphic breaks have been recognized in the belt to date.

During the 1992 field season we found that the Millinocket Lake belt volcanics and volcaniclastics are closely associated with phyllitic rocks. The phyllites are structurally more complex than the volcanics, for their phyllitic cleavage predates a tectonic foliation common to all rocks in the belt. In most cases, the phyllites are found immediately at the periphery of the volcanic belt (see Boody Pond phyllite below), although in a few cases, they are interlayered with the volcanic rocks. For example, on the hilltop immediately to the southeast of Jones Pond, a light green-gray tuffaceous phyllite with local lappilli is interlayered with medium green-gray intermediate to dacitic pillow lavas with individual pillows up to ~1m in diameter. Other examples of the phyllite/volcanic rock relationships are given below with descriptions of the phyllite.

The Millinocket Lake volcanic belt has previously been considered equivalent to the Ireland Pond volcanics, which outcrop to the south of Millimagassett Lake (Hibbard & Hall, 1992). These two volcanic-dominated belts have similarities and differences. Features common to both belts include i) both are dominated by pillow lava, with dark green to medium gray chert as the most common interpillow material, ii) both belts are associated with varicolored phyllites, iii) both belts display heterogeneous deformation and record an early deformation generally not found in the Grand Lake Seboeis Group and the Millimagassett Lake formation, and iv) in most places, both belts structurally underlie the Grand Lake Seboeis Group and in almost all places where the volcanics are in contact with the group, Grand Lake Seboeis strata young away from the contact. Features that distinguish the belts from each other include i) the Ireland Pond volcanics appear to be compositionally bimodal, predominantly composed of mafic volcanics with a subordinate volume of white-grey felsic tuffs, whereas the Millinocket Lake volcanics, although mainly mafic, display a compositional gradation through intermediate to dacitic volcanics, ii) phyllites associated with the Ireland Pond volcanics are mainly dark green, chloritic rocks, whereas those in the Millinocket Lake belt are commonly varicolored (light green, gray, purple, red, etc.), and iii) the Ireland Pond felsic volcanics are associated with a granitoid rock not found in the Millinocket Lake belt.

The stratigraphic relationship between the two volcanic belts remains moot; they may represent either a single, internally variable, volcanic belt or two distinct belts. The sum of the evidence to date, in particular, the structural position of both belts with respect to the Grand Lake Seboeis Group, weighs in favor of the two belts representing a single belt with internal variations. The structural position of the volcanics beneath the Grand Lake Seboies Group suggests that the group was deposited on or tectonically emplaced atop a single volcanic terrane, now represented by the Ireland Pond and Millinocket Lake belts. In the near future, we intend to undertake a petrochemical study of the volcanics of both belts in order to help resolve this issue.

THE BOODY POND PHYLLITE

Formerly termed the 'Varicolored slate' unit (Hibbard & Hall, 1992), a distinct varicolored slate to phyllite unit that outcrops in the area of Jones Pond, Boody Pond, and Grand Lake Seboeis is herein informally termed the Boody Pond phyllite. In most places, the unit displays a faint to strong satiny sheen on cleavage surfaces, hence the change in nomenclature from slate to phyllite. Very locally, the phyllite contains thin beds of quartz-sandstone-siltstone.

In addition to the Boody Pond area, the unit has been mapped during the present study along Millinocket Stream near Round Pond, in the area northeast of Sawtelle Pond, just north of Wadleigh Brook Lower Deadwater, and by the Libby Camp at Aroostook Forks. Similar phyllites have been mapped by Hall (in Hibbard & Hall, 1992) along the south side of Millinocket Lake. Similar, although dominantly chloritic green phyllites, have also been mapped at Beaver Pond and in many places in the Ireland Pond volcanics (Hibbard & Hall, 1992).

Rocks here included in the Boody Pond phyllite were originally included with the Ireland Pond volcanics on the basis of i) the similarity in structural histories of the Boody Pond phyllite with the chloritic phyllite in the volcanics and ii) the apparent on strike continuity of the Millinocket Lake belt volcanics with the phyllite. With further mapping in the 1992 season, it is now recognized that the volcanic outcrop belt bifurcates around the phyllite unit. However, new observations indicate a close relationship between the phyllite and volcanic belt.

The Boody Pond phyllite outcrops at the periphery of the Millinocket Lake belt in the Boody Pond-Sawtelle Pond areas and along Millinocket Stream. The relationship between the units is revealed at two locales; the contact is also exposed on Millinocket Stream, but its nature is equivocal, here. On the hill just east of Jones Pond, finely layered chloritic phyllite contains bomb-sized pillow fragments of purple vesicular intermediate-basaltic vocanic rock, indicating a depositional relationship between the volcanics and the phyllite protolith. Carbonaceous black and gray Boody Pond phyllite outcrops at the base of the hill. In the area just east of Sawtelle Pond, chloritic purple and green phyllite contains deformed mafic volcanic pebbles and cobbles and outcrop within a few meters of massive purple and blue-green basalt here assigned to the Millinocket Lake belt. Southwest of this outcrop, purple and red phyllite outcrops alternate with outcrops of basalt, with an increase in phyllite towards Sawtelle Pond. Again, the observed relationships indicate a depositional relationship between the volcanics and the phyllite protolith. At Millinocket Stream, between 0.25 and 0.5 miles from the outlet of Round Pond, light olive phyllite is interlayered with Millinocket Lake belt volcanics; here an approximately 5 m section of greenstone is bounded by olive phyllite. Downstream from this contact, the phyllite is more varicolored, ranging from olive to light green to dark burgundy and purple. The nature of the contact between the greenstone is not clear due to the strong foliation in the phyllite. The slates appear to contain knots of greenstone a few cms. across; these knots may be clasts in tuffaceous phyllite or represent clasts within a shear zone in the phyllite. Future work will address this problem.

From the observations noted above, the Millinocket Lake volcanics are closely associated with the phyllite unit; two of the three observed contact areas indicate that the phyllite is in depositional contact with the volcanic belt. Thus, the original assessment that the phyllite is associated with the volcanic belt is upheld. However, it is not clear if the volcanic belt is correlative with the Ireland Pond volcanics (see above).

THE 'GNARLSTONE' PROBLEM

In general, all phyllitic rocks in the region are structurally more complex than surrounding rocks, as the phyllitic cleavage predates the dominant northeast-trending Acadian cleavage (see structure in Hibbard & Hall, 1992). This structural complexity led R. Neuman (mapped adjacent Shin Pond 15' quadrangle, 1967, and initiated reconaissance mapping in present area) to term the phyllite 'gnarlstone' (R. Neuman, pers. comm., 1990).

A controversy, here termed the 'gnarlstone problem', has arisen over the significance of the phyllite in the area. In essence, the 'gnarlstone problem' is concerned with whether all of the phyllites in the area (Boody Pond, those in the Ireland Pond assemblage, and Saddle Pond units of Hibbard & Hall, 1992) represent a single pre-Middle Ordovician substrate to other strata in the area or if they represent heterogeneously deformed portions of mid-Paleozoic stratigraphic units.

R. Neuman has suggested that all of the 'gnarlstone' may represent a unit that records a pre-Acadian, Cambrian-Lower Ordovician Penobscottian fabric and thus, is equivalent to the Grand Pitch formation of the Lunksoos anticlinorium, to the southeast of the present area. Indeed, some of the phyllite in the area sporadically contains thin layers of quartz-rich sandstone, such as in the quarry just north of Boody Pond; this feature is reminiscent of finer-grained portions of the Grand Pitch formation. This characteristic tends to support a correlation of the 'gnarlstone' with the early Paleozoic Grand Pitch formation.

However, in contrast to this view we have been shown that phyllites in the Saddle Pond area are continuous with less deformed volcanics containing Late Silurian-Early Devonian faunas; thus these phyllites represent the effects of heterogeneous, or partitioned, deformation of a middle Paleozoic succession. Likewise, the observations made during 1992 tend to confirm that the complexly deformed Boody Pond phyllite is stratigraphically related to the more simply deformed volcanic rocks of the Millinocket Lake belt. Also, it has been shown in previous years that chloritic phyllite is commonly interleaved with volcanics of the Ireland Pond assemblage. Neither the Millinocket Lake belt nor the Ireland Pond assemblage have equivalents within the Grand Pitch formation, and both are likely Silurian in age (Hibbard & Hall, 1992). Thus, it appears that much of the gnarlstone in the Grand Lake Seboeis region represents more deformed portions of the mid-Paleozoic units in the area.

However, in the absence of stratigraphic relationships such as those outlined above, the nature of isolated units of phyllite remains moot. For example, the phyllites at Aroostook Forks and those to the southeast of Grand Lake Seboeis may represent either isolated inliers or tectonic lozenges of early Paleozoic rock or more deformed portions of younger, middle Paleozoic units.

EXTENT AND INTERNAL STRATIGRAPHY OF THE GRAND LAKE SEBOEIS GROUP

During the 1992 field season, the Grand Lake Seboeis Group (Hibbard & Hall, 1992) was extended into two areas, one northeast of Millinocket Lake and the other to the east of Grand Lake Seboeis. Other areas of the group previously mapped in reconnaissance on the west side of Grand Lake Seboeis were 'filled in' by continued mapping.

Northeast of Millinocket Lake, the Grand Lake Seboeis Group forms two outcrop belts on either side of the Moosehorn syncline (defined by Millimagassett Lake strata; see below). Only a few outcrops were observed in each belt; however the rocks observed were diagnostic of the group and fossil determinations support the field assessment that the rocks are part of the group. On the north side of the syncline, a few exposures of the group were observed on Millinocket Stream in the vicinity of Devil's Elbow. Here, red boulder conglomerate lies between outcrops of rhyolitic volcanics. The boulder conglomerate contains a preponderance of flow banded red-purple rhyolite clasts. South of the conglomerate is a dark wine red rhyolitic lithic (?) tuff that is moderately cleaved and locally contains clasts of reddish siltstone. To the north of the conglomerate lies a gray to purple-red fragmental rhyolite with local quartz phenocrysts. Limited stratigraphic younging indicators suggest that the Devil's Elbow section is facing northwards, away from the Millimagassett Lake formation in the core of the syncline. Because previous mapping has shown that the formation overlies the group, it is likely that the Grand Lake Seboeis rocks at Devil's Elbow are faulted against the Millimagassett Lake formation.

Grand Lake Seboeis Group rocks on the south limb of the Moosehorn syncline form an outcrop belt generally less than 0.5 km wide and are confined between the Millimagassett Lake formation and rocks of the Millinocket Lake belt. Stratigraphic younging indicators within the group indicate that it overlies the Millinocket Lake belt rocks and underlies the Millimagassett Lake formation. The group, here, consists of red conglomerate and sandstone, purple fine-grained, calcareous sandstone, gray slate, calcareous slate, calcareous turbidites, mafic epiclastic breccias and minor mafic volcanics at the south end of the syncline. It appears that the conglomerate forms the base of the sequence whereas the calcareous slate occurs in the upper portions of the belt. Two new fossil localities were found in this portion of the group and indicate a Silurian age for the strata. Specifically, sample SC-8 from a calcareous lens in purple sandstone has yielded an upper Llandovery-Pridoli age fauna (A. Boucot, pers. comm., 1992) and sample SC-9 from calcareous slate has yielded a nonspecific Silurian fauna (A. Boucot, pers. comm., 1993).

In the area just to the southeast of Moosehorn syncline and to the east of the Boody Pond phyllite, red conglomerate and sandstone form extensive outcrops on the hills bordering Dead Brook. The conglomerate is very similar to that described from Devil's Elbow (above) and other portions of the Grand Lake Seboeis Group. On the hillside just south of Dead Brook, the conglomerate is associated with a dark red rhyolitic tuff very similar to that found at Devil's Elbow. A sparse chonetid fauna was collected from sandstone associated with the conglomerate (sample SC-12) and has yielded a nonspecific Silurian age (A. Boucot, pers. comm., 1993).

In the area east of Grand Lake Seboeis and to the west of Cut Lake, preliminary mapping has revealed what appears to be a transition zone between the Grand Lake Seboeis Group and the overlying Millimagassett Lake formation. The top of the group in this area consists of fossiliferous quartz-grit slate, gray slate, dacitic to intermediate epiclastic rocks with angular plagioclase grains, and slaty boulder conglomerate with clasts of intermediate-felsic volcanics and quartzite. These strata grade up into gray slate and alternating beds of gray slate and cinammon-colored fine-grained sandstone, typical of the Millimagassett Lake formation. Brachiopods from the gritty slate (sample SC-28) indicate a nonspecific Silurian age for the section (A. Boucot, pers. comm., 1993).

During the 1992 field season, we recollected fossils from a locality first found by R. Neuman on the northern part of Scraggly Lake (Neuman, 1967), in rocks we have assigned to the Scraggly Lake sandstone of the Grand Lake Seboeis group (Hibbard & Hall, 1992). The sample, SC-27, has yielded a late Silurian fauna, comparable to that reported by Neuman (1967) (A. Boucot, pers. comm., 1993).

In addition, continued mapping of the group in the area of Scraggly Lake has revealed a link between the Ireland Pond assemblage and the group. Red conglomerate approximately 0.4 km south of the western tip of Scraggly Lake contains a boulder of distinct, intermediate pyroxene tuff, with altered pyroxene crystals up to 2 cm across. This rock is lithically identical to a pyroxene tuff that forms a stratigraphic member of the Millinocket Lake volcanic belt (S. Hall, pers. comm., 1992). Thus, a portion of the volcanic belt was probably exposed and eroded before depostion of the Grand Lake Seboeis Group. This supports our previous contention that the group is likely unconformable on the volcanics (Hibbard & Hall, 1992).

As noted in a previous report (Hibbard & Hall, 1992), the Grand Lake Seboeis group is very heterogeneous and lacking a laterally continuous stratigraphy. In order to summarize the known stratigraphy to date, I have compiled a highly schematic chart that depicts the general stratigraphy of the group as we know it from different areas in the region (Figure 1). It is stressed that this figure is based on scant stratigraphic younging indicators and sparse data in most of the areas, and thus, should be considered tenuous at this time.

STRUCTURE OF THE MILLIMAGASSETT LAKE FORMATION

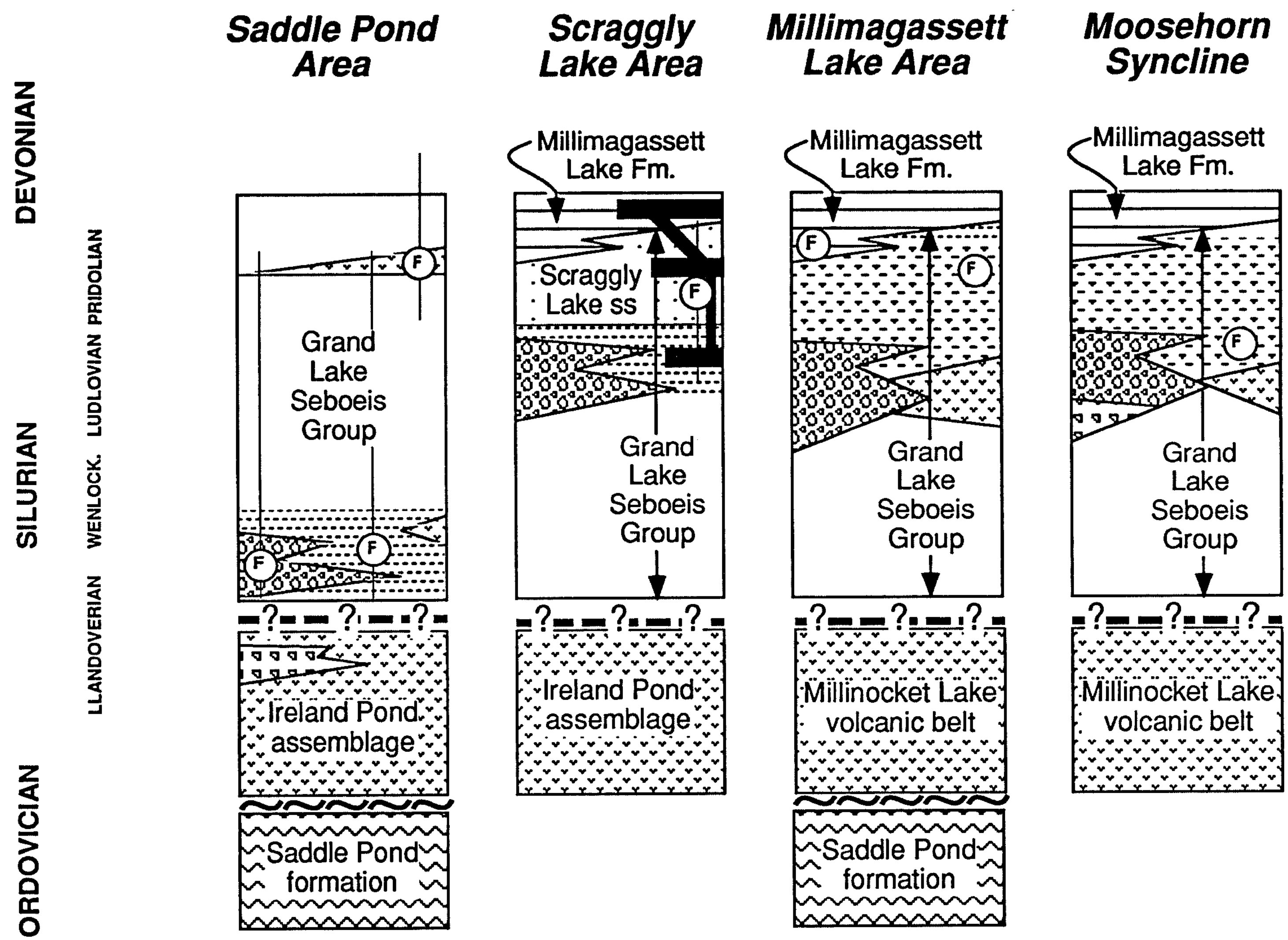
The latest Silurian-Devonian Millimagassett Lake formation forms the youngest stratified unit in the region and has been correlated with the Seboomook Group of northern Maine (Hibbard & Hall, 1992). In the Grand Lake Seboeis region, the Millimagassett Lake formation preserves the oldest known Seboomook strata in northern Maine. In 1992, we recollected a fossil locale discovered in 1991 at the base of the Millimagassett Lake formation in the area between Millimagassett Lake and Sawtelle Pond. Sample SB-44 has yielded a Ludlovian-Pridolian, more likely Pridolian, brachiopod and coral fauna (A. Boucot, pers. comm., 1992; W. Oliver, pers. comm., 1992).

The fomation is generally comprised of monotonous slate-sandstone interbeds that are commonly well-bedded and contain primary stratigraphic younging indicators. As such, the Millimagassett Lake formation is one of the best units in which to deduce the regional folding pattern. During the 1992 season, we mapped out the formation in three general areas, including the area around the Mountain Catcher Ponds (south of Scraggly Lake), the area around Moosehorn Crossing, and in the area of Lost Pond, in order to help elucidate the regional structure.

In the area of the Mountain Catcher Ponds, the Millimagassett Lake formation is intruded by a pair of granitic sills; the larger, more northerly sill extends from the area of Mountain Catcher Pond to Scraggly Lake. The formation is deformed into upright folds with subhorizontal axes trending approximately 245° (Figure 2). More data is needed to assess the symmetry of these folds. The regional post-Early Devonian, classic Acadian cleavage transects these folds anticlockwise by approximately 25°.

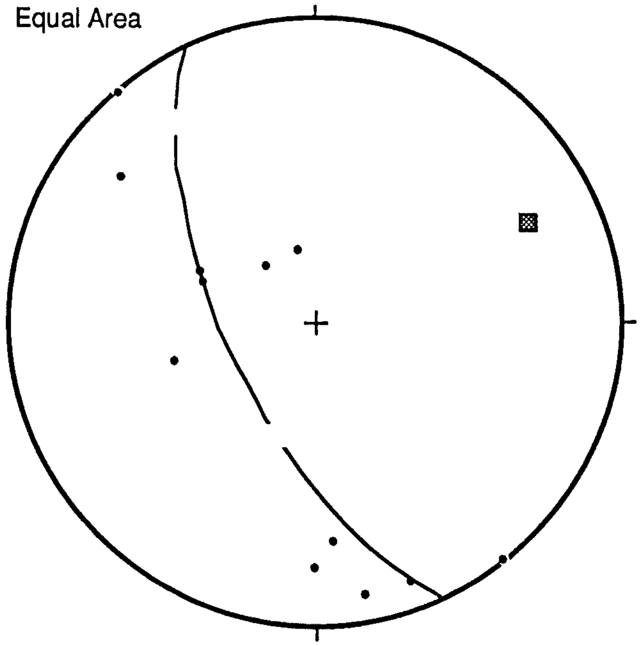
In the area of Moosehorn Crossing, the Millimagassett formation is deformed into a tight, subhorizontal, syncline that appears, from limited data, to be asymmetric. The fold has a steeply north-dipping to vertical southerly limb and a more moderately south-dipping northerly limb. The syncline plunges 24° in a 065° direction (Figure 2). The regional, classic Acadian cleavage transects the fold by approximately 20°.

The orientation of both of these folds, their imprinting upon Silurian-Devonian strata, and the transection of these folds by the regional, post-Early Devonian, classic Acadian cleavage all indicate that the folds represent the 'early Acadian' deformation phase in this area (Hibbard & Hall, 1992, 1993). The early stage Acadian

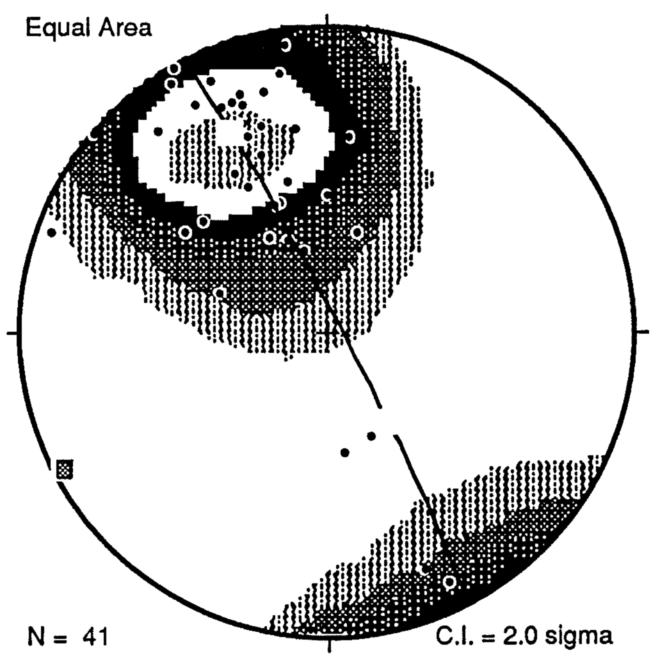


DEVONIAN
SILURIAN
ORDOVICIAN
LLANDOVERIAN WENLOCK. LUDLOVIAN PRIDOLIAN
Saddle Pond Area
Scraggly Lake Area
Millimagassett Lake Area
Moosehorn Syncline
Millimagassett Lake Fm.
Scraggly Lake ss
Grand Lake Seboeis Group
Ireland Pond assemblage
Millinocket Lake volcanic belt
Saddle Pond formation
F
?

Figure 1



POLES TO BEDDING (12)
MOOSEHORN SYNCLINE



POLES TO BEDDING
MOUNTAIN CATCHER POND AREA

Figure 2

deformation has been linked to inhomogeneous sinistral shear during late Silurian times (Hibbard & Hall, 1992, 1993). Thus, these folds indicate that early Acadian sinistral shear is more widespread in the region than previously known.

To the east of Grand Lake Seboeis, in the area of Lost Pond, preliminary mapping has outlined an apparent homocline of Millimagassett Lake strata. The strata appear to lie between outcrop areas of Grand Lake Seboeis group rocks and should prove significant in helping to resolve the structure of this area.

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