STRATIGRAPHY AND STRUCTURE OF THE ROACH RIVER SYNCLINE, PISCATAQUIS COUNTY, MAINE

by

EDWARD W. HEATH

Geological Engineer, Colorado School of Mines

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Signature of Author ______________________
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Certified by ______________________
Thesis Supervisor

Accepted by ______________________
Chairman, Departmental Committee on Graduate Students

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Submitted to the Department of Geology and Geophysics on May 25, 1959, in partial fulfillment of the requirements for the degree of Master of Science.

ABSTRACT

This thesis describes the stratigraphy and structure of the Roach River syncline, in northwest Maine. The syncline lies southeast of and parallel to the Moose River synclinorium. Physiographically the region is part of the New England Upland; geologically it belongs to the northern Appalachians. The thesis area includes parts of the Ragged Lake, North East Carry, Moosehead Lake, and First Roach Pond quadrangles.

Strongly folded Lower Paleozoic rocks are exposed in the area, and fossils of Silurian and Early Devonian age have been found in them. These stratified rocks have a composite thickness of 26,000 feet. The oldest units of Cambrian (?) or Ordovician (?) age includes slates, dark-colored quartzites, phyllites, and carbonate rocks, as well as diorite and diabase in intrusive bodies.

During the Taconic orogeny, the area was deformed and eroded. Silurian and younger strata were then laid down in a subsiding area, the earliest deposits of Silurian age being red conglomerate of terrestrial origin. These grade upward into carbonate-rich sequences of slate, silt, sandstone, limestone, and quartzite. Their limited lateral extent combined with the difficulties in correlating them suggest that these beds are the product of erratic shallow marine deposition marked by contemporaneous erosion and adjacent sedimentation.

Unconformably overlying strata of Silurian age are cyclically banded slate and argillaceous sandstone, thick sequences of dark gray slate and sandstone, and varicolored siltstone. These lithologies of Lower Devonian age are assigned to formations with complex lateral facies relationships. They represent relatively shallow and deep marine sediments of contemporaneous deposition, the coarser-grained sandstone and siltstone having been deposited in marginal zones, the fine-grained slate in deeper zones.

Igneous activity, represented by rhyolitic rocks associated with flows, sills, dikes, and stocks, plus "trachytes" associated with a sill, marks the close of Lower Devonian time. The area was then affected by a second period of deformation, the Acadian orogeny.

The dominant structural features within the area studied include the doubly plunging Roach River syncline flanked on the northwest by the northeast-plunging Lobster Mountain anticline and on the east by the northwest-plunging Caribou Lake anticline. One relatively large northeast-trending fault cuts the Caribou Lake anticline and terminates in the Roach River syncline. A maximum net slip of approximately 14,000 feet, essentially all of which is strike slip, has been estimated from map and geometric data. Minor faulting and such secondary structural features as slaty cleavage, drag folds, tension fractures, and deformed fossils are found in the area.

The rocks of the Roach River area contain no known materials of commercial value. Locally there are some metallic minerals, chiefly associated with the igneous intrusions of Cambrian (?) or Ordovician (?) age. The Pleistocene glacial deposits which blanket the area could be used for road metal. The area is not favorable for the formation or accumulation of fuels.

Thesis Supervisor: Arthur J. Boucot
Title: Associate Professor of Geology

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II. INTRODUCTION

Brief geological summary - This report deals with the geology of an area in northern Maine (Figure 1) about which little has previously been known. The geological features encountered include a stratigraphy marked by lateral facies changes as well as unconformities; two periods of tectonism that have produced tight folding, cleavage, and low grade metamorphism; faulting; and at least three episodes of igneous activity that have yielded dikes, sills, stocks, and one volcanic body. Strata representing Cambrian (?) or Ordovician (?) through Lower Devonian time have been deposited in terrestrial, paralic, and marine environments. Three predominant geologic features in the area are, from west to east, the Lobster Mountain anticline, the Roach River syncline, and the Caribou Lake anticline.

Purpose and scope of investigation - A study of the area was initiated at the suggestion of Dr. Arthur J. Boucot while the writer was a student in the Department of Geology and Geophysics, Massachusetts Institute of Technology. The initial purpose of the study was to determine the structure and stratigraphy of Paleozoic sediments lying west of the Harrington Lake quadrangle and east of the Lobster Mountains (North East Carry quadrangle). Field work was done during the summer of 1958, when some 14 weeks were spent collecting data. As the mapping progressed, it became necessary to extend the areal coverage in attempting to integrate various geological phenomena, such as facies complications and the large number of igneous units that were encountered. Therefore, the study developed essentially into one of reconnaissance rather than one of detailed mapping restricted to a limited area.

To facilitate a more thorough understanding of the stratigraphy and structure of northwestern Maine, several field trips were taken into either previously mapped or better known areas. These included portions of (Figure 1) the Brassua Lake quadrangle, mapped by Boucot (in preparation, A); the Harrington Lake quadrangle, mapped by Griscom (thesis in preparation); and the Greenville quadrangle, presently being mapped by Dr. Gilbert Espenshade of the United States Geological Survey. Fossils, which were collected from several localities within the Roach River syncline, have been identified by Dr. Boucot. Samples of sedimentary and igneous rocks were collected for laboratory study.

The result of this study is a thesis concerning the structural geology and stratigraphy of the Roach River syncline and adjacent areas, plus a limited amount of information concerning the mineralogy and petrology of the rocks.

Location and accessibility - The area included within this thesis is in western Piscataquis County, north-central Maine. Physiographically this area is part of the New England Upland; geologically it belongs to the northern Appalachians. Most of the area is in the Ragged Lake quadrangle, though portions of the Moosehead Lake, North East Carry, and First Roach Pond quadrangles are also included. The area is bounded to the south by the Roach River (First Roach Pond quadrangle), to the west by the Lobster Mountains (North East Carry quadrangle) and Big Spencer Lake (Moosehead Lake quadrangle), to the north by a line running from the outlet of Lobster Lake (North East Carry quadrangle) through Deer Pond (Ragged Lake quadrangle), and to the east by the boundary between the Ragged Lake and Harrington Lake

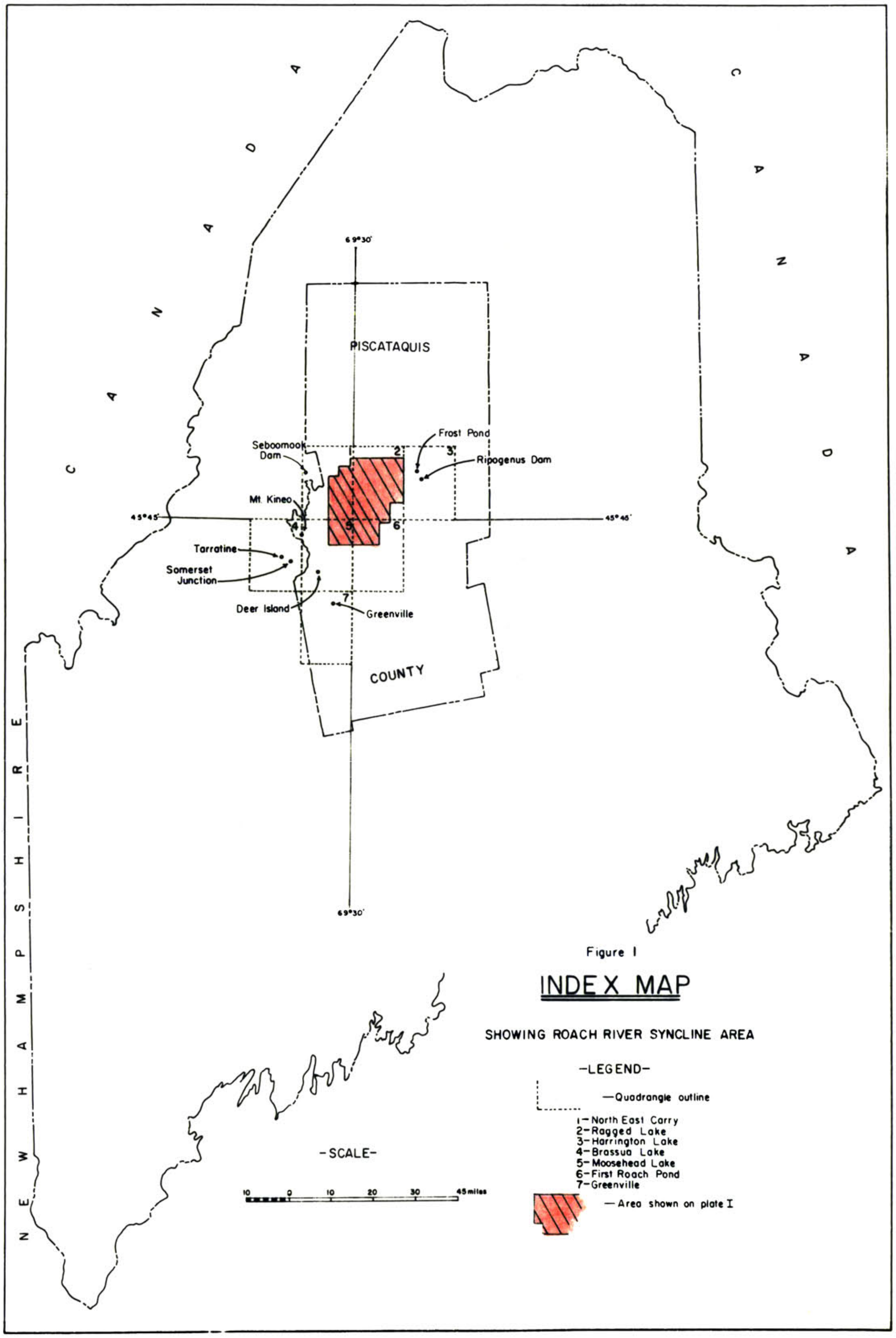

Figure I

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SHOWING ROACH RIVER SYNCLINE AREA

quadrangles. This includes roughly 180 square miles. Portions of this area have not been traversed; consequently conclusions involving these areas are the result of projection from better known areas. Additional data for some surrounding areas were provided by Boucot (in preparation, A).

Access to the area is limited. A partly paved road extends north from Greenville (25 miles south of the region) to Kokadjo (First Roach Pond quadrangle). Between Kokadjo and Ripogenus Dam (Harrington Lake quadrangle) the Great Northern Paper Company maintains a gravel road. Branching from this road near Bear Creek (Ragged Lake quadrangle) is a gravel road bearing west-northwest which serves the fire tower on Big Spencer Mountain. This road is passable to within one and one-half miles of Kidney Brook (North East Carry quadrangle). From here a four-wheel-drive jeep can travel south to within one-half mile of Kidney Pond by way of a logging road. In the northern portion of the area a gravel road is maintained to a group of camps at North East Carry on Moosehead Lake. This same road allows access to the Penobscot River where boats may be launched. Other than these few roads, the only access is by foot, canoe, or pontoon-equipped airplane.

Method of investigation - Mapping was done on U. S. Geological Survey topographic maps, which were adequate for most features but in places were unreliable in detail.

The topography, climate, and difficulty of access contribute to the difficulty in doing field work. Thick woods cover the entire area, making necessary a continuous compass and pace traverse whenever away from roads or lake shores. In places, pulp-wood cuttings and blow-downs render traversing difficult. The use of an aneroid proved helpful, particularly where slope steepness or unusually thick vegetation resulted in inconsistent pacing. The aneroid had to be relied on with discretion, however, due to sparse bench mark distribution for elevation control plus changeable weather conditions affecting atmospheric pressures.

As a rule the best outcrops are found along the shores of some of the larger lakes. Most of the smaller ponds had no exposures. An unusually wet summer in 1958 kept water in the lakes at a high level, and many outcrops that would have been exposed were under water. Lake shore geology was performed by canoe. The slopes of hills and the intervening flats are covered with a veneer of glacial drift which conceals the bedrock, but in places streams and gullies penetrate this drift and expose the underlying rock. Outcrops are also found along crests of ridges.

Roads and old logging trails sometimes offer exposures. A four-wheel-drive jeep was used in traveling these roads, some of which were inaccessible with conventional vehicles. More remote areas which could not be reached by water necessitate carrying camping gear by back-pack on foot. On one occasion, a pontoon-equipped airplane provided transportation to and from Big Spencer Lake for the writer and his assistant.

Data collected on stream and cross-country traverses were plotted on 15 minute quadrangle sheets, using elevations obtained with the aneroid, pace counts, and the bearings of the traverses. Information collected on lake shore traverses was plotted directly on a base map.

Previous geologic studies - Prior to this report, very little was known about the geology of the Roach River syncline area. In his compilation of the geology of Maine, Toppan (1932) mentions the rhyolites of Big Spencer and Lobster Mountains, as well as an occurrence of Silurian rocks which he placed within the Lobster Lake and Ripogenus series. E.S.C. Smith (1933) described the rhyolites of Big Spencer Mountain and gave a chemical analysis for them. Keith (1933) prepared a generalized geologic map of Maine. Willard (1945) established the age of Silurian fossils collected at Ripogenus Dam. Boucot (in preparation, A and B) describes the structure and stratigraphy of adjacent areas to the south and east as well as that of several localities within the area covered by this report. Griscom (thesis in preparation) has mapped the geology of the adjacent Harrington Lake quadrangle.

III. ACKNOWLEDGMENTS

Dr. Arthur J. Boucot first suggested the problem, spent six days in the field with the writer, identified the fossils collected, spent many hours editing the manuscript, and provided an untold amount of helpful criticism and encouragement. The writer is deeply grateful to Dr. Boucot, without whose guidance and interest this project could not have been accomplished.

Dr. William F. Brace spent one day in the field with the writer, helping significantly with several structural problems, and read and criticized the chapter dealing with structural geology. His assistance greatly facilitated the interpretation of the complex structure of the region, for which the writer is appreciative.

Particular recognition must be given Mr. Peter Clark, who assisted the writer through the duration of the field work. He worked and lived under difficult conditions without complaint, and many thanks are due for his able assistance in gathering field observations.

The Great Northern Paper Company, Bangor, Maine, greatly facilitated the field work by allowing unrestricted access to their woodlands and placing their facilities at Grant Farm at our disposal.

IV. GEOGRAPHY

Relief - The area is dominated by two isolated mountains, around which are found rolling hills coupled with low-lying, relatively flat regions. The few linear features that can be deciphered trend northeast-southeast in the southwestern portion of the area and northwest-southeast in the northeastern portion. The relief of the rolling hills ranges between 500 and 1,100 feet, and the isolated mountains are about 2,000 feet high. The northern slopes of these features are relatively gentle, but the south slopes are precipitous in many places.

The trends of the topography and drainage in this region are controlled largely by the parallel fold axes and the attitude of bedding planes. However, these trends are partly obscured by the occurrence of a large number of randomly-distributed igneous rocks and by the fact that the plunges of the structural features give rise to reversals in bedding attitudes. The two isolated mountains and the larger surrounding hills are composed of resistant igneous rocks. The more massive sandstones, particularly those of the Tarratine formation, form knolls and ridges, the slates with which they are interbedded being much less resistant to weathering. Slates and siltstones predominate in those areas which are topographically low lying and flat, as well as those covered by the larger lakes and swamps.

The numerous lakes and swamps appear to be closely related to the glacial debris that blankets the region. This debris appears to have formed natural dams at the outlet of many of the lakes. Some of the swamps were originally ponds which have since silted up, incorporating a large amount of organic debris. Several ponds have been observed to be in the process of filling with fine debris, resulting in their being quite shallow and stagnant. In places the margins of these ponds are quaking bogs.

Drainage - Little can be said concerning the drainage pattern in this region, as the streams appear to form a more or less random pattern. Around the larger, isolated topographic features there is some indication of local radial drainage; away from these the pattern is more or less dendritic. Lakes and swamps, which cover about 20 percent of the area, play a very important role in the drainage system. The northern portion of the region is drained by the West Branch of the Penobscot River by way of Lobster Lake, Pine Stream flowage, Ragged Lake, Caribou Lake and Chesuncook Lake. A rough drainage divide may be drawn from Siras Hill (First Roach Pond quadrangle) west to Little Spencer Mountain. South of this divide the area drains into Moosehead Lake by way of the Spencer Lakes and the Roach River.

Climate and vegetation - This portion of northern Maine is characterized by a relatively damp climate. During the winter months heavy snows blanket the region, restricting field work to the summer season. Rainfall during the summer months varies from year to year. More than three-fifths of the 1958 field season consisted of rainy days. This dampness is reflected by the large number of swamps, which compound the difficulty in negotiating the terrain.

The lush vegetation also reflects the high annual rainfall. The low, flat, swampy areas abound with thick alder and cedar thickets, as well as with heavy undergrowth of grasses and bushes. Slopes of hills are normally covered with a veneer of glacial debris, which supports hardwood and pine trees plus the usual undergrowth. Ridge crests and mountain tops are studded with vegetation which varies with the underlying bedrock. The igneous mountains with a thin soil mantle support only dwarfed, very densely spaced pine trees, locally called "black growth". To traverse this thick growth often necessitates crawling over or under it. Pine and hardwood trees are found on the ridges underlain by sedimentary rocks, but these trees are often broken by the weight of ice or snow or are blown over by winds.

V. STRATIGRAPHY

General

Most of the bedrock exposed in the Roach River area consists of consolidated sedimentary rocks. Such rocks also underlie the Pleistocene gravels found along the limbs of topographic highs as well as in many low areas. Intrusive igneous rocks occupy a surprisingly large area, and extrusive rocks are found in at least two localities.

The stratified rocks of the region are of Lower Paleozoic age and represent the Cambrian (?) through the Lower Devonian. The total thickness of the Paleozoic rocks is roughly 26,000 feet, of which the pre-Silurian strata comprise perhaps 10,000 feet, the Silurian 4,000 feet, and the Lower Devonian 12,000 feet. Marine invertebrate fossils have been found in the rocks of Silurian and Devonian age.

Changing geographic conditions prevailed during deposition of the stratified rocks. The Cambrian (?) or Ordovician (?) unit includes slates, phyllites, intrusive rocks, dark colored sandstones, and minor limestones. Too little is known of the age and structural relations of these various lithologies at the present time to attempt subdivision of this unit.

The rocks above the pre-Silurian were laid down in a subsiding area. The lowermost beds of Silurian age consist of reddish conglomerates and coarse sandstones which reflect a terrestrial or near-shore environment. These comprise the Big Claw member along the west flank of the Roach River syncline and the base of the Ripogenus formation along the east flank. The conglomerates grade upward into dark colored sandstones and carbonate-rich siltstones which presumably reflect paralic conditions. These in turn grade upwards into shallow marine sediments of the Lobster Lake and Ripogenus formations which are dominated by argillaceous limestones, quartzitic sandstones, limestone conglomerates, arenaceous limestones, and limy slates. It is difficult to correlate beds of this age across the Roach River syncline as well as along strike.

Devonian rocks exposed in this region are contained in the Seboomook formation, the Roach River formation, and the Tarratine formation (of which the Misery member is a part). These units show abrupt lateral facies changes (Figure 2). The Roach River formation is made up of brown and

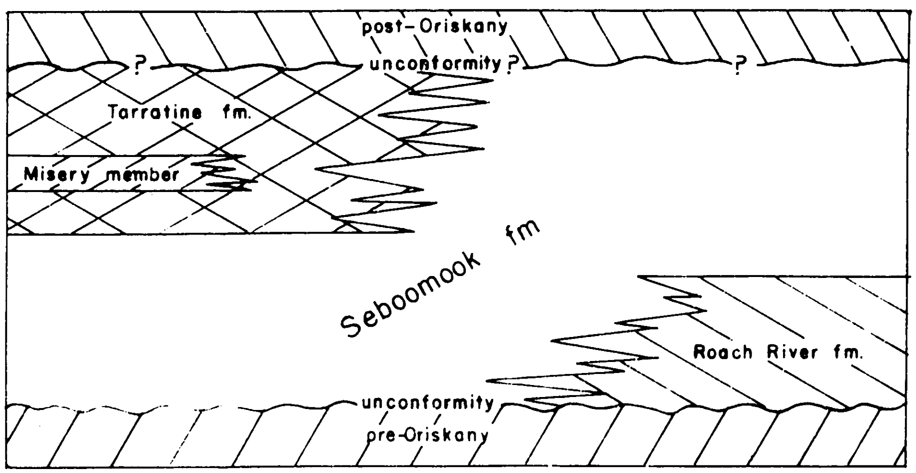

Figure 2 - Schematic diagram of stratigraphic relationships between formations of Devonian age.

maroon siltstones which were deposited in marine waters along the margins of a positive feature located to the south and from which oxidized clastics were derived. The Seboomook is a deep-water marine facies consisting of interbedded slates and argillaceous sandstones, sometimes cyclically banded. The Tarratine formation is a marine, shallow-water equivalent of the Seboomook formation and consists of argillaceous sandstones plus interbedded slates.

The Misery member of the Tarratine is a clean quartzitic sandstone deposited in shallow waters during a period of structural stability or exceedingly slow deposition during which time fine fractions were being winnowed out.

The rocks of the region stand in a variety of structural attitudes, and most of them have been greatly deformed. The earlier Paleozoic rocks of the Roach River syncline were folded and faulted before Silurian time by the Taconic orogeny, and the Silurian rocks lie unconformably on them. The Devonian rocks in turn truncate unconformably both the folds of Cambrian (?) or Ordovician (?) age and the rocks of Silurian age. The Devonian and Silurian rocks have themselves been deformed by the Acadian orogeny of Middle Devonian age.

Devonian

Big Spencer Volcanics

Name and distribution - The Big Spencer volcanics are found on Big Spencer Mountain (Ragged Lake quadrangle), the most prominent topographic feature in the Roach River syncline. Toppan (1932, p. 70) has described the rock comprising Big Spencer Mountain as a Kineo-Traveller type rhyolite.

These volcanics are confined to an elongate ellipsoidal body, which trends northeast-southwest. The body is about two and one-half miles long and about 0.9 of a mile wide. The exact configuration and areal extent of this unit are not known due to heavy glacial overburden which covers most of the bedrock in the immediate vicinity. The northeast and northwest extremities, in particular, may well extend the limits shown on the geologic map (Plate I). The contact shown is interpreted from topography.

Thickness - The thickness of this unit is not known. As estimated from a cross section (Plate IV, section C-C'), the volcanics are at least 2,400 feet thick.

Lithology - Though textural features of the Big Spencer volcanics vary from outcrop to outcrop, certain other features seem consistent throughout the unit.

The volcanics are a series of greenish-gray to bluish-gray rhyolite porphyries that contain small, glassy, equi-dimensional quartz phenocrysts. The rock is tough, fractures conchoidally, and weathers to bone white or light brown. Many specimens contain numerous white, vari-shaped feldspar phenocrysts, mostly orthoclase; somewhat less common are very small metallic inclusions, perhaps magnetite. In at least one outcrop small, reddish-brown garnet crystals were observed. In describing the aphanitic ground mass, Smith (1933) says that "the thin section reveals the usual mosaic of quartz and feldspar, mostly orthoclase." The results of analyses by Smith (1933), given in Table I, of various rhyolites from the region shows clearly that chemically the rocks of Mount Kineo (Moosehead Lake quadrangle), Big Spencer, and Soubunge Mountain (Harrington Lake quadrangle) are very similar. Some dark gray rhyolites were noted, these containing as little as 5 percent feldspar and relatively few, small quartz phenocrysts of one millimeter or less diameter.

One of the most striking, and certainly the most common, textural feature associated with the Big Spencer volcanics occurs in the welded tuffs. These have a delicate, streaky lamination deceptively like the fluidal banding seen in many lavas. Individual dark gray, elongate, highly deformed shards are firmly annealed in a gray, aphanitic ground mass. These

Table I

Analyses of Rhyolites (from Smith, 1933)

	Soubunge Mountain	Big Spencer Mountain	Mount Kineo
SiO_2	69.46	73.01	75.41
Al_2O_3	13.04	12.62	12.89
Fe_2O_3	2.00	1.55	0.08
FeO	3.55	2.45	1.79
MgO	0.44	0.44	0.01
CaO	1.96	1.22	1.09
Nu_2O	4.19	3.80	2.87
K_2O	3.87	3.69	4.63
H_2O+	1.01	0.64	0.56
H_2O-	n.d.	n.d.	0.06
TiO_2	0.15	0.13	0.10
MnO	0.07	0.07	0.06
P_2O_5	-	-	0.12
TOTAL	99.74	99.62	99.67

shards, though linear, appear as wavy bodies in polished section, are up to one inch long and up to two millimeters thick. Phenocrysts of feldspar and quartz are normally found in these rocks.

Flinty rhyolites with homogeneous textures are common. They probably reflect a quiet eruption. The blue-gray rhyolites with feldspar-rich, aphanitic ground mass typically display this homogeneous texture. Quartz phenocrysts are associated with these also.

Dark gray, very fine-grained volcanics with a large number of spherical inclusions occur on the south slope of Big Spencer Mountain. The mineralogy of the inclusions is apparently the same as that of the ground mass, and such rocks have been termed spherulites (Johannsen, 1939, p. 15), (Williams, Turner, Gilbert, 1954, p. 154). Individual spheres reach a maximum diameter of seven millimeters. Extremely fine-grained, glassy quartz phenocrysts have been noted, as well as a few white feldspar phenocrysts.

Adjacent to the spherulites are dark gray tuffs. These are characterized by a high percentage of quartz (30%) which occurs as glassy, fine- to meditm-grained, round phenocrysts. Both euhedral and anhedral light gray feldspars comprise about 30 percent of the rock. The remaining 40 percent is dark gray aphanitic ground mass.

Age - The age of the Spencer Mountain volcanics is not precisely known. Stratigraphically they overlie the Tarratine formation of Oriskany age and therefore are interpreted to be younger. In all probability these rocks are of Early Devonian age.

Stratigraphic Relationship - The relationship between these volcanics and those associated with Mount Kineo to the south and the Traveler Mountains to the north is not known, though several postulations may be offered for consideration. As noted above, the chemical make-up of the rhyolites in Big Spencer is very similar to those comprising the Kineo and Soubunge Mountains. Boucot (oral communication, 1959) has noted a similarity between the Big Spencer rhyolites and those associated with the Traveler Mountains (Traveler Mountain quadrangle). Professor Douglas W. Rankin (written communication, 1959) notes that the welded tuffs of Big Spencer Mountain are identical in appearance to much of the Traveler felsite.

He prefers to genetically classify these felsites as flows. Rankin did not observe sperulite textures, like those described above, in the Traveler felsites. Though the mode of formation of the Big Spencer and Kineo rhyolites must have been different, as suggested by a variation in textural characteristics (in particular, the absence of welded tuffs within the main mass of Mount Kineo), they seemingly were formed during the same period of volcanic activity. The Traveler Mountain-Mount Kineo rhyolites lie roughly in a northeast-southwest trend which is extended to the southwest by Boucot (in preparation, A) to include the Heald Mountain volcanics (Pierce Pond quadrangle). Thus, the rhyolite mountain trend is some 80 miles in length.

The Big Spencer rhyolites are decidedly different, both mineralogically and texturally, from the igneous rocks associated with the Little Spencer and Lobster Mountains, but they are clearly similar to some of the various dikes and sills occurring in the region.

Lower Contact - The contact of the Big Spencer rhyolites with the underlying sandstones of the Tarratine formation has not been observed, and the relationship between the two is therefore not known. An interval of 2,500 feet (as calculated from cross-sections) lies between the base of the Big Spencer and the top of the Misery quartzite member and is believed to remain constant throughout the extent of these two units.

Mode of formation - Textural evidence, particularly as shown by the spherulite, tuffs, and welded tuffs show the rhyolites of Big Spencer Mountain to be extrusive. Spherulites are generally formed by a rapid crystallization of viscous magma, and some are probably formed even before the lavas cease to flow. In describing the formation of welded tuffs, Williams (1954, p. 154) says that "some vitric ashes form by distension of magma in which the vapor tension is low . . . So mobile are these mixtures that they spread over vast areas . . . Because these deposits accumulate rapidly and usually to great thickness, many remain hot for a long time . . . As a result, shards of glass, while still hot and under heavy overburden, are squeezed and flattened . . . At the same time pumiceous lapilli and bombs are deformed to disks, some of them paper-thin, and all the constituents become firmly annealed."

Tarratine Formation

Name and Type Section - The name Tarratine formation was proposed by Boucot (in preparation, A) for a series of interbedded massive, dark greenish-gray, highly argillaceous sandstones, orthoquartzites (Misery quartzite member), dark gray slates, and dark-colored siltstones occurring in the Moose River synclinorium. Fossil, lithologic, and stratigraphic evidence indicate that a rock series in the Roach River syncline is the same as the Tarratine formation described by Boucot. The type section cited by Boucot is located along the right of way of the Canadian Pacific Railroad between Tarratine and Somerset Junction (Brassua Lake quadrangle), the Tarratine formation deriving its name from the former.

Distribution - Rocks of Tarratine lithology occupy the center of the Roach River syncline. The southern, eastern and western extremities of this formation are fairly well defined, the contact being drawn where a predominance of Tarratine sandstone yields to a greater percentage of slate of the Seboomook formation. The northern boundary of the Tarratine is much more irregular. Though this contact is based on the same relationship as the above, a lateral facies change combined with a vertical gradational change greatly complicates the map pattern. Therefore, although most of the contact between the Tarratine and Seboomook is vertically gradational, the abrupt changes in the northern sector are largely attributed to lateral facies changes.

Tarratine sandstones, siltstones, and slates extend from the north in the vicinity of Big Pine Pond (Ragged Lake quadrangle) southward to Jewett Pond (Moosehead Lake quadrangle), a distance of about 11 miles. The maximum width is about three and one-half miles; it is exposed roughly parallel to the Spencer Mountain fire station road, extending from the point where Maxfield Brook nearly intercepts the road eastward to the point on the road just south of Little Berry Pond.

The structural and stratigraphic position of the Tarratine formation suggests that at least the uppermost portion of it is younger than the upper Seboomook.

Thickness - The thickness of the Tarratine formation within the Roach River syncline is highly variable (Plate V); in the vicinity of the Lobster Mountain complex, it is estimated to be as much as 10,000 feet. These great changes in thickness are interpreted as resulting from the Lobster Mountains having been a positive clastic-producing feature during Lower Devonian time, the weathered debris being deposited in greater thicknesses basinward.

Comparison of the isopachs of the Seboomook and Tarratine formations (Plates V, VI) reveals that generally the maximum thickness of the Tarratine sandstones occurs where the slates of the Seboomook are at a minimum, and vice versa.

Lithology - The Tarratine formation within the Roach River syncline consists of interbedded, massive, ridge-forming sandstones, less massive siltstones, and slates. A portion of the formation includes the Misery member, an inconspicuous ridge-forming orthoquartzite sandstone, which by facies changes trends laterally into slates and sandstones of typical Tarratine lithology. Where the Misery member is found, it roughly divides the Tarratine into an upper and lower part. The upper portion is predominantly sandstone; the lower portion consists of many interbedded sandstones and slates. Where the Misery is absent, the same relationship holds, the lower slaty portion grading upward into a more sandy lithology. The sandstones and siltstones of the Tarratine comprise roughly 80 percent of the total formation, the slates and shales the remaining 20 percent.

Massive ridge-forming sandstones of the upper Tarratine formation are best exposed in an area two and one-half miles wide that extends from the Spencer Mountain fire station road (Ragged Lake quadrangle) in the vicinity of Blood Pond northward to just south of Big Pine Pond. This area is characterized by generally north-south trending ledges of the more resistant sandstone beds which rise with considerable relief above the more easily eroded slates. A single ridge will normally continue for a few hundred feet and then grade laterally into slates. The lateral gradation of these ridge-forming beds gives a rough impression of an en echelon effect. The height which these ledges attain above the surrounding slates is largely dependent on the thickness of the sandstone beds. These thicknesses range from only a few inches in the lower portion of the formation to at least several hundred feet in Black Cap Mountain. The most prominent feature formed by these massive, resistant sandstones is Black

Cap Mountain, rising 700 to 800 feet above the surrounding slaty rocks. South of the fire station road the sandstones apparently grade into less resistant, more argillaceous rock types which do not form such distinct ridges. As noted above, in the vicinity of Big Pine Pond, the sandstones of the Tarratine formation grade laterally into slates of the Seboomook formation.

The massive sandstones located within the Tarratine formation predominantly consist of greenish-gray, fine-grained, impervious, well cemented, highly argillaceous graywacke sandstone (Pettijohn, 1957, p. 291) (Appendix I). Quartz grains, which comprise 60 percent of the rock, are well sorted and quite angular in shape. A fine-grained matrix composes 20 percent of the rock, and a minor percentage of feldspar plus rock fragments can be observed. Many intergranular spaces are filled with carbonate. From thin section observations the carbonate comprises as much as 10 percent of the sandstone and appears to be replacing silica cement as well as quartz grains. This suggests a secondary rather than primary origin. In the area of Big Spencer Mountain the sandstones become noticeably more argillaceous and less massive, and in several localities they are intricately cross bedded. Thin gray lenses of sandstone (1 to 2 millimeters thick) are interbedded with dark gray siltstones, the light bands of sandstone accentuating the primary structural features. These more argillaceous sandstones do not contain carbonate as did the more massive graywackes.

The siltstones associated with the Tarratine formation vary from one locality to another, but may generally be described as being fine- to medium-grained, bluish gray to black, moderately well cemented, only slightly micaceous, and containing a high percentage of argillaceous matrix. Rounded to subrounded, glassy quartz particles of medium grain-size are normally distributed randomly. No lensing or other primary features were observed. As in the more argillaceous sandstones of this formation, no carbonate was detected in the siltstones. The siltstones weather gray, forming a very rough surface on which quartz grains stand out in relief from the decomposed clay matrix.

Slates found interbedded with the graywacke sandstones and the siltstones resemble those of the Seboomook formation. They are dark blue-gray, slightly micaceous, soft, highly cleaved, and rusty weathering. Only a relatively few slate beds are found associated with the graywackes of the upper portion of the Tarratine, but they become appreciably more abundant both laterally and vertically down section.

Cleavage is well developed in the more argillaceous beds of the Tarratine formation, particularly within the slate zones. The thin, platy nature of the cleavage planes makes the slates highly fissile. The converse is found in the thick massive sandstone beds where essentially no cleavage has developed. The occurrence of cleavage, therefore, is directly related to the sand content of the rock; the argillaceous sandstones displaying only poorly developed cleavage, the slates well developed cleavage.

Bedding within the more massive, sandy portions of the Tarratine is often difficult to detect due to the massiveness and homogeneity of the sandstones. Exceptions are the thin bands of fossil material which are occasionally encountered, two such localities being found in the Roach River syncline (fossil location 2 and 3, Plate I). These bands are commonly a few centimeters thick and weather to a characteristic brownish soft punky material, caused by the leaching out of the calcite which leaves a silt residue.

Age - Fossils have been collected from the Tarratine formation in two localities within the Roach River syncline (Plate I). Boucot has identified the following fauna: *Chonetes canadensis*, *Nanothyris sp.*, *Tentaculites sp.*, *Leptocoelia flabellites*, *Plicoplasia cf. plicata*, and crinoid columnals. Boucot (in preparation, A) considers this fauna to be of Oriskany age. With the exception of the crinoid columnals and *Tentaculites*, the above fauna are brachiopods. Boucot (oral communication, 1959) has suggested a tentative relationship between lithology and the associated fauna. *Nanothyris* is believed to be associated with the thicker, more sandy beds of the Tarratine whereas *Chonetes* is normally related to the thinner-bedded, more shaly zones. *Tentaculites* and *Leptocoelia* are found associated with both thin, shaly beds and thick, sandy beds, and therefore are not considered to be diagnostic of any associated rock types.

Stratigraphic relationships - The abrupt changes from thick, massive ridge-forming Tarratine sandstones to low-lying slates cannot be explained by structure alone. These relations are largely attributed to lateral facies changes from dark, massive Tarratine sandstones to the dark, banded slate and sandstones of the Seboomook formation. This phenomenon is best developed in the area south of Big Pine Pond (Ragged Lake quadrangle) where, in a distance of one mile, massive, thick, ridge-forming sandstones of the Tarratine grade northward into low-lying slates of the Seboomook which outcrop along the shore of the pond.

Lower Contact - The Tarratine formation grades vertically downward into the underlying Seboomook formation. The contact is drawn where in percentage the sandstones of the Tarratine equal the slates of the Seboomook. The lower part of the Tarratine formation is interpreted to be stratigraphically equivalent to at least the uppermost portion of the Seboomook.

Environment of deposition - Fossil, lithologic, and stratigraphic observations of the Tarratine formation have established it as a relatively shallow marine deposit. These observations further suggest that the Tarratine sandstones and siltstones are a marginal deposit grading laterally into the finer-textured, deep-water-deposited shales comprising the Seboomook formation. This indicates at least a partially contemporaneous deposition of the two formations.

The Tarratine formation is much more fossiliferous than the Seboomook formation. This general presence of shelly benthonic fauna indicates shallow, warmer waters. The relatively coarse-grained texture of the Tarratine sandstones further suggests a shallow-water depositional environment. Though a certain degree of current action is evidenced by cross bedding, the large amount of fine-grained matrix associated with the quartz grains eliminates the possibility of strong currents, which would have winnowed out the finer fractions and carried them to deeper waters. An alternative interpretation may lie in a rapid deposition of sands and clays, the currents not having time to winnow out the fines thoroughly.

The presence of a notable amount of carbonate material within the more massive graywacke sandstones of the Tarratine formation is of questionable significance. Thin section evidence suggests a secondary introduction of these carbonates through solution activity. This conclusion is based on a partial replacement of quartz grains by carbonate. The general absence of such carbonate traces within the Tarratine lithologies of the Moose River synclinorium studied by Boucot (in preparation, A) is also noteworthy. Several thin sections from Boucot's collection do not show any carbonate. This may indicate differences in post-depositional history between the Tarratine of the Roach River syncline and that of the Moose River synclinorium lying to the west.

The clastic fractions comprising the Tarratine formation are believed to be largely locally derived from adjacent positive areas lying to the west and the south. Undoubtedly some of the finer matrix materials have been carried from the same distant sources that were supplying fine-grained material to the Seboomook formation.

In summary, the Tarratine formation is interpreted to be the coarser-grained, shallow-water equivalent of the finely textured deep-water deposits of the Seboomook formation. These coarser sandstones were deposited along the marginal zones of the existing positive features and were subjected to only moderate current action. The clastics comprising the formation are mostly locally derived.

Misery Member

Name and Distribution - Perkins (1925, p. 371), in describing the lithologies included within the Moose River sandstone, noted that "in Misery Notch and in the hill just to the east of Mount Kineo is a white quartzite which weathers to a bright red." Boucot (in preparation, A), in mapping the Moose River synclinorium, found similar quartzites throughout the region and named them the Misery member, after Misery Ridge (Brassua Lake quadrangle). In the Roach River syncline this member is composed of a relatively thin sequence of orthoquartzites, argillaceous sandstones, and slates which characteristically form low ridges. The Misery member is located within the lower half of the Tarratine formation and roughly divides it into an upper and lower portion.

The Misery member has been found only along the east, southeast, and southern extremities of the Roach River syncline. Its northernmost outcrop is located along the east limb of the syncline in a low hill just east of Berry Pond (Ragged Lake quadrangle), where it has been observed to thin down to a thickness of ten feet before grading into typical Tarratine sandstones and slates. Along the southwest limb of the trough the Misery has been traced to a low hill located northeast of Jewett Pond (Moosehead Lake quadrangle). This quartzite was not observed elsewhere along the west limb of the syncline or in the northern extremities. Numerous glacial erratics of Misery-type quartzite distributed in many places in the Blood Pond (Ragged Lake quadrangle) region strongly suggest that outcrops of Misery should lie to the west and north.

Thickness - The maximum thickness attained by the Misery member in this area is about 500 to 600 feet. Its thickness is quite variable, however; near the zones where the massive quartzites grade laterally into slates and sandstones of the Tarratine, the Misery consists of a few quartzite beds comprising a total thickness of no more than ten feet.

Lithology - The Misery member includes interbedded orthoquartzites, protoquartzites (Pettijohn, 1957, p. 291), siltstones, and slates. Individual beds seldom exceed five feet in thickness and never continue for more than a few hundred feet along strike before grading into a different lithology. Though the quartzites compose only 60 percent of the member, the superior resistance of the quartzites to weathering results in the formation of low ridges.

The quartzites vary noticeably in grain size and shape between individual beds as well as between outcrops. They are, however, very well size-sorted, clean, and well indurated in most places. The majority of the quartzites contain 75 to 95 percent quartz, 5 to 10 percent clay and other fine-grained materials, plus minor amounts of feldspar, hematite, chert, and other impurities (Appendix I). Quartz grain sizes range from medium to coarse, and grain shapes from subrounded to angular, but any one bed is consistent in grain shape and size. Several of the sandstones contain some hematite, which imparts a light red to pink color to the rock. More commonly the quartzites are gray, weathering light gray to white and in many places with a sugary-appearing surface. Several beds of proto-quartzite of characteristic olive-brown color were noted, the color apparently resulting from a large amount of limonite scattered throughout the rock. The quartzites of the Misery member are often crisscrossed with an apparently random series of milky white quartz veinlets, which are deposited within pre-existing fractures. In places the quartzite contains a small amount of carbonate. Thin section study of one such rock led to the conclusion that this was a secondary solution deposit. The carbonate appears to be replacing an original silica cement.

The interbedded siltstones and slates of the Misery resemble those of the surrounding Tarratine formation. Their poor resistance to weathering relative to the quartzites results in a tendency to overestimate the ratio of quartzites to slates and siltstones.

Age - The Misery member has not yielded fossils, but its relation to the overlying and underlying Tarratine formation establishes it as being of Oriskany age.

Stratigraphic relationships - In this area the Misery member is situated stratigraphically within the lower portion of the Tarratine and is a facies of it. The member has not been located anywhere north of Little Berry Pond along the east limb of the Roach River syncline, nor has it been observed north of Jewett Pond along the west limb. The absence of the member along these limbs is interpreted to be the result of facies changes. This, plus the inability to trace any one quartzite bed from one outcrop to another, shows that the Misery member is a discontinuous series of lensing quartzites interbedded with slates and siltstones, which occupy a constant stratigraphic position within the Tarratine formation wherever it is found. The base of the Misery is located approximately 2,000 feet above the base of the Tarration formation and some 3,000 feet below the base of the overlying Spencer Mountain rhyolites. Its consistent stratigraphic position within the Tarratine makes the Misery a useful horizon in interpreting the structure of the area.

Upper and Lower Contacts - The Misery member grades vertically both upward and downward into the Tarratine formation.

Environment of Deposition - Lithologic evidence suggests that the quartzite beds of the Misery member are shallow water, current-winnowed deposits. The interbedded slates and siltstones were presumably deposited under conditions like those of the Tarratine formation.

The clean quartzites of the Misery with their well sorted and subrounded grains appear to represent a relatively stable period during the depositional history of the geosyncline in this region. Presumably, during this period relatively few clastic materials were being introduced, and currents were working over existing sands, separating out, entraining, and carrying to deeper waters the finer fractions, leaving the cleaner, coarser fractions in the more shallow zones. An alternate interpretation for the formation of these quartzites may lie in assuming that the finer fractions of clay were not available during deposition, resulting in the locally derived quartz being deposited in the absence of contaminating matrix materials. This seems less likely in view of the grain sorting and rounding which indicates intense current action. The absence of any fossil evidence within the Misery further substantiates the concept of intense current action which would have abraded and ultimately destroyed any faunal remains which may have been deposited.

The lateral discontinuity displayed by the quartzite lenses may reflect a highly erratic current action which was depositing sands in one local area while eroding those of an adjacent area. The picture may have been complicated by the topography of underlying beds, with deposition taking place in local depressions and erosion along local highs. The absence of this member along the west limb of the syncline as well as to the north may be explained in the same manner, though on a more regional scale. That is, deposition may not have occurred, or deposition may have been followed by erosion prior to the deposition of the overlying Tarratine.

Seboomook Formation

Name - Perkins (1925) has described a series of dark bluish slates interbedded with gray sandstones located at Seboomook Dam (North East

Carry quadrangle) as the Seboomook Slate. Boucot (in preparation, A), in giving the name Seboomook formation to the entire series of slates and sandstones, emphasized the abundance of the dark gray sandstones, particularly in the lower half of the zone. The type section described by Boucot for this formation begins at the eastern end of Seboomook Lake (Seboomook Lake and North East Carry quadrangles) and extends for one mile down the Penobscot River below Seboomook Dam. The interbedded black slates and dark sandstones comprising the Seboomook formation in the Roach River syncline have been shown by mapping and lithologic relationships to be a continuation of those described by Perkins and Boucot.

Thickness - The thickness of the Seboomook formation within the Roach River syncline is variable (Plate VI). The Lobster Mountain anticline is believed to have been a positive feature throughout Oriskany time. Clastics comprising the Seboomook were deposited around the flanks of the anticline, giving rise to an unconformity between the Seboomook and the underlying formations. This presumed unconformity beneath the Seboomook has not, however, been observed in the field. Where the Seboomook formation lapped upon the Lobster Mountain complex, it thinned to extinction; basinward it thickened rapidly until ultimately 12,000 feet of sediments were deposited along the eastern limb of the Ragged Lake syncline (Plate IV). These thicknesses have been interpreted from cross-sections. Boucot (in preparation, A), in his study of the Moose River synclinorium, reports a maximum thickness of 15,000 to 20,000 feet for the Seboomook formation.

Lithology - The Seboomook formation in the Roach River syncline consists of interbedded dark gray slates and gray sandstones. Outcrops are exposed in enough places in the area surrounding Blood Pond (Ragged Lake quadrangle) and Ragged Lake to allow division of the Seboomook into an upper and lower zone. The upper zone is located along the Spencer Mountain fire station road west of Bear Pond Brook and consists predominantly of slates with relatively few sandstones. The lower zone is best exposed on the southwest shore of Ragged Lake and includes an appreciably larger number of sandstone layers interbedded with the slates. A division of the Seboomook formation into two zones along the western limb and the southern end of the Roach River syncline is not attempted.

The slates of the Seboomook formation are characteristically dark blue-gray, soft, light gray weathering, and have many fine-grained specks of micaceous material throughout. The slates are commonly highly cleaved into thin, platy, oval-shaped slivers. This cleavage is characteristically steeply dipping and, in the absence of sandstone beds, renders the determination of bedding difficult. The presence of iron-oxide along cleavage planes causes brown and red staining on fresh surfaces, and in places large portions of an outcrop are stained brown.

The sandstone beds, which comprise 20 to 30 percent of the Seboomook formation in this area, are a fraction of an inch to several feet thick. In portions of the lower zone the slates and sandstones are cyclically banded, each band being one to two inches thick. These sandstones are similar lithologically to the Tarratine sandstones: fine-grained, angular to sub-angular in grain shape, extremely argillaceous, greenish gray, tough, and weathering to light buff. Thin, brown, limonite-stained banding was observed in several sandstone specimens. The contact of the sandstone with the underlying slate is usually sharp, but the contact with the overlying slate is gradational. Along the southwest shore of Ragged Lake (Ragged Lake quadrangle) numerous examples of cross bedding, rapid thinning and thickening, flow casting, and other primary structural features were observed in the banded sandstones and slates.

Outcrops of the Seboomook formation exposed on the banks of the Roach River (Moosehead Lake quadrangle) approximately two miles east of Moosehead Lake display pronounced structural deformation in the form of drag folding. These beds are predominantly dark gray, highly cleaved slates, dipping very steeply (75°-90°), and with relatively few sandy layers.

Age - No fossils were found in the Seboomook formation in this area. Boucot (1954, p. 148) notes the presence of Beachia in the Moose River synclinorium, indicating that the bulk of the Seboomook formation is of Oriskany age. Boucot also notes that the uppermost part could be of either Oriskany or Onondaga age, and that the same species observed in the Seboomook are also found in the Tarratine formation.

Perkins (1925, p. 375) reported finding Monograptus in a road cut in the Seboomook Lake quadrangle. Later collecting by Boucot (in preparation, A) did not uncover any additional specimens of this fossil.

Griscom (thesis in preparation) has collected fossils from the Seboomook slates at a locality three miles north of the southern tip of Sandy Point on the west shore of Chesuncook Lake (Ragged Lake quadrangle). Boucot (1959, p. 22) has identified these as Plicoplasia plicata and Leptocoelia flabellites, both of Oriskany age. The precise relationship of the Seboomook formation with the underlying Lobster Lake and Ripogenus formations is not known. It is possible that at least a small part of the lower Seboomook is Upper Silurian in age.

Stratigraphic Relationships - The Seboomook formation grades laterally into both the Tarratine and the Roach River sandstones. This gradational relationship with the lower section of the Tarratine formation is well displayed in the area north of Black Cap Mountain (Ragged Lake quadrangle), and with the Roach River formation in the area north of the First Roach Pond outlet (First Roach Pond quadrangle). The contact between the Seboomook and the Tarratine is drawn where dark slates exceed in percentage the massive sandstones of the Tarratine. With the Roach River formation, the boundary is drawn where typical Seboomook slates grade into purple and brown argillaceous sandstones.

Lower Contact - The Seboomook is interpreted to overlie unconformably the Lobster Lake formation (including the basal Big Claw member) and the Ripogenus formation, and is believed to have this same relationship with the Lobster Mountain volcanics along the northwest limb of the Lobster Mountain anticline. No outcrops exhibiting these contacts have been observed, and these conclusions are based on mapping relationships.

Environment of Deposition - Studies of the lithologies, the field relationships of the various rock units, and faunal evidence as cited by Boucot (in preparation, B) have established the Seboomook formation as a marine deposit.

The number of fossils found within the Seboomook is small, and none were recovered from this formation in the Roach River syncline. The general absence of shelly, benthonic faunas in the Seboomook and their presence in the sandstone members of the Tarratine formation is significant. This lack of shelly, benthonic faunas may be explained by a depositional environment of deeper, colder waters that discouraged the existence of shallow water, shelly, benthonic animal life. This concept of cold and deep waters is further substantiated by the absence of carbonate beds throughout the Seboomook; limestones would suggest relatively shallow, warm waters. In the Moose River synclinorium, Boucot (in preparation, B) has recognized Chonetes canadensis and Beachia thunii faunas in the more shaly parts of the Tarratine formation, and he considers that these faunas indicate deeper water deposition. It is of interest that Beachia has been found by Boucot in the Seboomook formation at Gero Island (Chesuncook quadrangle). The fine-grained texture, the dark color, the absence of carbonates, and the high clay content of the Seboomook slate further suggests a normal deep-water deposit. The gradation of the deep-water facies into the Tarratine sandstones may reflect the relationship of these two formations: the shallow marine sandstones and silts comprising the Tarratine representing marginal, current-worked sediments, and the finer fractions of sand and clay of the Seboomook representing the deeper water facies equivalent. This hypothesis infers a penecontemporaneous deposition of the two formations.

The presence of the thin sandstones interbedded with the slates is not easily explainable. The cyclic banding of these two lithologies, particularly evident in the lower Seboomook, suggests pulsating fluctuations in the transporting medium. The gradation between the slate and the overlying sandstone reflects transportation of both sands and muds simultaneously. These characteristics might well be explained by the occurrence of turbidity currents during Seboomook times. Turbidity current action would help explain the absence of any obvious source area, as such currents could have transported clastics hundreds of miles. The presence of primary features within individual sandstone lenses is not characteristic of typical turbidity current deposits. These minor features may have been formed by local currents generated by violent storms capable of entraining small amounts of the sand fractions. Another characteristic which is not typical of turbidity currents is the absence of a coarser sand fraction at the base of individual sandstone strata, these in turn grading into finer sand grains and ultimately into shales. This anomaly might be explained by presuming that the coarser fraction was not available on the slopes where the turbidity currents were initiated.

The source for the clastics comprising the great thicknesses of Seboomook rocks located in both the Roach River syncline and the Moosehead Lake synclinorium must have been extensive. Certainly the Lobster Mountains and possibly the range including Lily Bay, Shaw, and Farrar Mountains lying to the south and east of the Roach River syncline could not alone have provided the total volume of material necessary. One is forced to look at least tens, possibly hundreds, of miles away for an adequate source area.

In summary, the Seboomook is a marine deposit as evidenced by fossil and lithologic observations, and most likely is a deep water facies equivalent of the sandier Tarratine formation. The Roach River basin of deposition is believed to have been a typical geosynclinal feature during Oriskany times. An associated positive area was the Lobster Mountain anticline lying to the west. There is some suggestion, as indicated by the Roach River formation, that additional highlands lay to the southeast. Both these and the Lobster Mountains acted as provenance areas contributing to at least part of the formation thickness. The questions of additional source areas and means of transportation have not been fully resolved in northern Maine.

Roach River Formation

Name and Type Area - A series of varicolored siltstones and argillaceous sandstones located along the southeast limb of the Roach River syncline in the vicinity of Kokadjo (First Roach Pond quadrangle) are named the Roach River formation. This name is derived from the river which flows between First Roach Pond and Moosehead Lake, and the type area for this formation extends from the outlet of First Roach Pond downstream for roughly three miles and northeastward along the Lazy Tom drainage for some four or five miles. Too little information is available to designate either a type section or to precisely define areal limits of the formation. The best exposure of this formation is located on the Roach River two miles downstream from Kokadjo. The most accessible outcrop is located along the road to Ripogenus three-quarters of a mile north of Kokadjo opposite a bench mark (elevation 1,319 feet).

The southwestern extremity of this formation is interpreted to lie somewhere between Roach River and Lily Bay (Moosehead Lake quadrangle) to the south. Boucot (in preparation, A), in mapping the north shoreline of Lily Bay, found dark gray slate and hornfels, but no Roach River lithologies. It is therefore assumed that the Roach River grades laterally into the Seboomook formation before reaching this area.

Thickness - The Roach River formation is interpreted to be variable in its thickness as a result of its lateral and vertical gradational relationship with the Seboomook formation. The maximum thickness, believed to exist along a section coinciding with the Roach River, is about 9,000 feet.

Lithology - The Roach River formation includes a series of graywacke sandstones interbedded with siltstones. The rocks of the Roach River can readily be distinguished from those of the surrounding formations by their characteristic brown, red, lavender, and maroon colors.

The graywacke sandstones are extremely argillaceous, poorly cemented, porous, hematite-rich, and poorly bedded. The quartz is fine grained, and moderately well sorted; in thin section the quartz grains are commonly sutured together into clusters and their margins are highly decomposed by post-depositional solution action. The clay matrix is partly altered to a micaceous material. A few grains of detrital mica are noted. The hematite content is high, giving rise to the characteristic coloration of these sandstones. Thin section study reveals the hematite to be detrital in origin. This hematite exists in distinct, separate, irregularly shaped grains or flakes and does not stain other clastic fractions as would a solution of iron oxide. The sandstones of this formation have been highly compacted, resulting in a moderately well developed foliation. The color of a sandstone of this formation is dependent on its percentage of hematite and its state of oxidation. Topographically the Roach River formation is low-lying as a result of its poor resistance to weathering.

At one outcrop along the Roach River a band of graywacke sandstone very similar in appearance to the Tarratine formation was noted. From this band fossils have been collected (fossil location 1, Plate I).

Age - Fossils were collected from one locality within the Roach River formation (the above-mentioned graywacke sandstone band). Boucot identified the following species from this collection: *Loxonema sp.*, *Leptocoelia flabellites*, and *Chonetes canadensis*. The brachiopods represent an Oriskany age. Chonetes is most often found associated with the more shaly facies in various sediments of Oriskany age in northern Maine, and therefore its presence in the Roach River is not unusual in view of the argillaceous character of the formation.

Stratigraphic Relationships - The Roach River formation grades laterally into the Seboomook formation and is also interpreted as grading vertically upwards into the Seboomook. This makes the Roach River stratigraphically equivalent to at least part of the lower Seboomook formation. The contact between the Roach River and Seboomook formations is drawn where typical dark gray slates of the Seboomook grade into purple and brown argillaceous sandstones. The Roach River, as interpreted from mapping relationships, is stratigraphically lower than the Tarratine sandstones. For this reason, and because of its obvious lithologic differences from the Tarratine, the Roach River is here considered as a separate formation.

Lower Contact - The contact between the Roach River and the underlying Ripogenus formation has not been observed. It is believed to be unconformable, not unlike that of the Seboomook with the underlying Lobster Lake and Ripogenus formations. There is a possibility that rocks of Silurian age do not exist below the Roach River formation, since Siras Hill (First Roach Pond quadrangle) is the point farthest south where the Ripogenus has been observed, and the continuation of the formation southward to First Roach Pond is only a projection.

Environment of Deposition - The presence of shelly, benthonic fauna within the Roach River formation indicates a marine environment of deposition. The high percentage of clastic hematite and the red and brown colors found in the sandstones are puzzling, since these are more often associated with oxidizing conditions found in continental environments. It is believed that the clastics comprising this formation were deposited in relatively shallow marine (shallow as compared to the adjacent Seboomook) waters adjacent to a positive source area. The majority of the clastics must have been derived from this source after having been weathered in an oxidizing environment which yielded the hematite. The high percentage of clay matrix suggests a fairly rapid deposition with very little winnowing from current action. Presumably the source area lay somewhere to the southeast. Additional mapping of this formation where it is predicted to exist in the area between Roach River and Lily Bay would be useful in further defining the extent and location of the positive feature.

Silurian

Lobster Lake Formation

Name and Type Section - Toppan (1932, p. 71) mentions a sedimentary area of Silurian age in Piscataquis County which he termed the Lobster Lake series. Boucot (in preparation, A) later designated these calcareous sedimentary rocks located along the east shore of Lobster Lake (North East Carry quadrangle) as the Lobster Lake formation, and the basal portion of this formation, consisting of interbedded conglomerates, argillaceous and orthoquartzite sandstones, siltstones, and shales, was designated as the Big Claw member. The type section for the Lobster Lake formation lies along the east shore of the lake from which the name is derived, from the point opposite the northern tip of Big Island northward along the shore to an unnamed point on which is located a triangulation station lying directly west of the Little Lobster Stream outlet.

Distribution - This formation has been traced from a point roughly two miles southwest of Jackson Cove (North East Carry quadrangle) where it wedges out against the Lobster Mountain volcanics, around the nose of the Lobster Mountain anticline to a point opposite Kidney Pond (Ragged Lake quadrangle), where it again is wedged out against the underlying formation (Plate I).

Thickness - The Lobster Lake formation is roughly 4,000 feet thick. This is the maximum thickness calculated to be present in the vicinity of the plunging nose of the Lobster Mountain anticline. Along the flanks of this structure the formation thins to extinction where the Lobster Lake has been eroded away before deposition of the overlying Seboomook formation.

Lithology - The Lobster Lake formation, exclusive of its Big Claw member, includes limestones, limestone conglomerates, calcareous sandstones, calcareous siltstones, calcareous slates, and quartzitic sandstones. Topographically these lithologies are mostly found in low-lying regions, perhaps a little higher than the overlying Seboomook formation but lower than most of the underlying Cambrian (?) or Ordovician (?) rocks. Several of the more massive and thicker limestone conglomerate beds as well as the interbedded calcareous shale and limestone sequences form low ridges, but these never continue laterally for more than several hundred feet.

The limestones in this formation vary in many aspects between outcrops, and can seldom be traced for any distance. Some of the cleaner limestones are very fine grained, light gray to blue-gray, unbedded, conchoidally fracturing, and gray-weathering. Cracks and voids are filled with white crystalline calcite. As the percentage of argillaceous material increases, the limestones become darker. One of these argillaceous limestones was treated with acid, and the residue, consisting largely of clay sized fractions, was calculated to comprise 47 percent of the total. Some of these argillaceous limestones are fossiliferous, containing crinoidal debris, and some are fine-grained and entirely homogenous. The more argillaceous limestones weather to a buff-brown, punky rind, the calcite being leached away leaving a soft clay residue. Many of these are interbedded with calcareous slates, and on weathering the limestones decompose more rapidly, resulting in a characteristic differentially weathered surface. A typical outcrop is composed of thin beds (2 to 4 inches), the shales standing out in relief relative to the less durable limestones. These limestone beds in turn are typically pitted, each pit being concave and roughly ellipsoidal in shape. The resulting "pitstone" is common in the formation. One such limestone collected north of Cranberry Pond (North East Carry quadrangle) contained many very small pyrite crystals.

The limestone conglomerates observed were likewise somewhat variable between outcrops. Individual blocks are normally cobble-sized, and these in turn are cemented with buff, soft, highly calcareous, fine-grained siltstone. The cobbles vary from blue-gray, clean limestones to dark gray, fossiliferous, argillaceous limestones. Impressions of corals and other marine fauna were noted on the surface of several of these rocks. These conglomerates were normally located in low ledges and occurred as massive, unbedded units.

Calcareous sandstones have been observed at a few places in this formation. They normally contain moderately sorted and rounded quartz grains, a high percentage of feldspar (Appendix I), some brown clay matrix, and an abundance of calcite cement. These sandstones, which occur in massive unbedded outcrops, are gray and weather differentially, yielding a rough surface.

Siltstones and slates of the Lobster Lake formation comprise some 70 percent of the total section and vary greatly in texture and color. The argillaceous beds are more commonly associated with the upper portion of the formation; in the lower portion the limestone and arenaceous beds predominate. The similarity between the dark gray slates of this formation and those of the Seboomook makes a determination of the contact between the two difficult. This contact is drawn between calcareous slates assigned to the Lobster Lake and non-calcareous slates of the Seboomook, in places a difficult distinction to recognize in the field. In addition to the dark slates, there are light gray siltstones and slates as well as green slates. These are invariably cleaved, the thickness and smoothness of the resulting planes being a function of the grain size and mineralogy. That is, the coarser and more sandy the slate, the fewer and less smooth the cleavage planes, and vice versa. Some slates are finely micaceous, and most of the slates characteristically weather light brown.

Occasionally quartzitic sandstones are found within the main body of the Lobster Lake formation, though more often they are confined to the Big Claw member. These normally are buff, non-porous, well cemented with silica, moderately sorted, and with a predominance of fine- to medium-grained quartz. The color results from the presence of a small amount of brown clay matrix. These sandstones are found in relatively thin beds, rarely over two to three feet thick.

Age - Boucot (in preparation, A) cites the occurrence of the tetracoral *Tryplasma* and *Halysites* within this formation, indicating an Upper Silurian age. No fossils were collected by the writer.

Lower Contact - The contact between the Lobster Mountain formation and the underlying Big Claw member has not been observed. The relationship may be conformable, one unit grading into the other, since beds on either side of the contact zone are parallel.

Environment of Deposition - The presence of fossil evidence as well as the general calcareous nature of the various lithologies of the Lobster Lake formation indicate a relatively shallow marine environment of deposition.

Corals and crinoidal debris have been recognized at several outcrops. The coarse, fossiliferous nature of the various conglomerates strongly suggests a close proximity to reef-type bodies. All of these must have originated in shallow marine waters.

Associated with the sandstones of this formation are feldspars, rhyolites, and heavy accessory minerals. These occur in moderate abundance, often as coarse sand-sized grains. The size and abundance of these fragments reflect a nearby terrestrial source from which they were eroded, swept into a near-shore, shallow marine environment, and ultimately deposited.

The absence of carbonate rocks within the Seboomook formation has been cited as evidence for a deep, cold water environment of deposition. The general presence of carbonates within the Lobster Lake formation may well provide evidence for a shallow, warm, marine environment.

Big Claw Member

Name and Type Location - The Big Claw member of the Lobster Lake formation was described by Boucot (in preparation, A), the name being derived from the Big Claw portion of Lobster Lake. The type section of the member is located along a point on the east shore of Lobster Lake (Ragged Lake quadrangle) that lies opposite the northern tip of Big Island. Other exposures have been observed on the west shore of Lobster Lake along the north side of Jackson Cove, in the larger drainage features flowing west into Lobster Lake, and on the west shore of Kidney Pond. A basal conglomerate bed similar to the lowermost beds of the Big Claw type section and correlative with the basal conglomerate member of the Ripogenus formation exists along the western limb of the Caribou Lake anticline. The writer tentatively considers this conglomerate as a stratigraphic equivalent of the basal Big Claw.

Thickness - The Big Claw member is approximately 250 feet thick on Lobster Lake and is interpreted to maintain this thickness throughout its extent along the flanks of the Lobster Mountain anticline. The basal member of the Ripogenus formation observed along the west limb of the Caribou Lake anticline is believed to be much thinner, perhaps 25 to 50 feet.

Lithology - The Big Claw member includes interbedded conglomerates, argillaceous and orthoquartzitic sandstones, siltstones, and shales. The Big Claw is readily distinguished from surrounding formations by the vivid red, brown and maroon colors it exhibits.

The basal bed of the Big Claw member is a conglomerate a few inches to one foot thick. Pebble-sized sub-angular grains, ranging from one-fourth to three-fourths inches in diameter and composed of quartz, phyllite, and felsite, are imbedded in a matrix of clay which includes numerous smaller grains of the pebble equivalents. Many of the clastics as well as much of the matrix are hematite-stained, and numerous small specular hematite grains are scattered throughout the conglomerate. The rock is only moderately indurated, porosity is low, and bedding is poorly defined (Appendix I). The Big Claw basal equivalent on the western limb of the Caribou Lake anticline is similar in appearance to that described above, the outstanding differences being the presence of feldspar, limonite, and a silica cement which makes the rock much better indurated. The feldspar comprises as much as 20 percent of the rock, consists of fairly fresh pink and gray orthoclase, and is believed to be of granitic origin.

At Lobster Lake the basal conglomerate is overlain by a section of interbedded sandstones, siltstones, and shales comprising a thickness of approximately 175 feet. The siltstones and shales of this zone of the Big Claw are characteristically maroon; individual beds are one to three feet thick, contain a large amount of glassy, poorly sorted, angular quartz grains, and include badly decomposed, tan feldspar and felsite particles. A few grains of relatively fresh plagioclase feldspar were observed in thin sections. The matrix in these silts and shales consists of red hematite-stained clays (Appendix I).

The quartzitic sandstone beds associated with the siltstones on Lobster Lake are from three to five feet thick. These sandstones have a wide textural range, including fine to coarse sand-sizes plus several conglomerate beds. The coarser-grained zones overlie the basal conglomerates described above and grade upward into finer-grained, more argillaceous sandstones. The coarse-grained sandstones are very hard, massive, clean, red, and conchoidally fracturing. They weather red and contain numerous veins of milky white quartz. These sandstones form pronounced ledges.

Within the Big Spencer Mountain and Blood Pond area large blocks of vividly colored siltstone have been randomly distributed by glacial activity. These blocks have a characteristic red color with numerous mottles of dark maroon scattered throughout, yielding a leopard-skin appearance. This unusual rock type has been observed in place on the west shore of Kidney Pond interbedded with greenish and pinkish ortho-quartzitic sandstones that are three to five feet thick. These sandstones are dense, impervious, fine-grained, and white-weathering.

Overlying the zone of sandstones and siltstones at Lobster Lake are about 75 feet of thin-bedded, brightly colored sandy shales and argillaceous sandstones. Colors in this zone include red, pink, and yellow, and the uppermost bed exposed is grayish green. These beds are moderately to poorly indurated, and they contain a large amount of clay material and a noticeable percentage of black organic matter. At least one band contains carbonate.

In summary, the Big Claw member contains three predominant zones: a basal conglomerate a few inches to one foot thick, 150 feet of overlying interbedded quartzose sandstones and siltstones, and, at the top, 75 feet of shales and argillaceous sandstones. The total section contains about 60 percent quartzose sandstones and conglomerates, 30 percent siltstones and argillaceous sandstones, and 10 percent shales.

Age - No fossils have been found in the Big Claw member. The well defined angular unconformity at its base on Lobster Lake, the presence of widely contrasting lithologies, and the basal conglomerate suggest that the Big Claw member is decidedly younger than the underlying Cambrian (?) or Ordovician (?). In the Lobster Lake area fossils described by Boucot (in preparation, A) show that the limestone beds of the overlying main body of the Lobster Lake formation are of Upper Silurian age. Conceivably the Big Claw may be as young as Upper Silurian.

Lower Contact - The contact between the Big Claw member and the underlying Cambrian (?) or Ordovician (?) beds is well exposed on the east shore of Lobster Lake. Relatively shallow-dipping red sandstone and conglomerate beds unconformably overlie steeply dipping red and green phyllites. The conglomerate is thin and contains numerous inclusions of phyllite derived from the underlying beds. During deposition, depressions were cut into the phyllites and subsequently filled with conglomerate, resulting in a highly irregular contact zone with as much as six inches of relief. The contact with the Cambrian (?) or Ordovician (?) has not been observed elsewhere.

On the northwest flank of the Lobster Mountain anticline the Big Claw member is concluded to lie unconformably upon the Lobster Mountain volcanics. The age of these volcanics is uncertain, though fossil evidence described by Boucot (in preparation, A) places them somewhere within the Middle Ordovician to Upper Silurian. This unconformable relationship between the Lobster Mountain volcanics and the overlying Big Claw member is suggested by projecting in cross section the northwest dipping Big Claw and noting its intersection with the volcanics.

Environment of Deposition - The presence of a large amount of hematite, the lack of marine fossils, and the textural and mineralogical relationships found within the Big Claw member suggest a predominantly terrestrial environment of deposition. The iron-rich source which provided the red-staining and the specular hematite probably was associated with the igneous rocks which comprise a large part of the Cambrian (?) or Ordovician (?). These rocks have been observed to contain as much as 50 percent mafic minerals. The high iron content of the Big Claw rocks plus the nature of the conglomerate beds indicate very rapid deposition probably preceded by significant tectonism. The felsitic debris incorporated into the basal conglomerate of the Lobster Lake and Ripogenus formations very closely resembles the ground mass of the rhyolites found in the Lobster Mountain volcanics. This again suggests uplift followed by rapid erosion and deposition. The source for the quartz throughout the time of deposition was paragenetic, the larger pebbles comprising the conglomerates being igneous, and many of the smaller grains found in the sandstones and silts conceivably being derived from pre-existing sediments. The presence of several clean, fairly well sorted sandstones indicates intense shallow-water action. The upper argillaceous zone of the Big Claw is believed to have been deposited under lagoonal conditions, probably before the extensive sea invasion which ultimately deposited the overlying carbonate section.

Ripogenus Formation

Name and Distribution - Toppan (1932, p. 71) has given the name Ripogenus series to a sequence of Silurian rocks at Ripogenus Dam (Harrington Lake quadrangle). The same sequence is exposed along the limbs of the Caribou Lake anticline and is considered here to belong to the Ripogenus formation (emended name).

This formation has been mapped along the southwest limb of the Caribou Lake anticline, and is thought to outline the plunging nose of the fold completely (Plate I). In the Harrington Lake quadrangle, Griscom (thesis in preparation) recognized the formation along the northeast limb of this anticline. The southernmost outcrop observed along the west limb is at Siras Hill (First Roach Pond quadrangle), and the northernmost at Deer Pond (Ragged Lake quadrangle). Only two outcrops on the northeast limb were visited by the writer, one being near Holmes Hole (Ragged Lake quadrangle), the other below Ripogenus Dam. Boucot had previously noted Silurian lithologies at Quaker Brook (Ragged Lake quadrangle) and on the southwest shore of Chesuncook Lake at a point opposite Holmes Hole.

Thickness - Thicknesses ranging from a minimum of 1,600 feet at Siras Hill to a maximum of 4,200 feet in the area lying between Ragged and Caribou Lakes are estimated from cross sections (Plate IV). From outcrop distributions of this formation mapped by Griscom (thesis in preparation) in the Harrington Lake quadrangle, a thickness ranging between 425 and 960 feet was calculated for that area. The difference between this thickness and that found along the southwest limb of the Caribou Lake anticline is notable.

Lithology - The Ripogenus formation consists of (bottom to top) a basal conglomerate and quartzite, interbedded limestones and calcareous shales which in two localities includes red and green slates, a white orthoquartzitic sandstone, and interbedded carbonate-rich shales and argillaceous sandstones. The white orthoquartzitic sandstone separates the Ripogenus into an upper and lower limy section.

A basal conglomerate bed has been observed at four localities: Ripogenus Dam, Deer Pond, the south shore of Caribou Lake, and a small knoll one mile south-southwest from the Ragged Stream outlet on Caribou Lake. Though these outcrops display minor mineralogical differences, the similarities in texture and bedding thickness indicate they all belong to the conglomerate. Thickness of the conglomerate ranges from 15 to 25 feet. It consists of poorly sorted, angular grains of glassy quartz, red hematite-stained rhyolite, white and pink feldspars, some specular hematite, and a large amount of iron stained clay matrix (Appendix I). The color of this matrix ranges from bright red (Deer Pond and Caribou Lake), to dark red (Ripogenus Dam), to brownish gray (southwest of Caribou Lake), the shade of red being a function of the hematite content. The entire mass is well indurated with a hematite-silica cement plus a minor amount of carbonate. Feldspar content is as high as 25 percent; therefore this basal bed is in fact an arkosic conglomerate. At Ripogenus Dam this conglomerate grades upwards into a quartzite.

Directly overlying the conglomerate is a limy unit (interbedded limestones and calcareous shales) of highly variable thickness. At Caribou Lake this unit is about 180 feet thick, at Deer Pond about 400 feet (calculated from outcrop distribution), and at Ripogenus Dam about 400 to 500 feet. The sequence at Caribou Lake includes 100 feet of red and green slates. Though not observed, these slates may well occur at Deer Pond also. At Ripogenus Dam they are absent. Similar slates have been noted by Griscom (thesis in preparation) on the north shore of Ripogenus Lake approximately one mile northwest of the dam. The limestones are dark gray, very argillaceous, fossiliferous, and weather to a soft, buff, punky residue. In many places they are interbedded with more resistant calcareous slates, the slates occurring as thin ridges in relief above the limestones. The surface of the limestones typically displays concave, ellipsoidal recesses two to three inches across, giving the rock a pitted appearance.

South of Deer Pond and at the outlet of Ragged Stream on the south shore of Caribou Lake, this lower limy sequence is overlain by a ledge-forming, white orthoquartzitic sandstone. This is undoubtedly the same quartzite found below Ripogenus Dam which has been described by Toppan (1932, p. 71) and mapped by Griscom (thesis in preparation). It is a massive, tough, silica-cemented, well sorted, fine-grained, unusually clean orthoquartzite (Appendix I). Individual grains are subrounded, and a few have dark-colored inclusions. Thickness of this unit is 15 feet at Caribou Lake, 25 feet at Deer Pond, and up to 50 feet below Ripogenus Dam.

The upper portion of the Ripogenus formation above the white orthoquartzite, consists of a variety of lithologies. These include carbonate-rich sandstones, slates, and siltstones, plus argillaceous limestones and some non-calcareous red slates.

Carbonate-rich sandstones are particularly numerous in the region east of Ragged Lake. These are normally found in massive beds ranging up to several feet thick. Fresh surfaces of the rock display a distinct pink tinge, but weathered surfaces buff. This is a very well sorted, fine-grained, well-cemented, calcareous sandstone with a large number of brown iron-rich specks scattered throughout. On fresh surfaces no indication of bedding is detectable, but weathered surfaces show distinct banding.

A few gray, thinly laminated, tough, calcareous, well-cemented siltstones were noted within the upper portion of the Ripogenus formation. In an area about 0.8 of a mile west of the northern half of Bear Pond (Ragged Lake quadrangle) are several outcrops of massive, ledge-forming, dark gray, very argillaceous, tough, slightly micaceous, carbonate-rich siltstones. These weather brown.

Slates associated with the upper portion of this formation are dark gray to gray-green, carbonate-rich, soft, normally cleaved, and light-brown-weathering. The gray slates are usually interbedded with argillaceous limestones. At Siras Hill is a bed of dark red, fine-grained, cleaved, slightly micaceous, non-calcareous slates.

Limestones in the upper Ripogenus formation are characteristically dark gray, very argillaceous, fossiliferous, and weather to a soft, buff, punky residue. These limestones are commonly interbedded with more resistant calcareous slates, differentially weathering to give a pitted effect. With the exception of one thin, six-foot bed of clean, massive, gray-blue marble lying stratigraphically below the white quartzite and situated on the south shore of Caribou Lake, cleaner limestones are noticeably absent from the Ripogenus.

Age - Willard (1945, p. 66) has studied Silurian fossils from limestones of the Ripogenus formation collected in the vicinity of Ripogenus

Dam, and has concluded that the fauna is dominated by fossils belonging to the Niagaran of New York State. Though no fossils were collected by this writer, the fossiliferous nature of the limestone outcropping along the west flank of the Caribou Lake anticline would offer adequate fauna to warrant a detailed study.

Stratigraphic Relationships - Fossil evidence has placed the middle portion of the Lobster Lake formation in the Upper Silurian. Though the relationships between the Ripogenus and Lobster Lake formations are not known, parts of each may be stratigraphically equivalent.

The basal conglomerate beds of these two formations are of particular interest. The basal conglomerate of the Ripogenus is better cemented and has a high feldspar content, but otherwise the similarity of both conglomerates in appearance, mode of origin, and their relationship with the underlying units suggests that they are stratigraphic equivalents. Certainly within the Ripogenus formation itself, the basal conglomerate is clearly one unit from Ripogenus Dam to the south shore of Caribou Lake.

The Lobster Lake formation does not include an upper and lower limy section as does the Ripogenus, nor has the white orthoquartzite bed which separates them in the Ripogenus been found in the Lobster Lake formation. This lower limy unit of the Ripogenus, the Chesuncook limestone of Willard (1945), has been mapped in the Harrington Lake quadrangle by Griscom (thesis in preparation), and the equivalent of this unit has been noted at Caribou Lake and also is believed to exist at Deer Pond. The limestones of both the upper and lower sections of the Ripogenus are similar in most respects, and they closely resemble many of the argillaceous limestones found throughout the Lobster Lake formation.

The absence of an upper limy unit within the Ripogenus formation throughout the Harrington Lake quadrangle is significant. Here the white orthoquartzite, where present, is overlain by basalts. Just as significant is the general absence of the white quartzite unit along strike northwest from Ripogenus Dam. Where the quartzite is missing, the Chesuncook is directly overlain by basalts. The absence of the upper limy and quartzite units may very well represent an unconformity. In the Lobster Lake area this same unconformity may have eroded away the equivalents of the lower limy unit and the white quartzite of the Ripogenus, which would explain the presence of only one limy unit in the Lobster Lake formation. A series of lateral facies changes may be an alternate explanation.

Also noteworthy is the uncommon occurrence of clean, well developed limestones and the limestone conglomerates in the Ripogenus, these lithologies being quite common within the Lobster Lake formation.

On the shore of Chesuncook Lake between Holmes Hole and Quaker Brook are a series of typical interbedded limestones and slates which weather to brown pitted surfaces. These are tentatively placed in the upper section of the Ripogenus, the lower limy bed with its associated basal conglomerate and overlying orthoquartzite presumably lying beneath the lake.

The red slates at Siras Hill are underlain by green slates and limestones and overlain by Seboomook slates. In the Harrington Lake quadrangle at Frost Pond Griscom has mapped a series of "red shales" which are overlain by the Seboomook, and he has placed this unit in the Lower Devonian. These shales may well be correlative with those on Siras Hill, and can tentatively be considered stratigraphically equivalent to the Capens formation mapped by Boucot (in preparation, A) on Deer Island (Moosehead Lake quadrangle). The Capens consists of red and green slates and is of Silurian or Lower Devonian age.

In summary then, the rocks of the Ripogenus formation are very similar to those of the Lobster Lake. The following exceptions are noted: the basal conglomerate of the Ripogenus contains more feldspar and is better indurated; the formation as a whole is more sandy than the Lobster Lake, contains fewer clean limestones and no limestone conglomerates, and includes red slates which are absent in the Lobster Lake formation.

Lower Contact - The contact between the Ripogenus formation and underlying units have been observed at two localities, below Ripogenus Dam and in the cove where Ragged Stream enters Caribou Lake. At Ripogenus Dam the basal conglomerate of the Ripogenus formation overlies pre-Silurian basalts nonconformably. At Caribou Lake, the basal conglomerate is believed to overlie beds of Cambrian (?) or Ordovician (?) age with angular unconformity, but the true nature of the contact may be obscured by minor faulting.

Environment of Deposition - The Ripogenus formation is assumed to have been deposited under environmental conditions not unlike those of the Lobster Mountain formation -- a predominantly non-marine, oxidizing terrestrial environment for the basal conglomerate with minor differences in source area to account for the increase in feldspar, followed by a relatively shallow, warm, marine environment in which the carbonate-rich sandstones, the slates, the limestones, and the clean orthoquartzites were deposited. The brief orthoquartzite interval must represent a period of almost no deposition accompanied by intense current action which acted to winnow out and transport to deeper waters the fines and to destroy any faunal remains.

Cambrian (?) or Ordovician (?)

Lobster Mountain Volcanics

Name - Toppan (1932, p. 70) has noted that the Lobster Mountains are composed of rhyolite plus a minor amount of pyroclastic conglomerate, and Boucot (in preparation, A), in further describing these rocks, referred to them as the Lobster Mountain volcanics. Since so little information is available for this unit, it will here also be referred to as the Lobster Mountain volcanics.

Distribution - Exposures of the volcanics are found in topographically prominent hills that trend northeast-southwest. These attain a relative relief of 1,100 feet in the vicinity of Lobster Lake (North East Carry quadrangle) and 500 feet at Moosehead Lake. The northernmost extremity of the Lobster Mountain volcanics is on the west shore of Lobster Lake, opposite Big Island. They were traced as far southwest as the Little Duck Pond area by this writer, and Boucot has mapped a continuance of the volcanics to the Cowan Cove (Moosehead Lake quadrangle) area. This gives the volcanics an overall outcrop length of some 15 miles, a maximum width of some two and one-half miles.

Thickness - The thickness of the Lobster Mountain volcanics is not known. It may safely be assumed to be at least several thousand feet, and may range up to a maximum thickness of 10,000 to 12,000 feet. The maximum figure would be valid only if the volcanics occurring within the greatest outcrop width represent a steeply dipping monoclinal series, but this cannot be proved.

Lithology - The rock types found within the Lobster Mountain volcanics include predominantly porphyritic-rhyolitic felsites and non-porphyritic rhyolitic felsites with lesser amounts of pyroclastics (both conglomerates and tuffs).

The porphyritic rhyolites are light gray to dark gray, usually contain phenocrysts of feldspar (both orthoclase and plagioclase), always contain phenocrysts of glassy quartz, are normally highly fractured, and weather chalky white or rusty brown. Most samples collected contain small phenocrysts of metallic sulfides which oxidize to limonite where weathered and which explain the occurrence of a large amount of iron staining along fracture planes. Though the aphanitic matrix of these rocks is normally homogeneous, some outcrops displayed a mixture of dark- and light-colored matrix giving an overall spotted effect.

Green felsites were observed only in one locality, in the Tom Young Pond area. These consist essentially of greenish-gray, massive, conchoidally fracturing, homogeneous volcanics with pyrite phenocrysts.

Two types of pyroclastics have been recognized in the Lobster Mountain volcanics. In the general area bounded by Little Spencer Pond and Tom Young Pond (North East Carry quadrangle), several outcrops of volcanic conglomerates were observed. These consist of a gray-green matrix with numerous feldspar-rich, light-gray as well as white and black spotted pebbles up to one and one-half centimeters in diameter. The whole rock has been sheared, with the result that these flint inclusions have become essentially fused with the matrix, their boundaries being poorly defined. The rock weathers chalky white, the surface displaying differential weathering where the feldspars decompose more rapidly than the matrix.

On the west shore of Lobster Lake, near bench mark elevation 965 feet opposite Big Island, are a mass of pyroclastic rocks overlying Cambrian (?) or Ordovician (?) sediments. These are made up of ash and lapilli well lithified into gray tuffs which are very heterogeneous in both mineralogy and grain size. These contain glassy quartz, light gray cherty felsite fragments, some white crystalline feldspars, dark gray mafic fragments, and a minor amount of pyrite. Bedding is inconspicuous, the outcrops being quite massive.

Age - The age of the Lobster Mountain volcanics is not known. The oldest datable sediments overlying the volcanics are those of the Lobster Lake formation, which contain Late Silurian fossils. Boucot (in preparation, A) has found a limited number of fossils in the tuffs, and of these one brachiopod could questionably belong to forms known from the Middle Ordovician to the Middle Silurian. The relatively small amount of cleavage in the Lobster Mountain volcanics may be considered evidence for their postdating the Taconic orogeny. However, the poorly developed cleavage may instead be a function of the lithology rather than the age of these volcanics.

Lower Contact - The relationship of the Lobster Mountain volcanics to the underlying rocks of the Cambrian (?) or Ordovician (?) is not known.

Cambrian (?) or Ordovician (?) Undifferentiated

Name and Distribution - This unit includes slates and phyllites, light and dark colored igneous rocks, a few carbonate rocks, and dirty quartzitic sandstones. This assemblage is here referred to as Cambrian (?) or Ordovician (?) undifferentiated.

The rocks of this unit are confined to the interiors of the Lobster Mountain and the Caribou Lake anticlines (Plate I), where they are the oldest unit present. They are best exposed on the shores of Lobster and Caribou Lakes, as well as along Ragged Stream (Ragged Lake quadrangle).

Thickness - Since the structure of the Cambrian (?) or Ordovician (?) has not been resolved nor a lower contact found in the region, the thickness of this unit is not known. Boucot (in preparation, A) suggests these rocks may attain a thickness of tens of thousands of feet.

Lithology - Detailed study of the lithology or the structure of the Cambrian (?) or Ordovician (?) rocks was not a primary object of this study. Consequently, only limited data were collected for this unit. An attempt was made to subdivide the unit stratigraphically, but information was too sparse. With more detailed study this unit could be subdivided into separate stratigraphic units. With this thought in mind, a numerical descriptive listing of each outcrop observed has been included (Appendix II), with location references to Plate I.

Rocks within the unit consist of about 50 percent to 60 percent slates and phyllites, 20 percent to 30 percent very argillaceous quartzitic sandstones, and the remainder both intermediate and basic igneous rocks.

The slates and phyllites are of various colors, including red, green, and dark gray. They are fine-grained, highly cleaved, often micaceous along cleavage planes, and soft. At Lobster Lake and the southern portion of Caribou Lake, red and green phyllites predominate. At most localities these exhibit a great deal of minor drag folding. In the Little Spencer

Mountain and Spencer Lake region dark gray shales predominate. These are highly cleaved, rendering them very fissile, and along cleavage planes they show distinct brown iron-oxide staining.

The sandstones of this formation are typically dark gray, well cemented, medium- to fine-grained, and very argillaceous. A few of the more argillaceous sandstones have mica flakes along cleavage planes. These sandstones are normally thin-bedded (a few inches to two or three feet) and are commonly interbedded with slates. An intricate network of fractures invariably cuts the sandstones at random angles, and the fractures are filled with milky white quartzite or, in places, with carbonate. Sandstone outcrops are normally associated with low, rounded, massive knolls. A few of the sandstone lenses associated with phyllites are pyritic and green. No primary sedimentary structural features were observed.

The various igneous rocks assigned to the Cambrian (?) or Ordovician (?) are quite inconsistent between outcrops in mineralogic and textural characteristics. These igneous rocks are often cut themselves by later igneous intrusions, this being accompanied by a low grade of contact metamorphism of the host rock.

In the Little Spencer Mountain (North East Carry quadrangle) area the Cambrian (?) or Ordovician (?) is largely represented by a group of very fine-grained, greenish-gray to black diabasic rocks. The color is largely dependent on the ratio of ferro-magnesian minerals to feldspars -- the higher the proportion of ferro-magnesian, the darker the rock. Most of these rocks, whether light or dark colored, contain pyrite. These in turn are intruded throughout by igneous rocks which are thought to be of Lower Devonian age, like the volcanics on Big Spencer Mountain. Igneous rocks in the Little Spencer Mountain area have been observed to intrude slates and quartzites of Cambrian (?) or Ordovician (?) age. The Little Spencer Mountain area may therefore be interpreted as a complex of igneous and sedimentary rocks intruded by younger igneous rocks of possible Lower Devonian age.

Cambrian (?) or Ordovician (?) quartzites and slates in the Caribou Lake region are randomly intruded by medium- to coarse-grained diorites which form as much as 30 percent of the unit. The diorites consist of about 50 percent ferro-magnesian minerals and alkali feldspar, a trace of quartz, and the remainder potash feldspars. This gives the rock a salt-and-pepper appearance. The diorites have also been found in the Lobster Mountain region, but at fewer localities.

Age - No fossils have been found in this unit, so conclusions concerning its age are based on stratigraphic relationships with overlying formations. Along the east shore of Lobster Lake, rocks assigned to the Cambrian (?) or Ordovician (?) are unconformably overlain by the Big Claw member of Silurian age. Though the age of the Big Claw is not absolutely known, it is overlain conformably by beds of Upper Silurian age and therefore is considered to be of Silurian age. It is therefore concluded that the unit underlying the Big Claw is pre-Silurian, that is, Cambrian (?) or Ordovician (?). Whether the lithologies within the Cambrian (?) or Ordovician (?) include any pre-Cambrian is not known, though it is generally believed by Boucot (in preparation, A) that they do not.

Intrusive Rocks

Distribution - A large number of intrusive rocks are included in the area. These occur as sills, dikes, and stocks which are randomly distributed and consist of rhyolites, "trachytes", and alkali-rich basic igneous rocks. Mineralogic and textural differences are noted between some of the intrusive bodies, but others are quite similar. Comparisons have been made between the intrusive rocks of the Roach River syncline and those mapped by Boucot (in preparation, A) west of the Lobster Mountains near Big and Little Duck Ponds (North East Carry quadrangle).

The most prominent topographic feature associated with intrusive rocks in the Roach River syncline is Little Spencer Mountain (North East Carry quadrangle). This intrusive complex reaches a maximum elevation of 2,900 feet and rises some 1,900 feet above the surrounding terrain. The body is elliptical in shape with the long axis trending northeast-southwest and attaining a length of about two and one-half miles. Its maximum width is one and one-half miles.

From a point just west of the southwest tip of Big Spencer Mountain to the area near Round Pond (Ragged Lake quadrangle), a distance of 10 miles, is a narrow, ridge-forming rhyolite sill. Its width is variable, ranging from 1,000 to 1,200 feet south of Maxfield Brook (Ragged Lake quadrangle) to a minimum of about 500 feet to the north. This north-south-trending ridge is reflected by the topography (Plate I). The nature of its southern extremity is poorly known as a result of heavy glacial cover. Its northern terminus strikes directly into an irregularly shaped rhyolite body interpreted as a stock, but the relationship between the two is not known.

Little is known of the areal extent of the irregularly shaped stock. Only a small portion of its southern extremity has been observed in the field, and the remainder of its boundary is mapped solely on topography. Its northern boundary is believed to lie in the vicinity of Salmon Pond (Ragged Lake quadrangle). These rhyolites are topographically low-lying and extend four and one-half miles in a southerly direction to the vicinity of Round Pond. The maximum width attained by the stock is roughly two and one-half miles in an east-west direction.

Lying east of Ragged Lake is an irregularly linear topographically prominent intrusive mass which is tentatively classified as a "trachyte". Its northern terminus lies northwest of Otter Pond and its southern terminus west of Bear Pond, giving a total length of four miles. Its width averages about 1,500 feet. The line of hills resulting from these tough intrusive rocks reaches an altitude of 1,600 feet and a relative relief of some 500 feet above surrounding sedimentary rocks.

Small dikes of rhyolite have been observed at two localities along the shores of Ragged Lake, one at the northern tip of the lake, and the other on a point east and north of Little Berry Pond. Another small dike is located on the fire station road half a mile northwest from the Bear Brook crossing.

<u>Lithology</u> - The different intrusive bodies in the Roach River syncline differ in texture and mineralogy. Variations are also common between outcrops within the same body, though to a smaller degree. Rocks found within these intrusions have been placed in three rather broad categories: (1) alkali-rich basic igneous rocks, (2) intermediate igneous rocks (trachytes), and (3) acid igneous rocks (rhyolites).

The intrusive diabasic rocks of Cambrian (?) or Ordovician (?) age found on Little Spencer Mountain have been considered in the section dealing with rocks of that age. These diabases have in turn been intruded by later igneous rocks of unknown age.

The later intrusives of Little Spencer consist of dark gray, silica-poor, alkali-rich basic rocks. These contain both non-descriptive glass and well formed crystals and are, therefore, hypocrystalline. The texture ranges between aphanitic and phaneritic, the latter including fine to medium-sized grains of green-black mafic minerals ("augite") and light gray to white feldspars. The augite crystals are commonly euhedral, but other dark minerals are anhedral. The feldspars usually occur as anhedral crystals, but sometimes as subhedral crystals. Most of these rocks are quite limy and react with acid. In several specimens poorly developed pyrite inclusions were noted. Most weathered surfaces are light gray, though some are brown; those that are phaneritic weather differentially, the mafic minerals decomposing more rapidly than the matrix.

The elongate sill extending from west of Big Spencer Mountain to Round Pond consists of gray to light brown rhyolites. Though these are most certainly different texturally from the Big Spencer volcanics, mineralogically they are essentially the same.

The acid igneous rocks of the sill are predominantly hypocrystalline, containing from 5 percent to 10 percent euhedral crystals of quartz up to one millimeter in diameter plus minor amounts of anhedral feldspar grains. Mafic minerals ranging from only a trace up to 5 to 8 percent are associated with these rhyolites. These invariably occur as anhedral, black and/or green, variable-sized bodies. The aphanitic ground mass representing devitrified glass is believed to consist of a mosaic of quartz and feldspar, predominantly orthoclase. These rocks weather light gray and are normally found in steep, highly jointed ridges.

Though the exact relationship of this sill with the Big Spencer volcanics is not known, lithologic and mapping evidence (Plate I) strongly suggest that the sill may well be a feeder extending from a main igneous body represented by Big Spencer Mountain.

The relationship between the sill and the large irregularly shaped intrusive body lying between Round and Salmon Ponds is not known. Similarities in both texture and mineralogy between the two bodies suggests they may well be continuous, though this interpretation is questionable (Plate I).

As noted above, the rhyolites comprising the stock are very similar to those of the sill, particularly in quartz and mafic constituents. The aphanitic ground mass differs in that it seemingly contains a larger percentage of feldspar and is more flinty in appearance. Weathering yields a gray or brown surface, and within the rock the mafic minerals decompose to a brown color. Several outcrops are light pink on fresh surfaces. This coloring results from numerous, very small, reddish-brown grains which are distributed throughout the ground mass. These probably represent a decomposed iron-rich constituent.

The dikes observed along the shore of Ragged Lake and on the fire station road differ in some respects, though each is hypocrystalline and contains euhedral phenocrysts of quartz in a quite flinty aphanitic ground mass. These acid igneous rocks may best be classified as rhyolites.

These dikes are greenish gray, the green resulting from the presence of about 15 percent green glassy ferromagnesian minerals. Besides this mafic mineral, no others have been observed. The quartz phenocrysts are half a millimeter to a millimeter in diameter and euhedral; the orthoclase phenocrysts are one to three millimeters in diameter and anhedral. The texture of the dike on northern Ragged Lake is unique in that its ground mass consists of numerous, small, plume-like structures made up of closely intergrown quartz and feldspar arranged in small, radially fibrous forms. These rocks weather light gray.

The dike that outcrops on the southwest shore intrudes the Seboomook slates. This dike consists of light gray, white-weathering rhyolites with about 15 percent euhedral orthoclase phenocrysts one to two millimeters in diameter and only a few percent quartz grains up to one millimeter in diameter. Also present are metallic sulfide inclusions, probably magnetite. The Seboomook slates adjacent to the rhyolites appear slightly baked for a distance of several inches from the contact, indicating low-grade contact metamorphism. These slates are dark grayish brown and weather rusty brown.

Intrusive rocks of distinctly different mineralogy and texture occur in the ridge-forming sill between Ragged and Caribou Lakes. These rocks are more intermediate in their mineralogy in that they are more acidic than the Little Spencer rocks but more basic than the rhyolites just described. These intermediate rocks are tentatively classified as "trachytes" (Williams and others, 1954, p. 93), and contain phenocrysts which consist of poorly developed, light gray anhedral grains of feldspar plus black or green mafic minerals, yielding an overall color of dark gray on a fresh surface. The quartz content is very low, less than 5 percent, and quartz phenocrysts are rare. On the other hand, the alkali feldspar content is about 75 percent. Texturally the rock is rather featureless, though some of the feldspars appear in plume-shaped bodies with a minor amount of glassy quartz disseminated between feldspar fingers. The surface of the rock weathers light brownish-gray. Where decomposition by solution has taken place within the rock, the feldspars have dissolved, leaving iron-stained voids, and the mafic constituents are oxidized to brown.

Age and Comparisons - Intrusives found associated with the Cambrian (?) or Ordovician (?) have previously been concluded to be of pre-Silurian age. Included in this group were the diabasic intrusive rocks found on Little Spencer Mountain. The age of the alkali-rich igneous rocks intruding the diabases of this area is not known. Similar igneous rocks have not been found elsewhere. The more basic mineralogy as well as the pyrite inclusions of these later intrusives sets them apart from intrusives of Devonian age. The inference is that these may well represent intrusions of Late Cambrian (?) or Ordovician (?) age rather than of Silurian or younger age, as mapping relationships (Plate I) suggest. West of Kidney Pond (Ragged Lake quadrangle) the Big Claw member strikes directly into intrusives of the Little Spencer complex, suggesting that some intrusions post-date at least part of the Silurian. If indeed these intrusives are all Cambrian (?) or Ordovician (?), then the contact as it is drawn may be explained in two ways: (1) by a fault contact, or (2) the intrusives represent a fossil cliff which was a positive feature during Silurian times, the Big Claw and Lobster

Lake being deposited at its base. The information available is not conclusive.

The similarity in the rhyolites comprising the elongate sill, the irregular intrusive body at the northern terminus of the sill, and the several dikes justifies the assumption that these were derived from the same magma source. This, in turn, infers a common age for these intrusives. Though their relationship with the Big Spencer volcanics is not known, the dikes and sill may be feeders extending from this large igneous mass. If this is so, then the same Lower Devonian age might be assumed for these rocks. That the dikes are post-Seboomook has been proved by the rhyolite intrusive on the southwest shore of Ragged Lake.

A study of intrusive rocks collected by Boucot from two localities near Big and Little Duck Ponds (North East Carry quadrangle) has shown them to be rhyolites quite similar in most respects to those in the Roach River syncline.

The intrusive body east of Ragged Lake is interpreted to be a sill, as it roughly parallels the bedding of the adjacent rocks. Since this sill is known only to intrude rocks of the Ripogenus formation, it can be dated as post-Silurian. A norm calculated for a rhyolite from Big Spencer Mountain showed that about 30 percent of the total rock was quartz. The small percentage of quartz found in the trachytes of this sill suggests dissimilarity between these and the other intrusives of the area.

VI. STRUCTURAL GEOLOGY

General Statement

The rocks of the Roach River syncline and adjoining areas are tightly folded. The major structural features have been produced by two main orogenies, the Taconian and Acadian. The Ordovician (?) and older strata in the area were folded, faulted, and metamorphosed before Silurian time. In places, the absence of some Silurian and Lower Devonian units may be ascribed to local unconformities. Toward the close of the Early Devonian, the Acadian orogeny again deformed the region, the Ordovician (?) and older beds being complexly refolded, and the Silurian and younger beds being also deformed.

The dominant structural features in the area include the doubly plunging Roach River syncline flanked on the northwest by the northeast-plunging Lobster Mountain anticline and on the east by the northwest-plunging Caribou Lake anticline. One relatively large northeast-trending fault cutting the Caribou Lake anticline and terminating in the Roach River syncline extends for a distance of about 14 miles. A maximum net slip of approximately 14,000 feet has been calculated from map and geometric data. This fault is believed to be an extension of one mapped by Griscom (thesis in preparation) in the adjoining Harrington Lake quadrangle. Minor faulting has been observed, one such fault being located in the Lobster Lake region. Igneous activity is evidenced by the general occurrence of mafic and felsic intrusive rocks and felsic volcanic rocks. Slaty cleavage is common in argillaceous rocks but uncommon in the more competent graywackes, quartzites, and limestones. The cleavage is steeply dipping, and with very few exceptions, strikes obliquely to bedding.

Methods Employed

A geologic map (Plate I) was first constructed from field data which included structural and lithologic information. From bedding attitudes and mapped thicknesses, a series of cross-sections (Plate IV) were next constructed. Structure contour maps on two horizons (Plates II, III) were made, based on the cross sections. Data provided by Boucot for the area to the southwest allowed extension of the structural interpretation from the Roach River syncline to the Deer Island anticline. The isopach maps of the sandstone (Plate V) and slate (Plate VI) facies of the Lower Devonian were constructed with thickness data taken from the cross sections.

The accuracy of the isopach and structure contour maps, then, is a direct reflection of the accuracy of the cross sections on which they are based. Although the cross sections themselves are largely interpretive, the geologic map is considered to represent a fair degree of accuracy, except in those areas designated by question marks. The heavy vegetation and glacial cover in northern Maine necessitates a certain amount of projection between outcrops. Plunge magnitudes were measured from the intersection of cleavage and bedding, and the measured figures were generally larger than those calculated from the structure contour maps. The former are therefore attributed to minor drag folding superimposed upon the major folds. Plunge figures given in the following sections are those calculated from the structure contour maps.

Folding

The structure of the area is dominated by three features: from west to east, the Lobster Mountain anticline, the Roach River syncline, and the Caribou Lake anticline (Plate II). These consist of open, plunging folds, slightly asymmetrical and very roughly parallel, striking northeast through the southern half of the mapped area and north-northwest in the northern half.

Lobster Mountain Anticline

The most extensive and topographically prominent fold is the Lobster Mountain anticline, which strikes generally N 20° E. Its angle of plunge is shallow in the vicinity of the southern shore of Lobster Lake (North East Carry quadrangle) being approximately 8 degrees to 10 degrees, then steepens to 25 degrees before plunging beneath gray slates of the Seboomook formation two miles northeast of Lobster Lake (Ragged Lake quadrangle). The Lobster Mountain anticline is known to continue southwest at least as far as Somerset Junction (Brassua Lake quadrangle), a distance of 25 miles, and is interpreted to extend an additional 50 miles in a southwesterly direction. This fold varies in width from five miles at Lobster Lake to six miles on Moosehead Lake (Moosehead Lake quadrangle). Its width farther to the south is not known, as the southeast limb of the anticline has not been mapped.

The oldest rocks exposed along the axial trace of the Lobster Mountain anticline are those assigned to the Cambrian (?) or Ordovician (?). These consist predominantly of complexly folded, black, rusty-weathering, soft slates, plus minor amounts of green phyllite, dark quartzites, and intrusives.

Attitudes are steep and highly variable in the strata of this formation, ranging between 50 degrees and 90 degrees. The strike of both bedding and cleavage reflects the northeast structural trend, though dips are commonly reversed in a short distance. These lithologies erode readily, resulting in low, flat-lying topography which lies roughly southeast and east of the anticlinal axis trace. Lying northwest and west of the axial trace are the Lobster Mountains, which consist predominantly of a complex series of volcanic rocks. This relationship (the Lobster Mountain volcanics to the northwest and the Cambrian (?) or Ordovician (?) to the southeast of the axial trace) holds only as far south as the north shore of Moosehead Lake, where the Lobster Mountains terminate. The volcanics comprising Lobster Mountain are predominantly rhyolites plus minor amounts of other felsitic and basaltic lithologies. These rocks are tough and resist weathering; consequently, they are prominent topographically.

Unconformably overlying the sediments and volcanics which are found in the core of the Lobster Mountain anticline are representatives of the Silurian and Lower Devonian. The basal Big Claw member of the Lobster Mountain formation of Upper Silurian age defines the northern portion of the anticline. The Big Claw dips off the northwest limb at an angle of approximately 55 degrees; this shallows to 30 degrees around the anticlinal nose and maintains this attitude along the southeast limb to Kidney Pond (Ragged Lake quadrangle), where a dip of 25 degrees is recorded. From these observations the axial plane of the anticline is concluded to dip steeply to the southeast. Erosion of Upper Silurian beds of the Lobster Lake formation prior to deposition of Oriskany age sediments has resulted in the unconformable contact of the Seboomook and Tarratine formations with the volcanics found along the northwest limb of the Lobster Mountains beginning at a point east of Norcross Mountain (North East Carry quadrangle) and extending to the southwest. The same unconformable relationship is assumed to occur between the Seboomook and Cambrian (?) or Ordovician (?) formations along the southeast flank of the anticline, beginning south of Little Spencer Mountain (North East Carry quadrangle) and continuing southwest to the area east of Spencer Bay (Moosehead Lake quadrangle), where Boucot (in preparation, A) has mapped Silurian lithologies.

Roach River Syncline

Lying to the east, and essentially paralleling the Lobster Mountain anticline, is the Roach River syncline. This doubly plunging structure is moderately asymmetric, and the axial trace roughly resembles an inverted "S". The strike of the axis in the northern sector of the mapped area at Big Pine Pond (Ragged Lake quadrangle) assumes an attitude of about N 35° W, and, after some changing of bearing to the south, strikes N 45° E in the vicinity of the Roach River (Roach Pond quadrangle) (Plate II).

The Roach River syncline has been traced for a distance of 24 miles. Its northern extremity has not been studied, but it may continue as far in a northwesterly direction as the inferred termination of the Caribou Lake anticline. This would extend the overall length to about 30 miles. The syncline has a shallow plunge at both ends. The plunge at the northern terminus is 13 degrees south; it continues for some 12 miles to the vicinity of Big Spencer Mountain (Ragged Lake quadrangle) where the syncline reaches its maximum depth. At this point, the direction of plunge is reversed to the north with a magnitude of about 15 degrees. This plunge is maintained south for eight miles to Roach River (First Roach Pond quadrangle), where it becomes horizontal. The syncline then extends to the southwest horizontally for nine miles to Deer Island where Boucot (in preparation, B) has mapped the northeast plunging Deer Island anticline (Moosehead Lake quadrangle). At this point, the Roach River synclinal axis bifurcates, the two traces striking into the intrusive complex comprising Squaw Mountain.

The greatest width attained by the Roach River syncline is seven miles (Plate I, section C-C'). This width narrows to about five miles at the northern end of the syncline. South of Roach River the width is questionable owing to granite intrusives which cut the southeastern limb of the syncline; by projection, an original structural width of about four miles may be assumed.

The oldest sediments exposed in the Roach River syncline are of Silurian age, and the youngest are of Lower Devonian age. Silurian beds define the east and west limbs of the syncline, the Lobster Lake formation of Upper Silurian age along the west limb and the Ripogenus formation of Middle Silurian age along the east limb. To the east, attitudes in the Lobster Lake formation range from 24 degrees to 44 degrees. Cross sections and structure contouring suggests that the beds along this limb steepen at depth, particularly in the Spencer Mountains region (Plate IV). Dips in the beds of the Ripogenus formation range from 30 degrees to 60 degrees, the beds being steeper to the north of Ragged Lake and shallower to the south. These variations in dip reflect the asymmetry of the fold. South of Big Spencer Mountain where the syncline plunges north, the axial plane dips steeply west, but to the north the west limb is the more shallow and the axial plane dips to the east.

The gray slates and cyclically banded cark-colored sandstones and slates of the Seboomook formation are the predominant rocks which outcrop within the Roach River syncline. Bedding in the slates is observable only where sand lenses are present, and characteristically the angle of dip is very steep, ranging from 50 degrees to 90 degrees and in places is overturned. An exception to this is found on the northwest limb, where dips as shallow as 28 degrees have been observed. The attitudes recorded from the various outcrops of the Seboomook apparently reflect very well the general northeasterly trend of the Roach River syncline, and to a lesser degree, the position of the axial trace. In general, dips recorded in the Roach River (First Roach Pond quadrangle) area and to the south are noticeably steeper than those to the north, which may indicate that the beds to the south were subjected to greater compressional forces during folding.

During deposition of the clastics comprising the Seboomook formation, there was a rapid thickening of material from the vicinity of the Lobster Mountain anticline eastward (Plate IV) across the present Roach River syncline. In a distance of six miles, the formation is interpreted to expand rapidly from zero feet to 12,000 feet in thickness (Plate VI). The Acadian orogeny and subsequent downwarping of this wedge-shaped section of sediments has produced a highly asymmetric syncline. Therefore, the asymmetry of the syncline as reflected by Seboomook slates results from both orogenesis and anomalous stratigraphic relations.

In the central portion of the Roach River syncline extending from Jewett Pond (First Roach Pond quadrangle) northward to Big Pine Pond (Ragged Lake quadrangle) are found sandstones of the Tarratine formation. These grade both laterally and vertically into the Seboomook formation. The Tarratine in this area is certainly younger than the lower Seboomook and, at least in part, is stratigraphically equivalent to the upper Seboomook formation. The graywacke sandstones of the Tarratine are very massive and resistant to weathering, forming ridges that trend north-south. The Seboomook slates, on the other hand, weather readily and produce low topography. Black Cap Mountain (Ragged Lake quadrangle) is composed of steep, westward-dipping, massive sandstones of the Tarratine, the topography rapidly becoming less prominent in all directions as a higher percentage of slate is encountered. Bedding is difficult to observe in the Tarratine due to the massiveness of the lithology, but attitudes can be recorded where slates are interbedded with the sandstones. For the most part, the Tarratine is steeply dipping and displays the same asymmetric characteristics as the Seboomook. A few reversals of bedding recorded in the sandstones have been attributed to drag folding along the flanks of the syncline.

The Misery member of the Tarratine formation is a thin, ridge-forming, orthoquartzitic sandstone. Its stratigraphic position (Boucot, in preparation, A) and pronounced resistance to weathering make it useful in interpreting the structure of the Roach River syncline. This quartzite has not been located in the northern or western sectors of the syncline, but along the eastern limb and southern extremity of the fold it is seen (Plate I) to reflect the structure.

In the vicinity of Kokadjo (First Roach Pond quadrangle), the Roach River formation consists of a series of varicolored siltstones and sandstones which apparently grade both laterally and vertically into the Seboomook formation. In contrast to the Tarratine, the Roach River formation, like the Seboomook, is soft and weathers readily to yield low relief.

Caribou Lake Anticline

Of the dominant structural features in the area, the least information has been recorded on the extent and configuration of the Caribou Lake anticline. This structure lies to the east and north of the Roach River syncline and the northern end apparently strikes diagonal to the axial trace of the Lobster Mountain anticline (Plate II).

The axial trace of the Caribou Lake anticline north of Ragged Stream (Ragged Lake quadrangle) strikes N 40° W and is interpreted to extend for about 13 miles, plunging to the northwest at about 11 degrees along its entire length. The exact form and location of the nose of the structure is not known since no traverses have been made into the area where the nose should be located, but is presumably in the vicinity of the Big Pine Flowage (Ragged Lake quadrangle). The contacts shown on the map (Plate I) are drawn from topographic relations. Since no data has been collected in the area south of the road from Grant Farm (Ragged Lake quadrangle) to Ripogenus (Harrington Lake quadrangle), the character of the southern end of the Caribou Lake anticline is not known. Griscom (thesis in preparation) mapped lithologies of Cambrian (?) or Ordovician (?) and Silurian age whose attitudes suggest a continuation of the northeast limb of the anticline into the Harrington Lake quadrangle. These beds are known to strike into granite intrusives.

South of Ragged Stream the west limb of the Caribou Lake anticline bends to the south and presumably continues on a bearing of N 20° E to the vicinity of First Roach Pond (First Roach Pond quadrangle), where it strikes into intrusives comprising the Lily Bay and Number Four Mountains. This extends the structure an additional 15 miles for a total of 28 miles, the southern half of the fold striking essentially parallel to the Roach River syncline.

A maximum width of about seven miles is mapped for the Caribou Lake anticline. This distance is measured along a line perpendicular to the axial trace of the fold which extends from a point north of Ragged Lake Dam to the east shore of Chesuncook Lake (Ragged Lake quadrangle) near Holmes Hole. South of this area, the width of the anticline is not known. The granite intrusives mapped by Griscom are assumed to be present along the east limb of the anticline south of the Harrington Lake quadrangle.

The oldest beds exposed by the Caribou Lake anticline are those of Cambrian (?) or Ordovician (?) age. The exposed rock types of this age include: red, green and black slates, dark quartzites, a few carbonate beds, and numerous igneous rocks consisting of basalts and diorites. Dips within these rocks are normally steep, ranging from 40 degrees to 90 degrees. Cleavage is also steep, ranging between 60 degrees and 90 degrees. The strikes recorded with both bedding and cleavage are exceedingly inconsistent and show no apparent pattern. For this reason the structural and stratigraphic relationships of the various lithologies within the Cambrian (?) or Ordovician (?) have not been resolved.

Overlying the Cambrian (?) or Ordovician (?) with angular unconformity are the limestones and sandstones comprising the Ripogenus formation of

Middle Silurian age. This formation is presumed to outline the Caribou Lake anticline completely, except where intruded by granite, and is characterized by shallow-dipping beds along the northeast limb and steeply dipping beds along the west limb. Attitudes range from 20 degrees to 25 degrees along the northeast flank and from 35 degrees to 65 degrees along the west limb, except where drag folding occurs. The drag folds mapped between the southern end of Ragged Lake northwest to Deer Pond (Ragged Lake quadrangle) are probably responsible for the irregularities in bedding attitude in that area. Anomalous plunges calculated with a stereo net from cleavage and bedding data suggest that the drag folding in this region may be appreciably more complex than that which is mapped. The difference in attitudes along opposing limbs of the anticline indicate an asymmetrical structure with the axial plane dipping steeply to the northeast. The Ripogenus formation erodes to form moderately low topography that is higher than the topography formed by the overlying Seboomook but lower than that of the underlying Cambrian (?) or Ordovician (?).

Faulting

Criteria indicating significant faulting in the area have been observed. The Chesuncook-Ragged fault, largest in extent and displacement, cuts south transversely across the Caribou Lake anticline (Ragged Lake quadrangle) to the vicinity of Ragged Lake Dam. At the dam the fault begins to parallel bedding and becomes longitudinal as it continues south. Faults of lesser magnitude have also been mapped, particularly along the west shore of Lobster Lake (North East Carry quadrangle) as well as on the shores of Ragged and Caribou Lakes.

Chesuncook-Ragged Fault

This fault extends from a point in the Roach River syncline approximately three miles southeast of Big Spencer Mountain northward on a bearing of N 33° E to the east shore of Chesuncook Lake (Ragged Lake quadrangle) one-quarter of a mile south of Holmes Hole. Griscom (thesis in preparation) has mapped a fault in the Harrington Lake quadrangle to the east which is assumed to be a continuation of the one mapped by this writer. This gives the fault trace a total length of roughly 19 miles.

The actual fault plane has been observed in two localities, both at the south end of Caribou Lake. The first is located on the northeast tip of a point of land which lies to the east of the Ragged Stream outlet. The second exposure is located in the cove which marks the outlet of Ragged Stream. In both of these localities, data were collected which indicated the presence of a thin sliver of the Ripogenus formation (Plate I). The fault plane in these exposures dips essentially vertical, and is interpreted to continue as a vertical plane along its entire length. A vertical attitude is further suggested from the map pattern of this fault. Slickensides or other features indicating the direction of relative movement were not found.

As would be expected in such a complexly folded area, several formations are cut and displaced by this extensive fault. The southern termination of the fault is believed to be in the great thickness of Seboomook located in the Roach River syncline. The evidence for a second sliver of Ripogenus formation which is faulted into the Seboomook of the Roach River syncline is found largely along the Spencer Mountain fire station road (Ragged Lake quadrangle). Here the normal sequence of

Seboomook slates and sandstones is interrupted by a series of dark gray carbonate-rich slates, which have been assigned to the Silurian. The absence of typical basal quartzites and conglomerates normally associated with the lower Ripogenus formation suggests that only the upper strata of the unit are present in this fault sliver. Anomalous attitudes recorded in the area further substantiate the southward continuance of the fault. East of Ragged Lake the Chesuncook-Ragged fault cuts diagonally across the west limb of the Caribou Lake anticline before striking northward into rocks of Cambrian (?) or Ordovician (?) age. From here the fault continues on a northeast bearing defining the north contact of the sliver of the Ripogenus formation which is exposed on the southwest shore of Caribou Lake. This sliver contains a white quartzite member, basal conglomerates, and limestones, and is interpreted to be the lower counterpart of the sliver of upper Ripogenus which is faulted into the Seboomook formation of the Roach River syncline. The lower Ripogenus sliver unconformably overlies the Cambrian (?) or Ordovician (?) which is the normal relationship for this region. Boucot (1954, p. 145) mapped a small outcrop of Silurian-type limestones on the west shore of Chesuncook Lake opposite Holmes Hole. This is interpreted as an isolated sliver of Ripogenus formation bounded to the north by the main fault and to the south by a secondary minor fault. Presumably this sliver was first vertically displaced downward by faulting, as in a graben, then left in its present position when the main body of the southern block of Ripogenus was moved to the northeast relative to the north block, which was displaced to the southwest. Beyond this point, the major fault bends to a N 60° E bearing and continues to cut the northeast limb of the Caribou Lake anticline until it ultimately terminates in the Seboomook formation of the Harrington Lake quadrangle (Griscom, thesis in preparation).

Graphic calculations and measurements were made directly from maps based on the outcrop distribution and bedding attitudes of the faulted Ripogenus formation on the opposing limbs of the Caribou Lake anticline. The Chesuncook-Ragged fault is assumed to cut across the anticline transversely. The beds in the north block are displaced southwest with respect to those in the south block; therefore, the fault is left-handed. On the southwest limb of the Caribou Lake anticline the relative movement between opposing blocks on either side of the fault trace is the same as on the northeast limb. However, on the southwest limb the fault intercepts the Ripogenus formation diagonally at the point where the strike of the formation changes from northwest to southwest. This results in the peculiar map distribution of the formation (Plate I), and complicates the measurement of displacement in the area. In view of this, the following figures for relative movements are approximate.

Using descriptive geometry (Billings, 1954, p. 474), the net slip along the fault was calculated as 12,600 feet and its plunge as roughly 4 degrees to the northeast. From the very low angle of plunge, it can be concluded that the net slip is essentially all strike slip. Due to the similarity in bedding attitudes within opposing blocks, the fault movement is interpreted as translational rather than rotational. On the southwest limb, measurement of mapped relationships shows a strike slip of 15,000 feet, an offset of 1,000 feet, and an overlap of 1,140 feet. These magnitudes appear reasonable when compared to the calculated net slip of 12,600 feet. On the northeast limb the strike slip was found to be approximately 10,000 feet, the gap 1,580 feet, and the offset 10,010 feet. The difference between the net slip measured on the southwest limb and that on the northeast limb is about 5,000 feet. It is evident that maximum movement along the fault took place in the Ragged Lake area, displacement becoming less as the fault continues to the northeast and southwest and finally dying out in Seboomook shales at both ends.

Before attempting to explain the mechanics involved in the Chesuncook-Ragged fault, the relationship of the axial trace of the Caribou Lake anticline with the fault trace must be reviewed. As noted above, the fault cuts the southwest limb of the fold diagonally and the northeast limb transversely. As a result of this differing relationship with strata on opposing limbs of the fold, the question of whether the axial and fault traces intercept each other diagonally or perpendicularly is raised. If it could be shown that this is truly a diagonal fault, then with the application of Anderson's (1951) stress ellipsoid theory, the mechanics of the fault might readily be explained. If it is found that the fault is essentially perpendicular with respect to the fold axis, then some other explanation must be attempted.

Prior to confronting this problem, the fault trace was interpreted as cutting the fold axis at an angle of approximately 70 to 75 degrees, therefore more nearly perpendicular than diagonal. Nevertheless, due to the highly interpretive nature of these figures, Anderson's theory was applied. The compressive forces that folded the Caribou Lake anticline are assumed to have also caused the fault, and displacements are assumed to be strike slip movement, one set right-handed and the other left-handed. In theory, then, the strike shear fault more nearly paralleling the Caribou-Ragged fault must be right-handed. Since the mapped fault is left-handed, it is apparent that it does not exhibit the simple relations to be anticipated from Anderson's theory. The axial trace of the fault may therefore be concluded to be essentially perpendicular. According to Billings (1951, p. 281), there are several possible reasons why the theory presented by Anderson may not be applicable to some strike-slip faults. (1) The theory assumes that the same forces caused the initial rupture and also caused the movement along that rupture. Also it is assumed that the fault and fold are genetically related. What very well may happen is that the fractures form under one set of forces but the actual movement takes place under different forces. In fact, this concept seems quite likely to be applicable here when one considers the isolated sliver of Silurian lithology on Chesuncook Lake which presumably was faulted down prior to strike slip displacement, suggesting two distinct and separate movements. (2) The theory assumes that the region being deformed was essentially homogeneous, or at least could be treated as such. A review of the number of formations intercepted by the fault and the involved lithologic variations would suggest that the area was not homogeneous. In fact the discrepancies in relative movement at different points along the fault suggest that the area was heterogeneous. Presumably, if the region were perfectly homogeneous, rupture and any subsequent movement would probably be more nearly uniform. This, of course, assumes translational movement, as any rotational movement could equally well explain such discrepancies.

In summary then, Anderson's theory does not seem applicable to the Chesuncook-Ragged fault. The most likely interpretation seems to be that the fault trace intercepts the axial trace at about 90 degrees, that the fault plane dips vertically, that the southeast block moved north in relation to the northwest block, that at least two separate sets of forces were involved, and that the movement was predominantly strike slip.

Minor Faults

Evidence for several minor faults have been observed in the area of this study. The largest of these is located in the Lobster Lake region.

Though the fault trace at Lobster Lake has not actually been observed, its existence is inferred from the abvious displacement of the Big Claw member of the Lobster Lake formation, plus the anomalous thickening of this formation along the north shore of Lobster Lake. The fault trace is interpreted to be roughly four miles long and to strike N 20° E. It cuts the northwest limb of the plunging Lobster Mountain anticlinal nose transversely and intercepts the axial trace diagonally. The block west of the rupture has been displaced to the north with respect to the east block, making this a right-handed fault. The fault is thought to continue through the Lobster Lake formation to the north into the overlying Seboomook formation to a point one mile north of Sunset Point, where it dies out. Its southern extremity is presumed to lie somewhere within the slates and phyllites of Cambrian (?) or Ordovician (?) age in the vicinity of the southwest shore of Lobster Lake. Since the fault plane has not been observed, an estimate of the magnitude and attitude of the net slip was not made. From mapping relationships a strike slip of 2,900 feet is measured.

Very small faults have been observed in two places. On the east shore of Caribou Lake at a point approximately one mile south of the narrows joining Chesuncook and Caribou Lakes, a diorite mass is in fault contact with green slates and gray quartzites of Cambrian (?) or Ordovician (?) age. The fault strikes N 28° W and dips 80 degrees north. A second small fault is located on a tip of land on the west shore of Ragged Lake lying some 0.7 of a mile in a direction north-northeast from the northern end of Berry Pond. Though the fault trace was not observed, two discordant attitudes measured in Tarratine sandstones within a very short distance apart justify such an interpretation. The fault trace is believed to strike northeast and to represent very little displacement.

Minor Structures

Numerous secondary structural features occur in the area. Minor structures on which data were collected include slaty cleavage, drag folds, deformed fossils, and tension fractures.

Slaty Cleavage

Most sedimentary rocks within the Ragged Lake syncline and adjacent anticlines are highly cleaved. The cleavage planes characteristically dip steeply at magnitudes ranging from 45 degrees to 90 degrees. The strikes of cleavage planes within the Silurian and younger formations roughly parallel structural trends except around plunging noses, where the planes are diagonal to the fold axes. Cleavage attitudes in Cambrian (?) or Ordovician (?) beds are apparently random, perhaps a reflection of refolding during the Acadian orogeny. The steepness at which cleavage planes dip is apparently a function of the rock texture; the finer the grain size, the steeper the dip. The massive sandstones often display no cleavage, whereas any interbedded argillaceous strata display numerous cleavage planes dipping as steeply as 80 degrees to 90 degrees.

A wide range of cleavage development has been observed. Several formations (e.g., the Seboomook), characteristically display cleavage planes which are almost parallel and which break off into thin plates of one to two millimeters thick. In contrast are some of the sandy slate beds closely associated with the Tarratine sandstones. These cleave into very irregular and discontinuous planes which cause the rock to break into roughly elongate rectangular particles. The slates and phyllites of Cambrian (?) or Ordovician (?) age are typically highly cleaved and display well defined planes. These cleavage planes are normally very contorted and cause the rock to appear crinkled.

No appreciable displacement along cleavage planes has been recorded, though minor lineations on these planes, perhaps resulting from slippage of one plane over another, have been observed in pre-Silurian slates. Secondary cleavage has been found at several localities, particularly in Cambrian (?) or Ordovician (?) strata. This secondary cleavage cuts the primary cleavage plane at a steep angle in most places; it apparently is the result of refolding and makes a crinkled appearance. Cleavage planes within the various slates are often stained brown with iron oxide. At several localities where fine-grained cleaved rocks are found, a large amount of fine micaceous material has been noted along the cleavage planes.

The relationships between the various cleavage attitudes recorded throughout the Roach River syncline are inconclusive. The best indication of any continuity is found along the east limb of the syncline, where a steep (55° to 83°) west-dipping cleavage pattern prevails. Cleavage attitudes along the west limb of the syncline do not seem to fit any pattern, although the majority of cleavage planes along this limb dip to the east and all dips are steep. Many of the anomalous dip attitudes are interpreted as the result of drag folding.

Lineations resulting from the intersection of bedding and cleavage planes were observed and their attitudes measured in the field. When not actually observed, bedding and cleavage attitudes were recorded and plunges were calculated using a stereo net. Again, the results were inconclusive due to sparse information. However, the few existing plunges reflect regional trends fairly well, particularly for the doubly plunging Roach River syncline, though the magnitude of plunge was often as much as twice that interpreted from the structure contour maps (Plates II, III). This discrepancy is attributed to minor drag folding.

Drag Folds

Small drag folds have been observed at only a few localities, particularly in argillaceous sediments of the Seboomook and Cambrian (?) or Ordovician (?). These are well exposed along the southern shore of Caribou Lake (Ragged Lake quadrangle) and the banks of the Roach River (Moosehead Lake quadrangle). Little significance is placed on their reflection of major structure, though the axes of drag folds within the Seboomook formation along the Roach River roughly parallel those of the major folds but plunge at a greater angle than the estimated regional plunge. Larger drag folds are apparently quite common throughout the mapped area as suggested by the large number of anomalous dips recorded in all formations. Too few drag folds were observed and too little data collected to note any particular significance in their attitudes.

Tension Fractures

Numerous fractures have been observed in the Roach River syncline area, though no data was collected on their attitudes. They are particularly prominent in the more competent rocks, including several of the rhyolite bodies. The fractures associated with arenaceous beds are commonly filled with milky white quartz, and those with carbonate-rich beds are filled with calcite. These tension fractures are presumably the result of regional compression; characteristically they strike normal to bedding and cleavage and dip almost perpendicularly. According to Billings (1954, p. 96) these might best be classified as extension fractures.

Deformed Fossils

The fossils collected from each of the three fossil localities in the Roach River syncline (Plate I) were deformed to some degree. Stretching of plicated brachiopods along the axis of least compression is estimated to be as much as 25 percent for some shells. A median rib on a plicated brachiopod (*Chonetes canadensis*) has been observed to be deformed as much as 30 degrees from its original position. These observations are in accordance with those of Boucot (in preparation, B), in which he noted that originally hemispherical brachiopods were flattened to as little as one-third their original thickness. A distorted crinoid columnal collected from Ragged Lake is estimated to be compressed 2.75 millimeters along the minor axis of the resulting ellipse and elongated a like amount along the major axis. Assuming an original circular diameter of 9.75 millimeters, a deformation of 22 percent is calculated.

VII. HISTORICAL GEOLOGY

The geologic history of the Roach River syncline area includes two known orogenies, an erratic deposition of sediments marked by facies changes, periods of non-deposition and erosion, igneous activity that formed both intrusive and extrusive bodies, and glaciation which has left a thick blanket of debris over much of the area.

Pre-Silurian

The oldest rocks occurring in the area of this study are those of Cambrian (?) or Ordovician (?) age. Since no fossils have been found within this sequence of rocks, its exact age is not known. Evidence which establishes these rocks as pre-Silurian in age stems largely from stratigraphic relations with overlying sediments, these to be considered later. This sequence of rocks may possibly include some rocks of pre-Cambrian age.

Slates and phyllites, dark gray quartzitic sandstones, a few carbonates, and light- and dark-colored igneous rocks make up this unit. The igneous rocks intrude the sedimentary rocks, and are consequently younger. In at least one locality, later intrusives cut earlier intrusives, suggesting that two periods of igneous activity may have affected the rocks of Cambrian (?) or Ordovician (?) age. These later intrusives may well be Lower Devonian in age.

Too little is known about the lithology and structure of this unit to warrant subdividing it stratigraphically. Therefore, no attempt is made to reconstruct the sequence of environments under which the sediments were deposited or the igneous and sedimentological relationships.

Toward the close of the Ordovician, or following it, northwestern Maine was strongly affected by the Taconic orogeny. Evidence for this orogeny in the Roach River syncline is two-fold: (1) a pronounced angular unconformity exists between rocks of Silurian age and younger and those of pre-Silurian age; (2) pre-Silurian rocks are notably more altered than overlying rocks.

Stratigraphically between rocks of post-Ordovician age and rocks of pre-Silurian age is a unit of volcanic rocks, the Lobster Mountain volcanics. The absence of fossil evidence renders their dating questionable, but they are interpreted as post-Taconic. This conclusion hinges on the general absence of cleavage, which presumably excludes these volcanics from the highly cleaved rocks of Cambrian (?) or Ordovician (?) age.

Lithologically the Lobster Mountain volcanics include both porphyritic and non-porphyritic rhyolites, dark-colored greenstones, and lesser amounts of pyroclastics (conglomerates and tuffs). These were probably extruded under subaerial conditions as suggested by the virtual absence of marine fossils in the pyroclastics.

Silurian

Unconformably overlying the Cambrian (?) or Ordovician (?) is a series of red beds consisting of conglomerates, argillaceous and orthoquartzitic sandstones, siltstones, and shales. In the Lobster Lake area these are placed within the Big Claw member of the Lobster Lake formation, of Silurian age. Outlining the Caribou Lake anticline are basal red beds of the Ripogenus formation which display the same relationship with the underlying pre-Silurian rocks as does the Big Claw. These two red-bed sequences are considered stratigraphic equivalents. In the Lobster Lake area the field relationships suggest that an angular unconformity exists between the pyroclastics of the Lobster Mountain volcanics and the Big Claw member.

The Big Claw member and the basal red beds of the Ripogenus formation are terrestrial units, deposited unconformably on the older units under oxidizing conditions as evidenced by a large amount of hematite, the absence of marine fossils, and the textural and mineralogical relationships occurring within these rocks. The nature of the conglomerate beds suggests very rapid deposition. Various clastics were derived from adjacent positive features, one of which was the Lobster Mountains. The basal units grade upwards into argillaceous materials which were presumably deposited under lagoonal conditions preceding the extensive marine envasion that ultimately deposited the overlying carbonate section.

The erratic distribution of the Lobster Lake formation (including the Big Claw member) and the Ripogenus formation may be the result either of widespread distribution with subsequent removal prior to deposition of younger beds, or of patchy deposition within local basins of limited areal extent. Both factors must have influenced deposition during Silurian times. The difficulty in correlating between the Lobster Lake and Ripogenus formation across the Roach River syncline may be explained by the occurrence of at least one unconformity during the interval of deposition of these formations.

The first well-dated Silurian in the area is the Chesuncook limestone of Middle Silurian age. The Chesuncook is part of the Ripogenus formation, which includes a basal conglomerate, argillaceous limestones, red and green slates, dark gray slates, arenaceous limestones, and a white orthoquartzitic sandstone that divides the Ripogenus into upper and lower portions. The limited distribution of this sandstone, the absence of an upper limestone unit at Ripogenus Dam, and the absence of known Middle Silurian lithologies in the Lobster Lake region all suggest an unconformity. However, these same phenomena might alternately be explained by lateral facies relationships.

The Lobster Lake formation, of Upper Silurian age, includes argillaceous limestones, carbonate-rich slates, siltstones, sandstones, and lesser amounts of limestone conglomerates and quartzitic sandstones. Both the Lobster Lake and Ripogenus formations were deposited in an area where fine and medium-grained terrigenous material was being deposited together with a substantial amount of carbonate material, and the presence of corals in some limestones suggests an environment of shallow marine waters.

The problem of whether or not the rocks assigned to the Seboomook formation of Oriskany age are instead partly of Silurian age remains a dilemma. From mapping relationships post-Silurian age sediments are interpreted unconformably to overlie the Lobster Lake formation, including its Big Claw member, and the Ripogenus formation, and are believed to hold this same relationship with the Lobster Mountain volcanics. The patchy distribution of strata of pre-Oriskany age suggests that significant erosion took place at this time.

Oriskany

Sedimentation during this time is marked by both lateral and vertical gradations from one formation into another, and the resulting strata, though stratigraphically equivalent, reflect variations in environment and source. Rocks of this age have been assigned to three formations -- the Seboomook, Roach River, and Tarratine.

Of the formations mapped in this report, the Seboomook is the most extensive, both in area and volume. Its thickness is estimated to expand from zero feet along the flanks of the Lobster Mountain anticline basinward to a maximum of 12,000 feet (Plate V). The Seboomook has been divided into an upper and lower portion. The lower portion consists of cyclically banded slates and sandstones, the upper portion of slates.

Grading both laterally and vertically into the Seboomook is a series of extremely argillaceous, poorly cemented, porous, hematite-rich, brown and purple color sandstones and siltstones which are assigned to the Roach River formation. This formation is assumed to be stratigraphically equivalent to the lower Seboomook and to be stratigraphically lower than the Tarratine formation.

The Tarratine formation grades laterally and vertically into the slates of the Seboomook formation. The Tarratine predominantly consists of greenish-gray, fine-grained, well cemented, ridge-forming, very argillaceous graywacke sandstone. Interbedded with this sandstone are blue-gray slates typical of the Seboomook, the formation boundary being drawn where in percentage the slates equal the sandstones of the Tarratine formation. The Tarratine formation, which occupies the center of the Roach River syncline, represents the youngest sediments in the area, excluding Pleistocene glaciation. The Tarratine is thought to be stratigraphically equivalent to the upper portion of the Seboomook. The Misery member, a discontinuous series of quartzitic sandstones, divides the Tarratine into two parts. The base of the Misery is located some 2,000 feet above the base of the Tarratine and its persistence at this stratigraphic level within the Tarratine makes it a key horizon in interpreting the area's structure. Its absence in the northern half of the Roach River syncline results from a lateral facies change into typical Tarratine graywackes. The maximum thickness attained by the Tarratine is estimated to be less than that of the Seboomook, and isopach (Plates V, VI) relations of the two formations suggest that where one thickens the other thins.

The Seboomook slates were deposited in relatively deep marine waters, as suggested by the absence of shelly benthonic fauna, lack of limestones, dark color, fine-grained texture, graded bedding, and high clay content. The Tarratine sandstones, on the other hand, have several characteristics typical of shallow, warm marine deposits, including a relatively large number of fossils, a coarse-grained texture, and cross bedding indicating some current action. The quartzites of the Misery member probably represent a period of stability during which deposition was very slow and current action was winnowing out the finer fractions, which were carried to deeper waters.

Thin sandstones cyclically interbedded with slates predominate within the lower portion of the Seboomook formation. These are gradational in texture, the coarser grains grading upwards into finer, and may well indicate deposition by turbidity currents.

The Tarratine formation, then, is apparently a coarser grained, shallow-water equivalent of the finely textured deep-water deposits of the Seboomook formation. The coarser sandstones were deposited along the marginal zones of the existing positive features and were subjected to current actions, while the finer fractions were being deposited in quiet, deeper waters. These conditions are typical of a geosynclinal environment.

The source area for the large volume of clastics comprising the Seboomook formation as well as its mode of transportation remains an unanswered problem. Certainly some material was locally derived from such positive features as the Lobster Mountain anticline, though the large majority of it must have been derived from unknown sources.

Though laterally equivalent to the Seboomook formation, the Roach River formation is decidedly different in lithology and genesis. It consists predominantly of varicolored hematite-rich siltstones and argillaceous sandstones up to 9,000 feet thick. A shelly benthonic fauna has been found within this formation. Therefore, the clastics comprising the Roach River are assumed to be derived from a local positive feature after first being weathered in an oxidizing environment, then deposited in adjacent shallow marine waters.

Overlying as well as intruding rocks of Oriskany age are several igneous bodies of post-Oriskany and pre-Acadian age. Whether significant erosion of Oriskany strata occurred prior to this third period of igneous activity (the Little Spencer Mountain intrusives being the first, and the Lobster Mountain volcanics the second) is not known.

Post-Oriskany

No stratified rocks of Middle Devonian age or later exist in the Roach River syncline area. The only surviving representatives of geological time since the Oriskany are a group of igneous rocks and a layer of Pleistocene deposits.

The rhyolitic volcanics of Big Spencer Mountain, including several sills and dikes as well as a large stock which are interpreted to be feeders branching from the main body of the Big Spencer volcanics, are Early Devonian in age. Boucot (in preparation, A) has observed sediments of Lower Onondaga age overlying Kineo-Big Spencer-type volcanics in the Moose River synclinorium, suggesting that these volcanics may be intermediate between Oriskany and Onondaga times. This same relationship is reported by Rankin (oral communication with Boucot, 1959) in the Traveler Mountain region to the northwest. A "trachyte" sill of intermediate mineralogy lies between Ragged and Caribou Lakes. Though this sill has been mapped as intruding only Silurian age strata, it is interpreted as contemporaneous with the other Lower Devonian intrusives.

Towards the close of Early Devonian time the last major orogeny in northwestern Maine occurred. This orogeny, the Acadian orogeny, refolded the Ordovician (?) and older strata and folded the Silurian and younger formations.

VIII. ECONOMIC CONSIDERATIONS

At the present time the only commercial activity in the Roach River syncline area is that associated with the paper industry. The thick vegetation that thrives in this area is cut intermittently for pulp wood which in turn is trucked and/or floated by lake and river to mills of the Great Northern Paper Company and the Scott Paper Company.

Ore Deposits

No economically important ore deposits are known to exist in the area. However, some areas may be favorable for the occurrence of metallic minerals. Several of the igneous bodies which are common in the region contain rocks with metallic sulfide inclusions. These inclusions consist of only a small percentage of the total rock, but careful search might locate an area in which the percentage was larger. The majority of these metallic fractions are associated with the Lobster and Little Spencer Mountain complexes of the Cambrian (?) and Ordovician (?). It seems doubtful that the sedimentary and the igneous rocks in the Roach River syncline and the Caribou Lake anticline contain any ores.

Igneous rocks of the Little Spencer and Lobster Mountains probably intrude strata of carbonate and quartzite lithologies, both of these favoring mineralization. The intrusions within the area have only slightly metamorphosed the enclosing sediments.

A core drilling program has been undertaken in a body of volcanic rocks in The Forks quadrangle to the southwest (Boucot, oral communication, 1959). These volcanics are of Ordovician age and on direct strike with the

Lobster Mountain volcanics which are either of Ordovician or Lower Silurian age. To date this coring program has found zinc, lead, and copper though not of commercial quantity, but the exploration program is continuing.

On a knoll one-half mile northwest of the Kidney Pond outlet (location no. 385, Plate I), were collected samples of dark gray quartzite which were laced with a relatively large number of veinlets of pyrite.

Building Materials

There are no quarries in the Roach River region. Some of the massive sandstones of the Tarratine formation or the Big Claw and Misery members might be suitable for building purposes, but none of the rocks of the area would be of much value as commercial building stone.

Several excavations are located along the roads within the Ragged Lake quadrangle from which ungraded glacial gravels have been extracted for local road fill. For other construction purposes, these gravels contain too many fines to be of any commercial value.

Fuels

The possibility of an occurrence of coal, oil, or gas in this portion of northern Maine is very unlikely. The depositional history of the Lower Paleozoic in this region apparently was not favorable for the accumulation of organic materials which could ultimately form coal. Several factors are against any accumulation of liquid hydrocarbons, these include: the extremely tight folding and igneous intrusions with subsequent formation of cleavage and low grade metamorphism, the compaction of possible reservoir rocks which has devoided them of fluid content and porosity, and the absence of entrapping conditions for the few rocks that may be potential reservoirs.

IX. APPENDIX

APPENDIX I

THIN SECTION DESCRIPTIONS

Thin sections cut from samples collected in the area are listed below by stratigraphic unit and are accompanied by a brief description of both the hand specimen and the section.

Devonian

Tarratine Formation

Sample no. 42

Location - Summit of Black Cap Mountain (Ragged Lake quadrangle).

Hand Specimen - Greenish-gray, fine-grained, tough, well indurated, very argillaceous graywacke (Pettijohn, 1957, p. 291) sandstone. Some carbonate is detected when acid is applied. The rock weathers light grayish brown.

Thin Section - A heterogeneous assortment composed roughly of quartz 50-60%, feldspar 5%, clay matrix 20%, carbonate matrix 10%, plus minor amounts of organic matter, opaque hematite-magnetite, zircon, and biotite. The quartz is fine-grained, angular, and moderately sorted. Some grains are tightly sutured into clusters; others display solution-decomposed margins; some authigenic silica noted. The feldspars include plagioclase, orthoclase, and microcline. Some, particularly the plagioclases, appear fresh, others highly decomposed. The clay matrix is slightly altered to a micaceous (sericite) substance. Carbonate appears to replace several of the feldspar grains, but is distributed around quartz grains. No bedding or foliation is noted.

Misery Member

Sample no. 224

Location - On Spencer Mountain fire station road at point southeast of Berry Pond.

Hand Specimen - Gray, tough, well indurated, fine- to medium-grained, slightly argillaceous protoquartzite (Pettijohn, 1957, p. 291) sandstone. This specimen is notably more argillaceous and darker colored than the average Misery quartzite. A slight reaction occurs when acid is applied. The rock weathers light brown.

Thin Section - A randomly distributed complex of grains including quartz 75%, clay matrix 10%, carbonate 10%, plus minor amounts of feldspar (orthoclase and microcline) and opaque minerals with at least one good pyrite cube noted. The quartz grains are fairly well sorted, subrounded to subangular in shape, and are either sutured together into clusters or are partly decomposed by solution. The carbonate appears to be secondary, having filled voids and cracks between or in quartz grains respectively. No indications of foliation or bedding were noted.

Roach River Formation

Sample no. 461

Location - On Greenville-Ripogenus dam road 0.8 miles north of Kokadjo (First Roach Pond quadrangle).

Hand Specimen - Moderately indurated, brownish gray to slightly lavender, highly argillaceous, fine-grained sandstone. Grains of quartz are fairly well sorted. Numerous brown iron oxide grains are scattered throughout. The rock breaks into platy layers, indicating weak foliation.

Thin Section - A very compactly arranged assortment of quartz 50%, detrital hematite 20%, and altered clay matrix 30%. The quartz consists of medium to fine sand-sized grains. Many grains display strain shadows, many clusters are sutured together, and all grains show highly irregular solution boundaries. No silica cement was noted. Numerous red-brown hematite specks appear as distinct grains and are randomly distributed throughout the section. The clay matrix appears to be altering to a micaceous-appearing substance and is arranged in a linear direction, giving the section foliated appearance. The high degree of foliation plus the decomposition of the quartz grains suggest compaction accompanied by solution action.

Silurian

Lobster Lake Formation, Main Body

Sample no. 7

Location - Maxfield Brook (Ragged Lake quadrangle), 1.4 miles upstream from Lobster Lake.

Hand Specimen - Buff, tight, well indurated, silica-cemented, moderately sorted quartzite. Predominantly quartz, fine- to medium-grained. The smaller grains are angular, the larger rounded. A fair amount of light brown intergranular matrix is noted plus some black metallic fractions.

Thin Section - Quartz 75-80%, clay matrix 10-15%, rhyolite or chert grains 5%, plus minor amounts of biotite and opaque heavy mineral fractions. The quartz and chert (?) grains are moderately to poorly sorted, the larger rounded to subrounded, the smaller angular to subangular. Many grains are seemingly not in contact and display slightly dissolved grain boundaries. Some are pressed together displaying contact solution zones, and others are sutured together into clusters. The cement is silica-rich clay, the clay slightly altered. A few quartz grains display strain shadows, though most are optically continuous. A protoquartzite (Pettijohn, 1957, p. 291).

Sample no. 200

Location - 1.2 miles west of Big Pine Pond (Ragged Lake quadrangle) outlet.

Hand Specimen - Light gray to slightly buff, carbonate-rich, moderately well indurated, well sorted quartzitic sandstone. The quartz grains are medium grained with a few coarse grains noted, and are subrounded in shape. Several light gray to white feldspar grains noted, plus quite a bit of light brown intergranular matrix. The surface weathers differently, due to the leaching of carbonate.

Thin Section - 50% quartz and 10% rhyolite grains, poorly sorted and angular; 20% carbonate cement, both fine and coarsely crystalline; 15% feldspar, both plagioclase and orthoclase. The quartz and rhyolite grains are highly decomposed, many being replaced by carbonate. The feldspars range from moderately fresh to badly decomposed; carbonate also replacing some of these. A light brown stain is noted within these decomposed feldspars. Very little clay or few heavy mineral fractions are present, yielding a fairly clean feldspathic (Pettijohn, 1957, p. 291) sandstone.

Big Claw Member

Sample no. 53-315 (collected by A. J. Boucot)

Location - East shore of Lobster Lake (North East Carry quadrangle).

Hand Specimen - Maroon, highly iron-stained, soft, fine-grained siltstone with numerous rounded, coarse sand-sized quartz grains scattered throughout. No indication of bedding.

Thin Section - 50% quartz, individual grains are very poorly sorted and range in size from coarse (2 mm.) to fine sand. The larger fractions are very well rounded, the smaller are angular to subrounded. Grain boundaries are sharp, with no appreciable solution having taken place. Most grains have optical continuity, though some display strain shadows. One plagioclase grain noted, with 15-20% highly decomposed matter which is partly orthoclase and partly rhyolite debris. Fine grained matrix is highly iron-stained red and composes 15 to 25% of the rock. Minor amounts of sericite and opaque specular hematite and a few isolated zircons are present. One carbonate fragment was observed.

Sample no. 53-316 (collected by A. J. Boucot)

Location - East shore of Lobster Lake at type section for Big Claw member (see text) (North East Carry quadrangle).

Hand Specimen - Conglomerate composed of extremely poorly sorted quartz, felsite, and phyllite grains, ranging in size from coarse pebbles (30 mm.) to fine sand. The quartz is angular, but many of the felsite grains are moderately rounded and stained red. The whole mass is buff to pink and well cemented.

Thin Section - 60% pebble (3 mm.) to coarse sand-sized quartz grains, all highly fractured and containing numerous dark columnar inclusions. Some show sutured contacts and others have solution boundaries; many display strain shadows. Grain shape varies from angular to subrounded. Rhyolite fragments are not unlike those associated with known rhyolite formations (Lobster Mountain complex, for example) and comprise 10% of the total. 10% phyllite and felsite fragments are noted, many of them hematite stained. The remainder of the rock consists of altered clay matrix which displays banding and deformation around the more resistant grains. Several individual crystals of tourmaline, plus grains which are pleochroic and appear bluish-green, are associated with both the matrix and the quartz.

Ripogenus Formation

Sample no. 431

Location - Ragged Stream inlet on south shore of Caribou Lake (Ragged Lake quadrangle).

Hand Specimen - Very heterogeneous assortment of quartz grains; red hematite-stained rhyolite fragments; white and pink feldspars, some fresh, others decomposed; some specular hematite and a great deal of brown stained matrix material. The entire mass is well cemented with silica (rock breaks across quartz grains). Various constituents are angular in shape, poorly sorted and display no indication of bedding.

Thin Section - 60% quartz, rhyolite, and quartzite grains; 20-25% feldspar; 10% clay matrix and 10% carbonate cement. An extremely poorly size-sorted, mineralogically heterogeneous, arkosic conglomerate. The quartz grains display a wide range in size and shape, most display strain shadows, and many are decomposed from solution action. Several highly irregular quartzite grains noted. The feldspars include microcline, plagioclase, and orthoclase, all in various degrees of decomposition; many are so decomposed that they are difficult to distinguish. Some iron staining is associated with these decomposed feldspars. The clay matrix is minor and is slightly altered to sericite. The carbonate is somewhat randomly distributed, but is most abundant as a replacement mineral in decomposed feldspars.

Sample no. 468

Location - Two-tenths mile south of Deer Pond (Ragged Lake quadrangle).

Hand Specimen - Conglomerate consisting of extremely poorly sorted grains of quartz, angular and glassy; feldspar, pink to light gray with various degrees of decomposition; rhyolite, fragments ranging up to 7 mm. in size and iron-stained red; and specular metallic hematite. Whole mass well cemented with silica, non-porous, with no signs of bedding.

Thin Section - 40% quartz grains, 20% rhyolite grains, 25% feldspar, and 15% silica and clay matrix cement. A heterogeneous mixture in grain size, shape, and mineralogy, i.e., an arkosic conglomerate. The quartz grains are poorly sorted, decomposed by solution, often sutured together into clusters, contain inclusions, and often display strain shadows. The feldspars, predominantly orthoclase, are generally highly decomposed. The rhyolite grains are irregular in size and shape, and many are hematite stained. The clay matrix is randomly distributed and appears slightly altered.

Sample no. 469

Location - Four-tenths mile southwest of Deer Pond (Ragged Lake quadrangle).

Hand Specimen - White, very tough, silica-cemented, well sorted, extremely clean orthoquartzite. The quartz grains appear well rounded. A few isolated dark-colored grains noted; these appear to be quartz with some contamination. A few brown clay matrix spots noted, but these in only a small number of specimens.

Thin Section - A well sorted, unusually homogenous assortment of quartz (90%) plus minor amounts of quartzite grains (5%); all well cemented by silica to form an impervious orthoquartzite. All grains range in shape from rounded to subangular and display contact solution, with authigenic silica precipitated within intergranular spaces as cement.

APPENDIX II

OUTCROP DESCRIPTIONS OF CAMBRIAN (?) OR ORDOVICIAN (?) ROCKS

The following is a listing in numerical order with rock descriptions of Cambrian (?) or Ordovician (?) outcrops observed by this writer. Outcrop locations are given on Plate I.

8 Green, soft, highly contorted, fine-grained phyllite interbedded with well indurated, dense, very hard greenstone consisting of 50% pyrite.

9 Same as 8, plus irregular bands of milky white quartz which cut the greenstone.

10 Same as 9.

58 Very fine-grained, tough, grayish-green, brown-weathering, diabasic rock intruded by rhyolite. Some carbonate detected.

59 Massive, very tough, rough-fracturing, dark gray, light gray-weathering diabase.

60 Banded, fissile shale, highly cleaved, interbedded with thin lenses of silty quartzite. Shale is dark gray, weathers light gray, and appears highly deformed. The quartzite beds grade laterally into slates.

61 Same as 60.

62 Same as 60, except the quartzite is thick-bedded and grades laterally into slate.

63 Dark gray, highly contorted slate.

64 Same as 63.

65 Gray-green, very fissile, cleaved phyllite with massive, green, highly pyritic greenstones interbedded.

66 Same as 65.

79 Gray-green, tough, very fine-grained diabasic rock intruded by rhyolite. Several specks of pyrite noted.

82 Same as 79.

85-86 Same as 79.

98 Greenish-gray, tough, very fine-grained rock of uncertain origin (probably igneous), buff weathering. The rock is intruded with rhyolite.

99 Same as 98.

100 Grayish-green, very fine-grained, tough, brown-weathering diabasic rock. The grain size and the metamorphosed state of this rock makes it difficult to identify.

101 Same as 100.

106 Same as 100, except in close association with black, extremely fine-grained, pyritic, ferromagnesian-rich diabasic intrusives.

111 Very dark gray, tough, brown-weathering, fine-grained diabasic intrusive type rock.

114 Same as 111.

115 Dark gray, cleaved, highly fissile, dark brown-weathering slate.

117 Gray, tough, relatively coarse-grained, massive, diabasic intrusive rock. Rusty brown-weathering.

141 Dull red, highly cleaved, fissile, soft, silky, soapy-feeling phyllite overlain by Big Claw conglomerate. A large amount of rusty-red staining along cleavage planes.

155 Green, thinly cleaved, soft, green-weathering phyllite.

156 Tough, black, slightly greenish, highly pyritic, massive, unbedded, brown-weathering diabasic rock with a few small white feldspar phenocrysts.

157 Interbedded gray-green, massive, brown-weathering, medium-grained, dirty quartzitic sandstone and green phyllite.

158 Green phyllite.

159 Interbedded, gray-green, fissile phyllite and hard, massive, gray-green, pyritic, argillaceous quartzite. 75 to 85% phyllite.

160 Very dark gray to black, fissile, soft, rusty-weathering shale. A distinct contrast to the green phyllites above.

171 Dark gray to black, massive, ledge-forming, medium-grained, pyritic, very tough, rusty-weathering diabase. Weathered surface displays differential decomposition. Intrudes black slates.

172-175 Same as 171.

176 Dark gray, slightly greenish, phyllitic slates, highly cleaved and very friable, interbedded with dark gray, very fine-grained, dark gray quartzitic sandstones in thin beds.

177 Same as 176.

179 Very well bedded (individual beds 2 to 6 inches in thickness), medium-grained, rusty-weathering, conchoidally fracturing, tough, carbonate-rich sandstone, interbedded with thin bands of dark gray slate.

181 Dark gray, tough, massive diabase.

203 Gray to gray-green, very fissile and soft, highly cleaved, soapy-feeling phyllite.

235 Gray and green, highly fissile, cleaved, slick-feeling phyllite interbedded with massive, green, highly pyritic greenstone beds. Phyllite is highly contorted.

236 Same as 235.

245 Dark gray, very fissile, soft, highly cleaved slates with a few sandy lenses. Rusty weathering along cleavage planes.

246-249 Same as 245.

261 Dark gray, low ridge-forming, highly cleaved, rusty-weathering, extremely fine-grained though slightly gritty siltstone.

262 Same as 261.

265 A low ledge that is light gray-weathering, gray, tough, highly fractured, conchoidally fracturing, massive, non-bedded, slightly pyritic, very fine-grained. May be either felsite or a highly metamorphosed sediment.

266 Same as 265, but this rock is much darker in color.

267 A dark gray, low ledge-forming, light gray-weathering, argillaceous, tough, highly fractured quartzite sandstone. This is one of the better developed quartzites found within the unit. The fractures are filled with carbonate, and the sandstones are interbedded with gray slates.

268 Dark gray to black, rusty-weathering, highly cleaved, fissile slates.

269 Interbedded slates and shaly sandstones lithologically the same as 267 and 268. Beds highly contorted and stained rusty-brown.

270 Same as 269.

271 Dark gray shales intruded by diorite, ledge-forming.

272 Interbedded massive, fine-grained, pyritic, gray-green sandstones and gray slates.

273 Dark gray slates, highly cleaved, but cleavage planes very irregular and contorted, interbedded with a few sandy lenses.

282 Gray, very rusty-weathering, highly cleaved, crinkled, soft slate.

283 Rounded knoll-forming, gray-green, gray-weathering, massive, rough-fracturing, tough, slightly pyritic, highly fractured igneous intrusive-type rock. Originally a diabase, though highly metamorphosed. Fractures are filled with carbonate.

284 Same as 283.

285 Same as 282.

286 Same as 283.

329 Massive, hard, gray to gray-green, dense, arenaceous, fine-grained slate with numerous medium-grained mica flakes. Moderately cleaved. Closely associated with massive, very pyritic greenstone.

330 Knoll-forming, gray, tough, arenaceous slates, very micaceous along cleavage planes, interbedded with massive, hard, dark gray, fine- to medium-grained quartzite.

331 Very hard, massive, cherty-appearing, fine-grained, grayish-green, conchoidally fracturing igneous rock.

384 Knoll-forming, very massive, hard, highly fractured, gray to spotted black-and-white diabasic intrusive, displaying various ratios of ferromagnesian minerals and feldspar as well as various grain sizes. Gray-green, cleaved, rusty-weathering slates are closely associated.

385 Highly fractured, dark gray, fine-grained quartzites containing a large amount of hydrothermal sulfide mineralization. These closely associated with slates and igneous intrusives.

286 Rusty-weathering, dark gray, highly cleaved slates.

387 Slates and argillaceous sandstones intruded by several types of igneous rocks, mostly diabasic, though some are quite felsic.

388 Gray to black, slightly greenish, highly pyritic diabase.

407 Very hard, massive feldspar plus black ferromagnesian minerals, equaling a diorite. Numerous veinlets of quartz throughout.

408 Interbedded slates and quartzites.

409 Green slate and gray quartzite closely associated with diorites.

410-413 Diorites.

414 Questionable intrusive contact between greenish-gray slates and greenish diorites.

415 Diorite.

416 Banded red and green shales and slates, some sandy zones present, drag folding well exposed.

417 Diorite.

418 Banded red, violet, and green slates.

419 Extremely contorted slates, green and violet, with banded quartzites present.

420 Greenish-gray, slightly pyritic, massive, jointed, very fine-grained greenstone (diabase).

421 Banded green, gray, and red slates and numerous quartzites.

422 Same as 421, except cut by dikes of greenstone and drag folded.

423 Same as 422.

424 Fault contact between Cambrian (?) or Ordovician (?) slates and limestones and Silurian calcareous shales.

425 Green, non-bedded, cleaved slates and shales.

426 Banded green and red shales, drag folded.

427 Greenish, medium- to fine-grained diorite.

428 Sediments dipping south.

429 Cleaved slates, closely associated with pyritic greenstone.

431 Fault contact zone of Silurian beds with dark gray to black, highly cleaved slates of the Cambrian (?) or Ordovician (?).

432 Diorite.

443 Green mudstones closely associated with diorite.

444 Diorite.

445 Diorite intruding green slates.

446-447 Diorite.

448 Dark green, hard, massive, gray quartzite.

463 Diorite.

464 Dark gray, massive, dirty, light gray-weathering, highly jointed quartzite intruded by diorite.

465 Interbedded, dark gray, soft, rusty-weathering, contorted, highly cleaved shales and dark gray tough quartzites; the whole being intruded by an andesite porphyry (dark gray aphanitic matrix with large white feldspar phenocrysts).

466 Very hard, dense, massive, dark gray to black, highly pyritic quartzite, slight carbonate trace.

470 A complex similar to 465.

471 Diorite.

472 A complex of slates and quartzites intruded by diorites.

473 Diabase intruded by dikes of greenstone.

476 Dark gray, highly jointed interbedded slates and quartzites.

484 Predominantly massive, hard, dark gray quartzites.

485 Low ledge of light gray, fissile, tough, rusty-weathering slates.

486 Gray, slightly sandy slates.

487 Silurian interbedded limestones and slates overlying dark gray, silty quartzite sandstones of Cambrian (?) or Ordovician (?) age.

488 Questionably in place. Gray-green, massive, tough, unbedded, very argillaceous, carbonate-rich sandstone.

489 Rusty-weathering, tough, green, non-calcareous shales.

492 Interbedded, hard, fine-grained, gray quartzites, some quite calcareous, and green phyllitic slates. Entire mass highly jointed.

APPENDIX III

REVISIONS

Mr. Andrew Griscom (oral communication, May 13, 1959) examined the igneous specimens collected in the Roach River syncline area and suggested the following revisions in their classification:

(1) The "trachyte" located in the sill lying between Ragged and Caribou Lakes (page 72) appears to be granophyre similar to that found in the Harrington Lake quadrangle.

(2) The rocks in the elongate sill extending northward from the southwest end of Big Spencer Mountain (page 70) may best be classified as quartz latite rather than rhyolite. Griscom suggests that these latites are compositionally similar to the granophyres of Harrington Lake.

(3) Rocks associated with the large stock east of Lobster Lake (page 71) have been correctly classified as rhyolites in Griscom's opinion. These rocks are probably similar in their potash feldspar content to the Mount Kineo rhyolites. Rocks associated with the aforementioned sills contain more plagioclase than potash feldspar which also characterizes other igneous rocks of the Traveler Mountain and Harrington Lake quadrangles. The Roach River syncline area may, therefore, include two distinct Lower Devonian felsic rock types, the potash feldspar rich Kineo-type rhyolites and the plagioclase rich Traveler Mountain-Big Spencer felsites.

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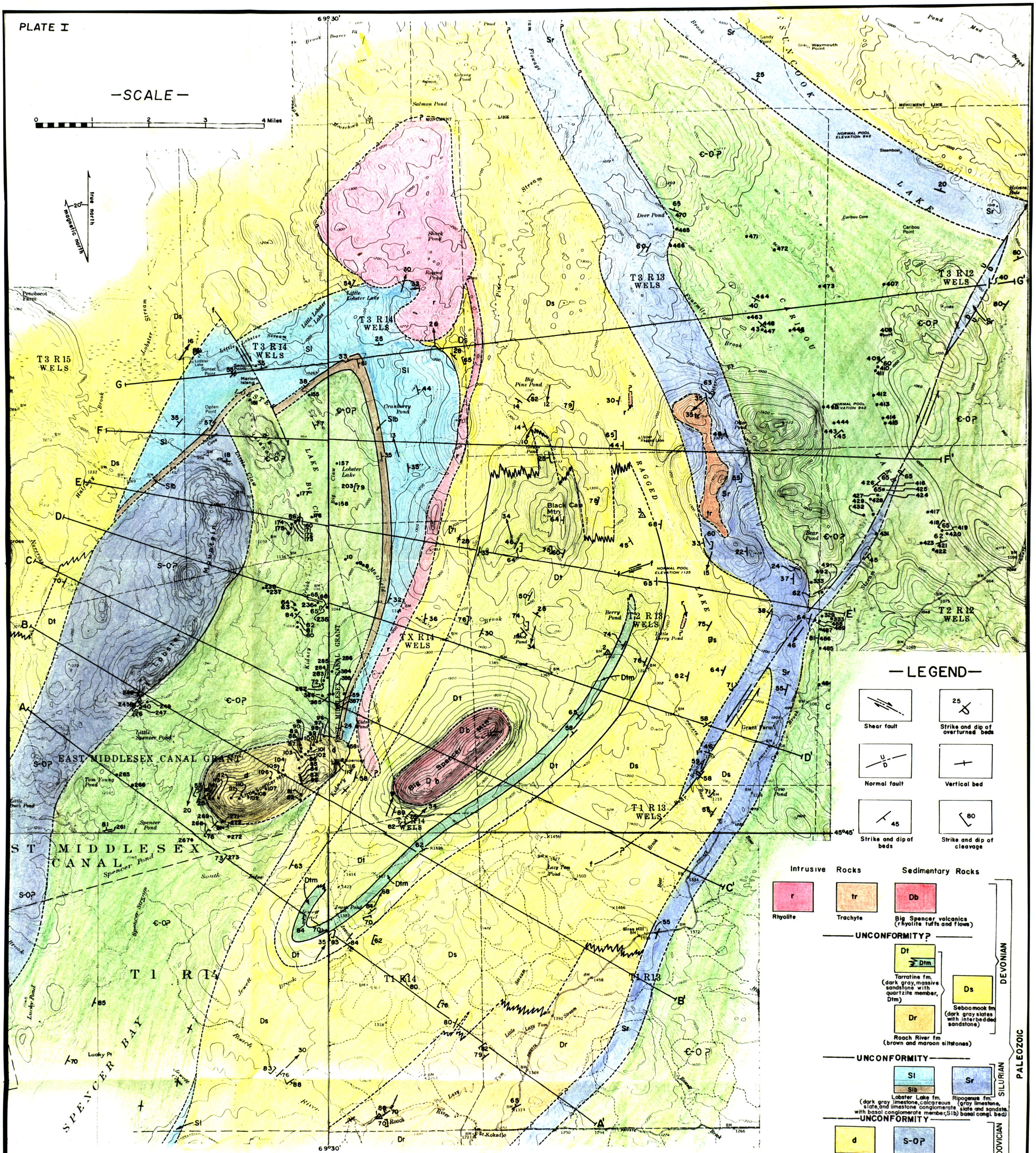

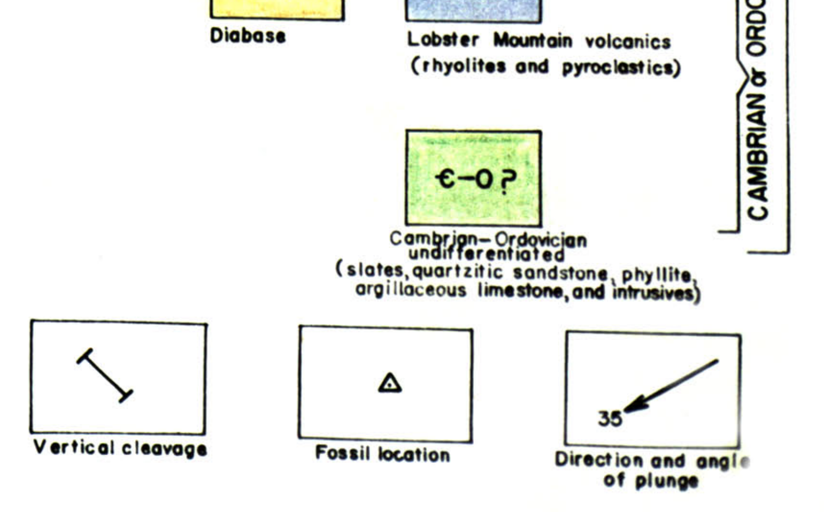

PLATE I

GEOLOGIC MAP of the ROACH RIVER SYNCLINE

Piscataquis County, Maine

by E.W. HEATH

Massachusetts Institute of Technology

1959

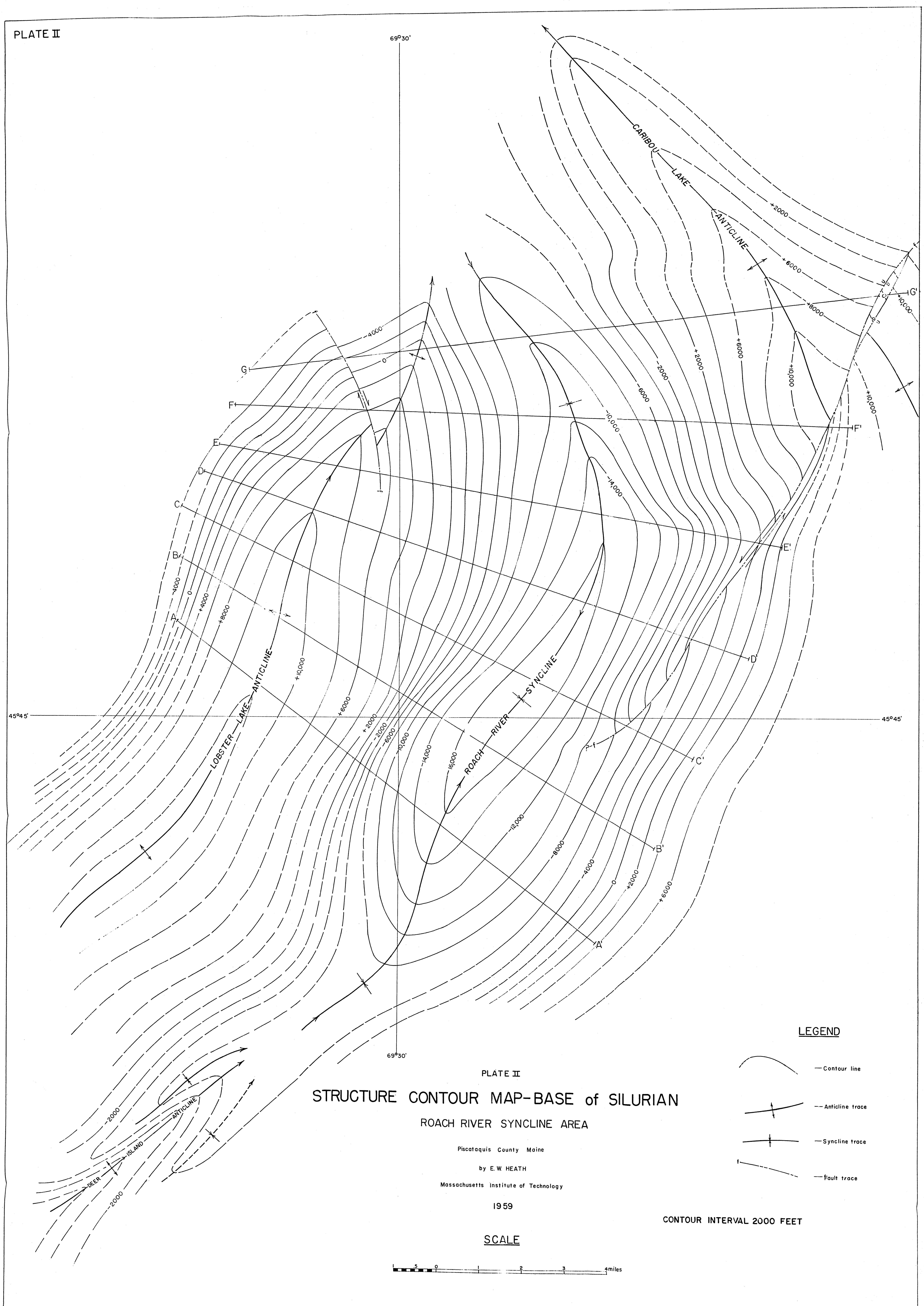

PLATE II

STRUCTURE CONTOUR MAP-BASE of SILURIAN

ROACH RIVER SYNCLINE AREA

Piscataquis County Maine

by E. W. HEATH

Massachusetts Institute of Technology

1959

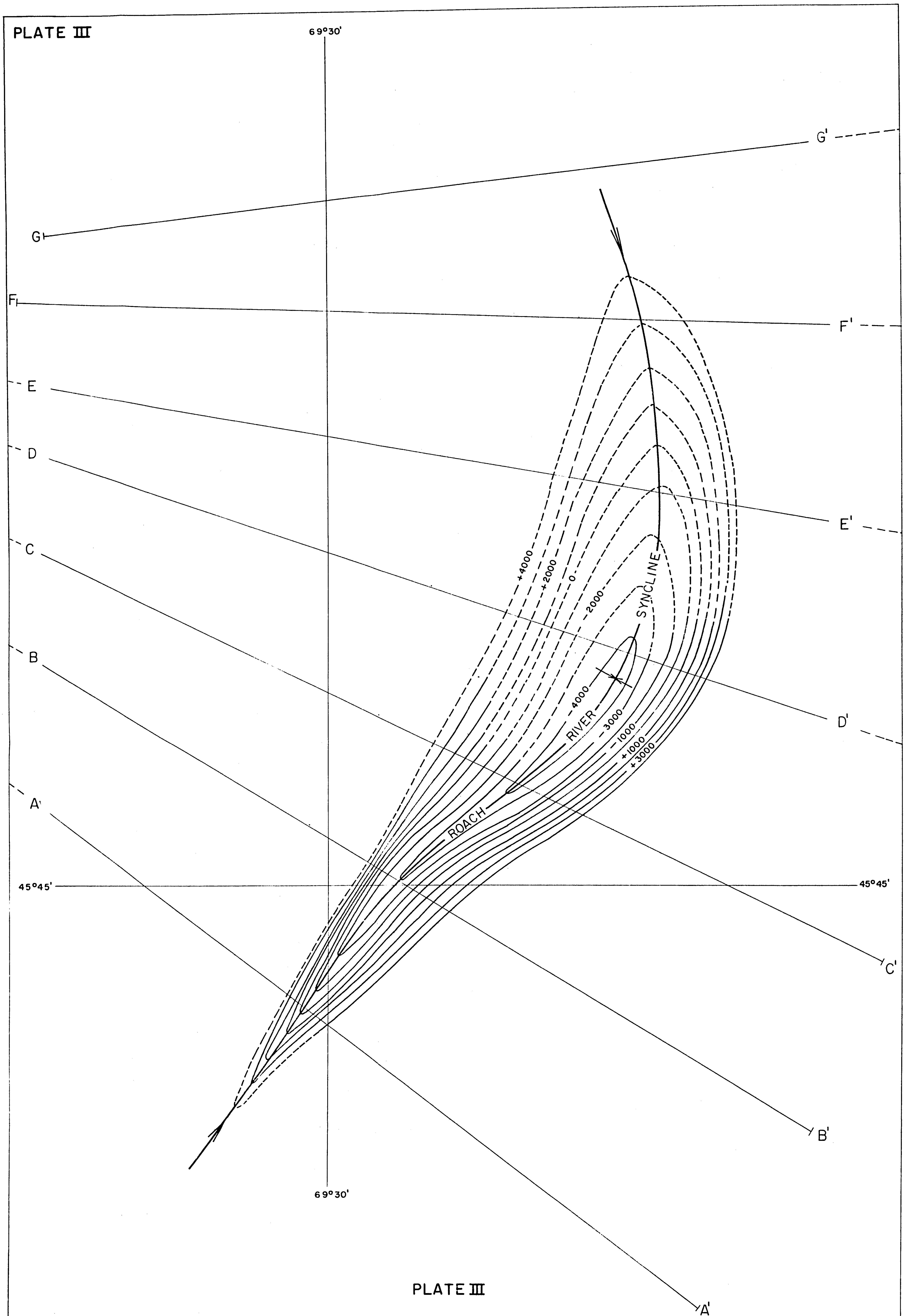

PLATE III

STRUCTURE CONTOUR MAP-TOP of MISERY MEMBER

ROACH RIVER SYNCLINE AREA

Piscataquis County, Maine

by E.W. HEATH

Massachusetts Institute of Technology

1959

—LEGEND—

— CONTOUR LINE

— SYNCLINE AXIS

—CONTOUR INTERVAL—

1000 feet

—SCALE—

1 .5 0 1 2 3 4 miles

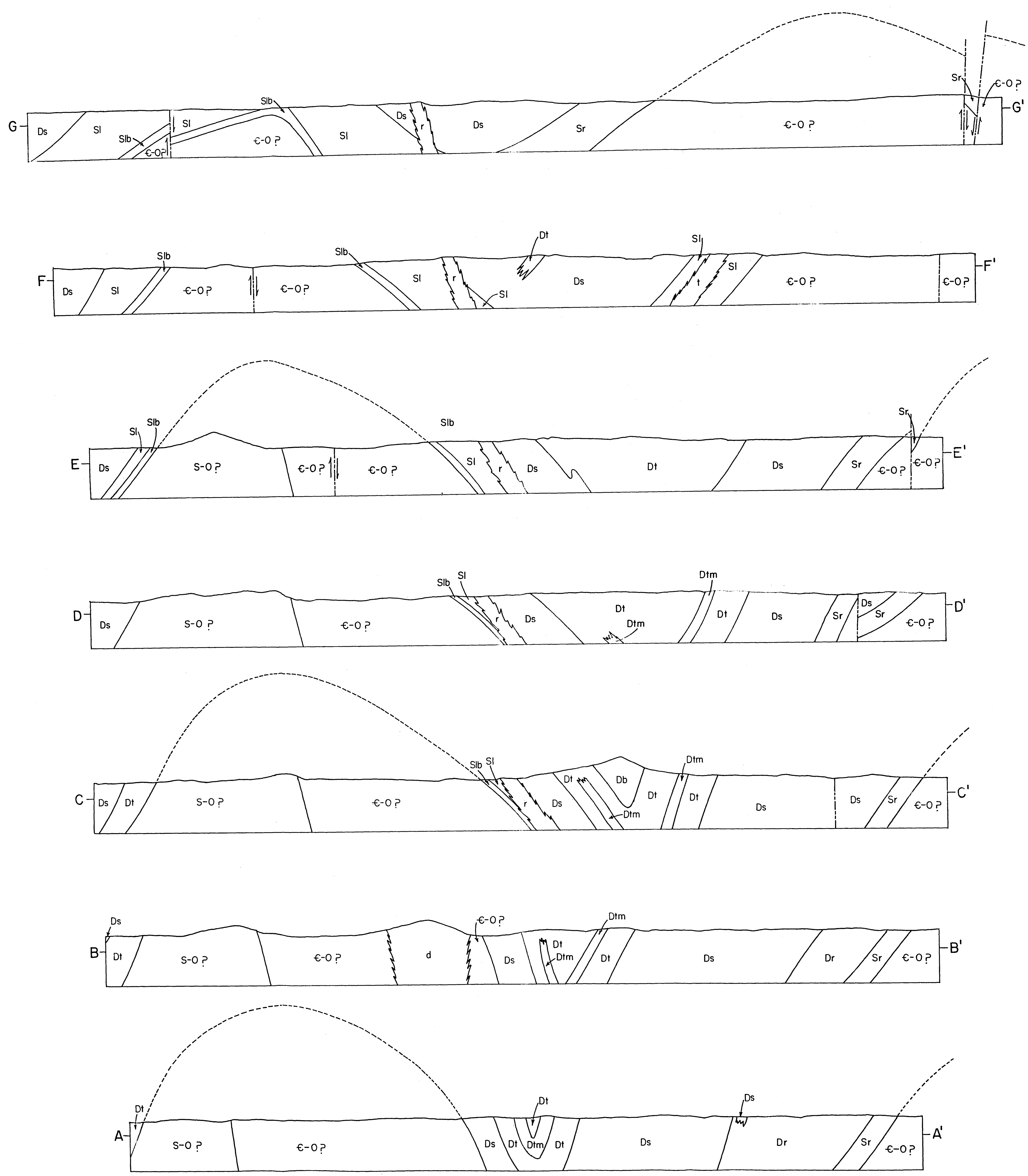

PLATE IV

CROSS SECTIONS

OF THE

ROACH RIVER SYNCLINE

Piscataquis County, Maine

by E.W. HEATH

Massachusetts Institute of Technology

1959

—LEGEND—

— Fault trace

— Projected formation boundary

r — Rhyolite
t — Trachyte
Db — Big Spencer volcanics
Dt — Tarratine formation
Dtm — Misery member
Ds — Seboomook formation
Dr — Roach River formation
Sl — Lobster Lake formation
Slb — Big Claw member
Sr — Ripogenus formation
S-O? — Lobster Mountain volcanics
d — Diorite
Є-O? — Cambrian or Ordovician undifferentiated

A' — Signifies sea level

—SCALE—

horizotal = vertical

3 miles, 2, 1, 0

4 miles, 3, 2, 1

PLATE V

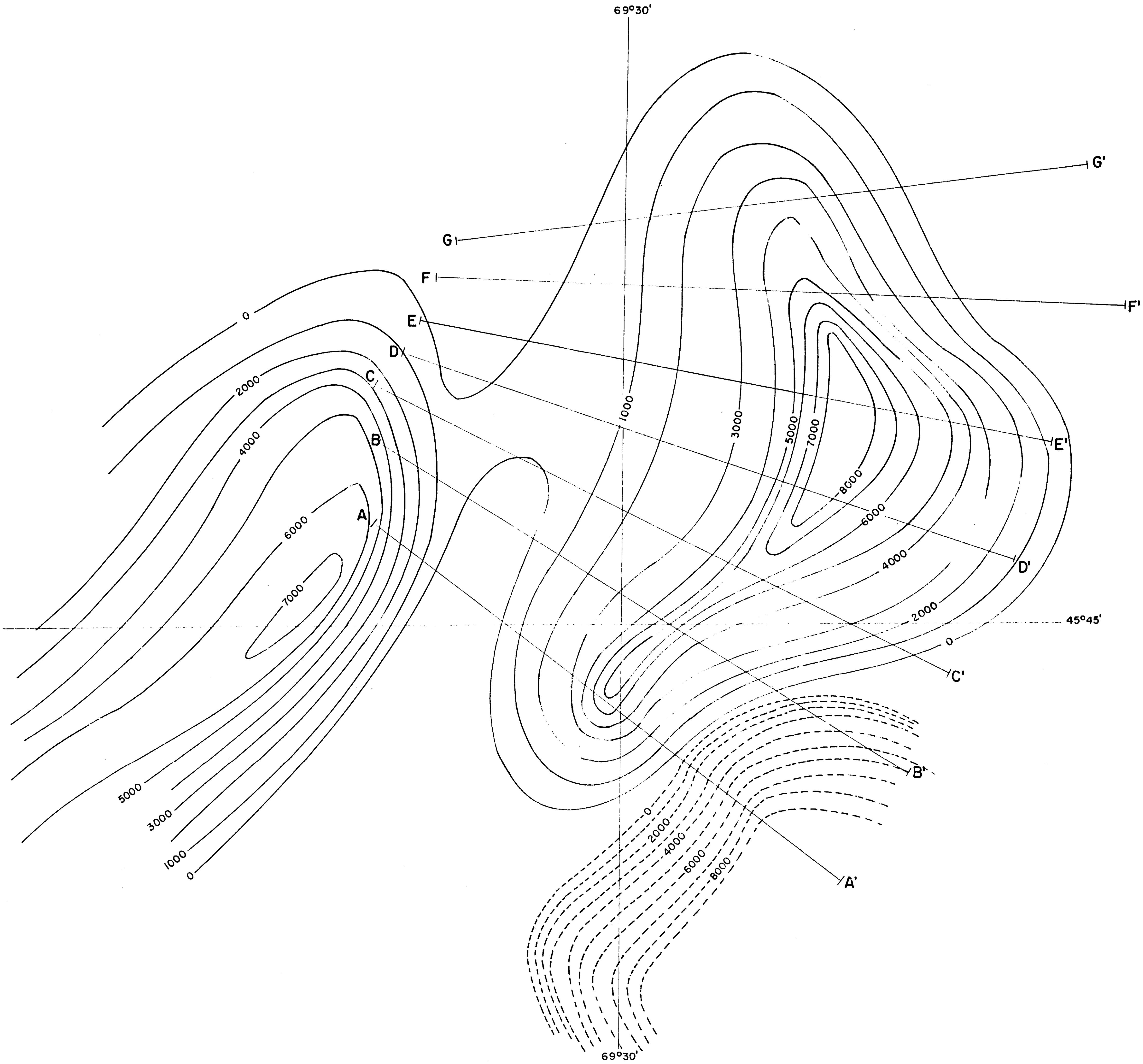

PLATE V

ISOPACH MAP of TARRATINE SANDSTONE

ROACH RIVER SYNCLINE AREA

Piscataquis County, Maine

by E. W. HEATH

Massachusetts Institute of Technology

1959

—LEGEND—

— Tarratine formation contour line

— Roach River formation contour line

—CONTOUR INTERVAL—

1000 feet

—SCALE—

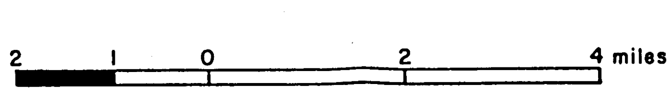

PLATE VI

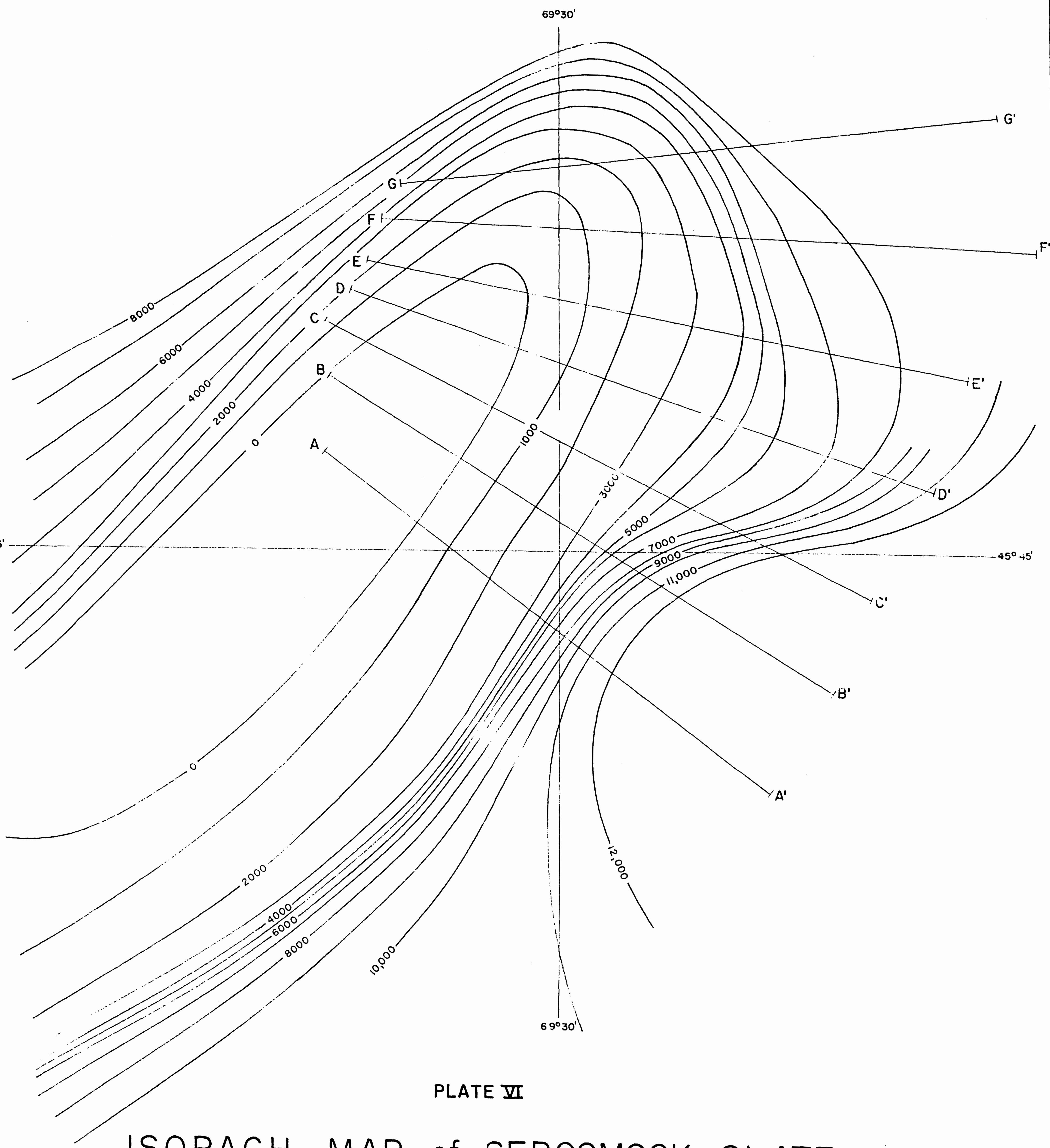

PLATE VI

ISOPACH MAP of SEBOOMOOK SLATE

ROACH RIVER SYNCLINE AREA

Piscataquis County, Maine

by E.W. HEATH

Massachusetts Institute of Technology

1959

—LEGEND—

— Seboomook formation contour line

—CONTOUR INTERVAL—

1000 feet

—SCALE—